COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-012/CENIPA/2021

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-FIB**
MODEL:	**150M**
DATE:	**27JAN2021**

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 is the Final Report of the 27 January 2021 accident with the Cessna 150M aircraft, registration marks PT-FIB. The accident received the typification of “[FUEL] Fuel related”.

While the aircraft was cruising, its engine lost power and shut down subsequently.

The pilot made an emergency landing in a rural area close to the city of *Serra Azul*, State of *São Paulo*.

One found that there was no fuel in the tanks and engine feeding lines.

The aircraft sustained substantial damage.

The pilot suffered minor injuries.

Being the USA the State of aircraft manufacture, the American *National Transportation Safety Board* (NTSB) designated an Accredited Representative for participation in the investigation of the occurrence.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AGL	Above Ground Level
ANAC	Brazil's National Civil Aviation Agency
AvGas	Aviation Gasoline
DCTA	Department of Science and Aerospace Technology
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIV	Pilot Logbook
CMA	Aeronautical Medical Certificate
CVA	Airworthiness-Verification Certificate
DTCEA-YS	*Pirassununga*'s Airspace Control Detachment
IFRA	IFR Flight Rating – Airplane
INVA	Flight Instructor Rating - Airplane
METAR	Routine Meteorological Aerodrome Report
MGSO	Safety Management Manual (SMM)
MLTE	Multi-Engine Land Airplane Class Rating
MNTE	Single-Engine Land Airplane Class Rating
NTSB	USA's National Transportation Safety Board
OM	Maintenance Organization
PCM	Commercial Pilot License - Airplane
PIC	Pilot in Command
PRI	Private Registration Category - Instruction
RBAC	Brazilian Civil Aviation Regulation
SACI	Integrated Civil Aviation Information System
SBRP	ICAO location designator - *Leite Lopes* Aerodrome, *Ribeirão Preto*, State of *São Paulo*
SBYS	ICAO location designator - *Campo Fontenelle* Aerodrome, *Pirassununga*, State of *São Paulo*
SERIPA IV	4th Regional Service for the Investigation and Prevention of Aeronautical Accidents
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
SNBA	ICAO location designator - *Chafei Amsei* Aerodrome, *Barretos*, State of *São Paulo*
US Gal	American Gallons
UTC	Coordinated Universal Time
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** 150M **Registration:** PT-FIB **Manufacturer:** Cessna Aircraft.	**Operator:** *Aeroclube de Barretos*.
Occurrence	**Date/time**: 27JAN2021 - 19:35 UTC **Location:** Rural Area in the Municipality of *Serra Azul*. **Lat.** 21°15'06"S **Long.** 047°31'27"W **Municipality – State:** *Serra Azul – São Paulo*	**Type(s):** [FUEL] Fuel related

1.1. History of the flight.

At around 15:50 UTC, the aircraft took off from SBRP (*Leite Lopes* Aerodrome, *Ribeirão Preto*, *São Paulo*) on an area reconnaissance flight, with 01 POB (pilot).

About 3 hours and 50 minutes into the flight, the pilot informed *Academia* Control (*Pirassununga* Approach Control callsign - SBYS) that he would make a forced landing in a field close to a highway, on the outskirts of the city of *Serra Azul* due to engine failure.

The aircraft and the pilot were located in a waterlogged area at 20:20 UTC by a helicopter of the State of São Paulo's Military Police Aviation Command.

The plane sustained substantial damage and the pilot suffered minor injuries.

Figure 1 - View of the PT-FIB at the accident site.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The aircraft sustained substantial damage. There was damage to the nose landing gear, wing extrados, empennage, and fuselage.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience	
	PIC
Total	373:58
Total in the last 30 days	17:00
Total in the last 24 hours	07:00
In this type of aircraft	17:00
In this type in the last 30 days	17:00
In this type in the last 24 hours	07:00

N.B.: data on the PIC's flight experience obtained through records from the pilot's Individual digital Logbook (CIV) available in the Integrated Civil Aviation Information System (SACI) of the National Civil Aviation Agency (ANAC), which was not up to date. The investigators did not have access to the crewmember's physical CIV**.**

1.5.2. Personnel training.

The PIC (Pilot in Command) did his PPR course (Private Pilot – Airplane) in 2013 at the *Aeroclube de Uberlândia*.

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), MLTE (Multi-Engine Land Airplane), IFRA (Instrument Flight - Airplane) and INVA (Flight Instructor - Airplane)

1.5.4. Qualification and flight experience.

The pilot had qualification and experience for the flight.

According to data extracted from the SACI system, he had undergone a proficiency exam flight to revalidate his license on 11 January 2021. After that he conducted six other flights, all of them in the PT-FIB, with 4 local flights departing from SNBA (*Chafei Amsei* Aerodrome), a flight from SNBA to SBRP, and then flight the accident flight.

No records of ground- or flight-training prior to the proficiency exam were presented to the investigators.

Before the aforementioned license-revalidation flight, the last entry in the pilot's digital CIV was from 18 January 2020, on a flight that he had worked as INVA.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The serial number 15077325 aircraft was a product manufactured by Cessna Aircraft in 1975, and registered in the Private Instruction Registration Category (PRI). In such Registration Category, the aircraft could not be used to perform Specialized Air Services, such as aerial surveys or filming.

The CVA (Airworthiness-Verification Certificate) was valid.

