COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-022/CENIPA/2021

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-PPJ**
MODEL:	**PA-36-375**
DATE:	**12FEV2021**

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 that 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 accident involving the PR-PPJ aircraft, model PA-36-375, which occurred on February 12, 2021, classified as "[SCF-PP] System/Component Failure or Malfunction (Powerplant)".

During an agricultural fertilizer application flight, the aircraft experienced a loss of engine power. The pilot jettisoned the load and executed an emergency landing in a sugarcane plantation on a farm.

It was determined that a catastrophic in-flight failure of the powerplant occurred, leading to the loss of engine power.

The aircraft sustained substantial damage.

The pilot was uninjured.

Being the United States of America the State of manufacture of the aircraft, an Accredited Representative from the USA's NTSB (National Transportation Safety Board) was designated for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AEV	Special Flight-Authorization
ANAC	Brazil's National Civil Aviation Agency
CENIPA	Brazil's Center for the Investigation and Prevention of Aeronautical Accidents
CIV	Digital Pilot-Logbook
CMA	Aeronautical Medical Certificate
CVA	Certificate of Airworthiness
DCTA	Department of Science and Aerospace Technology
DECEA	Department of Airspace Control
GRSO	Safety Risk Management
IAE	Institute of Aeronautics and Space
IS	Supplemental Instruction
METAR	Routine Meteorological Aerodrome Report
MNTE	Single-Engine Landplane Class Rating
NTSB	USA's National Transportation Safety Board
PAGA	Agricultural Pilot Rating (Airplane)
PCM	Commercial Pilot License (Airplane)
PIC	Pilot in Command
PPR	Private Pilot License - Airplane
PSO-BR	Brazilian Program for Civil Aviation Safety
RBAC	Brazilian Civil Aviation Regulation
SAE-AG	Private Registration Category of Specialized Public Air Services – Aeroagricultural
SBUR	ICAO location designator - *Mario de Almeida Franco* Aerodrome, *Uberaba*, State of *Minas Gerais*
SIPAER	Sistema de Investigação e Prevenção de Acidentes Aeronáuticos
SWAU	ICAO location designator - *Fazenda Nossa Senhora Aparecida* Aerodrome, *Pirajuba*, State of *Minas Gerais*
UTC	*Coordinated Universal Time*

1. FACTUAL INFORMATION.

Aircraft	**Model:** PA-36-375 **Registration:** PR-PPJ **Manufacturer:** Piper Aircraft.	**Operator:** *Santo Ângelo Aeroagrícola Ltda*.
Occurrence	**Date/time**: 12FEV2021 – 16:00 (UTC) **Location:** *Fazenda Jataí.* **Lat.** 19°51'19"S **Long.** 048°27'24"W **Municipality – State:** *Conceição das Alagoas – Minas Gerais.*	**Type(s):** [SCF-PP] Powerplant failure or malfunction

1.1. History of the flight.

At around 15:40 UTC, the aircraft took off from SWAU (*Fazenda Nossa Senhora Aparecida* Aerodrome, *Pirajuba*, State of *Minas Gerais*) on an agricultural fertilizer application flight, with 01 POB (pilot).

Approximately twenty minutes into the flight, during one of the application passes, the aircraft experienced vibrations followed by an engine failure with loss of power.

The pilot jettisoned the load, and made an emergency landing in a sugarcane field of a farm.

During the landing, the left wingtip struck a tree. Upon ground contact, the aircraft rotated around its vertical axis and came to a stop facing the direction opposite to its initial trajectory.

Figure 1 - Aircraft after coming to a complete stop.

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 entire structure.

Dents and wrinkles were observed on the wings, tail cone, empennage, and underside of the fuselage.

Figure 2 - Image captured from the rear of the aircraft.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Hours Flown	
	PIC
Total	1.294:20
Total in the last 30 days	00:00
Total in the last 24 hours	00:00
In this type of aircraft	805:10
In this type in the last 30 days	00:00
In this type in the last 24 hours	00:00

Note: Flight-hour data obtained from the records of the pilot's digital CIV (Pilot Logbook).

