

COMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A - 054/CENIPA/2017

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PP-EPB
MODEL:	PA-42
DATE:	31MAR2017



NOTICE

According to the Law n° 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

The elaboration of this Final Report was conducted taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document which reflects the result obtained by SIPAER regarding the circumstances that contributed or may have contributed to triggering this occurrence.

The document does not focus on quantifying the degree of contribution of the different factors, including the individual, psychosocial or organizational variables that conditioned the human performance and interacted to create a scenario favorable to the accident.

The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree n° 21713, dated 27 August 1946.

Thus, it is worth highlighting the importance of protecting the persons who provide information regarding an aeronautical accident. The utilization of this report for punitive purposes maculates the principle of “non-self-incrimination” derived from the “right to remain silent” sheltered by the Federal Constitution.

Consequently, the use of this report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. Taking into account the nuances of a foreign language, no matter how accurate this translation may be, readers are advised that the original Portuguese version is the work of reference.

SYNOPSIS

This is the Final Report of the 31MAR2017 accident with the PA-42 aircraft, registration PP-EPB. The accident was classified as “[FUEL] Fuel / Fuel Starvation”.

During the approach, the aircraft collided against the ground, approximately, 1km from the runway.

The aircraft was destroyed.

The pilot and passenger suffered fatal injuries.

An Accredited Representative of the National Transportation Safety Board (NTSB) - USA, (State where the aircraft was designed) and an Accredited Representative of the Transportation Safety Board (TSB) – Canada, (State where the engine was designed and manufactured) were designated for participation in the investigation.



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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
APA	Aeronautical Propulsion Division
AQI	IAE Chemistry Division
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
DAESP	São Paulo Airways Department
DCTA	Department of Science and Airspace Technology
FCU	Fuel Control Unit
FL	Flight Level
IAE	Aeronautics Space Institute
IAM	Annual Maintenance Inspection
IFRA	Instrument Flight Rating - Airplane
METAR	Aviation Routine Weather Report
MLTE	Airplane Multi Engine Land Rating
NTSB	National Transportation Safety Board (USA)
PCM	Commercial Pilot License – Airplane
POH	Pilot's Operating Handbook
PPR	Private Pilot License – Airplane
RBHA	Brazilian Regulation of Aeronautical Certification
SBKP	ICAO Location Designator – Viracopos Aerodrome, Campinas - SP
SBBW	ICAO Location Designator – Barra do Garças Aerodrome - GO
SBEG	ICAO Location Designator – Eduardo Gomes International Aerodrome, Manaus - AM
SBMT	ICAO Location Designator – Campo de Marte Aerodrome, São Paulo - SP
SDCO	ICAO Location Designator – Sorocaba Aerodrome, São Paulo - SP
SN	Serial Number
SWFN	ICAO Location Designator – Flores Aerodrome, Manaus - AM
TPP	Registration Category of Private Service - Aircraft
TSB	Transportation Safety Board
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	Model: PA-42	Operator: Itapara Sport Fishing Ltda. – ME
	Registration: PP-EPB	
	Manufacturer: Piper Aircraft	
Occurrence	Date/time: 31MAR2017 - 1745 UTC	Type(s): [FUEL] Fuel
	Location: Terezinha Troy Giraldi St.	
	Lat. 23°27'40"S Long. 047°29'24"W	Subtype(s): Fuel Starvation
	Municipality – State: Sorocaba – SP	

1.1 History of the flight.

The aircraft took off from the Flores Aerodrome (SWFN), Manaus - AM, to the Barra do Garças Aerodrome (SBBW) - MT, at about 1110 (UTC), to carry personnel, with one pilot and one passenger on board.

Still en-route, there was a change of destination to the Sorocaba Aerodrome (SDCO) - SP.

During the approach, the aircraft crashed into the ground, approximately 1km from the SDCO runway.

The aircraft was destroyed.

The crewmember and the passenger suffered fatal injuries

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft was destroyed.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours	Pilot
Total	3,382:45
Total in the last 30 days	13:37
Total in the last 24 hours	06:37
In this type of aircraft	118:48
In this type in the last 30 days	13:37
In this type in the last 24 hours	06:37

N.B.: The Data related to the pilot's total hours were obtained through the ANAC's Digital CIV and the recent experience data were extracted from the aircraft flight logbook.

1.5.2 Personnel training.

The pilot took the PPR course in 1980.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PCM License and had valid MLTE and IFRA Ratings.

1.5.4 Qualification and flight experience.

The pilot was qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilot had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 42-8001035, was manufactured by Piper Aircraft, in 1981 and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The airframe, engines and propellers logbooks records were outdated. The last total flown hours was launched in August 2016, the same month of the last aircraft inspection and also the IAM.