The records of the airframe logbook were out of date. The other logbooks contained up to date records.

The last inspection of the aircraft (“50-hour” type) was performed on 18 November 2020 by a qualified technician. The aircraft flew approximately 30 hours after the said inspection.

The last overhaul of the aircraft (type “*IAM* - Annual Maintenance Inspection*”*) was performed by the *Aerocenter Manutenção Aeronáutica e Peças* Maintenance Organization in *Jaboticabal*, State of *São Paulo*, on 20 July 2020. The aircraft flew approximately 139 hours after the referred inspection.

The aircraft had two metal structures fixed to the soffit of the fuselage that served as support for fitting a device contained in a metal box, found inside the airplane at the initial investigation (Figures 2 and 3).

Figure 2 - Metallic structure fixed to the fuselage's underside.

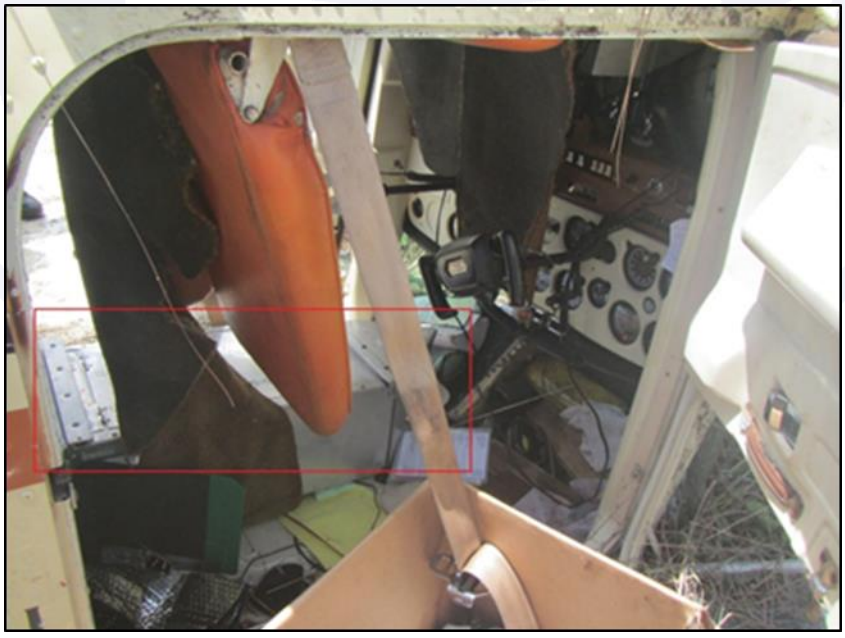


Figure 3 - Metal box that was fixed to the existing structure on the fuselage soffit.

According to information, the purpose of the said external structures was to support equipment used for aerial surveys/filming.

No records related to such modification were found in the aircraft documentation. When consulted, the OM that performed the last *IAM* affirmed that they were unaware of the aforementioned installation.

The investigation commission did not receive any documentation concerning a process by means of which the civil aviation authority could have been notified or consulted on the implementation of the said modification.

There were no records in the aircraft logbook of any breakdowns or discrepancies related to the systems or components.

General Characteristics of the Cessna 150M Aircraft

The aircraft was equipped with the SN L-251536 O-200A Teledyne Continental engine of 100 HP at 2,750 RPM, with 4 opposed cylinders, and carburetor feeding. It used a model 1A102/COM twin-blade metallic fixed-pitch McCauley Propeller (SN G15436), measuring 1.75 m in diameter.

Fuel System

The fuel supplied to the engine came from two tanks, one on each wing.

According to the airplane Owner's Manual, the quantities of usable, unusable, and total fuel in the tanks were 22.5, 3.5, and 26.0 US Gal, respectively (Figure 4).

FUEL QUANTITY DATA (U. S. GALLONS)

TANKS	TOTAL USABLE FUEL ALL FLIGHT CONDITIONS	TOTAL UNUSABLE FUEL	TOTAL FUEL VOLUME
STANDARD (13 Gal. Each)	22.5	3.5	26.0
LONG RANGE (19 Gal. Each)	35.0	3.0	38.0

Figure 4 - Fuel quantities for the 150M model. In the highlight, in red, the data of the version involved in the accident. Source: adapted from the plane's Owner's Manual.

The fuel would flow from the said tanks by gravity, passing through a selector valve on the cabin floor. From that point, it went to the impurity separator filter and, then, to the carburetor (Figure 5).

