

COMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A-105/CENIPA/2021

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PP-JCS
MODEL:	210L
DATE:	16SET2021



NOTICE

According to the Law n^o 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 n^o 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 is the Final Report of the 16SEPT2021 accident with the Cessna 210L aircraft, registration marks PP-JCS. The accident was typified as “[SCF-PP] Engine failure or malfunction | Engine failure in flight.”

Twenty minutes after taking off on a ferry flight, the aircraft sustained engine failure.

The pilot landed in the waters of the *Mariauá* River.

Later, one verified that the “connecting rod cap” (part of the connecting rod that is attached to the crankshaft) of the cylinder nº 1 had a failure due to a fatigue mechanism.

The aircraft sustained substantial damage.

The pilot suffered no injuries.

For being the USA the State of design and manufacture of both the aircraft and its engine, the NTSB (USA’s National Transportation Safety Board) appointed an accredited representative for participation in the investigation of the occurrence.



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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
COM	Maintenance Organization Certificate
CTM	Technical Control of Maintenance
CVA	Airworthiness Verification Certificate
DCTA	Department of Science and Aerospace Technology
MNTE	Single-Engine Land Airplane Class Rating
NSCA	System Norm of the Command of Aeronautics
OM	Maintenance Organization
PCM	Commercial Pilot License (Airplane)
PIC	Pilot in Command
PMI	Bottom Dead Center
PMS	Top Dead Center
PPR	Private Pilot License (Airplane)
RBAC	Brazilian Civil Aviation Regulation
RCC-AZ	<i>Amazonian Search and Rescue Coordination Center</i>
SERIPA VII	7 th Regional Service for the Investigation and Prevention of Aeronautical Accidents
SESAI	Brazil's Indigenous Peoples' Health Secretariat
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
SWPD	ICAO location designator - <i>Pouso da Águia Aerodrome, Cantá, State of Roraima</i>
SWTP	ICAO location designator - <i>Aerodrome of Santa Isabel do Rio Negro, State of Amazonas</i>
TPX	Non-Regular Public Air Transport Registration Category
TSN	Time Since New
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	Model: 210L Registration: PP-JCS Manufacturer: Cessna Aircraft.	Operator: <i>Voare Táxi Aéreo Ltda.</i>
Occurrence	Date/time: 16SET2021 - (UTC) Location: Rio Mariauá Lat. 00°25'02"S Long. 065°02'02"W Municipality – State: <i>Santa Isabel do Rio Negro - AM</i>	Type(s): [SCF-PP] Powerplant failure or malfunction

1.1. History of the flight.

At around 16:45 UTC, the aircraft took off with 01 POB (pilot) on a ferry flight from SWTP (Aerodrome of *Santa Isabel do Rio Negro*, State of *Amazonas*), bound for the unregistered aerodrome of *Missão Mariauá*, located in the municipality of *Santa Isabel do Rio Negro*, *Amazonas*.

About twenty minutes into the flight, an engine failure occurred.

The pilot made a ditching on the *Mariauá* River.

The aircraft sustained substantial damage. The pilot 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 the engine, engine housing and windshield. There was slight damage to the fuselage and propeller (Figure 1).



Figure 1 - Front view of the aircraft engine, after removal from the river.

1.4. Other damage.

NIL.

1.5. Personnel information.**1.5.1. Crew's flight experience.**

	PIC
Total	1,960:00
Total in the last 30 days	82:50
Total in the last 24 hours	02:20
In this type of aircraft	335:05
In this type in the last 30 days	43:25
In this type in the last 24 hours	00:00

N.B.: data on the hours flown by the pilot obtained through pilot's records kept by the operator.

1.5.2. Personnel training.

The PIC (Pilot in Command) did his PPR course (Private Pilot – Airplane) in 2012, at *Escola de Aviação Realizar*, in the city of *Tôres*, State of *Rio Grande do Sul*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PCM License (Commercial Pilot – Airplane), and had a valid MNTTE rating (Single-Engine Land Aircraft).

1.5.4. Qualification and flight experience.

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

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The SN 21060984 aircraft was a product manufactured by Cessna Aircraft in 1975, and registered in the TPX Registration Category (Non-Regular Public Transport).

The CVA (Airworthiness Verification Certificate) was valid.

