COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-015/CENIPA/2021

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-STO**
MODEL:	**A188B**
DATE:	**01FEV2021**

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 considering 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 distinct 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 Final Report has been made available to the ANAC and the DECEA so that the technical-scientific analyses of this investigation can be used as a source of data and information, aiming at identifying hazards and assessing risks, as set forth in the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).

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. Considering 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 Final Report refers to the 01 February 2021 accident with the A188B aircraft, registration marks PR-STO. The occurrence was typified as “[SCF-PP] Engine failure or malfunction | Engine failure in flight.”

After takeoff, the aircraft’s landing gear collided with a fence. Subsequently, the left-hand wing struck the ground.

The aircraft sustained substantial damage.

The pilot suffered no injuries.

For being the USA the State of manufacture of the aircraft, the NTSB (USA’s *National Transportation Safety Board*) appointed an Accredited Representative for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CAVOK	Ceiling And Visibility Ok (no clouds below 5000 ft or below the minimum height of the highest sector (whichever the greater), and horizontal visibility more than 10 km; No CBs nor significant weather condition for aviation.
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CG	Center of Gravity
CMA	Aeronautical Medical Certificate
CVA	Airworthiness-Verification Certificate
DECEA	Department of Airspace Control
inHg	Inches of mercury
METAR	Routine Meteorological Aerodrome Report
MNTE	Single-Engine Land Airplane Class Rating
MPH	Miles Per Hour
NM	Nautical Miles
NSCA	Command of Aeronautics' System Norm
NTSB	USA's National Transportation Safety Board
PAGA	Aeroagricultural Pilot Rating (Airplane)
PCM	Commercial Pilot License (Airplane)
PIC	Pilot In Command
PPH	Pounds Per Hour
PPR	Private Pilot License (Airplane)
PSI	Pound Force Per Square Inch
PSO-BR	Brazilian Program for Civil Aviation Safety
RBAC	Brazilian Civil Aviation Regulation
RPM	Revolutions Per Minute
SAE-AG	Specialized Public Air Service Registration Category (Aeroagricultural)
SBPA	ICAO location designator - *Salgado Filho* Aerodrome, *Porto Alegre*, State of *Rio Grande do Sul*
SERIPA V	5th Regional Service for the Investigation and Prevention of Aeronautical Accidents
SIPAER	Brazil's Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
TBO	Time Between Overhauls
UTC	Coordinated Universal Time

1. FACTUAL INFORMATION.

Aircraft	**Model:** A188B **Registration:** PR-STO **Manufacturer:** Cessna Aircraft	**Operator:** *Aero Agrícola São Miguel Ltda. - ME*
Occurrence	**Date/time**: 01FEV2021 – 09:20 (UTC) **Location:** *Claudemir* landing area for aeroagricultural use. **Lat.** 30°14'57"S **Long.** 050°45'54"W **Municipality – State:** *Viamão – Rio Grande do Sul*.	**Type(s):** [SCF-PP] Powerplant failure or malfunction

1.1. History of the flight.

At approximately 09:20 UTC, the aircraft took off from the *Claudemir* landing area for aero-agricultural use, municipality of *Viamão*, State of *Rio Grande do Sul*, on a local crop-dusting flight, with 01 POB (pilot).

During takeoff, the aircraft's landing gear struck a fence. Subsequently, the left wing of the aircraft collided with the ground.

The aircraft sustained substantial damage, whereas the crewmember suffered no injuries.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The aircraft sustained substantial damage to its landing gear, left-hand wing, tail section, and propeller.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience	PIC
Total	4,400:00
Total in the last 30 days	09:10
Total in the last 24 hours	00:00
In this type of aircraft	2,850:00
In this type in the last 30 days	09:10
In this type in the last 24 hours	00:00

N.B.: data on hours flown obtained through information provided by the pilot.

1.5.2. Personnel training.

The Pilot in Command (PIC) did his PPR course (Private Pilot - Airplane) in 2011 at the *Aeroclube de Blumenau*, State of *Santa Catarina*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PCM license (Commercial Pilot - Airplane) and valid ratings for MNTE (Single-Engine Land Airplane) and PAGA (Agricultural Pilot - Airplane).