1.5.2. Personnel training.

The Pilot in Command (PIC) completed the Private Pilot - Airplane (PPL) course at the Aeroclube de São Paulo, SP, in 2004.

1.5.3. Category of licenses and validity of certificates.

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

1.5.4. Qualification and flight experience.

Records from the digital CIV indicated that the pilot had been operating the PA-36-375 aircraft, registration PR-PPJ, since June 2016, with Fazenda Nossa Senhora Aparecida Aerodrome as a frequent destination.

Available information showed that the PIC had performed his first agricultural aircraft flight in 2008 and had been engaged in this category of aviation ever since.

Throughout his career, the PIC had flown the following aircraft models: EMB-712 *Tupi*, AB-115 *Aero Boero*, 182P Skylane, EMB-711 *Corisco*, C152 Cessna, PA-34-200T Seneca II, 56-C *Paulistinha*, EMB-201 *Ipanema*, 170A Cessna, A188A AGwagon, 8GCBC Scout, EMB-202 *Ipanema*, 7GCBC *Citabria*, PA-18-150 Super Cub, AB-180 *Aero Boero*, C170 Cessna, PA-36-375 Pawnee Brave, and PA-25-235 Pawnee.

The pilot was qualified and experienced in this type of flight.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The SN 36-8102012 airplane was manufactured by Piper Aircraft in 1981, and registered under the SAE-AG category (Private Specialized Air Service - Public Agricultural Aviation).

The Certificate of Airworthiness Verification (CVA) was valid.

The airframe logbook entries were outdated, as Part I contained no records of monthly usage after October 2016.

The engine and propeller logbooks were up to date.

The aircraft underwent its latest "500-hour" inspection on September 14, 2020, on the premises of *Tangará Aerocenter*, in *Orlândia*, State of São Paulo, and flew 87 hours and 50 minutes after the said inspection. At that time, its engine had accumulated 3,903 total operating hours.

The aircraft underwent its latest major inspection ("1,000-hour" type) on December 1, 2018, also on the premises of *Tangará Aerocenter*, and flew 584 hours and 20 minutes after the overhaul.

The Pawnee Brave airplane was equipped with a conventional piston engine, model IO-720-D1CD, serial number L-1334-54A, an eight-cylinder version manufactured by Lycoming Aircraft Engine, capable of producing 375 to 400 hp.

On May 18, 2016, in accordance with Supplemental Instruction (IS) nº 137.201-001, the PR-PPJ's powerplant was converted to operate on ethanol. For that reason, the aircraft operated under a Special Flight Authorization (AEV).

Tangará Aerocenter overhauled the engine on November 9, 2018. At that time, it had accumulated 3,405 total operating hours.

1.7. Meteorological information.

The routine Meteorological Aerodrome Report (METAR) of SBUR (*Mário de Almeida Franco Aerodrome*, *Uberaba*, State of *Minas Gerais*), located 28 NM from the accident site, contained the following information:

METAR SBUR 121600Z 04009KT 9999 FEW017 SCT020 24/20 Q1017=

Visibility was greater than 10 km, few clouds at 1,700 ft., scattered clouds at 2,000 ft., wind 040º at 9 kt.

Based on the SBUR weather data, the meteorological conditions in the accident area were above the minimum requirements for conducting the flight operation under the proposed flight rules at the time of occurrence.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

Not applicable.

1.11. Flight recorders.

Not required and not installed.

1.12. Wreckage and impact information.

Before the forced landing, the aircraft collided with a tree, damaging the tip of the left wing.

The aircraft's landing site was located 9 NM from SWAU and consisted of a sugarcane field. The plantation had an average height of 1 meter, and the terrain was predominantly uneven (Figure 3).

Figure 3 - Rear view of the aircraft at the final stop location.

The terrain had an elevation of 570 meters (1,870 ft.), and the tallest trees struck had an average height of 15 meters (49 ft.), measured from the ground to the treetops, totaling approximately 1,919 ft. in altitude. The aircraft's impact marks on the ground extended about 20 meters from the point of first contact to the full stop.