The airframe and propeller logbooks were up to date.

As per the engine logbook, the SN 553849 IO-520-L engine equipping the PP-JCS had a TSN (Time Since New) of 11,566 hours and 30 minutes in August 2021. However, after the inspection completed on 15SEPT2021, the TSN logged was 11,408 hours and 10 minutes.

Therefore, due to the discrepancy observed in the control of the engine utilization, one verified that the engine logbook was out of date.

According to the maintenance records, on 21FEB2019, when the engine had 10,603 hours and 10 minutes, an overhaul was carried out. Such procedure, in accordance with the Overhaul Manual, included the conduction of non-destructive tests and mandatory replacement of parts, as well as the application of Airworthiness Directives.

The last inspection of the aircraft (type “100 hours”) was performed on 15 September 2021 by the *Voare Táxi Aéreo Ltda* maintenance organization, in *Cantá*, State of *Roraima*. The aircraft flew 2 hours and 30 minutes after the referred inspection.

The last and more comprehensive inspection of the aircraft (type “200 hours”) had been carried out on 28 July 2021 in the same premises of the *Voare Táxi Aéreo Ltda* maintenance organization. The aircraft flew 104 hours and 20 minutes after the inspection.

1.7. Meteorological information.

The reported meteorological conditions were consistent with the conduction of VFR flights, with visibility above 10 km and FEW clouds, without the presence of significant weather in the area of the flight.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The occurrence was outside of aerodrome area.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The aircraft stayed submerged in the river for fifteen days before being removed by the operator. Nonetheless, according to a statement made by the PIC, the ditching was performed successfully, with the landing gear in the retracted position.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

NIL.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

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

1.14. Fire.

There was no fire.

1.15. Survival aspects.

Upon completion of the ditching, the pilot used the window on the right-hand side to evacuate the aircraft. He swam to the river bank and waited for help.

A few minutes after the emergency, the crew of a small boat, which was passing by the location, rescued the pilot and took him to *Santa Isabel do Rio Negro, Amazonas*.

Upon arriving in the city, the PIC managed to contact the company's headquarters. The company informed the RCC-AZ (Amazonian Search and Rescue Coordination Center) that the pilot had already been rescued, and that activation of the search and rescue procedures was not necessary.

1.16. Tests and research.

The SN 553849 model IO-520-L engine was sent for tests and research, which were monitored by the Investigation Commission and by the operator.

At the time, one verified that there was a hole in the upper part of the engine block, on the right-hand side, in an area adjacent to the cylinder nº 1 (Figure 2).

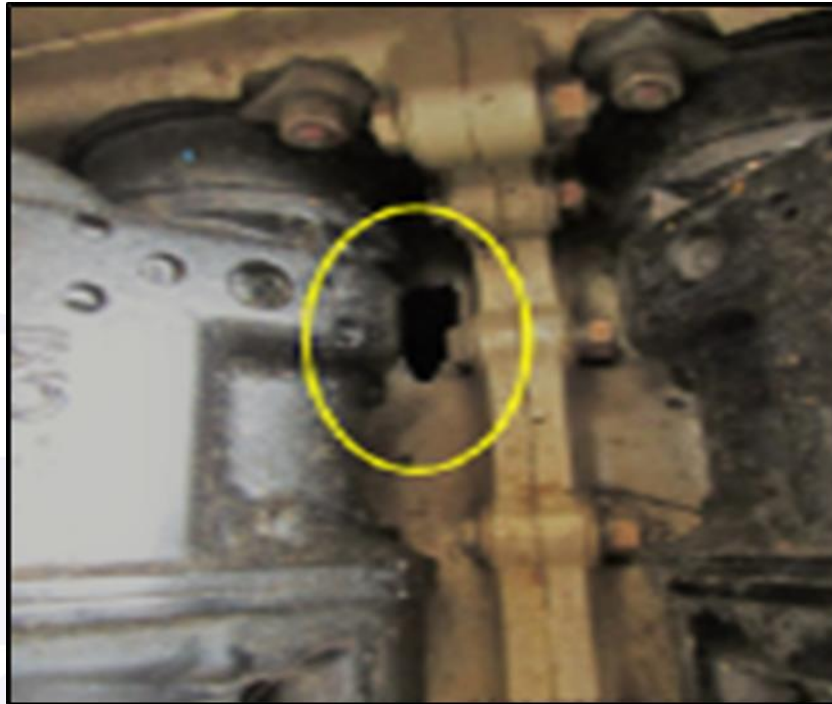


Figure 2 - Hole in the engine block housing close to the cylinder nº 1.