1.5.4. Qualification and flight experience.

The pilot had qualification and experience for the type of flight.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The SN 18800859 aircraft was a product manufactured by Cessna Aircraft in 1972, and registered in the Public Specialized Air Service Registration Category - Aeroagricultural (SAE-AG).

The Airworthiness-Verification Certificate (CVA) was valid.

The records of the airframe, engine, and propeller logbooks were up to date.

The aircraft underwent its last inspection - (type 100 hours/Airworthiness-Verification Certificate) – at the premises of *Aerovaley Manutenção e Comércio de Aeronaves Ltda*. on 28 July 2020, in *Novo Hamburgo*, State of *Rio Grande do Sul*. The aircraft flew 45 hours and 55 minutes after the referred inspection.

The aircraft underwent its last comprehensive inspection (type “200 hours”) on 26 July 2018 at the premises of *Aerovaley - Manutenção e Comércio de Aeronaves Ltda*, in *Novo Hamburgo*, State of *Rio Grande do Sul*. The aircraft flew 143 hours and 35 minutes after the said inspection.

The Teledyne Continental SN 1000477 model IO-52D26B engine was installed on the aircraft by *Aerovaley Manutenção e Comércio de Aeronaves Ltda.* on 19 July 2019, after undergoing an inspection process on account of a leak. The engine flew a total of 71 hours and 35 minutes after being installed, with a total 783 hours since new, and with a Time between Overhauls (TBO) of 1,200 hours.

1.7. Meteorological information.

The Routine Meteorological Aerodrome Reports (METAR - aerodrome meteorological report) of SBPA (*Porto Alegre* Aerodrome), located 26 NM away from the accident site, had the following pieces of information:

METAR SBPA 010900Z 29003KT 260V340 CAVOK 24/24 Q1009=

The meteorological conditions were consistent with visual flights.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The landing area for aeroagricultural use was private, under the administration of the *Aero Agrícola São Miguel Ltda*. company

The landing area surface was covered with gravel, with thresholds 09/27, dimensions of 720 m x 40 m, at an elevation of 65 ft.

In the overshoot area of the runway used in the accident flight in question, there was a perimeter fence and a ditch for water drainage.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The aircraft impacted a fence located past the departure end of the runway, during takeoff. Subsequently, the aircraft's left-hand wing collided with a ditch (Figures 1, 2 and 3).

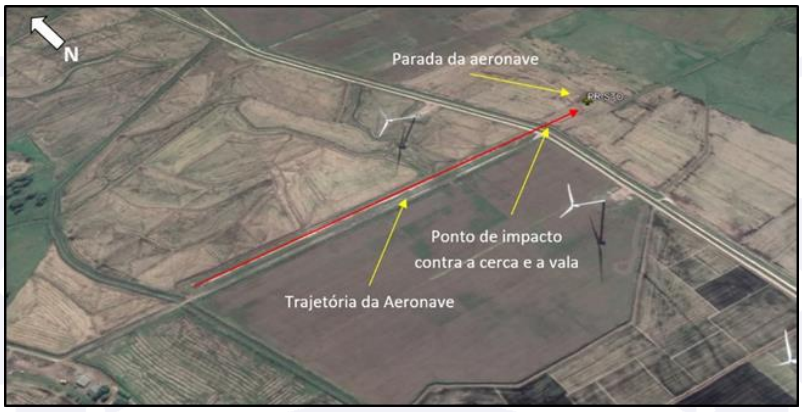

Figure 1 - Aircraft takeoff croquis.

Figure 2 - Points of impact.

Figure 3 - Final position of the aircraft after the collision with the fence and the ditch.

The aircraft was found in the takeoff configuration, outside the landing area for aeroagricultural use. Most of the wreckage was concentrated in the crash site. The collision

with the ground occurred in a field being prepared for plantation, since the soil had irregular contours.