The deflection of left landing gear strut upon ground impact caused the fairing to break in the root area, suggesting that the aircraft was in a yawing attitude to the left when it struck the terrain. After this collision, it rotated approximately 180° to the left, which resulted in the fuselage breaking apart and the empennage shifting about 30°.

The observed damage indicated a low-speed, low-angle impact. The flap surfaces were found in a position corresponding to 0º. The flap control lever in the cockpit was in the neutral position.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

There was no evidence that physiological factors or incapacitation affected the crewmember’s performance.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

There was no evidence that psychological factors affected the pilot’s performance.

1.14. Fire.

There was no evidence of fire in flight or after the aircraft stopped.

1.15. Survival aspects.

NIL.

1.16. Tests and research.

To determine the factors contributing to the aircraft's engine malfunction, physical-chemical tests were conducted on fuel (ethanol) and lubricating oil samples, with support from the Institute of Aeronautics and Space (IAE).

The results of the analysis indicated that these fluids were within specifications and showed no signs of contamination.

The SN L-1334-54A LYCOMING IO-720-D1CD engine of the PR-PPJ airplane was inspected and tested on the premises of *Tangará Aeroagrícola*, in the municipality of *Orlândia*, State of *São Paulo*. All procedures were monitored by members of the Investigation Committee and members of the Aeronautical Propulsion Subdivision (APR-A) of the Institute of Aeronautics and Space (IAE) of the Department of Science and Aerospace Technology (DCTA).

No abnormalities or discrepancies were found in the ignition, fuel, or lubrication systems that could have caused engine malfunction or failure.

During the initial inspection, upon removal of the aircraft's engine cowling, it was observed that cylinder nº 4 was detached from its base on the engine block, and the corresponding piston rod had separated from its crankshaft journal (Figure 4).

Figure 4 - Upper view of the engine showing the rupture of cylinder No. 4.

During the engine teardown, one observed that two through-studs and one fixed stud at the base of the cylinder nº 4 were fractured, and that the piston rod was no longer attached to the crankshaft journal.

These fractured studs were collected and forwarded, along with a portion of the connecting rod cap and its fastening bolt, to a specialized laboratory for failure analysis.

The results of the analysis indicated that the cause of the failure of the studs (through-studs and fixed studs) was material fatigue.

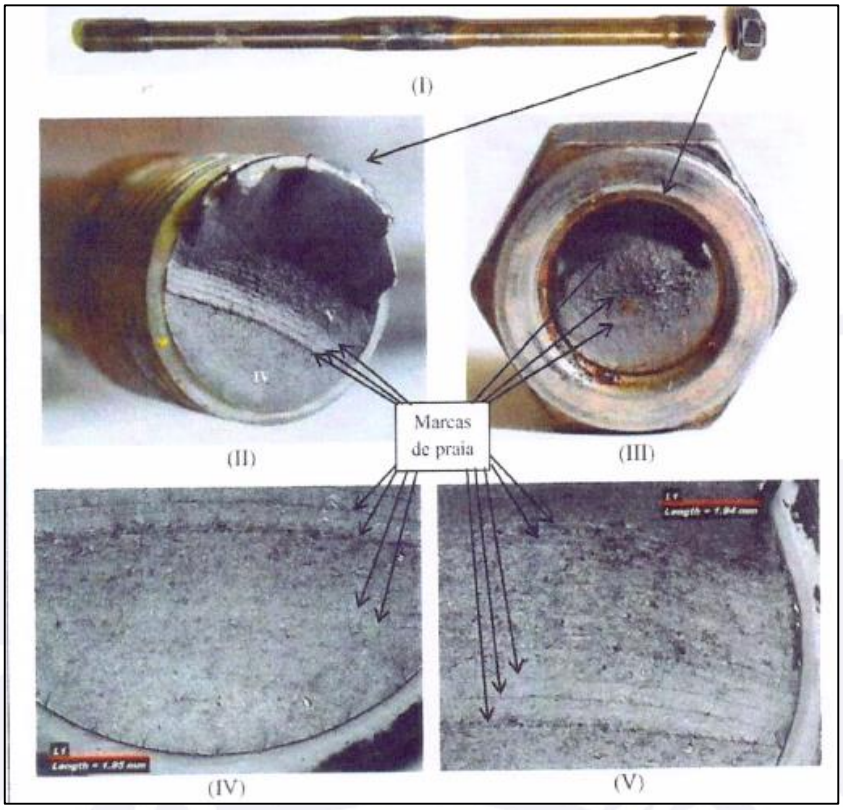


Figure 5 – View of the fracture surfaces of the P5 stud.