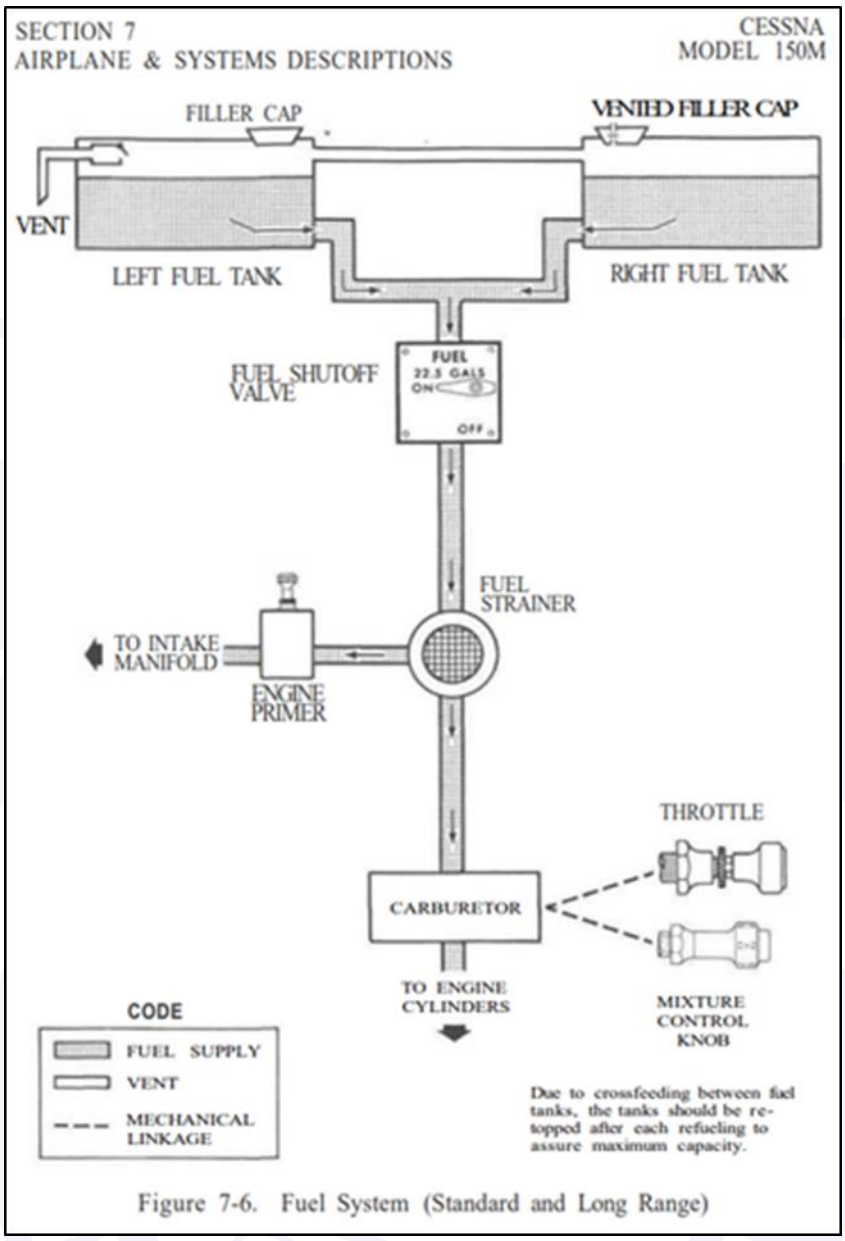


Figure 5 - Diagram of the 150M fuel system.
Source: Airplane Owner's Manual.

With the valve in the ON position, the fuel would flow through the filter to the carburetor. In the carburetor, it was mixed with the incoming air and sprayed into the cylinders through intake manifold pipes.

The amount of fuel was measured by two float-type quantity transmitters (one in each tank), and indicated by two quantity indicators in the lower left part of the instrument panel (Figures 6 and 7).

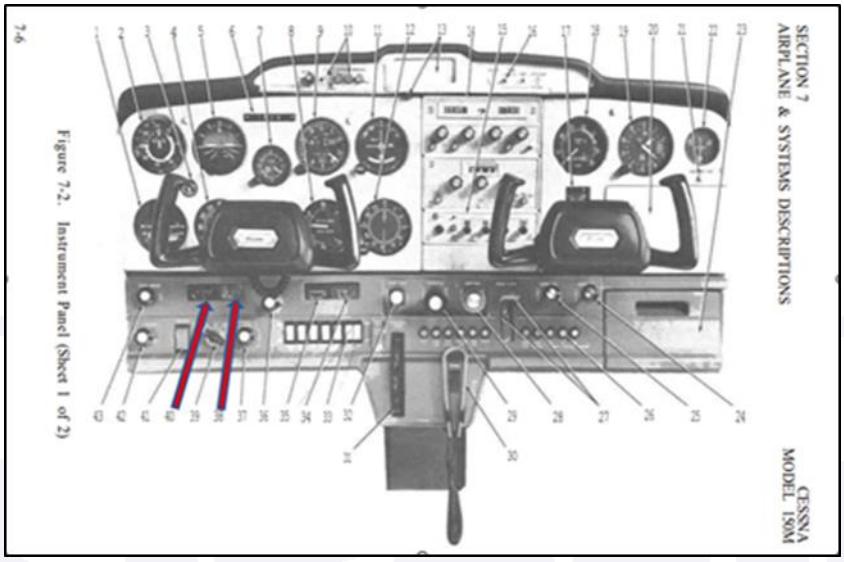


Figure 6 - Image of the aircraft panel highlighting the position of the fuel quantity indicators. Source: Airplane Owner's Manual.