The last inspection of the aircraft, the "100 hours" type, was carried out on 26AUG2016 by the CONAL - *Construtora Nacional de Aviação* Ltd. maintenance organization, in Sorocaba – SP, with the aircraft having flown 66 hours and 10 minutes after the inspection.

According to the aircraft Pilot's Operating Handbook (POH), the maximum amount of fuel usable in the tanks was of 3,752 pounds.

1.7 Meteorological information.

The conditions were favorable for the visual flight.

The METAR of the Eduardo Gomes International Aerodrome (SBEG), Manaus – AM, placed about 5km away from the Flores Aerodrome, provided the following information:

METAR SBEG 311000Z 0000KT 9999 FEW010 25/23 Q1011=

METAR SBEG 311100Z 04005KT 9999 SCT006 25/24 Q1012=

METAR SBEG 311200Z 05007KT 9999 SCT008 26/24 Q1013=

The METAR of the Campo de Marte (SBMT), São Paulo - SP and Viracopos (SBKP), Campinas - SP Aerodromes, away, 47 and 34 nautical miles from the crash site, respectively, provided the following information:

METAR SBMT 311700Z 14009KT 9999 BKN040 22/13 Q102=

METAR SBKP 311700Z 15009KT 9999 SCT040 25/// Q1019=

The wind and temperature chart on FL 100, valid until 1800 (UTC) on 31MAR2017, showed that the wind on the route traveled by the aircraft varied significantly, in direction and intensity.

Initially there was tailwind. In the course of the flight, it has changed to crosswind and may also have had a head component.

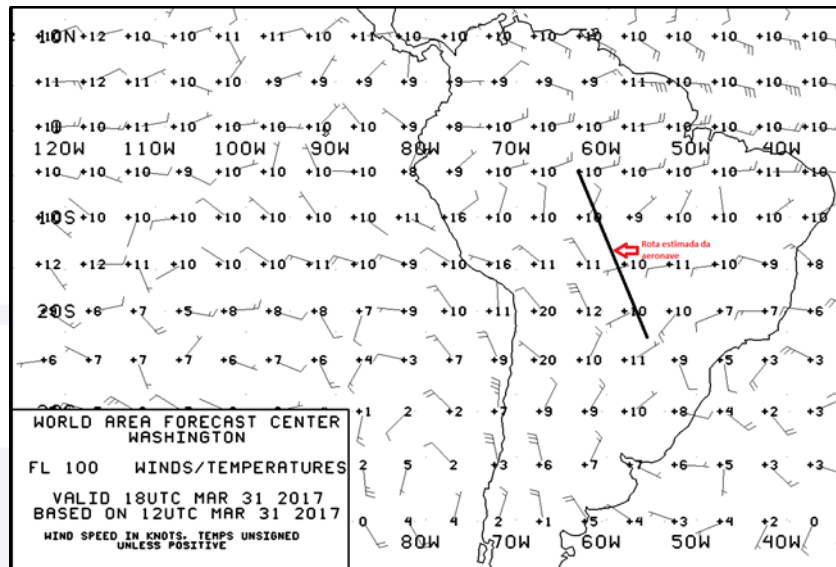


Figure 1 - Wind and temperature chart with estimated PP-EPD route marked.

1.8 Aids to navigation.

Nil.

1.9 Communications.

Nil.

1.10 Aerodrome information.

The Aerodrome was public, run by the DAESP and operated under Day and Night Visual Flight Rules (VFR).

The runway was made of asphalt, with 18/36 thresholds, dimensions 1,480m x 30m, with elevation of 2,077 feet.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The aircraft crashed approximately 1km from the Sorocaba Aerodrome runway threshold.

Before the impact into the ground, the plane crashed against trees. Some parts were found in backyards of houses near the final stop.

The landing gears were down. The three landing gears detached from the plane.

The tail cone had come off of the fuselage and was ahead of the wreckage concentration.

The propellers were found detached from the aircraft and severely damaged.

There was a smell of fuel on the crash site, but no dryness marks were found on the surrounding vegetation or other signs of fuel contact. There was no fire after the collision.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Not investigated.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

There were no survivors.

1.16 Tests and research.

Both aircraft engines were examined at the Pratt & Whitney Canada facility in Sorocaba, SP. The results of these examinations were recorded in a research report prepared by the APA of the DCTA's IAE.

The engines were identified as Pratt & Whitney, model PT6A-41, Serial Number (SN) PCE - 81897 (left) and PCE - 81891 (right), respectively. They were severely damaged on impact.

