COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 081/CENIPA/2019

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-DVR**
MODEL:	**T210N**
DATE:	**18MAY2019**

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 18MAY2019 accident with the T210N aircraft model, registration PR-DVR. The accident was classified as “[SCF-PP] System/Component Failure or Malfunction Powerplant – Engine Failure in Flight”.

Shortly after the take-off, black smoke coming from the aircraft was observed. The pilot tried to return to the Aerodrome making a left turn, but the aircraft lost altitude and collided with a residence.

The aircraft had substantial damage.

The pilot suffered fatal injuries, two passengers suffered serious injuries and another passenger suffered minor injuries.

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

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
DCTA	Department of Science and Airspace Technology
ELT	Emergency Locator Transmitter
FAB	Brazilian Air Force
FL	Flight Level
IAC	Civil Aviation Instruction
IAM	Annual Maintenance Inspection
INFRAERO	Brazilian Airport Infrastructure Company
METAR	Aviation Routine Weather Report
MNTE	Airplane Single Engine Land Rating
NSCA	Aeronautics Command System Standard
PN	Part Number
PPR	Private Pilot License – Airplane
RAB	Brazilian Aeronautical Registry
SBJC	ICAO Location Designator - Brigadeiro Protásio de Oliveira Aerodrome, Belém - PA
SERIPA I	First Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
TPP	Registration Category of Private Service - Aircraft
TWR-SBJC	Brigadeiro Protásio de Oliveira Aerodrome Control Tower - PA
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** T210N **Registration:** PR-DVR **Manufacturer:** Cessna Aircraft	**Operator:** Private
Occurrence	**Date/time:** 18MAY2019 – 1545 UTC **Location:** Residential Area - Bairro Souza **Lat.** 01°25'11"S **Long.** 048°26'54"W **Municipality – State:** Belém- PA	**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 Brigadeiro Protásio de Oliveira Aerodrome (SBJC), Belém - PA, at about 1545 UTC, in order to carry out a local flight, with a pilot and three passengers on board.

Shortly after the take-off, black smoke coming from the aircraft was observed. The pilot tried to return to the Aerodrome, making a left turn. However, it lost altitude, colliding with a residence.

The aircraft had substantial damage.

The crewmember suffered fatal injuries, two passengers suffered serious injuries and the other passenger suffered minor injuries.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage all over its structure.

1.4 Other damage.

The aircraft collided with a residence, damaging the roof and the structure of the 2nd floor. The impact also damaged, to a lesser extent, the roofs of three other homes in the vicinity of the accident site.

1.5 Personnel information.

1.5.1 Crew's flight experience.

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

N.B.: It was not possible to obtain reliable data on the pilot's flight hours. The last record in the Integrated Civil Aviation Information System was from 2017.

1.5.2 Personnel training.

The pilot took the PPR course at the Birigui's Aeroclub – SP, in 2010.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PPR License and had valid MNTE Rating.

1.5.4 Qualification and flight experience.

The pilot's documents were not presented to the Investigation Team. Thus, it was not possible to verify his recent experience. According to surveys performed, the pilot was used to flying piston aircraft, with a conventional engine, and had never operated the model T210N aircraft, which had a turbocharger.

1.5.5 Validity of medical certificate.

The pilot had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 21063393, was manufactured by Cessna Aircraft, in 1979, and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The airframe, engine and propeller logbook records were outdated.

The last major inspections of the aircraft, the "IAM + 50 hours + 100 hours" types were carried out on 10DEC2018 by the maintenance organization TEMA *Tecnologia Manutenção de Aeronaves* EIRELI, in Belém - PA, with the aircraft having flown 5min after the inspection.

The last most comprehensive inspection of the aircraft, the "200 hours" type, was carried out on 18SEPT2014 at a maintenance organization in the city of Carolina - MA, with the aircraft having flown 99 hours and 30 minutes after this inspection.

According to reports, the aircraft was parked in a farm hangar in the city of Ulianópolis - PA, with sporadic maintenance turns being carried out, however, there was no control of the time it was stopped, nor of the supposed turns that would have been performed or records on the fueling during that period.

The penultimate IAM performed on the aircraft took place on 14JUN2016, with 5.963,6 hours at the time. In the IAM held on 10DEC2018, the aircraft had 5.975,6 hours. The record of the performance of the IAM in 2017 was not found.

After the IAM performed on 10DEC2018, in a maintenance organization in Belém - PA, the aircraft was stopped on the premises of that company, with no flight being carried out until the date of the accident, on 18MAY2019.

According to the information obtained during the investigation, after the IAM of 10DEC2018, the company performed maintenance turns every fifteen days. However, there was no control of these turns, nor was there proof that the aircraft was refueled in the period between 10DEC2018 and 18MAY2019.