The crankcase was drained, that is, without oil, and many of its screws had been removed during the process of sending the engine to the workshop where the examinations were to be carried out.

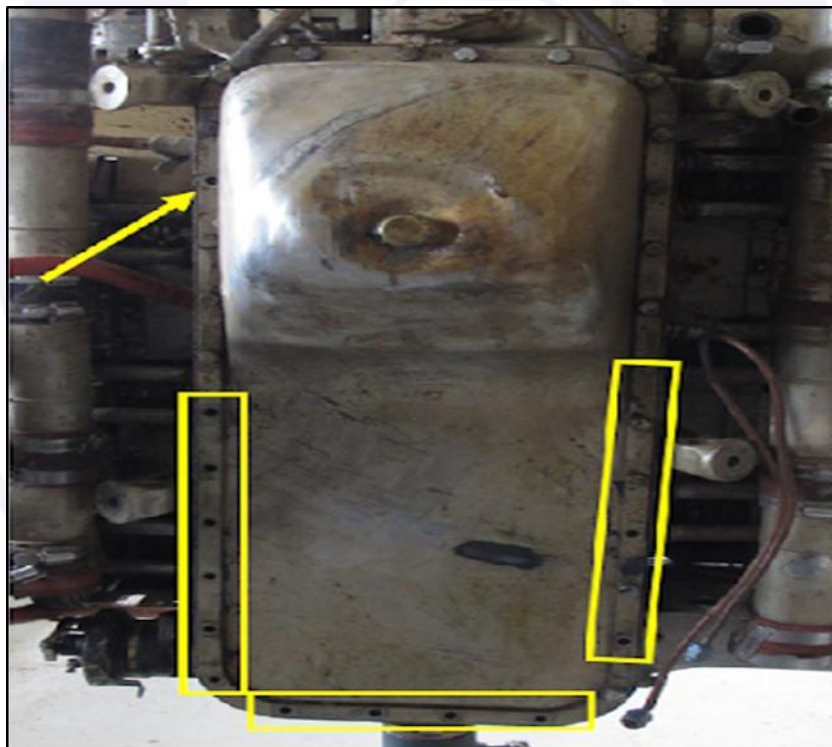


Figure 3 - Bottom view of the engine crankcase without some of the screws.

Fragments of the piston nº 1 were found inside the engine block, as well as parts of the respective connecting rod.

The damaged material was collected and sent to the Department of Science and Aerospace Technology (DCTA) for analysis aimed at elucidating the failure mechanism.

The analyses conducted at the DCTA revealed that the “connecting rod cap” (part of the connecting rod attached to the crankshaft) of the cylinder number nº 1 failed due to a

fatigue mechanism. However, it was not possible to identify the beginning of the pre-crack process, on account of the damage sustained after the failure, when the component was in operation.



Figure 4 - Material collected for analysis at the DCTA.



Figure 5 - General view of the piston and fragments. The red arrow indicates fractures attributed to an overload mechanism.

Due to the failure, the piston misaligned inside the cylinder, altering its upward and downward path, between the Top Dead Center (*PMS*) and the Bottom Dead Center (*PMI*).

As a consequence, during the motion, there was interference of the piston and piston rings with the inner wall of the cylinder. The sequence of piston movements under those conditions resulted in the rupture, due to overload, of the other interconnected components, such as connecting rod, piston body, piston pin and piston rings, generating the fragments found as illustrated in Figures 4 and 5.

As illustrated in Figure 6, the natural movement of the piston during operation of the engine is to move from Top Dead Center to Bottom Dead Center after the burning of the fuel-air mixture.