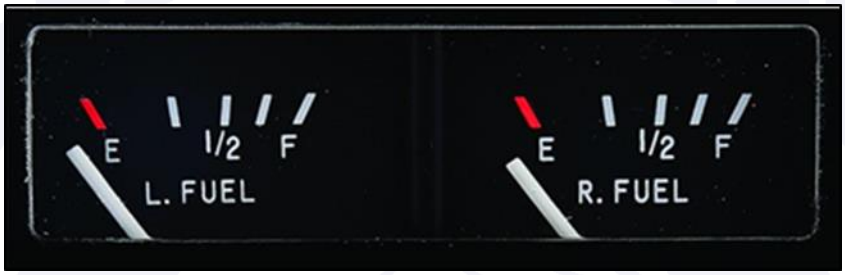


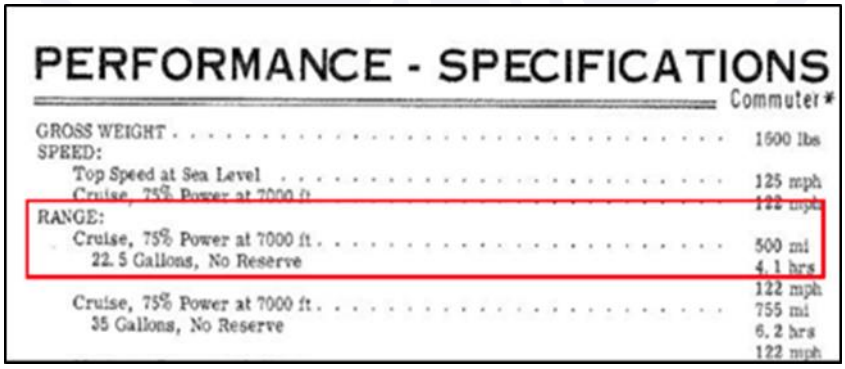
Figure 7 – Close-up view of the fuel indicators.
Source: adapted from the plane's Owner's Manual.

The empty-tank condition would be indicated by a red line and the letter E (Empty). With the indicator showing an empty tank, there would be approximately 1.75 US Gal of gasoline remaining in the respective tank, but such quantity was not usable.

According to the manufacturer's manual, the indicators would not have reliable readings during skidding or unusual maneuvers.

At an interview conducted at the initial investigation, the commission was informed by the PIC that the fuel quantity indicator of the right-hand tank was inoperative.

According to the Performance Specifications section of the aircraft manual, the 150M model's fuel endurance with full tanks (22.5 US Gal/85 liters) was 4 hours and 6 minutes of cruising flight time, using 75% power at an altitude of 7,000 ft. (Figure 8).

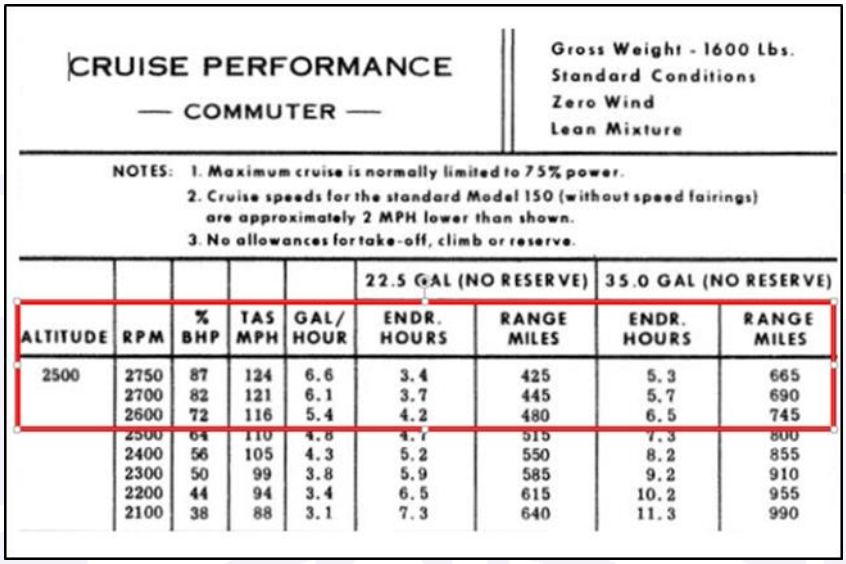


PERFORMANCE - SPECIFICATIONS

	Commuter*
GROSS WEIGHT	1600 lbs
SPEED:	
Top Speed at Sea Level	125 mph
Cruise, 75% Power at 7000 ft	122 mph
RANGE:	
Cruise, 75% Power at 7000 ft 22.5 Gallons, No Reserve	500 mi 4.1 hrs 122 mph
Cruise, 75% Power at 7000 ft 35 Gallons, No Reserve	755 mi 6.2 hrs 122 mph

Figure 8 - Performance specifications.
Source: adapted from the Aircraft Owner's Manual.

In turn, the Cruise Performance table in Section VI, Operational Data, of the Owner's Manual, showed that, at 2,500 ft altitude, the aforementioned endurance could vary between 3.4 hours (3 hours and 24 minutes) and 4.2 hours (4 hours and 12 minutes) (Figure 9).



CRUISE PERFORMANCE

— COMMUTER —

Gross Weight - 1600 Lbs.
Standard Conditions
Zero Wind
Lean Mixture

NOTES: 1. Maximum cruise is normally limited to 75% power.
2. Cruise speeds for the standard Model 150 (without speed fairings) are approximately 2 MPH lower than shown.
3. No allowances for take-off, climb or reserve.

					22.5 GAL (NO RESERVE)		35.0 GAL (NO RESERVE)	
ALTITUDE	RPM	% BHP	TAS MPH	GAL/ HOUR	ENDR. HOURS	RANGE MILES	ENDR. HOURS	RANGE MILES
2500	2750	87	124	6.6	3.4	425	5.3	665
	2700	82	121	6.1	3.7	445	5.7	690
	2600	72	116	5.4	4.2	480	6.5	745
	2500	64	110	4.8	4.7	515	7.3	800
	2400	56	105	4.3	5.2	550	8.2	855
	2300	50	99	3.8	5.9	585	9.2	910
	2200	44	94	3.4	6.5	615	10.2	955
	2100	38	88	3.1	7.3	640	11.3	990

Figure 9 - Extract from the Cruise Performance table.