The aircraft discrepancies were not recorded in relevant maintenance documentation - Part II of the Logbook, as provided for in the IAC 3151, in force at the time of the accident, as shown in the following excerpt:

> 5.5 PART II - AIRCRAFT TECHNICAL SITUATION
>
> Every Logbook must contain its respective Part II, in which records of the technical status of the aircraft must be kept. The following information must be registered in Part II, according to ANNEX 4 or 5 of this IAC:
>
> 1. Type of last maintenance intervention (except transit and daily).

2. Type of next maintenance intervention (except transit and daily).

3. Predicted airframe hours for the next maintenance intervention.

4. Flight date - day/month/year.

5. Location for recording technical discrepancies found by the crew and/or maintenance.

6. Location for maintenance release (transit, inspections, etc.) - approval for return to service.

7. Place for initials by the aircraft commander.

8. Place for initials of the mechanic responsible for releasing the aircraft, in accordance with the RBHA 43.

1.7 Meteorological information.

The METARs of the SBJC Aerodrome, on the day of the accident, had the following information:

METAR SBJC 181500Z 12005KT 9999 FEW023 BKN100 30/25 Q1012=

METAR SBJC 181600Z 11004KT 9999 FEW023 BKN100 29/24 Q1011=

It was verified, according to the METARs of 1500 (UTC) and 1600 (UTC) that the weather conditions were favorable for the visual flight, with visibility above 10km and few clouds at 2,300ft, and the wind with intensity between 04 and 05kt.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Transcripts of the communication audios between the PR-DVR, another aircraft that was in traffic, an unidentified transmitter and the ATS unit were analyzed. According to these messages, it was verified that the PR-DVR pilot maintained radio contact with the Control Tower of the Brigadeiro Protásio de Oliveira Airport (TWR-SBJC) and that there was no technical abnormality in the communication equipment during the flight.

In order to support the analysis of the sequence of events that preceded the occurrence, the Investigation Team highlighted some transmissions that can help in understanding the dynamics of the accident. To record the times described in this area, the UTC was used as a reference.

At 15h42min18s (UTC), the PR-DVR informed the TWR-SBJC that it was ready to enter runway 16: “Ready for entry and take-off”.

At 15h42min21s (UTC), the TWR-SBJC authorized the procedure and advised: “Authorized entry, alignment and take-off, *Delta Victor Romeo*, 150-degree wind, 04kt, 1010 adjustment”.

At 15h42min30s UTC, the PR-DVR reported: “Authorized to enter, align and take-off”.

At 15h43min34s UTC, the PR-DVR reported: “Beginning take-off, *Delta Victor Romeo*”.

From that moment on, communication was congested with statements about smoke coming from the plane and orientation for returning to the runway, with such information being transmitted on the Control Tower frequency (118.30MHz).

At 15h44min34s (UTC), the PT-IIX reported: "Come back, because there’s smoke! Get in taxi and land."

At 15h44min43s UTC, PT-IIX reported: “Romeo, come back! The plane has smoke”.

At 15h44min46s (UTC), the TWR-SBJC authorized the return and advised: “*Delta Victor Romeo*, authorized landing on runway 16, wind 140 degrees, 03kt, return”.

At 15h44min55s (UTC), an unidentified transmitter reported: "It’s fine... It's very easy, it's very easy. Head to the runway."

At 15h45min15s (UTC), the TWR-SBJC broadcast: “*Delta Victor Romeo*, Protásio”.

At 15h45min41s (UTC), an unidentified transmitter reported: "*India X-Ray*, is he spotting the... the... the... *Victor Romeo*?"

At 15h45min46s (UTC), the TWR-SBJC asked: “*Delta Victor Romeo*, Protásio Tower?”.

At 15h48min16s (UTC), the TWR SBJC broadcast: “*Delta Victor Romeo*, Protásio Tower?

1.10 Aerodrome information.

The Aerodrome was public, managed by the INFRAERO and operated under visual flight rules (VFR) during the day.

The runway was made of asphalt, with 16/34 thresholds, dimensions of 1,106m x 30m, with an elevation of 52ft.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The impact occurred against a residence approximately 860 meters from the threshold 34 of the SBJC runway, with no evidence of a previous impact. The distribution of the wreckage was of the concentrated type.

The collision occurred against the roof of a residence, in a pitched-up attitude (approximately 30°) and with an inclination of approximately 30° to the left.

With the impact, the propeller assembly detached from the aircraft. The landing gear, of the retractable type, was in the extended position. The left main landing gear was launched 40 meters away and was found on the street. The flaps were retracted.

After a complete stop, the aircraft was left hanging in the stairwell of the residence. There was fuel leak, however there was no fire due to the swift action of public security agents and the people around.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

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

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot involved in this occurrence had had a private pilot's license since 2010 and was 51 years old at the date of the accident. He was from Marabá - PA, and was in Belém - PA, looking for a permanent job opportunity.