The engine fuel filters were checked and presented a normal aspect in operation.

The fuel pumps were examined and there was evidence of cavitation in the gear bushings. In addition, there were rub marks on the gear housing and contact between their teeth.

On the right engine, there were scratch marks and damage to the compressor centrifugal stage vanes, light scratch marks on the segmented ring and fragments deposited on the compressor stator blades.

Still on the right engine, in relation to the power turbine, it was verified rubbing in the root of the first stage rotor vanes and in the ends of the second stage vanes. The power axis had broken.



Figure 2 - View of the right engine of the aircraft.

The Fuel Control Unit (FCU) drive shaft of the right engine showed misalignment in the stretch marks (Figure 3).

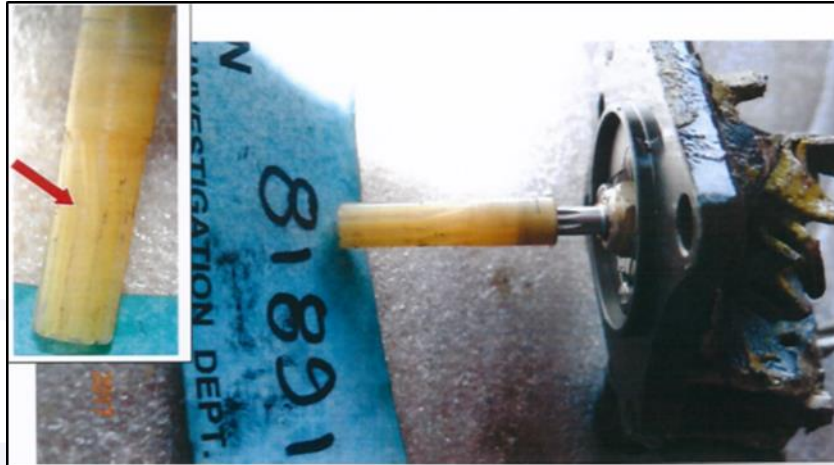


Figure 3 - Right engine FCU drive shaft. In detail, the misalignment of stretch marks.

The P3 filter was clean. P3 and Py lines were examined and no abnormalities were found.

Compressor bleed valves looked normal operation.

The engine oil filter was found and no evidence of filings was observed.

The fuel pump installed on the right engine had a different serial number than the one on the engine logbook and in the component control information map of the aircraft.

Over the left engine of the aircraft, similar cavitation conditions were observed in the fuel pump. However, the FCU drive shaft looked normal in the operation.

Likewise, the P3 filter was clean and the P3 and Py lines had normal operating conditions.

The left engine oil filter was checked and no fillings were found.

In the compression turbine, damage and rubbing were found at the ends of the rotor vanes. In the power turbine, the ends of the blades were rubbed and some of them fractured.



Figure 4 - View of the left engine of the aircraft.

On the left engine fuel pump, signs of cavitation were found in the gear bushings, indicating low or no fuel operation (Figure 4).



Figure 5 - View of left engine fuel pump bushings with evidence of cavitation.

In addition, the gear teeth showed characteristic of overheating discoloration. Gear housings are marked by their rotation, which is a characteristic situation in cases of lack of fuel starvation.

Examinations of the collected fuel samples confirmed that it was aviation kerosene. The samples contained a residual powder, which, according to the IAE Chemistry Division (AQI) test report, consisted of silicate or aliphatic compound. However, it was not possible to specify which material it was.

1.17 Organizational and management information.

The pilot was a partner of the aircraft operating company and regularly took off from Manaus, conducting passengers who visited an Inn, located to the North of the city, for conducting sport fishing. Later, it transported the passengers back to Manaus.

This route was made by plane due to the difficulty of reaching the place of the Inn by means other than air.

1.18 Operational information.

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

According to the information gathered, the fuel tanks were filled to their maximum capacity (3,752 lbs usable).

The flight plan was passed with the information that the aircraft would take off from SWFN to SBBW and would proceed on FL135. The estimated flight time was of 4 hours and it would have 7 hours of autonomy.

The plan, which estimated a speed of 220 knots, indicated that the alternate Aerodrome was Sorocaba (SDCO) - SP, and that the estimated takeoff time was at 1100 (UTC), 07:00 am, local time in Manaus.

The planned flight leg from Manaus to Barra do Garças was 887 nautical miles away, considering the straight-line route.

The pilot changed his destination in flight from Barra do Garças (SBBW) - MT, to Sorocaba (SDCO) - SP. The distance between the accident site and the takeoff Aerodrome was of 1,419 nautical miles.