The analysis of the fastening bolt that was found along with the connecting rod cap revealed that the fracture surfaces had characteristics typical of tensile overload failure (Figure 6).

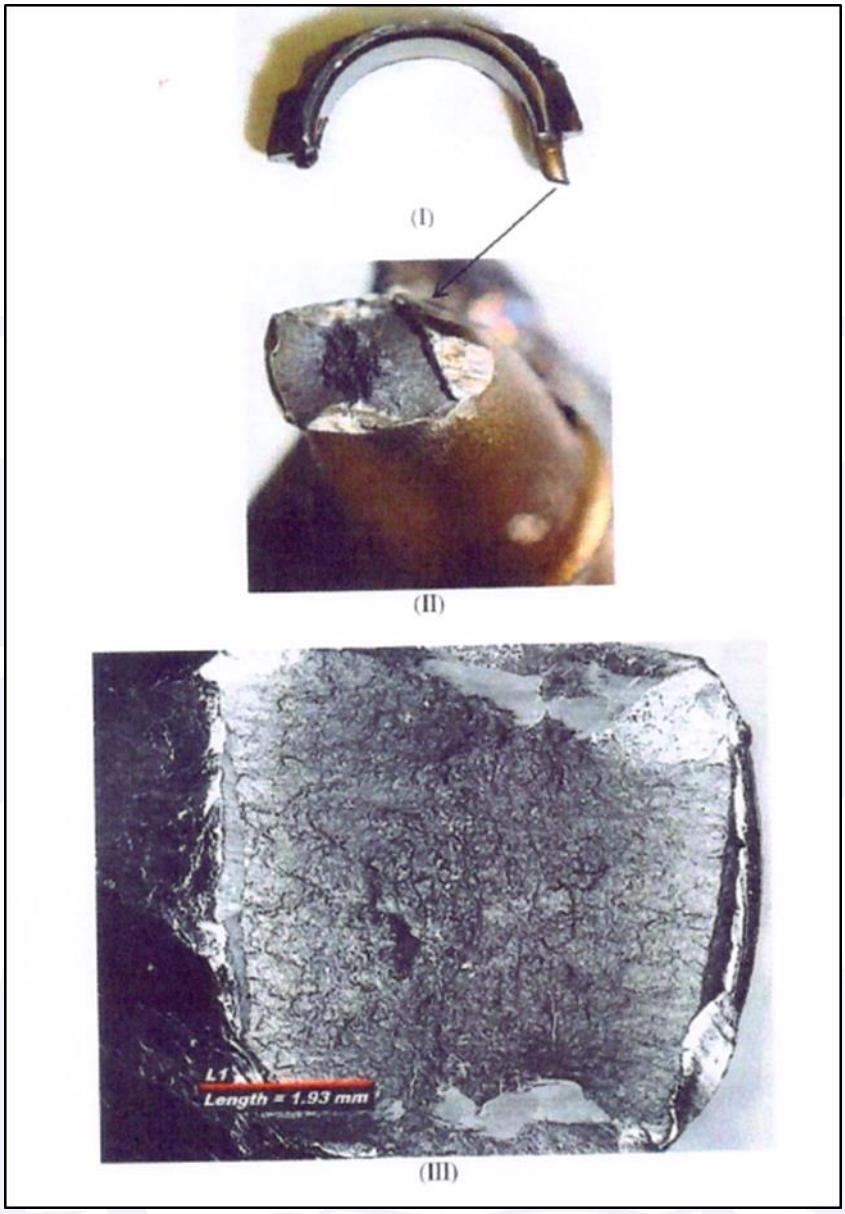


Figure 6 – View of the fracture surface of the connecting rod cap-fastening bolt, with characteristics of tensile overload failure.