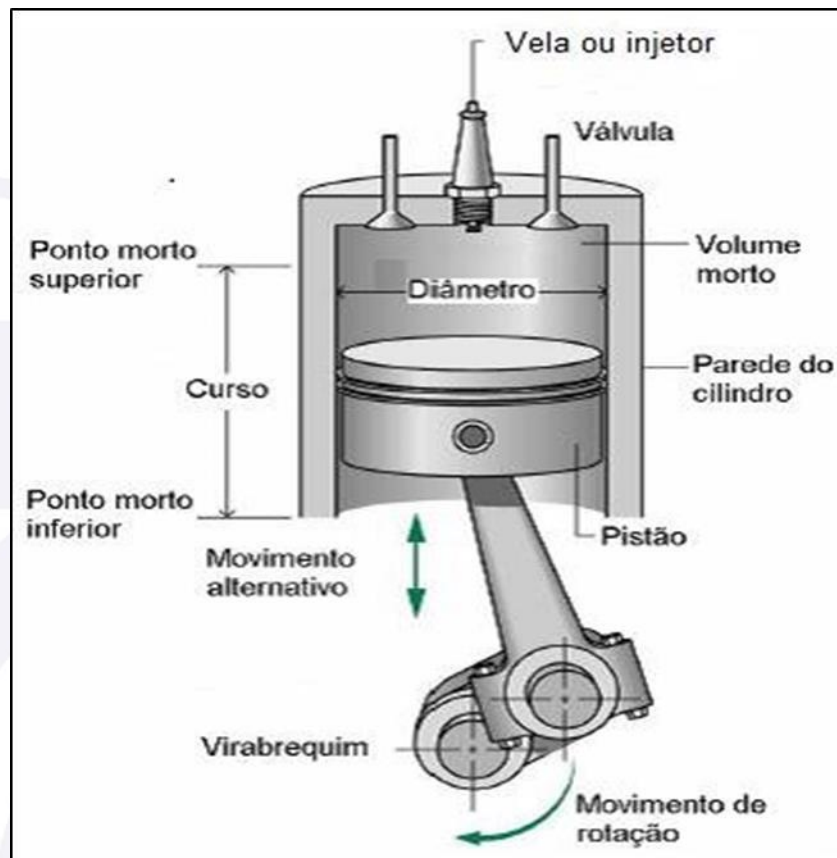


Figure 6 - Illustration of the piston, cylinder, rings, connecting rod and crankshaft.
Source: www.researchgate.net

One found the cap of the connecting rod corresponding to the piston nº 1 which had broken due to fatigue, and the piston which had broken due to stress as a result of the probable misalignment caused by the breaking of the connecting rod.

From that moment on, the engine started to work deprived of one cylinder, therefore unbalanced, vibrating strongly, and losing power and rotation, as the cylinder nº 1 lost effectiveness, thus overloading the other ones.

The remaining part of the connecting rod, still connected to the crankshaft, started to hit (hammer) against internal parts of the engine, such as the block and the bottom part of the cylinder nº 1. As a result, the skirt of the said cylinder was deformed and crushed.

In such chain of events, the connecting rod got deformed, and broke. Pieces of the connecting rod and parts of the piston caused secondary damage and filings inside the engine block.

From the analysis of the maintenance records made available to the Investigation Commission, one found that, among the services performed during the engine overhaul on 21 February 2019, the connecting rods underwent non-destructive tests, with utilization of fluorescent magnetic particles. All parts were approved, and, at that time, no traces of degradation of the material were evidenced.

It is worth noting that this kind of test aims at identifying degradation processes capable of compromising the microstructure of the material. It is also worth highlighting that the failure of the connecting rod* (*which had been approved in February 2019, when the engine had approximately 10,600 hours TSN) occurred in September 2021, when the engine had about 11,566 hours (i.e., after a period of time just over 2.5 years, with 960 hours of operation).

1.17. Organizational and management information.

The company *Voare Táxi Aéreo Ltda.*, with headquarters at SWPD (*Pouso da Águia Aerodrome, Cantá, State of Roraima*) started its activities on 08 August 2018, and operated in accordance with the RBAC-135 (Brazilian Civil Aviation Regulation nº 135). The company focused on passenger and cargo transport flights, in support of the Secretariat of Indigenous Health (SESAI).

On support missions, flights to unregistered locations, such as *Missão Mariauá*, were frequent. In this type of operation, the provisions of the Resolution nº 623 (issued by the ANAC on 07 June 2021) were applied. The referred Resolution approved specific rules for the use of unregistered land areas located within *Amazônia Legal* for the landing and takeoff of airplanes.