At the time of the accident, the pilot was working without employment.

During the investigation, it was reported that the pilot performed occasional flights for a religious organization, which carried out evangelization missions in communities and earned an allowance that would be insufficient to guarantee his financial support.

The pilot was described as a humble, calm person, with a good social relationship and simple.

It was not possible to identify information regarding the commander's routine on the day of the accident or psychological evidence that might have affected the crew's performance.

The flight in question was intended to demonstrate the aircraft for a sale negotiation.

According to the interviewees' perception, the pilot was motivated to carry out the flight due to the possibility of being hired by the possible purchaser of the aircraft.

During takeoff, it was pointed out, by the Aerodrome's flight controller and by the pilot of another aircraft, that there was smoke coming from the PR-DVR aircraft, with their suggestion/orientation for the pilot to return to landing on SBJC. The pilot started a left turn, possibly trying to return to the Aerodrome, but there was a loss of height and collision with a residence.

Also, according to information collected during the interviews, it was common for pilots not to use the checklist on their flights, in addition to not using standard phraseology frequently.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

The accident took place in a residential urban area, which facilitated the approach of public security agents and people that were around, who were even able to rescue the passengers.

Due to the impact, there was automatic operation of the Emergency Locator Transmitter (ELT).

1.16 Tests and research.

Researches were carried out in the manufacturer's service manual and it was verified that three types of storage/stocking of the aircraft were foreseen: for situations in which the aircraft was out of operation for periods of up to 30 days; from 30 to 90 days and above 90 days.

The first type of storage was defined as “Storage for Flight”, in which the aircraft spent a maximum of 30 days without operation or the first 25 hours elapsed with intermittent engine operation (Figure 1).

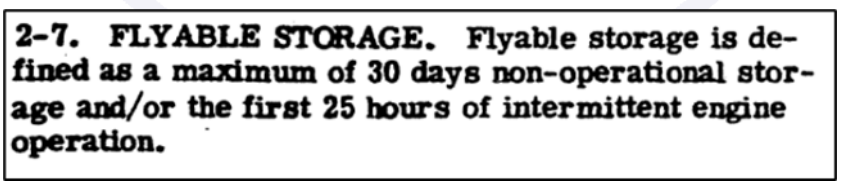
2-7. FLYABLE STORAGE. Flyable storage is defined as a maximum of 30 days non-operational storage and/or the first 25 hours of intermittent engine operation.

Figure 1 - Flight Storage (Model 210 & T210 Series Service Manual, Revision 2, Page 2-3, Item 2-7).

During this type of storage, there were some procedures to be performed, for example, turning the propeller manually every seven days, for five revolutions, stopping the blades at an angle of 45º to 90º from the initial position (Figure 2).

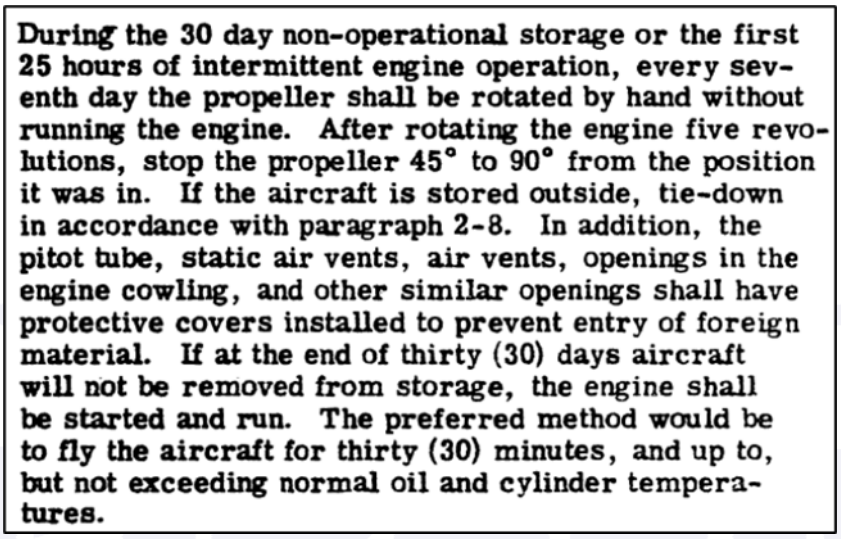
During the 30 day non-operational storage or the first 25 hours of intermittent engine operation, every seventh day the propeller shall be rotated by hand without running the engine. After rotating the engine five revolutions, stop the propeller 45° to 90° from the position it was in. If the aircraft is stored outside, tie-down in accordance with paragraph 2-8. In addition, the pitot tube, static air vents, air vents, openings in the engine cowling, and other similar openings shall have protective covers installed to prevent entry of foreign material. If at the end of thirty (30) days aircraft will not be removed from storage, the engine shall be started and run. The preferred method would be to fly the aircraft for thirty (30) minutes, and up to, but not exceeding normal oil and cylinder temperatures.