According to information gathered, the pilot intended to land on SDCO, in order to deliver the aircraft for inspection.

The flight was performed at low flight level (FL135), although the aircraft had the ability to fly at higher levels as it had a pressurization system.

According to the investigators' calculations, if the flight had been performed at Long Range Power, about 3,400lbs of fuel would be required just to fly from SWFN to SDCO. Under this regime, the cruising speed of the aircraft would be 202kt and it would arrive in Sorocaba with a reserve of 366lbs, enough to fly approximately 30 minutes more under Recommended Cruise Power.

	Distância (nm)	Velocidade (kt)	Tempo Estimado de Voo (horas)	Fluxo de Combustível (lbs/h)	Consumo (lbs)
Táxi e Decolagem	0				80
Subida	14	120	0,1		80
Cruzeiro	1382	202	6,8	462	3161
Descida	25	180	0,1		65
	1421		7,0		3386

Figure 6 - Performance data obtained from the POH "Long Range Power - 1700 RPM - ISA +10" chart for FL 135.

For the same journey under Recommended Cruise Power, consumption would be of approximately 4,200lbs. Under this regime, the cruising speed of the aircraft would be of 282kt.

	Distância (nm)	Velocidade (kt)	Tempo Estimado de Voo (horas)	Fluxo de Combustível (lbs/h)	Consumo (lbs)
Táxi e Decolagem	0				80
Subida	14	120	0,1		80
Cruzeiro	1382	282	4,9	806	3950
Descida	25	180	0,1		65
	1421		5,1		4175

Figure 7 - Performance data obtained from POH "Recommended Cruise Power - 1900 RPM - ISA +10" chart for FL 135.

These values considered the flight at the indicated level in the aircraft flight plan (FL 135).

On the other hand, if a higher level had been chosen, such as FL 250, it would take 3,058lbs of aviation kerosene to reach Sorocaba. In this case, the plane would arrive in Sorocaba with a reserve of 700lbs, enough to fly approximately 1 hour and 15 minutes under Recommended Cruise Power.

	Distância (nm)	Velocidade (kt)	Tempo Estimado de Voo (horas)	Fluxo de Combustível (lbs/h)	Consumo (lbs)
Táxi e Decolagem	0				80
Subida	32	120	0,2		160
Cruzeiro	1343	277	4,8	560	2715
Descida	46	180	0,3		103
	1421		5,3		3058

Figure 8 - Performance data from POH "Recommended Cruise Power - 1900 RPM - ISA +10" chart for FL 250.

At this altitude, under the recommended cruising regime, the range of the aircraft with fully filled tanks would be approximately 1,800 nautical miles.

None of these calculations took into account possible influences of the incident winds on the en-route aircraft.

Based on the time of takeoff, the time of the accident and the distance traveled, it was calculated that the average flight speed was 220kt. Values close to that were recorded by the air traffic control radars.

1.19 Additional information.

The RBHA No. 91 provided, in its section 91.151 - Fuel Requirements for Flights under VFR, the following:

"91.151 - VFR FLIGHT FUEL REQUIREMENTS

(a) No person may start a VFR flight on an airplane unless, given the known wind and weather conditions, there is sufficient fuel to fly to the intended first landing site and assuming normal cruise consumption;

(1) during the day, fly for at least 30 minutes more; or

(2) during the night, fly for at least 45 minutes more."

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

This was an aircraft transfer flight that would initially be performed on the SWFN - SBBW leg, whose destination Aerodrome was changed en-route to SDCO.

The pilot received the Private Pilot License in 1980 and was operating regularly in the North region of Brazil.

As partner and pilot of the aircraft operating company, the commander regularly took off from Manaus - AM, conducting passengers that were visiting an Inn in the north of the city to conduct sport fishing.

Later, it transported the passengers back to Manaus. This route was made because of the difficulty in reaching the place of the Inn by means other than air.

The flight plan was passed on the SWFN - SBBW leg, but, according to information collected, the pilot intended to land in Sorocaba - SP, in order to deliver the aircraft for inspection. Thus, if the commander landed at the informed destination (SBBW), a second flight leg (SBBW - SDCO) would be required.

The amount of fuel supplied corroborated to this intention of going straight to SDCO, depending on how the flight went to Barra do Garças - MT.

Through the visualization of the aircraft route, recorded by the air traffic agencies, it was observed that it was moving at a slower speed than the recommended cruise regime, which signaled the possibility of the pilot to be controlling the fuel consumption, in order to be able to make the direct flight on the SWFN-SDCO leg.

