COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 094/CENIPA/2018

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-FLW**
MODEL:	**208B**
DATE:	**22MAY2018**

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 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 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. 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 22MAY2018 accident with the 208B aircraft model, registration PT-FLW. The accident was classified as “[SCF-PP] System/Component Failure or Malfunction Powerplant – Engine Failure in Flight”.

During traffic for visual landing on the Flores Aerodrome (SWFN), Manaus - AM, the aircraft showed abnormal behavior, with loss of power.

The pilot took the plane for an emergency landing in an unprepared area, located approximately 300 meters from the threshold 11 of SWFN.

There was fire after the impact and the aircraft was destroyed.

The pilot suffered minor injuries.

An Accredited Representative of the Transportation Safety Board (TSB) - Canada (State where the engine was designed/manufactured) was designated for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AFA	Brazilian Air Force Academy
ANAC	National Civil Aviation Agency
APA	Aeronautical Propulsion Division
APP-MN	Manaus Approach Control
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CFOAv	Aviation Officer Formation Course
CMA	Aeronautical Medical Certificate
CRM	Crew Resource Management
DCTA	Department of Science and Airspace Technology
EPL	Emergency Power Lever
EO	Operating Specifications
EOBT	Estimated Off Block Time
FAB	Brazilian Air Force
FCU	Fuel Control Unit
FAP	Pilot's Evaluation Sheet
FPL	Flight Plane
IAE	Aeronautics Space Institute
IAM	Annual Maintenance Inspection
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
IMC	Instrument Meteorological Conditions
ITT	Inter Turbine Temperature
METAR	Aviation Routine Weather Report
MNTE	Airplane Single Engine Land Rating
PLA	Airline Pilot License – Airplane
POH	Pilot's Operating Handbook
PTO	Operational Training Program
P&WC	Pratt & Whitney Canada
QAv-1	Aviation Kerosene
RI	Investigation Report
SBEG	ICAO Location Designator - Eduardo Gomes International Aerodrome , Manaus - AM
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SWFN	ICAO Location Designator – Flores Aerodrome , Manaus - AM
TBO	Time Between Overhaul

TPX	Aircraft Registration Category of Non-Regular Public Air Transport
TSB	Transportation Safety Board
TSN	Time Since New
TSO	Time Since Overhaul
TWR-EG	Eduardo Gomes Aerodrome Control Tower
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** 208B **Registration:** PT-FLW **Manufacturer:** Cessna Aircraft	**Operator:** *Amazonaves Táxi Aéreo* Ltd.
Occurrence	**Date/time:** 22MAY2018 - 1350 UTC **Location:** Flores Neighborhood **Lat.** 03º04'15"S **Long.** 060º01'41"W **Municipality – State:** Manaus – AM	**Type(s):** [SCF-PP] System/Component Failure or Malfunction Powerplant **Subtype(s):** Engine Failure in Flight

1.1 History of the flight.

The aircraft took off from the Eduardo Gomes International Aerodrome (SBEG), Manaus - AM, to the Flores Aerodrome (SWFN), Manaus - AM, at about 1340 (UTC), in order to perform a shuttle flight, with a pilot on board.

During the performance of visual traffic for landing on SWFN, the aircraft showed abnormal behavior in the engine, with loss of power and lack of effectiveness in the use of the throttle.

The commander chose to make an emergency landing on an unprepared area near threshold 11 of SWFN.

After the total stop, the aircraft caught fire and was destroyed.

The pilot suffered minor injuries.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	1	-	-
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	10.073:20
Total in the last 30 days	68:50
Total in the last 24 hours	03:20
In this type of aircraft	4.637:40
In this type in the last 30 days	68:50
In this type in the last 24 hours	03:20

N.B.: The data related to the flown hours were obtained through the Operator's records.

1.5.2 Personnel training.

The pilot took the CFOAv at the Air Force Academy (AFA), Pirassununga –SP, in 1985.