Figure 2 - Flight Storage (Model 210 & T210 Series Service Manual, Revision 2, Page 2-3, Item 2-7).

After this type of storage, to return to the flight, a service should be performed, according to the manual, including draining the engine oil and cleaning the oil pressure screen or filter (Figure 3).

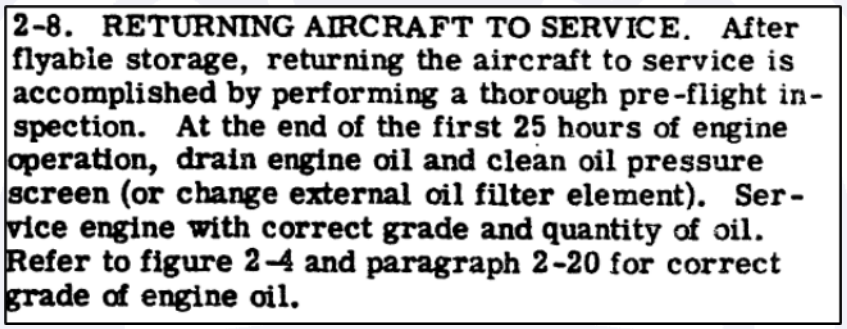
2-8. RETURNING AIRCRAFT TO SERVICE. After flyable storage, returning the aircraft to service is accomplished by performing a thorough pre-flight inspection. At the end of the first 25 hours of engine operation, drain engine oil and clean oil pressure screen (or change external oil filter element). Service engine with correct grade and quantity of oil. Refer to figure 2-4 and paragraph 2-20 for correct grade of engine oil.

Figure 3 - Flight Storage (Model 210 & T210 Series Service Manual, Revision 2, Page 2-3, Item 2-8).

At the end of the 30 days of "Storage for Flight", if the aircraft was not removed from this condition, the engine should be started, preferably, performing a thirty-minute flight without exceeding normal oil and cylinder temperatures (Figure 2), starting the second type of storage.

The second type of storage, according to the manual, was the “Temporary Storage”, defined as a maximum of 90 days out of operation (Figure 4).

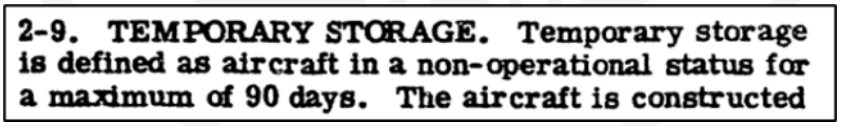
2-9. TEMPORARY STORAGE. Temporary storage is defined as aircraft in a non-operational status for a maximum of 90 days. The aircraft is constructed

Figure 4 - Temporary Storage (Model 210 & T210 Series Service Manual, Revision 2, Page 2-3, Item 2-9).

During this type of storage, several procedures were provided for the correct preservation of the aircraft, including to prevent corrosion of its structures and the engine.

The manual also described that an engine treated according to the procedures described in that document would be considered protected against normal atmospheric corrosion for up to 90 days.

After the Temporary Storage, in order to return the aircraft to air operation, there were also a series of procedures described in the manual, which should be followed, to enable the return to flight.

Finally, there was Storage for an Indefinite Period, in which several procedures were required to preserve the engine and its components against corrosion (Figure 5).

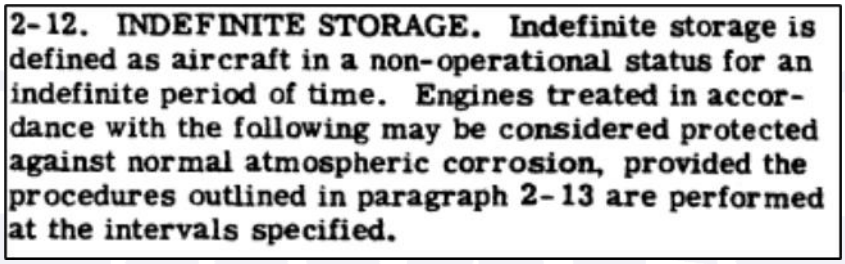
2-12. INDEFINITE STORAGE. Indefinite storage is defined as aircraft in a non-operational status for an indefinite period of time. Engines treated in accordance with the following may be considered protected against normal atmospheric corrosion, provided the procedures outlined in paragraph 2-13 are performed at the intervals specified.

Figure 5 - Indefinite Period Storage (Model 210 & T210 Series Service Manual, Revision 2, Page 2-6, Item 2-12).

Among the various steps described to perform this type of storage, there were a series of procedures for the preservation of the engine, including the use of a preventive anti-corrosion mixture.

During the period in which the aircraft was in “Storage for Indefinite Period”, its engine should be inspected every seven days, with the preventive anti-corrosion mixture being used again every 6 months, as specified in the manual.