No organizational or management factors were observed that could have contributed to the occurrence.

1.18. Operational information.

The aircraft was within the weight and balance limits specified by the manufacturer.

After the ferry flight, the aircraft would be engaged on a passenger transport flight in support of SESAI.

The pilot had all the necessary qualifications and training for the flight. He had joined the company in 2019, and had experience in operations in the rain forest environment. No operational factors were observed that might have contributed to the occurrence.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a ferry flight from SWTP destined to an unregistered aerodrome, known as *Missão Mariauá*.

According to a report from the PIC, after approximately twenty minutes of flight, the aircraft sustained an engine failure. He informed that he got prepared to make a ditching. The landing procedure was successful and the PIC, as the only occupant of the aircraft, abandoned the airplane via the passenger window, and swam toward the river bank. He was rescued shortly later by the crew of a small boat which happened to be passing by.

The aircraft stayed submerged for around fifteen days before the operator was able to remove it from the accident scene in the river. Soon after being removed from the aircraft, the engine was set apart for future tests and research.

The SN 553,849 model IO-520L *Continental engine* which equipped the PP-JCS was disassembled and analyzed. Internal damage was observed in the block of the engine, including a hole on the upper part of the right-hand side. Several parts and fragments of the piston as well as internal parts of the block were spread inside the engine.

One verified that the cap of the connecting rod corresponding to the piston nº 1 had broken on account of fatigue, and the piston had broken due to stress resulting from the misalignment caused by the breaking of the connecting rod. Following such breaking, the engine continued working but now deprived of one cylinder, that is, unbalanced, vibrating strongly, and losing power and rotation, since the cylinder nº 1 had lost effectiveness, overloading the other cylinders.

In such chain of events, the connecting rod itself got deformed and ended up breaking. Pieces of the connecting rod and parts of the piston caused secondary damage and filings in the interior of the engine block.

Even though the maintenance plan was followed in accordance with the manufacturer's prescriptions, a discrepancy was found in the control of the engine hours. This led the Investigation Commission to consider that the engine logbook was out of date. In that context, it is possible that the failure to control the engine's hours allowed the use of internal components exceeding the time intervals set out in the manual, which could in turn lead to the collapse of parts in service, as was the case with the cap of connecting rod.

With regard to the overhaul of the engine, although the documentation made available indicated that the services were performed in accordance with the manuals, and the fact that the engine failure occurred just over 2.5 years later and with 960 hours of operation, the commission deemed that it was not possible to rule out the hypothesis that some non-conformity occurred during the non-destructive tests of the connecting rods.

3. CONCLUSIONS.

3.1. Findings.

- a) the pilot held a valid CMA (Aeronautical Medical Certificate);
- b) the pilot held a valid MNTE rating (Single-Engine Land Aircraft);
- c) the pilot had qualification and experience for the type of flight;
- d) the aircraft held a valid CVA;
- e) the aircraft was within the weight and balance limits;
- f) the cell and propeller logbooks were up to date;
- g) the engine logbook records were out of date;
- h) the reported meteorological conditions were consistent with VFR flights;
- i) the operation occurred in accordance with the ANAC Resolution nº 623/2021;
- j) there was an engine failure in flight;
- k) the aircraft made a ditching on the *Mariauá* River;
- l) the cap of the connecting rod of the cylinder nº 1 broke due to fatigue;
- m) the piston of the cylinder nº 1 broke due to stress;
- n) the aircraft sustained substantial damage; and
- o) the pilot did not suffer any injuries.

3.2. Contributing factors.

- **Aircraft maintenance – undetermined.**

Associated with the failure to control the engine operation hours, which would allow the use of internal components beyond the limits provided for in the manual, one should also consider the probability of some non-compliance during the execution of non-destructive tests of the connecting rods on the occasion of the overhaul. Such conditions could have contributed to the breaking of the cap of the connecting rod.

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-105/CENIPA/2021 - 01

Issued on 11/01/2023

Work with *Voare Táxi Aéreo Ltda.* (COM No. 1506-61/ANAC), so that the referred operator demonstrates that its Technical Maintenance Control (CTM) mechanisms are appropriately implemented and functioning, especially with regard to the activities related to controlling the utilization of aircraft and equipment operated by the company.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On November 1st, 2023.