1.5.3 Category of licenses and validity of certificates.

The pilot took the PLA License and had valid MNTE and IFRA Ratings.

1.5.4 Qualification and flight experience.

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

The commander was 56 years old and was a military pilot of the Brazilian Air Force (FAB) for over 30 years. In 2009, he started flying in the civil aviation as an employee of the *Amazonaves Táxi Aéreo* Ltd.

According to the Individual Technical Crew Sheet provided by the company, the pilot exercised the functions of commander, flight instructor and accredited examiner.

During his time at the company, he spent approximately 1,230 hours on Piper PA-34 aircraft and 4,630 hours on Cessna 208B Grand Caravan aircraft.

No records were found that the pilot had any technical, theoretical or related to flight safety deficiencies in the FAP prepared during the periodic revalidations of his qualifications.

1.5.5 Validity of medical certificate.

The pilot had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 208B0451 was manufactured by Cessna Aircraft, in 1995 and was registered in the TPX Category.

The Airworthiness Certificate (CA) was valid.

The airframe, engine and propeller logbook records were updated.

The last inspection of the aircraft, the “IAM” type, was performed together with the “DOC 06 (200 hours or 12 months)” type revision, on 21MAR2018, by the maintenance organization *Amazonaves Táxi Aéreo* Ltd., in Manaus - AM, having flown 146 hours and 30 minutes after the inspection.

The aircraft was equipped with the PT6A - 114A model engine, Serial Number (SN) PCE-19332, manufactured by Pratt & Whitney Canada (P&WC).

The only general overhaul of the engine was carried out on 13JUL2009 by the company TURBSERV, in Sorocaba - SP, having flown, at the time, 4,051 hours and 36 minutes since new (TSN - Time Since New).

On the day of the occurrence, the engine had 8,776 hours and 50 minutes TSN and 4,725 hours and 10 minutes since the last general overhaul (TSO - Time Since Overhaul).

The PT6A - 114A engines overhaul should be carried out every 3,600 TSO hours. However, the engine involved in this accident was with approximately 1,125 extension hours authorized by the manufacturer.

At the time of this occurrence, P&WC authorized, through Service Bulletin No. 1703R13, the extension of Time Between Overhaul (TBO) by “sampling”. This meant that, after performing a general overhaul on one or more engines in a given operator's fleet with satisfactory results, the manufacturer authorized extensions, in increments of 500 hours, for the other propellers in the fleet.

A company would be able to receive such extensions if it met the following requirements:

a) possess a shop capable of performing all line maintenance activities, including all activities listed in the maintenance manual;

b) possess a periodic inspection table, boroscopic inspection, compressor and turbine washing, etc.;

c) have all the applicable tools available, in addition to specifically trained personnel to perform this type of task and/or have service contracts with facilities that have the applicable tooling and trained personnel; and

d) have a quality system that records all difficulties and maintenance activities related to the operation of the engine and accessories, such as the propeller, the over speed governor and the starter generator. Such records should be available for review by the P&WC upon request.

The research conducted showed that *Amazonaves Táxi Aéreo* Ltd. met these requirements.

The engine in question was on the third extension of TBO. On the first, its Time Between Overhaul went from 3,600 to 4,100 hours. On the second, from 4,100 to 4,600 hours, and on the third, from 4,600 to 5,100 TSO hours. The latter was also limited to 12 months, whichever came first.

The procedure for the extension of TBO described above was validated by the ANAC on 24MAR2017.