This type of storage also required procedures for returning the aircraft to service, including draining the engine oil, among others.

According to Service Manual D2057-3-TR14 Temporary Revision Number 8, of 05APR2004, in force at the time, there were measures that should be adopted to preserve the aircraft, in case it is not operating, for periods above 90 days, as described in Section 2, chapter 2-12- Indefinite storage, p. 2-6.

Inspections of 50hs, 100hs, IAM and Special Inspection Items were carried out in the period from 14AUG2018 to 10DEC2018 in a maintenance organization in the city of Belém - PA.

The verified records indicated that, among others, the following items were inspected, according to the manufacturer's manual:

- 50h Inspection:
  - Item 36 - Turbocharger pressurized vent lines to fuel pump, discharge nozzles and fuel flow gage

    Item 37- Turbocharger mounting brackets and linkage.
- 100h Inspection:
  - Item 34 - All oil lines to turbocharger waste gate and controller.
  - Item 35 - Waste gate, actuator and controller.
- Special Items Inspection:
  - Item 4 - General inspection every 50 hours. Refer to Section 12 for Special 100-hour inspection for IO-520 exhaust system. Refer to Section 12A for 50-hour inspection for turbocharged airplanes.
  - Item 9 - Remove insulation blanket or heat shield and inspect for burned area, bulges or cracks. Remove tailpipe and ducting; inspect turbine for coking, carbonization, oil deposits and impeller damage.

The mechanical fuel pump, model 646768-3A1, SN A07HA172, of the Continental engine, model TSIO-520-R, SN 522833, which equipped the aircraft, had its internal components tested. The work was carried out by a representative of the SERIPA I, and employees on the premises of a certified maintenance organization.

Figures 6 and 7 show the components of the mechanical fuel pump and aneroid capsule housing after disassembly and hydrostatic testing.

Figure 6 - View of the disassembly of the mechanical fuel pump.

Figure 7 - View of the aneroid capsule in the hydrostatic test.

It was verified, in the partial disassembly and analysis of the items, that the mechanical fuel pump had an internal leak in the retainer of the aneroid capsule, flooding its housing, a fact proven by hydrostatic test.

Thus, evidence was found that the aforementioned bomb could have shown abnormal functioning in the period prior to the accident.

No evidence of in-flight fire, biological contamination or damage caused by foreign object impact was found.

The aircraft's engine was sent to an approved shop for examinations and tests. The event was accompanied by the investigation committee and by a professional from the DCTA certified in material factor, providing the following results.

It was noted that the engine had severe impact damage (Figure 8).

Figure 8 - View from the bottom of the engine.

The magnetos, spark plugs and ignition system cables were observed and subjected to bench testing, showing sparks and normal operating aspects.

The spark plugs in cylinders 1, 2 and 5 showed a dark color (soot) on the central electrode (Figure 9).

Figure 9 - General view of the engine spark plugs. On the spark plugs of cylinders 1, 2 and 5, the presence of black soot was evident.

The fuel supply system was inspected and obstructions were found in the fuel through holes of the nozzles of cylinders 3, 4 and 6 (Figure 10).

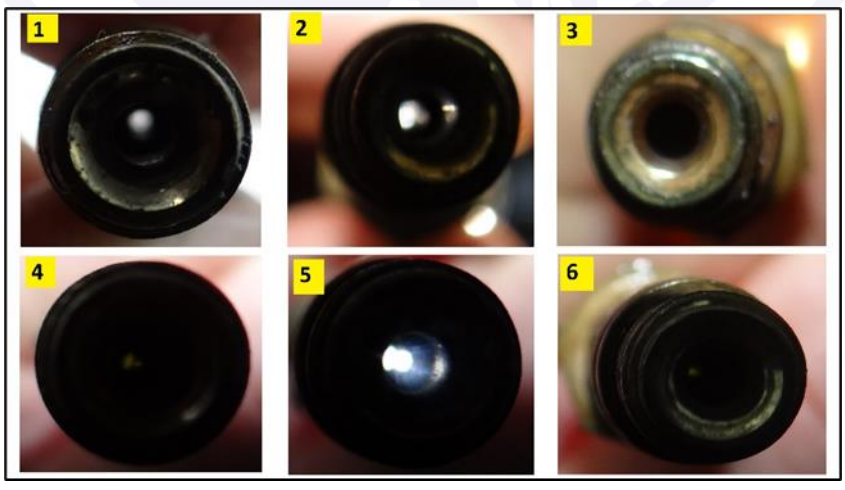

Figure 10 - View of the engine injector nozzle orifices.

The fuel distributor diaphragm piston was stuck. After removing that one, corrosion was found in its housing and in the distributor filter. (Figures 11 and 12).

Figure 11 - View of the diaphragm piston stuck by corrosion.

Figure 12 - View of corrosion in the distributor's internal fuel filter.