1.7. Meteorological information.

The Routine Meteorological Aerodrome Reports (METAR) of SBRP, located 15.74 NM away from the accident site, contained the following information:

METAR SBRP 271900Z 33008KT 9999 FEW040 32/17 Q1011=

METAR SBRP 272000Z 32007KT 250V360 9999 FEW040 32/18 Q101=

METAR SBRP 272100Z 28006KT 250V310 9999 FEW040 31/18 Q101=

Images captured 27 minutes after the emergency landing by the cell phone of a crewmember of the Air Radio-Patrol Group of the State of São Paulo Military Police during the overflight, showed the presence of few clouds and good visibility (Figure 10).

Figure 10 - View of meteorological conditions on the day of the occurrence.

The conditions were favorable for VFR flights, with visibility above 10 km, few clouds at 4,000 ft, and temperatures varying between 31°C and 32°C.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

Occurrence outside aerodrome area.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The emergency landing took place in an open, wet forest area.

The first contact with the ground was with the main landing gear. After traveling approximately 50 meters, the aircraft pivoted due to undulations in the terrain. The distribution of the debris was concentrated (Figure 11).

Figure 11 - Final position of the aircraft.

The landing gear assembly remained attached to the aircraft, but the nose gear sustained substantial damage. The flaps were in the retracted position.

Military personnel who rescued the pilot reported not having smelled any fuel during the rescue. There were also no signs that gasoline had drained from the tanks, such as dryness in the vegetation around the aircraft or other signs of fuel contact with the water surrounding the plane.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

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

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC informed that he had purchased a package of hours from the aeroclub with the purpose of improving his skills, as a friend would introduce him to the Operations Director of a company specialized in aerial photogrammetric surveys to which he was applying for a position as a pilot.

Thus, the flight on which the accident occurred was intended for reconnaissance of the area and solo pilot-training.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

The search was done by an aircraft on alert of the Military Police of the State of *São Paulo* (callsign *Águia 17*), called on by DTCEA-YS (*Pirassununga* Airspace Control Detachment).

After locating the crashed airplane and its pilot, the rescue helicopter landed in a safe area close to the crash site. Upon arriving at the wreckage, the rescue team found that the pilot just had a few bruises.

The PIC reported that, after the aircraft overturned, he freed himself from his seat belts, and managed to open the cabin door to get out. When faced with the flooded ground, he chose to stay on the aircraft's wings, awaiting rescue.

At an interview after the accident, the pilot reported having removed the metal box installed on the support attached to the fuselage, and stored it inside the aircraft.

1.16. Tests and research.

The engine of the aircraft was examined at the facilities of *Estrela Dourada* Maintenance Organization (COM no. 1601-42/ANAC), based in *Itápolis*, State of *São Paulo*. The work was conducted by investigators of the SERIPA IV (Fourth Regional Service for the Investigation and Prevention of Aeronautical Accidents, accompanied by technicians of the DCTA (Department of Science and Aerospace Technology).

The SN 251536, model O-200-A Continental engine had a total of 7,806 hours and 35 minutes TSN, and had flown 139 hours and 55 minutes since the last overhaul, and 30 hours and 55 minutes since the last "50-hour" inspection.

During the preliminary external analysis, one found that the engine had not sustained severe damage resulting from the emergency landing. Therefore, the investigators decided to submit it to a functional test on the OM test bench.

Thus, after an external wash, the ignition, fuel control, and lubrication systems were checked, and the engine was installed on the test bench.

Regarding the ignition system, one found that the magnetos were synchronized and working properly.

The carburetor, its connections, and intake pipe flanges did not show any abnormalities.

Upon turning the engine manually, one found that there was oil pressure in the hose that transmitted information to the aircraft panel, indicating that the lubrication system was operating properly.

During the functional test, the engine was started up and operated for 5 minutes at 1,197 RPM to warm up, before being turned off to check for possible leaks, which were not found. After restarting the engine, one accelerated it to 1,984 RPM to test the magnetos. No discrepancies were found in that system.

Then, the engine was accelerated to maximum power, and reached 2,616 RPM, remaining at this speed for 6 minutes to simulate takeoff conditions. The maximum rotation prescribed in the aircraft manual was 2,750 RPM, however, the angle of the windlass blade used for the test was greater than that of the propeller installed on the aircraft and limited the rotation to the value achieved. Therefore, one considered that the observed difference did not constitute a discrepancy (Figure 12).

Figure 12 - Engine running at 2,616 RPM during the functional test.

In the sequence, the engine was reduced to “IDLE”, remaining in this condition for one minute for stabilization of its parameters and for being cut off.

Thus, after 13 minutes of functional testing, no abnormalities that might result in loss of performance during the flight were observed in the operation of the engine.

It was not possible to collect fuel samples for tests of compliance, due to the absence of gasoline in the aircraft's tanks or in the engine fuel lines.

A sample of lubricating oil was subjected to analysis and the results obtained from the tests showed that it was in accordance with the pertinent specifications and had no signs of contamination.