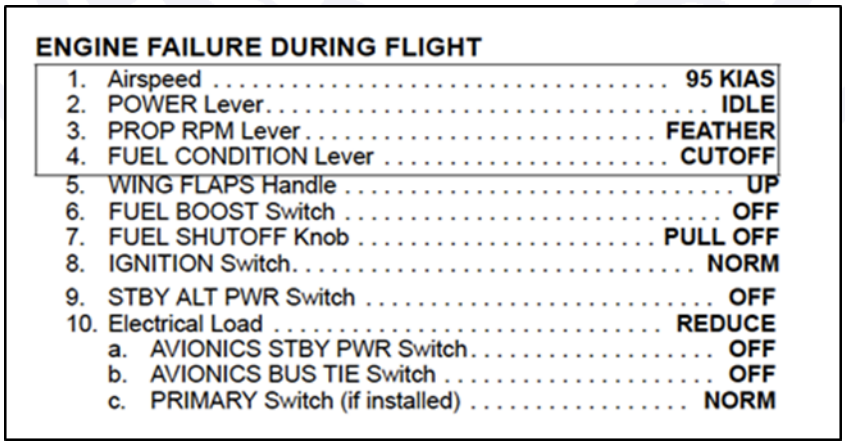
According to research carried out, this procedure was a well-established technique for many years. Through its application, aircraft engines of the same model, from a company of the regular passenger and cargo transportation sector, have had their TBO extended up to 8,500 hours.

The extension of the TBO of the PT-6 engines was part of a reliable maintenance program, as long as the operator followed correctly and strictly the provisions of the service bulletin, periodically collecting the parameters to be evaluated. There was no news that an extension was given and that the engine failed due to this condition.

The aircraft POH described Engine Failure as follows:

Engine Failure: an engine failure can be identified by abnormal temperatures, mechanical noise or high levels of vibration in conjunction with loss of power, which can be noted by a drop in the ITT, the torque and the rotation of the gas turbine (Ng).

For engine failure in flight, the POH prevised the following actions (Figure 1):



ENGINE FAILURE DURING FLIGHT

1. Airspeed ..... 95 KIAS
2. POWER Lever ..... IDLE
3. PROP RPM Lever ..... FEATHER
4. FUEL CONDITION Lever ..... CUTOFF
5. WING FLAPS Handle ..... UP
6. FUEL BOOST Switch ..... OFF
7. FUEL SHUTOFF Knob ..... PULL OFF
8. IGNITION Switch ..... NORM
9. STBY ALT PWR Switch ..... OFF
10. Electrical Load ..... REDUCE
    a. AVIONICS STBY PWR Switch ..... OFF
    b. AVIONICS BUS TIE Switch ..... OFF
    c. PRIMARY Switch (if installed) ..... NORM

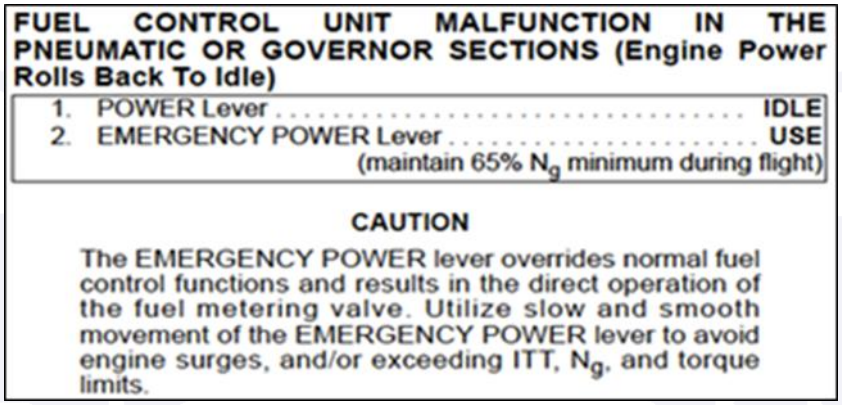
Figure 1 - Procedure for engine failure in the checklist.

According to the procedure described above, during an engine failure in flight, the pilot should seek the best gliding speed with the flagged propeller. Afterwards, the pilot should isolate the fuel and electrical systems, in order to minimize the chances of fire.

The aircraft POH described the Fuel Control Unit (FCU) Failure as follows:

Fuel Control Unit (FCU) failure: a malfunction in the pneumatic or governor sections of the FCU can cause engine power to drop to idle. Symptoms of this type of failure may include an indication of ITT typical of the idling range (500ºC to 600ºC), Ng by 48% or more (it rises with increasing altitude) and no engine response to throttle movements.