On the other hand, the regime used was not the Long Range Power, as the fuel was exhausted before landing in Sorocaba and the estimated average flight speed was 220kt, different from that calculated for this adjustment, which would be approximately 202kt.

In any case, the amount of aviation kerosene on board at takeoff did not guarantee compliance with the minimum fuel requirements set by RBHA No. 91, due to the cruise regime and flight level used.

Considering that the planning had been made to allow the flight to be performed between SWFN and SDCO, it was found that there was little margin for eventualities that could occur in its development.

In addition, although the aircraft model had pressurization capability, the pilot chose to fly FL135, which caused a considerable increase in fuel consumption, as can be verified by comparing the data from Figures 6 and 8.

The investigators calculations showed that flying on FL 250, for example, the plane would arrive in Sorocaba with a reserve of about 700lbs, enough to fly approximately 1 hour and 15 minutes at Recommended Cruise Power, attending then, the fuel requirements of the RBHA No. 91.

Although there was no record in the flight logbook, it is possible that the aircraft's pressurization system was down, which would explain the option for the low-level flight.

The aircraft landing gears were down, which, coupled with the proximity of the Aerodrome, indicated that the pilot tried to carry out the landing.

No evidence of engine malfunction was found before impact.

On the other hand, during the performed examinations, it was possible to verify a series of evidences consistent with a low fuel event.

Signals of rotation of the turbines were found, and the traces on the right engine were more significant and associated with a low power impact scenario.

On the left engine, there were indications that it no longer developed power, being found signs of residual rotation.

On the right engine FCU drive shaft, indications were identified that it could still develop some power, given the misalignment in the stretches of this component, indicating the occurrence of sudden stop.

The left engine did not present this evidence.

In the fuel pumps, signs of cavitation were found in the gear bushings indicating low or no fuel operation.

In addition, the gear teeth showed characteristic discoloration from overheating and their housings were marked by their rotation, which is characteristic in cases of fuel starvation.

Thus, based on the research elements raised, it was concluded that there was a loss of engine power during approach to SDCO landing, due to aircraft fuel starvation.

3. CONCLUSIONS.

3.1 Facts.

- a) the pilot had valid Aeronautical Medical Certificate (CMA);
- b) the pilot had valid MLTE and IFRA Ratings;
- c) the pilot was qualified and had experience in that kind of flight;
- d) the aircraft had valid Airworthiness Certificate (CA);
- e) the aircraft was within the limits of weight and balance;
- f) the airframe, engine and propeller logbooks records were outdated;
- g) the weather conditions were favorable for the visual flight;
- h) the pilot alternated his flight destination from Barra do Garças (SBBW) - MT to Sorocaba (SDCO) - SP;
- i) the position of the landing gear and the proximity of the Aerodrome indicated that the pilot was attempting to land;
- j) during the approach, the aircraft collided with the ground, approximately 1 km from the SDCO runway;
- k) in the fuel pumps, signs of cavitation were found in the gear bushings, indicating low or no fuel operation;
- l) the gear teeth of the fuel pumps showed characteristic of overheating discoloration and their housings were marked by their rotation, a characteristic situation in cases of fuel starvation;
- m) the aircraft was destroyed; and
- n) the pilot and passenger suffered fatal injuries.

3.2 Contributing factors.

- **Flight indiscipline – a contributor.**

The pilot failed to comply with the minimum fuel requirements laid down in the regulations, providing conditions for both engines to stop operating in flight, due to lack of fuel.

- **Piloting judgment – a contributor.**

It was found in this flight an inadequate evaluation for certain parameters related to aircraft operation, particularly with regard to the influence of the chosen flight level on fuel consumption.

This misjudgment led to the decision to proceed with the flight to the Aerodrome where it was intended to land, to the detriment of the more conservative option of finding a suitable place for an intermediate landing and a refueling, which led to the depletion of usable fuel in flight.

- **Flight planning – a contributor.**

Inadequate flight preparation work, especially with regard to fuel calculation and cruise level selection, has degraded the safety level and also contributed to the actual accident.

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

Difficulties in perceiving, analyzing, choosing alternatives, and acting appropriately due to inadequate judgment, may have resulted in poor assessment of flight parameters (available fuel, distance to destination, verified consumption, etc.), which may have favored the occurrence of lack of fuel failure.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 “Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State”.

Recommendations issued at the publication of this report:

To the Brazil’s National Civil Aviation Agency (ANAC):

A-054/CENIPA/2017 - 01

Issued on 04/22/2020

Disseminate the lessons learned in the present investigation, in order to alert the Brazilian civil aviation pilots and operators about the risks arising from non-compliance with the minimum fuel requirements prevised in the regulation.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On April 22th, 2020.