1.17. Organizational and management information.

The Aeroclub of *Barretos* handed in the following manuals to the investigators:

- Safety Management Manual - (MGSO);
- MLTE/IFRA Special Course Plan;
- Regulation for the Practical Flight Instructor Course - Airplane (INVA);
- Regulation of the Commercial Pilot/IFR Practical Course;
- Regulation of the Private Pilot Practical Course; and
- List of Procedures and Practices with a View to Safety.

The organization had a Risk Management System in place.

The Aeroclub showed to be well standardized and organized in relation to the training programs of the courses offered, although not yet possessing a certificate to function as a Civil Aviation Instruction Center (CIAC), according to data available on the ANAC website.

Upon analyzing the instructional programs of the courses in force at the time of the occurrence, one was not able to identify specific guidelines regarding the requalification of pilots not enrolled in the organization's regular courses.

Thus, there was no standardization of planning factors such as: availability of ground school, application of tests, requirements for the scheduled instructor, division of flight time between missions, and number of missions for re-adaptation, among others.

In a survey of the organization's manuals, no standards were identified concerning the fuel minimums for the different missions of the courses available.

As for the availability of the aircraft for the pilot involved in the occurrence, according to the Aeroclub, after some coordination, he paid for the contracted hours, and the dates on which the aircraft would be available to him were agreed.

The Aeroclub did not have authorization to carry out Specialized Air Services.

1.18. Operational information.

It was a private flight conducted under the requirements established by the Brazilian Civil Aviation Regulation nº 91 (RBAC-91), Amendment 01, which dealt with “General Operational Requirements for Civil Aircraft”, with take-off and landing procedures scheduled for SBRP (*Leite Lopes* Aerodrome, *Ribeirão Preto*, State of *São Paulo*.

It was not possible to determine whether the aircraft was within the weight and balance limits specified by the manufacturer since, after the installation of the aforementioned external structure, the aircraft was not weighed again.

According to a report by the PIC, the engine gradually lost power and “shut down” during the cruise flight without any other indications of abnormality. Faced with this situation, he decided to make a forced landing and, during the emergency procedure, the aircraft overturned.

According to information gathered, the pilot started up the aircraft's engine at 15:45 UTC. The aircraft took off at 15:50 UTC, and the accident was reported by *Academia* Control at 19:33 UTC. Thus, 3 hours and 48 minutes elapsed from the engine start-up to the forced landing.

The pilot reported that, during a considerable part of the flight, the aircraft was flying at 300 ft AGL.

He did not have a flight plan, and was not able to say whether he had considered the influence of the support installed under the fuselage on the aircraft's fuel endurance, as well as factors such as the wind along the route, the altitude of the flight, the air temperature in the regions through which he flew, and adjustment of the air/fuel mixture, among others.

As for the mixture adjustment used in the flight, the PIC reported that, upon taking over the aircraft, he was instructed by the Aeroclub not to handle the mixture lever because the system was out of order. He stated that in all the flights performed with the PT-FIB the throttle was in the same position. The pilot could not inform whether the mixture lever was locked in the “rich mixture” or “lean mixture” position.

No records were found in the aircraft documentation regarding problems with the mixture lever. The operator reported that he was unaware of the decision not to operate such lever.

According to the aircraft's logbook, the PIC had performed six flights with the PT-FIB, four of them without an instructor on board (solo flight), with takeoffs from SNBA (*Chafei Amsei* Aerodrome, *Barretos*, State of *São Paulo*).

The day before the accident, the aircraft took off from SNBA, being flown by the same pilot involved in the accident. After three hours and thirty minutes of flight, the aircraft landed in SBRP. The aircraft logbook records indicated that the airplane had received 90 liters of aviation gasoline before taking off from *Barretos*. The PIC was not able to inform the remaining fuel in the aircraft after the landing in Ribeirão Preto.

On the date of the occurrence, the logbook records indicated that the aircraft had 30 liters (7.92 US Gal) of fuel in the tanks. According to a fueling receipt presented to the investigators, the aircraft received an additional 72 liters of Aviation Gasoline (AvGas) (19.02 US Gal) before taking off for the accident flight.

The pilot was not able to explain the calculation he performed before logging that amount of remaining fuel in the aircraft logbook.

The fuel receipt presented by the pilot was in the name of the *Fotoagro* Company.

According to the PIC, the occurrence flight was his sixth contact with the PT-FIB between 24 and 27January 2021, a period in which he accumulated approximately 17 hours of flight.

At the interview with the pilot, he was not able to give prompt answers to any of the technical questions asked with respect to the aircraft, nor did he demonstrate knowledge of which chapter of the manual contained the information that was being asked.

1.19. Additional information.

Several environmental factors, such as altitude, air temperature, atmospheric pressure and air humidity, among others, have the potential to affect the air/fuel mixture.

Therefore, in order to maintain the engine operating efficiently, the pilot must constantly adjust the mixture, following the procedure prescribed in the aircraft operating manual.

An excessively rich mixture can cause, among other effects, loss of power, high fuel consumption, formation of residue (carbon) on the spark plugs, and rough engine operation.

On the other hand, an excessively lean mixture may result in high temperature in the cylinder head, capable of causing abnormal combustion (detonation), drop in power, and, in extreme cases, even engine shutdown.