For the FCU failure, the POH prevised the following actions (Figure 2):



FUEL CONTROL UNIT MALFUNCTION IN THE PNEUMATIC OR GOVERNOR SECTIONS (Engine Power Rolls Back To Idle)

1. POWER Lever ..... IDLE
2. EMERGENCY POWER Lever ..... USE
   (maintain 65% N_g minimum during flight)

CAUTION

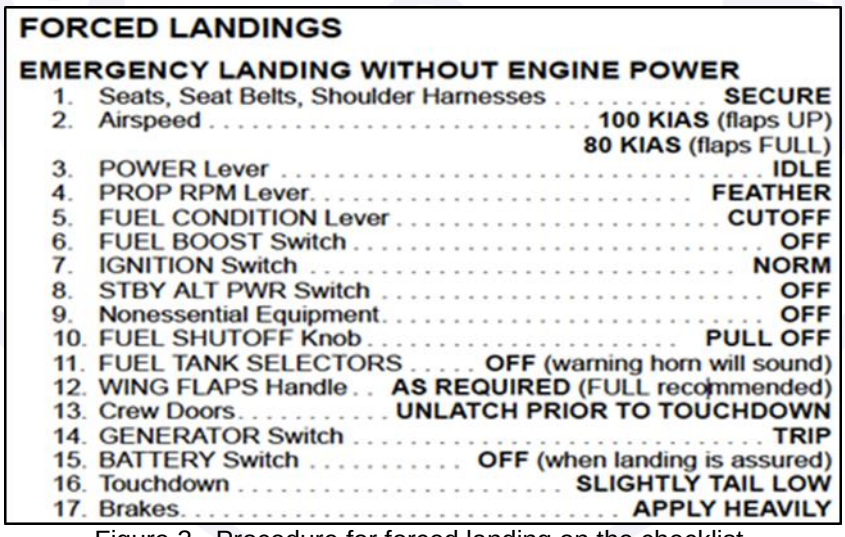
The EMERGENCY POWER lever overrides normal fuel control functions and results in the direct operation of the fuel metering valve. Utilize slow and smooth movement of the EMERGENCY POWER lever to avoid engine surges, and/or exceeding ITT, N_g, and torque limits.

Figure 2 - Procedure for FCU malfunction in the checklist.

According to the aircraft manual, the FCU aimed to measure the fuel from the system filter. In the event of its failure, it was possible to use the Emergency Power Lever (EPL) to try to control the engine. When this resource was used, the FCU was surpassed and the pilot began to perform manual control of the fuel supply to the engine, making its response faster than normal.

When using this feature, additional care was required when handling the EPL so that the engine limits, especially in relation to temperature, were not exceeded. The throttle should be kept in the idle position in flight.

The manual prevised the following actions for a forced landing (Figure 3):



FORCED LANDINGS

EMERGENCY LANDING WITHOUT ENGINE POWER

1. Seats, Seat Belts, Shoulder Harnesses ..... SECURE
2. Airspeed ..... 100 KIAS (flaps UP)
   80 KIAS (flaps FULL)
3. POWER Lever ..... IDLE
4. PROP RPM Lever ..... FEATHER
5. FUEL CONDITION Lever ..... CUTOFF
6. FUEL BOOST Switch ..... OFF
7. IGNITION Switch ..... NORM
8. STBY ALT PWR Switch ..... OFF
9. Nonessential Equipment ..... OFF
10. FUEL SHUTOFF Knob ..... PULL OFF
11. FUEL TANK SELECTORS ..... OFF (warning horn will sound)
12. WING FLAPS Handle .. AS REQUIRED (FULL recommended)
13. Crew Doors ..... UNLATCH PRIOR TO TOUCHDOWN
14. GENERATOR Switch ..... TRIP
15. BATTERY Switch ..... OFF (when landing is assured)
16. Touchdown ..... SLIGHTLY TAIL LOW
17. Brakes ..... APPLY HEAVILY

Figure 3 - Procedure for forced landing on the checklist.