The warping of the turbocharger shaft and the carbonization of oil from a leak through the seal, on the turbine side, were observed, due to the high temperature in the region.

The component analysis also made it possible to verify evidence of exhaust gas leakage through the throttle body, which reached the hydraulic actuator of the waste gate valve, in addition to cracks and holes in the throttle, caused by severe corrosion. (Figures 13, 14 and 15).

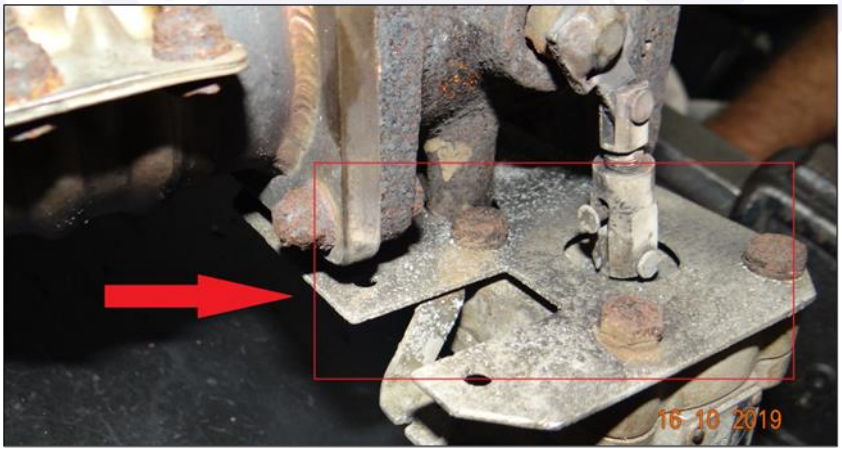

Figure 13 - Evidence of the actuator affected by the leakage of exhaust gases from the throttle body.

Figure 14 - View of severe corrosion on the inside of the throttle body.

Figure 15 - View of the crack and hole observed inside the throttle body, caused by severe corrosion.

About the operation of the waste gate, it was verified in the aircraft manual that, when the engine was activated, the oil pressure, coming from the lubrication system, was sent to the hydraulic throttle actuator through a tube. With the increase in the engine speed, the oil pressure in this actuator would increase, thus overcoming the force of the throttle spring, closing it.

When the throttle began to close, exhaust gases were directed to the turbocharger, producing a high velocity of air that entered the engine's induction intake manifold. Thus, the degree of turbocharging was controlled by means of the waste gate valve assembly, which varied the amount of exhaust gas sent to the turbine.

Finally, the exhaust gases were then discharged into the air through the exhaust outlet of the turbine housing and the exhaust tailpipe.

The crack and hole found in the throttle body of the waste gate bypass system, caused by severe corrosion, allowed the exhaust gases to leak into the atmosphere, reducing the efficiency of the turbocharger, due to the reduction in the air mass that should be forced into the cylinders.

This condition caused a rich mixture with a consequent loss of engine power, in addition to causing the black soot seen both on the spark plugs and in the black smoke noticed by people who observed the take-off.

The engine lubrication system showed evidence of normal operation and no contamination and/or obstructions were found.

The engine's cylinders and pistons were disassembled and analyzed, and no abnormalities were observed.

During its disassembly, the engine was considered operational, as excessive wear or damage, such as fractures in its internal mechanical components, was not observed.

Based on the results obtained in this analysis, the following conclusions were obtained:

- according to the evidence presented, it was concluded that the engine was operational, since all its moving components were intact; and

- the development of power was compromised by the fact that the injection nozzles were blocked. This situation was further aggravated by the inefficiency of the turbocharger, caused by severe corrosion in the throttle body.

There were still doubts about the fuel quality of the aircraft's tanks, as it was not possible to collect it, due to the characteristics of the accident.

Oxides were found inside the fuel chamber of the distributor; however, it was not possible to establish the origin of these inorganic substances, and their occurrence is likely due to water contamination.

1.17 Organizational and management information.

The aircraft was of private operation, however, until the date of the occurrence, the operator was listed as deceased in the RAB, and it was in an inventory process for subsequent transfer.

According to the information obtained, the IAM, inspections of 50/100 hours and Special Items were carried out in the period from 14AUG2018 to 10DEC2018 in a certified maintenance organization in the city of Belém - PA, and, at the end of the services, the owner showed interest in its sale.

At the time of the occurrence, the pilot did not have a formal employment contract and performed flights when requested.

According to reports, a potential buyer has shown interest in acquiring the plane and negotiations have started.

Also, according to information gathered, in the week before the flight, maintenance activities were carried out on the aircraft so that the negotiation could take place and the demonstration flight for the buyer could be carried out.

No records were presented regarding these maintenances, nor was the Logbook updated.

The last flight record found in the Logbook was from 03NOV2016. There are reports that the aircraft had been out of operation for approximately three years.