After the second impact, the aircraft rotated 90° counterclockwise relatively to the axis of the airstrip, skidding for approximately 115 m before coming to a complete stop.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

There was no evidence that issues of physiological nature or incapacitation might have affected the crewmember's performance.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

There was no evidence that issues of psychological nature or incapacitation might have affected the crewmember's performance.

1.14. Fire.

There was no evidence of fire either in flight or after impact.

1.15. Survival aspects.

NIL.

1.16. Tests and research.

The aircraft's engine, model IO-520-D (26), serial number 1000477, manufactured by Teledyne Continental, was disassembled and checked by SIPAER investigators.

Initially, one observed that the engine had not sustained severe damage resulting from the accident (Figure 4). Even when the engine was turned, one found that it was not stuck. However, due to some dents and deformations that prevented verification on a test bench or in another similar aircraft, the engine was subject to disassembly for analysis of its internal parts.

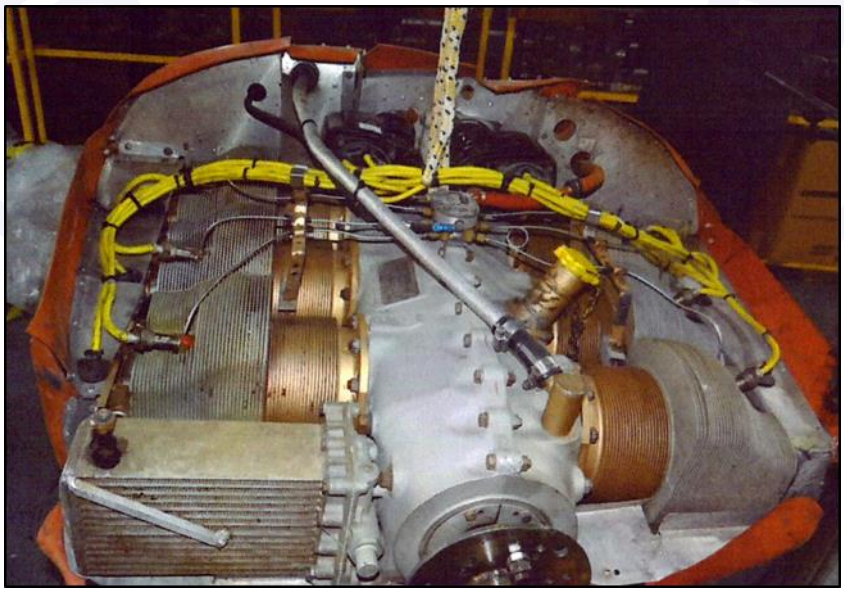

Figure 4 - View of the engine from above.

The lubrication system was not contaminated, and there was no evidence of lack or deficiency of lubrication.

The cylinders and pistons were subject to disassembling and analysis. No abnormalities were found, such as detonation, fractures, jammed valves, overheating, etc.

There were no signs of wear caused by erosion on the valve control cams or hydraulic tappets.

The propeller governor underwent test on the bench. Upon adjusting it at 2,700 RPM, the pressure gauge on the right-hand side indicated normal internal leakage, that is, within the limits of acceptance (Figure 5).

Figure 5 - Propeller governor test at 2,700 RPM. The pressure gauge on the right-hand side indicated normal internal leakage.

However, upon adjusting the governor to a value of 2,755 RPM, the pressure gauge on the right-hand side indicated maximum internal leakage, exceeding the acceptance standards, showing that the equipment was releasing oil at an RPM value that was 100 RPM lower than the one expected.