The investigation of the engine concluded that the failure of the studs caused cylinder nº 4 to detach from its base, leading to misalignment of its piston. The misaligned piston's movement toward bottom dead center resulted in a collision with the cylinder base.

The resulting overload transferred stress to the connecting rod cap bolts, which failed, as the crankshaft continued rotating toward bottom dead center. The loose connecting rod was then compressed against the camshaft and engine block.

This sequence of events resulted in all the damage observed during the engine teardown.

1.17. Organizational and management information.

The operator and owner of the PR-PPJ airplane was a small company, certified under the RBAC-137 (Brazilian Civil Aviation Regulation nº 137), Amendment 04, which governs the certification and operational requirements for agricultural aviation operations.

The harvest season had begun in November 2020, and the company's flights were conducted in the morning period.

According to reports from the PIC, he had two days off per week and considered his relationship with his employer and co-workers to be good.

The RBAC-137 defined Safety Risk Management (GRSO) as “the identification of hazards, the analysis, and elimination and/or mitigation of risks that threaten the capabilities of a civil aviation organization, ensuring that they remain at an acceptable level."

Regarding the development of the GRSO, the RBAC-137 established in section 137.517, items (b) and (c), the following requirements:

> 137.517 Records and Reports
>
> […]
>
> (b) The COA holder must develop and keep on file, at its headquarters, for a minimum period of five years, and make available to INSPAC upon request, the GRSO analysis reports developed for agricultural aviation operations.
>
> (c) The COA holder must record and document aspects related to the compliance with its Safety Management System (SGSO), operational safety processes, and GRSO cycles developed within the company.

During the course of the investigation, the company did not present the GRSO for the area where the operation was being conducted. Additionally, no evidence was provided to indicate an effective effort focused on operational safety.

1.18. Operational information.

The flight, conducted under the requirements of the RBAC-137, Amendment 04, encompassed the application of agricultural fertilizers in a sugarcane field. Only the pilot was aboard the airplane.

According to the weight and balance sheet provided to the investigators, the basic weight of the PR-PPJ airplane was 2,540 lb., and the maximum takeoff weight was 4,800 lb.

According to the PIC, the aircraft was fueled with 180 liters of ethanol and carried 750 liters of fertilizer. There were no records or any type of control regarding fuel supply operations or the agricultural product applied.

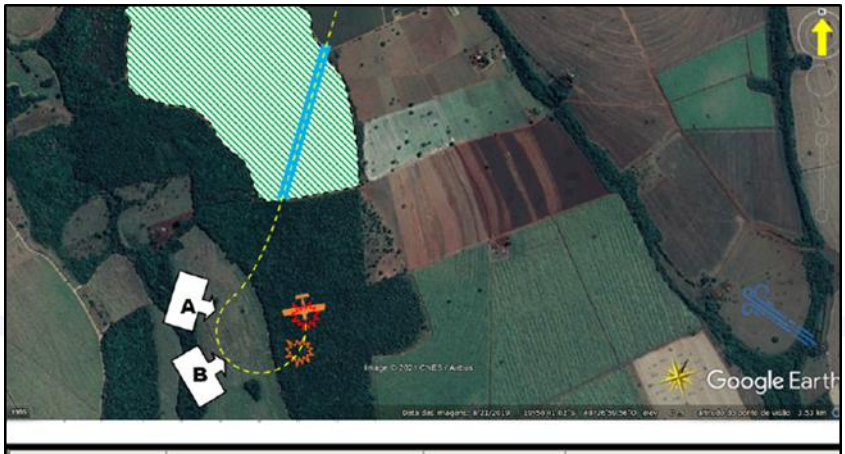
Nevertheless, considering the available data, one concluded that the aircraft was within the weight and balance limits specified by the manufacturer.

The PIC stated that before starting the flight, he carried out all inspections and checks on the aircraft, and did not notice any abnormalities.

According to the pilot, at approximately 16:00 UTC, during a reversal turn on the sixth flight of the day, he noticed a vibration followed by a loud bang coming from the aircraft’s engine.

According to the PIC, he jettisoned the entire load and continued the reversal turn. Shortly later, the left wingtip collided with a tree, leading him to make an emergency landing in the sugarcane plantation.