With respect to modifications in certified aeronautical products, the RBAC-21, Amendment 06, dealing with *Certification of Aeronautical Products and Articles*, established the following in Subpart D - Modifications to Type Certificates, section 21.93 “Classification of Modifications to the Type Design”, letter (a):

> 21.93 Classification of modifications to type design
>
> (a) In addition to the type design modifications specified in paragraph (b) of this section, type design modifications are classified as major and minor. A “minor modification” is one that does not have an appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, and other characteristics affecting the airworthiness of the product. All other modifications are “major modifications” (except as provided in paragraph (b) of this section).

The same Subpart of the said Regulation specified, in section 21.95 *Approval of minor modification to type design*, the following:

> 21.95 Approval of minor modification to the type design
>
> Minor modifications may be approved: (wording given by Resolution No. 495, dated 11.14.2018)

> (a) according to a method acceptable to the ANAC, without prior presentation of any supporting data; or (Included by Resolution nº 495, dated 11.14.2018)
>
> (b) through the design organization when certified according to subpart J. (Included by Resolution nº 495, dated 14.11.2018)

With regard to fuel requirements, the RBAC-91, Amendment 01, which established the "*General Operating Requirements for Civil Aircraft*", in its Subpart B - "*Flight Rules*", section 91.151 *Fuel and oil requirements for* VFR *flights*, letter (a), contained the following information:

> 91.151 Fuel and oil requirements for VFR flights
>
> (a) It is only permitted to commence a VFR flight in an airplane if, considering known wind and weather conditions, there is sufficient fuel and oil to fly to the first landing location scheduled and, assuming normal cruise speed:
>
> (1) during daytime, fly for at least 30 minutes further, except for aerobatic flights at a maximum distance of 50 km (27 NM) from an aerodrome; or
>
> (2) during nighttime, fly for at least 45 minutes further.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a private flight being conducted under the requirements established by the RBAC-91, Amendment 01, with takeoff and landing scheduled for SBRP.

Considering that the information gathered on the weather conditions in SBRP and at the site of the forced landing showed no significant meteorological phenomena in the region where the flight was being conducted, one concluded that the meteorological aspect did not play a role in the accident in question.

Similarly, considering that, after 13 minutes of functional testing, no abnormalities that could result in loss of performance during the flight were observed in the operation of the engine, one concluded that the engine shutdown was not due to a failure of its internal components or external systems (fuel, ignition, and lubrication).

On the other hand, considering that, during the initial investigation, the investigators found no gasoline in the aircraft's tanks or in the engine's fuel lines, and the military personnel responsible for rescuing the pilot reported that they did not smell any fuel, in addition to the fact that there were no signs that fuel had drained from the tanks after the plane overturned, the initial inference was that the engine had shut down due to fuel exhaustion.

Based on the information collected, the aircraft would have at the time of takeoff 26.94 US Gal of gasoline (7.92 US Gal remaining from the previous flight, and 19.02 US Gal received in SBRP), 22.5 US Gal of which would be usable.

One can see that, according to the aircraft manual, the total capacity of the fuel tanks was 26 US Gal. Therefore, the information logged in the aircraft's logbook was not correct.

However, with full tanks under normal operating conditions (Figure 9), the plane would have a fuel endurance of between 3.4 hours (3 hours and 24 minutes) and 4.2 hours (4 hours and 12 minutes).

Thus, considering that 3 hours and 48 minutes elapsed from the start-up of the engine until the forced landing, and that the pilot performed a large part of the flight at an altitude of 300 ft AGL without making any mixture correction, and that there was no gasoline in the aircraft's tanks or in the engine fuel lines, nor any signs that the fuel had drained from the tanks after the aircraft overturned, one concluded that there was no minimum safety margin in relation to fuel endurance and that the engine's shutdown was due to fuel exhaustion.

In this scenario, the inadequacy of the work of preparation for the flight was characterized as a contributing factor to the accident in question, specifically with regard to the calculation of the fuel necessary to safely carry out the intended flight segment.

In the context of the operation conducted, there was poor assessment of the implications of the non-conformities presented by the aircraft (irregular structure installed on the fuselage soffit, inoperative mixture lever, and inoperative liquid meter) on the aircraft's performance and control of fuel consumption during the flight, a circumstance that also played a role in the occurrence in question.

In the same way, the fact that the pilot agreed to fly the aircraft, despite the existing discrepancies, as well as the fact that the fuel requirements for VFR flights established in the RBAC-91 were not considered, characterized the adoption of a complacent attitude, increasing the level of risk of the operation, which contributed to the in-flight engine flameout.

It is possible that a high degree of motivation, resulting from the possibility of being hired by a company specialized in aerial photogrammetric surveys, led the pilot to value his own interests and disregard the implications for flight safety associated with the aircraft's non-conformities and with the non-compliance with fuel requirements established in civil aviation regulations.

As for the PIC's technical preparation: although he was qualified for the flight, the fact that, during the interview conducted by the investigators, the pilot was not able to immediately answer any of the technical questions about the aircraft, and did not demonstrate knowledge of which chapter of the manual contained the information he was being questioned about, indicated that the training process previously received may not have adequately prepared him for executing the air activity onboard the PT-FIB.

Since no records concerning either ground- or flight-training were presented, it was not possible to get to know details of the PIC’s preparation for the flight proficiency checkride performed on 11 January 2021.