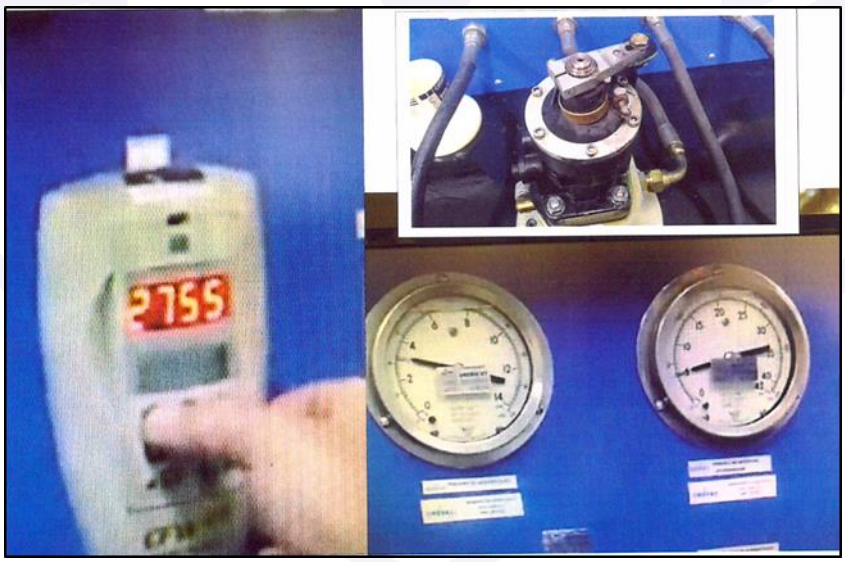

Fig. 6 - Propeller governor test at 2,755 RPM. The right-hand side pressure gauge indicated maximum internal leakage, with an RPM value of approximately 100 RPM below the expected one.

However, according to verification, such discrepancy would not result in loss of power either during or after takeoff.

According to the engine identification plate, the timing light, corresponding to the operation of the two magnetos, should illuminate at the mark of 22º before the top dead

center. This angle would be the correct one specified by the manufacturer for the spark from the spark plugs to start burning the air/fuel mixture.

During the analysis with the equipment, one verified that the initial ignition advance (*calibration of the magnetos*) was correct; however, the magnetos sparking occurred around 14º after the top dead center of the piston, as shown in Figures 7 and 8.

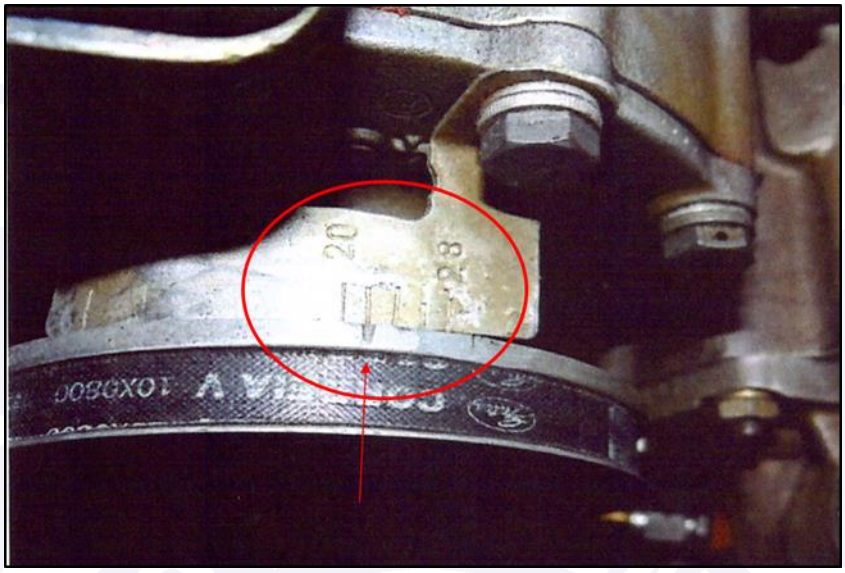

Figure 7 - Marking on the rear pulley with 22º as per the ignition advance engraved on the engine identification plate. At this marking, the timing light should illuminate.