The aircraft came to a stop approximately 180° misaligned in relation to its initial direction of travel. (Figure 7).



Símbolo	Nomenclatura	Símbolo	Nomenclatura
	Aeronave (PA 34-375 Piper Brave)	N	Indicativo de Norte Verdadeiro
	Trajetória da aeronave		Direção do Norte Verdadeiro
	Área de aplicação(Fazenda Jataí)		Indicativo Norte Magnético (declinação -21,34°)
	Área da última aplicação(tiro)		Direção do vento (120° / 04 KT)
A	Ponto do estouro do motor / perda de potência		Primeiro impacto (árvore)
B	Ponto do Alijamento do defensivo agrícola		Ponto do crash site

Figure 7 - Sketch of the occurrence.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was an agricultural fertilizer application flight conducted under the requirements of the RBAC-137, with 01 POB (pilot).

Based on the METAR data from SBUR, an aerodrome located 28 NM from the accident site, one concluded that the meteorological conditions in the region of the accident were above the minima required for conducting the operation under the applicable flight rules. Weather conditions were not a contributing factor to this occurrence.

Similarly, reports collected during the investigation did not indicate any inadequacies in the operation of the airplane that could suggest the participation of operational factors in this accident.

On the other hand, considering the information from PIC that, at approximately 16:00 UTC, the aircraft experienced vibrations followed by a loud bang from the engine, with a subsequent loss of power, the investigation focused on the analysis of the powerplant.

The aircraft, registered under the SAE-AG category, was operating under a Special Flight Authorization (AEV) due to its engine conversion to run on ethanol in 2016.

The ignition, lubrication, and fuel systems were within normal parameters, and no discrepancies were identified that could have caused the engine failure.

The investigation identified the source of the failure in the cylinder nº 4, after verifying that it had detached from its base on the engine block. This detachment resulted from the failure of the studs (bolts) securing the cylinder to the block.

The analysis of the fractured components revealed that two through-studs and one fixed stud exhibited signs of material failure due to fatigue. This process compromised the structural integrity of these components, ultimately leading to their failure.

The failure of the bolt of the connecting rod cap occurred due to overload and was a consequence of increased stress in the engine, associated with the misalignment of the piston and the crankshaft's movement toward bottom dead center.

The loose connecting rod was compressed against the camshaft and engine block, causing the damage observed during the engine teardown.

It was not possible to identify a specific event that could have initiated the fatigue process in the studs (bolts) securing the cylinder nº 4 to the engine block.

Although the conversion to operation with ethanol altered some of the engine's operational parameters, it was not possible to establish a direct link between this modification and the failure that occurred during the flight.

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 Landplane) and PAGA (Agricultural Pilot - Airplane);

c) the PIC was qualified and experienced in this type of flight;

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

e) the aircraft was within weight and balance limits;

f) the records of the airframe logbook were out of date, as Part I contained no records of monthly usage after October 2016;

g) the records of the engine and propeller logbooks were up to date;

h) the meteorological conditions were above the minima required for the flight;

i) the PR-PPJ's powerplant was converted to operate on ethanol on May 18, 2016, in accordance with IS 137.201-001;

j) the PIC reported that during a reversal turn, he noticed a vibration followed by a loud bang coming from the aircraft's engine;

k) the PIC reported that shortly afterward, the left wingtip collided with a tree, leading him to make an emergency landing in the sugarcane field;

l) during examination of the engine, one observed that the cylinder nº 4 was detached from its base on the engine block, and the corresponding piston rod had separated from its crankshaft journal;

m) during the engine teardown, one observed that two through-studs and one fixed stud at the base of the cylinder nº 4 were fractured;

n) the failure of the studs, both through-studs and the fixed stud, was caused by material fatigue;

o) the analysis of the fastening bolt found along with part of the connecting rod cap of the cylinder nº 4's piston showed that the fracture surfaces exhibited characteristics typical of tensile overload failure;

p) the aircraft sustained substantial damage; and

q) the PIC sustained no injuries.

3.2. Contributing factors.

Undetermined.

4. SAFETY RECOMMENDATIONS

None.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On June 16th, 2025.