Relatively to the aspect mentioned above, the fact that the Aeroclub's instruction programs did not include standardization for the provision of proficiency checks to pilots not enrolled in the Organization's regular courses may have undermined the quality of the evaluation during the license-revalidation flight, allowing to release the pilot for the conduction of subsequent flights despite not having all the required knowledge.

In this sense, the Aeroclub's manuals were found to be inadequate, as they did not provide individuals with information necessary for the appropriate and safe performance of their duties, a deficiency that may also have contributed to the accident in question.

With regard to the aircraft's airworthiness conditions, the fact that no records of the installation of a structure under the fuselage were found in the pertinent documentation, and that no process related to this modification was presented to the investigators, showing that the civil aviation authority had been notified or consulted about the intended implementation, as well as the operator's statement of being unaware of the determination not to operate the mixing lever revealed inadequate supervision by the Aeroclub management, with regard to the control of the documentation and to the technical conditions of the equipment.

Such non-conformities, particularly those related to the mixture lever and the right-hand liquid meter, interfered with the pilot's ability to control the aircraft's fuel consumption during the flight, and contributed to the accident under consideration.

Finally, assuming that the installation of the device found on the aircraft during the initial investigation constituted a minor modification in the design of the 150M model, one found that the requirements established in section 21.95 of the RBAC-21 were not met, something suggestive of low compliance of flight safety principles, capable of compromising the safety of operations.

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), MLTE (Multi-Engine Land Aircraft), IFRA (Instrument Flight - Airplane) and INVA (Flight Instructor - Airplane);

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

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

e) it was not possible to determine whether the aircraft was within the weight and balance limits;

f) with the exception of the airframe logbook, the other logbooks were up to date;

g) the meteorological conditions were consistent with the type of flight;

h) the PIC informed to have purchased a package of hours from the aeroclub;

i) no records of ground- or flight-training performed in the aircraft by the PIC were presented to the investigators;

j) the PIC reported that the aircraft's right-hand tank fuel indicator was inoperative;

k) the aircraft received 72 liters of AvGas on the day of the accident, but the pilot was unaware of the amount of fuel remaining from the day before;

l) the PIC reported that, during the flight, the engine lost power and then shut down;

m) the pilot made an emergency landing in a waterlogged rural area;

n) during the landing, the aircraft overturned;

o) at the initial investigation action, one found that the aircraft had two metal structures fixed to the soffit of the fuselage that served as support for fitting a device contained in a metal box found inside the plane;

p) no records of the abovementioned modification were found in the aircraft's documentation;

q) the investigators were not presented with any process related to the abovementioned modification in which the civil aviation authority was notified or consulted about its implementation;

r) at the initial investigation action, the investigators found no gasoline in the aircraft's tanks and in the engine fuel lines;

s) after 13 minutes of functional testing on the bench, no abnormalities were observed in the operation of the engine that could result in loss of performance during the flight;

t) the aircraft sustained substantial damage; and

u) the pilot suffered minor injuries.

3.2. Contributing factors.

Attitude – a contributor.

The acceptance to fly the aircraft under the observed conditions, as well as the fact that the fuel requirements for VFR flights established in the RBAC-91 were not considered, characterized the adoption of inappropriate attitudes such as complacency, non-compliance with operations and procedures, and passivity.

Instruction – undetermined.

With respect to the PIC's technical preparation, although he had qualification for the flight, the fact that he was unable to immediately answer technical questions about the aircraft at the interview conducted by the investigators indicated that the training process previously received may not have adequately prepared him for operation of the PT-FIB.

Piloting judgment – a contributor.

In the context of the operation being conducted, one found that the implications of the non-conformities presented by the aircraft (irregular structure installed on the fuselage soffit, inoperative mixture lever, and inoperative liquid meter) on the aircraft's performance and fuel control during the flight were not adequately assessed, a circumstance that played a role in the occurrence in question.

Motivation – undetermined.

It is possible that a high degree of motivation on account of the possibility of being hired by a company specialized in aerial photogrammetric surveys, led the pilot to value his own interests and disregard the implications for flight safety associated with the airplane's non-conformities, besides non-compliance with fuel requirements established in civil aviation regulations.

Flight planning – a contributor.

The investigation revealed that the inadequacy of the preparation work for the flight was a contributing factor to the accident in question, specifically with regard to the calculation of the fuel necessary for the accomplishment of the intended flight segment.

Support systems – undetermined.

The fact that the Aeroclub’s instruction programs would not include standardization for the conduction of proficiency checks for pilots not enrolled in the Organization's regular courses may have harmed the quality of the assessment during the check flights, resulting in the release of the pilot for subsequent flights without acquisition of all the necessary knowledge.

Managerial oversight – a contributor.

The absence of records regarding the installation of a structure under the PT-FIB fuselage in its documentation, the lack of presentation of any process related to this modification to the investigators, where the civil aviation authority was notified or consulted about its implementation, along with the operator's statement of being unaware of the directive not to operate the mixing lever, exposed inadequate supervision by the aeroclub’s management staff concerning the control of documentation and technical conditions of the equipment.

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-012/CENIPA/2021 - 01 **Issued on 02/09/2024**

Work alongside the Aeroclub of *Barretos*, in order to ensure that its managerial oversight mechanisms demonstrate proper control over the airworthiness conditions of the aircraft operated, particularly in what refers to the effective management of the documentation and the technical conditions of the equipment used in air operations.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On February 09th, 2024.