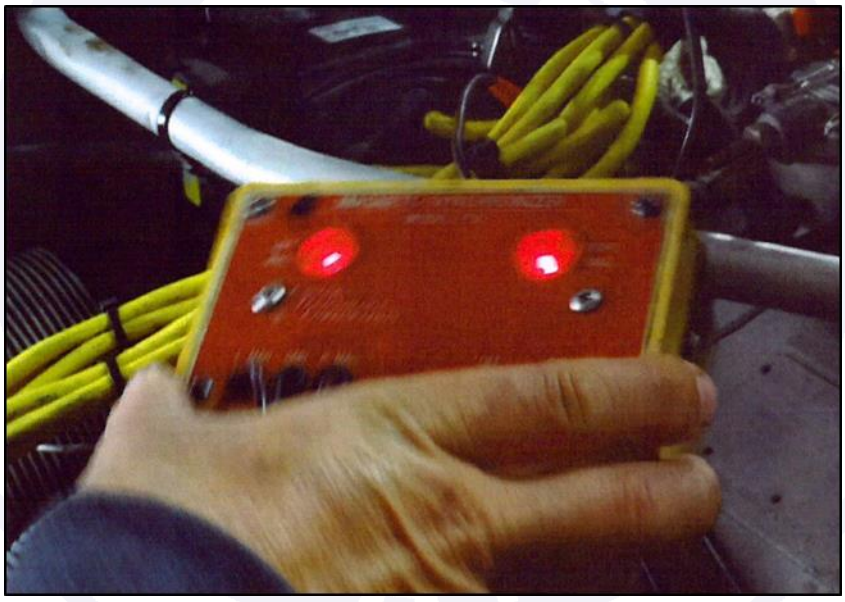

Figure 8 – Moment at which the timing light came on, with the ignition advance marking approximately 14º after the top dead center.

Such fact indicated that the burning of the air/fuel mixture was starting with the piston moving towards the bottom dead center.

As a general rule, the consequences of the discrepancies would be loss of engine power, increased exhaust temperature, and possible damage to the exhaust valve over time.

As for the magnetos, one verified that they were synchronized and working normally.

The spark plugs had excessive play in the central electrodes, compared to the play-pattern shown by a new spark plug. However, such condition did not mean that they were unsuitable for use, but rather that the condition would hinder the sparking that would start

the burning of the air/fuel mixture. The ceramic of the candles had a normal appearance and color.

One found no discrepancies in the pistons and cylinders that might indicate overtemperature and detonation.

The analysis of the fuel pump demonstrated that it was intact and without damage. Thus, the referred pump was subject to bench tests, as shown in Figure 9.