1.18 Operational information.

The aircraft was within the weight and Center of Gravity (CG) limits specified by the manufacturer.

According to information gathered during the investigation, the pilot would make a local flight, for which he would be remunerated, without any contractual formalization, carrying three passengers in a private aircraft. The purpose of the flight would be to demonstrate the plane for a sale negotiation.

Despite being qualified, the pilot had no experience in aircraft equipped with a turbocharger.

The aircraft was filled with 80 liters of aviation gasoline before the flight.

The take-off, according to the flight plan presented, was scheduled to take place at 1530 UTC.

After the checks provided, the pilot made the simplified flight plan and the passengers were accommodated as follows: one in the right front seat and two in the rear seats.

When trying to start, the aircraft had problems and it was only possible to complete the process after three attempts.

Shortly after the take-off, the pilot was alerted by observers that there was smoke coming from the aircraft. He then made a left turn in an attempt to return to the Aerodrome, but during this maneuver, the aircraft lost lift and collided with a residence (Figures 16 and 17).

Figure 16 - Sketch of the occurrence.

Figure 17 - View of the aircraft after the impact.

According to the account of one of the occupants, who was also an aircraft mechanic, the pilot kept the electric fuel pump on at all times, despite several warnings about it. This fact was further confirmed by the other occupant who was interested in purchasing the plane.

The checklist provided the following for the aircraft departure procedure:

- Mixture - RICH.
- Propeller - HIGH RPM.
- Throttle - CLOSED.
- Auxiliary Fuel Pump Switch - ON.

- Throttle - ADVANCE to obtain 50-60 lbs/hr fuel flow, then ETURN to IDLE POSITION.
- Auxiliary Fuel Pump Switch - OFF.
- Propeller Area- CLEAR.
- Ignition Switch - START.
- Throttle - ADVANCE slowly.
- Ignition Switch - RELEASE when engine starts.

Some observers present at the time of the take-off reported that, during the aircraft's run on the runway, it presented, for a few moments, a different noise from what they were used to hearing, which was interpreted as the sound of the engine failing.

1.19 Additional information.

Nil.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a local flight, with a pilot and three passengers on board, whose purpose was to demonstrate the plane for a sale negotiation.

Shortly after the take-off, black smoke was observed coming from the aircraft and the pilot was suggested, by external observers, to return to the Aerodrome.

The pilot made a left turn, but the aircraft lost height and collided with a residence.

Thus, it was inferred that there was an inadequate evaluation of the operational parameters that caused the loss of control and consequent collision with an obstacle.

Although it was not possible to prove the pilot's experience or even accurately calculate the flight hours up to the present occurrence, it was known that he had no experience in operating aircraft equipped with turbochargers. This, together with the fact that there was a history of the pilot in question not using a checklist, may have influenced his decision to leave the auxiliary fuel pump on, which probably contributed to deteriorating the quality of the air/fuel mixture, flooding the engine.

It was also not possible to rule out the possibility that the pilot had forgotten to turn off the fuel pump after the take-off, as prevised in the checklist.

The procedures performed by the pilot during the emergency led to the hypothesis that there was a degradation of his situational awareness, since he did not identify the variables that put the flight in question at risk.

The performance of a left turn right after the take-off with low power and low height may also have been the result of an inadequate assessment of the aircraft's maneuverability under those conditions, which resulted in the loss of control of the aircraft.

Therefore, it is assumed that the pilot was not able to perceive and project the consequences of the actions he was taking and apparently focused his attention only on returning to the runway and, in doing so, used the flight commands inappropriately, leading to loss of control of the aircraft and the consequent collision with a building, aggravating the consequences of the occurrence.

As for the functioning of the engine, tests and research showed that its internal mechanical components were intact.

However, the technical analysis of the mechanical fuel pump identified that there was a leak in the retainer of the aneroid capsule of this component.

Thus, it was hypothesized that, during the take-off, there was an inadequate flow of gasoline for burning, altering the air/fuel mixture and degrading the engine's performance.

This possibility is reinforced by the presence of black soot on spark plugs 1, 2 and 5, which is associated with burning a very rich mixture (with excess fuel).

Another fact that contributed to the unbalance of the air/fuel mixture was the inefficiency of the turbocharger, which had a hole in the throttle body and a crack in the waste gate.

These conditions, caused by severe corrosion, allowed the exhaust gases to leak into the atmosphere, making the turbocharger inefficient.

The visible result of a rich mixture in the engine would be the presence of black smoke coming from the aircraft exhaust, a condition reported by outside observers.

It was also verified that the fuel distributor (spider) had the diaphragm cylinder stuck. When this component was removed, the presence of oxides in the fuel chamber was observed.

Thus, it was inferred that part of this oxide had migrated to the injector nozzles 3, 4 and 6, causing its obstruction. With the loss of three cylinders, the engine's power development was further compromised.