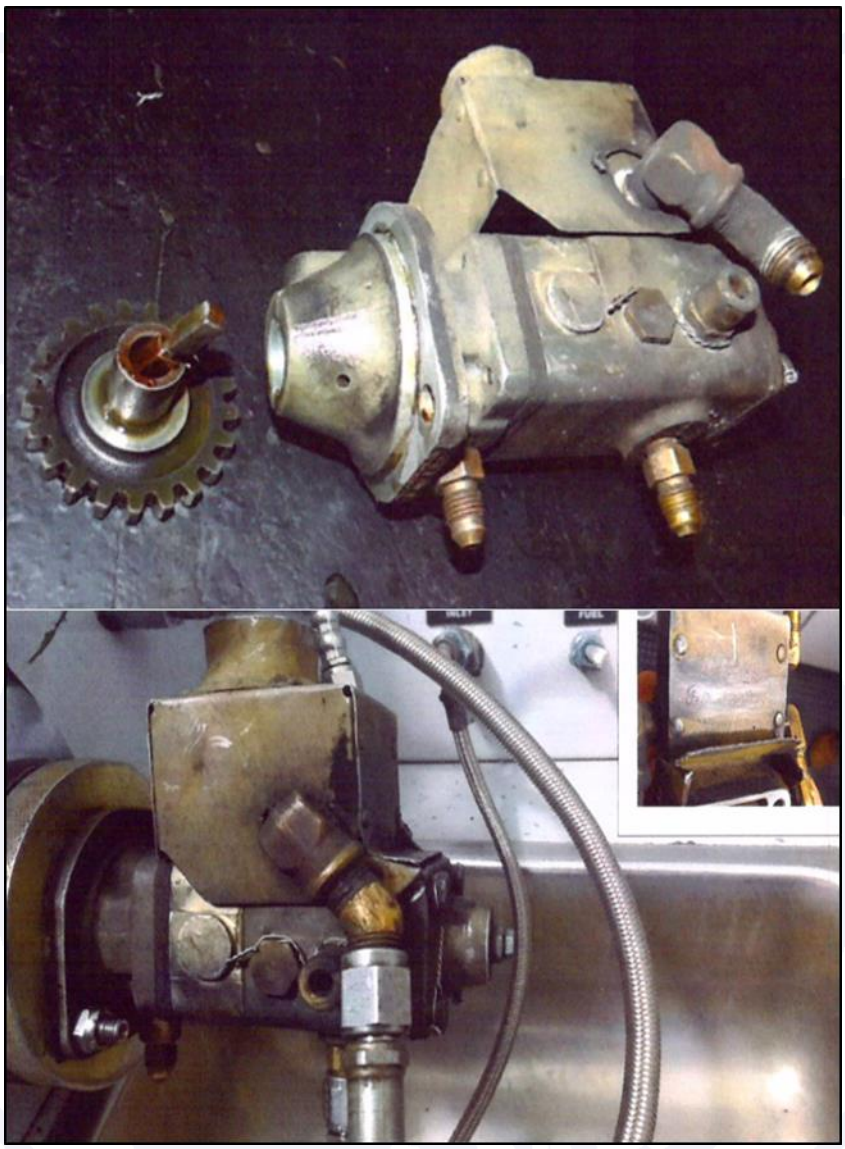

Figure 9 - (Above) View of the fuel pump and intact accessories.
(Below) View of the fuel pump on the test bench.

During the analysis of the pump on the bench, the rotameter indicated a flow rate of 270 PPH, well above the one specified for the engine model, while the maximum limit would be 153 PPH (Figure 10).

Considering normal flow rates for the operation, one found that this excess fuel could cause a loss of power or even engine shutdown.

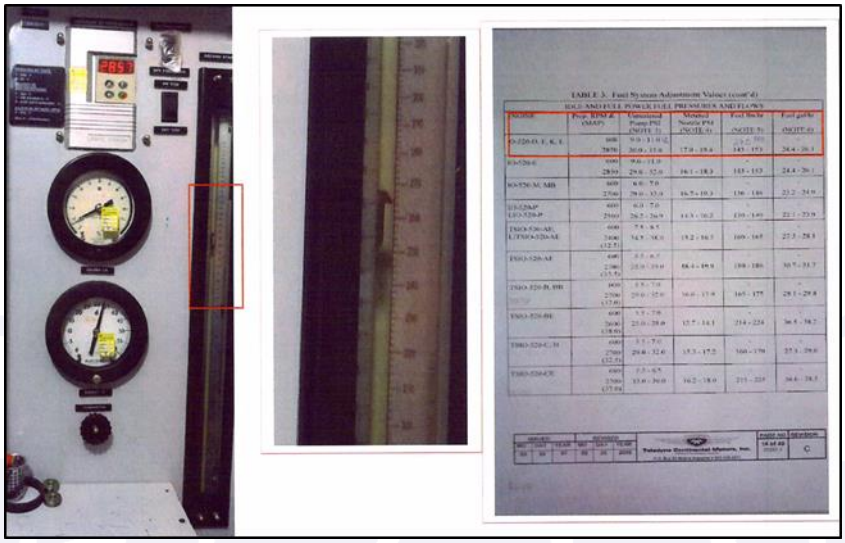

Figure 10 - (Left) Fuel pump test; (Center) Rotameter indicating the flow obtained in the test; and (Right) Table 3 of the engine manual showing the fuel system flow-settings.

Additionally, fuel samples were collected from the fuel tank and from the right-hand wing of the aircraft. The test results indicated that the fluids were in accordance with their respective specifications, without any signs of contamination.

1.17. Organizational and management information.

The operator (*Aero Agrícola São Miguel Ltda*. – ME), headquartered in the municipality of *Palmares do Sul*, State of *Rio Grande do Sul*, showed the company's Air Operator Certificate approved on 21 March 2016, with certification based on the RBAC-137 (Brazilian Civil Aviation Regulation nº 137).

The company's operational specifications allowed the application of liquids, solids and water supply, with restrictions of nighttime agricultural operations. Thus, the accident aircraft (PR-STO) was in the list of aircraft authorized by the ANAC for operation.

1.18. Operational information.

According to the pilot, he had maintained an undemanding routine in the days preceding the occurrence, had rested appropriately, and did not report fatigue at the start of the flight.

The PIC also stated that, upon arriving at the hangar of the operating base, in the municipality of *Viamão*, State of *Rio Grande do Sul*, he got involved in his regular activities and performed an inspection of the aircraft, including the verification of the engine oil, propeller, and fueling (when he drained the fuel). He reported not having found any abnormalities during the inspections.

The PIC said that he started the engine and waited approximately 12 minutes for it to warm up. Then, he taxied out the aircraft toward the runway threshold, and checked the engine, which had not shown any abnormalities until that moment.

The aircraft took off from the company's base of operations with approximately 2,500 RPM and 23 inHg, bound for the *Claudemir* landing area for aeroagricultural use.

After the owner of the farm arrived at the location, the pilot restarted the aircraft's engine, and noticed that it had an initial irregular operation. Thirty seconds after the restart, the engine operation returned to normal.

Upon completion of the aircraft loading, the pilot taxied in order to begin the operations of the day. The airplane was within its weight limits, and with the Center of Gravity (CG) slightly exceeding the rear limit. The start of the takeoff run was uneventful, with the power set to 28 inHg, fuel pressure above 25 PSI, and engine rotation at 2,750 RPM.

The pilot stated that, after approximately 450 m of takeoff run, a point normally used by the pilots for rotation, and at a speed of 75 MPH, he noticed the aircraft decelerating, with loss of power.

He said that, upon encountering the abnormality, he started jettisoning the hopper load, tried to apply the landing flap (third tooth) and pitched up the nose of the aircraft. However, the airplane's landing gear collided with a fence, and the left-hand wing hit a ditch. The aircraft came to a complete stop approximately 115 m after the first impact.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a crop dusting flight, the second of the day. The pilot held valid ratings and a valid CMA, had qualification and experience for the type of operation, and there was no evidence of physiological, psychological, or incapacitation issues that that might have affected his performance.

At the beginning of the day, all the checks and procedures provided for in the Cessna A188B manual were performed, and the aircraft was ferried from the operator's base to the *Claudemir* landing area for aeroagricultural use. On that occasion, the pilot did not notice any abnormalities. However, according to him, during the second takeoff of the day, the engine lost power.

In an attempt to continue the flight, the pilot started jettisoning the product from the hopper, applied the landing flap, and pitched up the nose of the aircraft, but did not succeed. The aircraft's landing gear hit a fence and the left-hand wing collided with a ditch.

The meteorological conditions were consistent with visual flights. The landing area for aeroagricultural use was private, its surface was covered with gravel, and it met the requirements for operation of the aircraft. However, in the overshoot area of the runway in use, there was a perimeter fence, and a ditch for water drainage.

The aircraft was registered as SAE-AG, had a valid CVA, and its logbooks were up to date. It had flown approximately 45 hours after the last inspection. Before takeoff, one verified that the aircraft was within the weight limits and with the CG slightly exceeding the rear limit. However, one concluded that this small excess in the rear limit of the CG did not influence the occurrence.

During the analysis of the aircraft's engine, while checking the magnetos, one found that the timing light (which was supposed to illuminate at the 22°-mark before the top dead center, as specified by the manufacturer for the correct sparking of the spark plugs and burning of the air/fuel mixture) was in fact illuminating at approximately 14° after the top dead center of the piston.

The sparking at the 14°- position after the top dead center indicated that the burning of the mixture occurred when the piston was already moving towards the bottom dead center. This could cause loss of power, increase the exhaust temperature and, over time, damage the exhaust valve.