In fact, while the spark plugs in cylinders 1, 2 and 5 had a typical coloration when operating with rich mixture, due to leakage in the seal of the aneroid pump cap and the inefficiency of air supply by the turbocharger, the spark plugs in cylinders 3, 4 and 6 had typical coloration when operating with a lean mixture (greater amount of air), due to obstruction of the injector nozzles.

It was observed that the correct storage procedures, provided for in the manufacturer's service manual, were not complied with by the aircraft operator, in the period between 2016 and 2018, nor by the maintenance organization, in the period between December 2018 and May 2019, the which resulted in the emergence of corrosion processes in various items and aircraft systems, contributing to the occurrence.

In this context, considering that the last flight record found in the Logbook was dated 03NOV2016 and that the reports indicate that the aircraft had not been regularly operated for approximately three years, it was concluded that the operator did not maintain a culture of standardized safety procedures, especially regarding aircraft maintenance and storage.

Due to the identified failures, it can be inferred that the maintenance procedures applied in the 50h, 100h and Special Items inspections, carried out by the maintenance organization, were not complied with as provided in the manufacturer's service manual (D2057-3 -TR14).

This fact demonstrated failures in the managerial supervision of the execution activities, in the technical scope, by the maintenance organization.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had valid CMA;

b) the pilot had valid MNTE Rating;

c) it was not possible to identify the pilot’s recent experience;

d) the aircraft had valid CA;

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

f) the airframe, engine and propeller logbook records were outdated;

g) the weather conditions were favorable for the visual flight;

h) after the take-off, the aircraft presented black smoke coming from the exhaust;

i) black smoke coming from the aircraft was observed and the pilot was suggested, by external observers, to return to the Aerodrome;

j) the aircraft started a descending turn to the left;

k) there was loss of control and the aircraft collided with a residence;

l) the aircraft was not operated for a long period, without having been properly stored, as prevised in the manufacturer's manual;

m) a few months before the flight, the aircraft had been subjected to inspections of 50hs, 100hs and Special Items;

n) the engine had all its internal components intact;

o) mechanical fuel pump and turbocharger problems were detected;

p) the injection nozzles of cylinders 3, 4 and 6 were blocked;

q) the engine had low power at the moment of impact;

r) the aircraft had substantial damage; and

s) the pilot suffered fatal injuries, two passengers suffered serious injuries and another passenger suffered minor injuries.

3.2 Contributing factors.

- **Control skills – a contributor.**

The inadequacy in the use of the flight controls led to the loss of control of the aircraft and the consequent collision with a building, aggravating the consequences of the occurrence.

- **Attitude – undetermined.**

The fact that there was a history of not using the checklist by the pilot in question, indicated a complacent attitude towards the correct execution of the aircraft's procedures, which may have contributed to deteriorating the quality of the air/fuel mixture, due to the respective pump has remained on after the take-off.

- **Piloting judgment – undetermined.**

The fact that the pilot made a left turn right after the take-off with low power and low altitude may have been the result of an inadequate assessment of the aircraft's maneuverability under those conditions, which resulted in the loss of control of the plane.

- **Aircraft maintenance – a contributor.**

The incorrect storage of the aircraft, over a period of approximately two years, resulted in the installation of corrosion processes in several systems and components. Associated with this, the fulfillment of inspections that did not detect critical conditions in its components contributed to a reduction in power during the take-off and to this accident.

- **Memory – undetermined.**

The pilot was not familiar with operating turbocharged aircraft. Furthermore, there was a history of not using the checklist. Thus, it is possible that the auxiliary fuel pump was

forgotten turned on during the take-off, which probably contributed to the unbalance of the air/fuel mixture.

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

The pilot's little experience in operating aircraft equipped with turbochargers, combined with the fact that there was a history of not using a checklist by the pilot in question, may have influenced his decision to leave the auxiliary fuel pump on, which, probably contributed to deteriorating the quality of the fuel/air mixture, flooding the engine.

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

The decision to return to the Aerodrome may have contributed to the evolution of the occurrence, since the conditions faced at the time (low power and low height) suggested that this maneuver might not be the most indicated in that operational context.

- **Managerial oversight – a contributor.**

The maintenance procedures of the inspections of 50h, 100h and Special Items, carried out by the maintenance organization, were not complied with as prevised in the manufacturer's service manual (D2057-3-TR14).

This fact demonstrated failures in the managerial supervision of the execution activities, in the technical scope, by the maintenance organization, contributing to this occurrence.

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-081/CENIPA/2019 - 01 **Issued on 12/30/2021**

Work with the TEMA *Tecnologia Manutenção de Aeronaves* EIRELI so that the organization demonstrates that the processes related to the management supervision of planning, execution and control activities, in the technical scope, are duly implemented and guarantee the quality of the services performed.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On December 30th, 2021.