When analyzing the spark plugs, one found that there was an excessive play in the central electrodes, and that such abnormality could hinder the sparking that would initiate the burning of the mixture.

During the bench analysis of the fuel pump, the rotameter indicated a flow rate well above the one expected for the engine model: around 270 PPH, while the maximum limit

would be 153 PPH. Regarding these values, it is known that excess gasoline driven by the fuel pump can cause a loss of power or even engine shutdown.

Therefore, the most likely hypothesis for the loss of power reported during the takeoff of the PR-STO from the *Claudemir* landing area was the sum of discrepancies observed: ignition advance, excessive fuel pump pressure, and excessive play in the electrodes spark plug centers, possibly resulting from deficiencies in the maintenance procedures, either in scheduled or unscheduled inspections.

3. CONCLUSIONS.

3.1. Findings.

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

b) the pilot held valid ratings for MNTE (Single Engine Land Airplane) and PAGA (Agricultural Pilot - Airplane);

c) the pilot had qualification and experience for the type of flight;

d) the aircraft had a valid CVA (Airworthiness Verification Certificate);

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

f) the records of the airframe, engine, and propeller logbooks were up to date;

g) the meteorological conditions were suitable for the flight;

h) during takeoff, the aircraft collided with a fence and with a ditch;

i) the engine had been installed on the aircraft on 19 July 2019, after undergoing an inspection aimed at fixing a leak;

j) the sparking of the magnetos was taking place at around 14º after the top dead center of the piston;

k) the spark plugs had excessive play at the central electrode;

l) the fuel pump showed a flow rate of 270 PPH, above the expected value of 153 PPH;

m) the aircraft sustained substantial damage; and

n) the pilot suffered no injuries.

3.2. Contributing factors.

- **Aircraft maintenance – undetermined.**

The incorrect spark adjustment of the magnetos, added to the excessive gap in the spark plugs and to the flow rate higher than expected in the fuel pump, may have contributed to the loss of power during takeoff. These discrepancies may have resulted from deficiencies in the maintenance procedures, either during scheduled or unscheduled inspections.

4. SAFETY RECOMMENDATIONS

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 consonance with the Law n°7565/1986, recommendations are made solely for the benefit of 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".

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

A-015/CENIPA/2021 - 01 **Issued on 12/29/2023**

Work with *Aerovaley Manutenção e Comércio de Aeronaves Ltda*, so that the referred organization demonstrates to possess and to apply all the necessary resources for the adequate provision of maintenance services on Cessna A188B aircraft, and on Continental IO-520 -D engines, as recommended by the legislation in force, the respective technical manuals, and the company's List of Capabilities.

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Disseminate the lessons learned in this investigation to *Aero Agrícola São Miguel Ltda. - ME*, so that that operator improves its administrative and operational mechanisms for the receipt, recording, and verification of the maintenance services performed on aircraft under the operator's responsibility, as a way of preventing aeronautical accidents.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On December 29th, 2023.

ANNEX A – COMMENTS BY THE STATES PARTICIPATING IN THE INVESTIGATION

In compliance with the provisions of the Chapter 6, item 6.3, of the Annex 13 to the Convention on International Civil Aviation, the States participating in this investigation had the opportunity to make their comments concerning the content of this final report.

Through the National Transportation Safety Board (NTSB), the United States of America forwarded a comment from the aircraft engine manufacturer Continental Aerospace Technologies.

The comment have not been included in the body of this report.

COMMENT

Comment from Continental

The timing plate on the rear of the engine shown in the pictures. Continental has a service bulletin that is obsolete (M84-8) recommending it being removed because the starter adapter had to be timed when installed. If not, the information could be inaccurate. I noticed the Timing note was way outside the specification. The photo showed them using the plate.

CENIPA´s Opinion

Not incorporated

CENIPA's Argumentation

From CENIPA's point of view, as specified in service bulletin M84-8, this should only be applied during the next starter adaptation rework or engine overhaul, situations that the engine in this investigation had not yet experienced.