1.7 Meteorological information.

The METAR of SBEG, 4,2 NM away from the accident site, showed the following information:

METAR SBEG 221100Z 17004KT 9999 BKN009 24/23 Q1013=

METAR SBEG 221200Z 15008KT 9999 BKN010 25/23 Q1014=

METAR SBEG 221300Z 17005KT 9999 BKN010 26/23 Q1015=

METAR SBEG 221400Z 16006KT 9999 BKN012 26/24 Q1015=

Therefore, SBEG operated by instruments, with a ceiling between 1,000 and 1,200 feet, at the time of the occurrence. However, the pilot reported that conditions were favorable for visual flight to land on SWFN.

1.8 Aids to navigation.

Nil.

1.9 Communications.

According to the transcripts of the communication audios between PT-FLW and the ATS agencies, the crewmember maintained radio contact with the TWR-EG and with the APP- MN.

The Investigation Team highlighted the following transmissions that helped to understand the dynamics of the accident.

The times described refer to UTC.

At 13h21min44s, the PT-FLW informed the TWR-EG that it had a Flight Plan (FPL) from Eduardo Gomes to Flores.

At 13h21min52s, the TWR-EG informed the PT-FLW that SBEG was operating under Instrument Flight Rules (IFR) and asked it to confirm its intentions.

At 13h22min08s, the PT-FLW reported that it would make a new Flight Plan.

At 13h26min, the pilot presented another FPL, now under “Y” flight rules, that is, starting under instrument flight rules, changing to visual flight at a point specified in the plan.

At 13h41min18, the PT-FLW reported that it was off the ground and asked the TWR-EG if it could call control. The TWR-EG subsequently authorized it.

Communications took place normally until 13h43min08s, when PT-FLW informed that it was entering the wind leg of runway 11, in Flores.

As a result, the APP-MN tried several calls, but did not get any more response.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The impact occurred on an open terrain, near Torquato Tapajós Av., in Manaus - AM, approximately 300 meters from threshold 11 of the Flores Aerodrome. The wreckage distribution was of the concentrated type. The flaps were found in the “retracted” position.

According to the pilot's report, the first and second impacts occurred during the attempted forced landing, in a descending attitude, and a slight left turn. In one of those moments, the landing gear broke down. Then, there was the third impact that caused the breakage of part of the Cargo Pod.

After the impacts, the aircraft yawed about 40 degrees to the left and dragged for 45 meters until it came to a complete stop. After the total stop, the plane caught fire and was destroyed (Figures 4 and 5).

Figure 4 - General view of the wreckage. The red circle indicates the point of the 1st impact, the dashed orange circle indicates the 2nd impact and the yellow circle shows the 3rd impact (part of the Cargo Pod in the detail).

Figure 5 - Approximate view of the aircraft. In detail, it shows that the flaps were retracted.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

According to information collected from the last health inspection, there were no significant medical changes that could affect the pilot's performance.

The toxicological and alcohol level tests performed showed negative results.

According to the information obtained, the pilot showed no signs of fatigue or stress on the day of the flight.

There was no evidence that physiological or disability considerations affected the performance of the crew.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

According to the information obtained, the pilot had an employment relationship with the operator for eight years. In addition to his pilot role, he also served as a flight instructor and examiner accredited by the ANAC.

1.14 Fire.

The fire, which started a few seconds after the pilot left the aircraft, consumed almost the entire plane, with the exception of part of the rear section.

1.15 Survival aspects.

Accident observers reported that the pilot abandoned the aircraft through the crew's door and left the scene afterwards.

Later, in an interview, he reported that he had gone to a nearby gas station to contact his family and the *Amazonaves* Company and he was taken to a hospital later.

1.16 Tests and research.

The PT6A-114A model engine, SN PCE-PC19332, which equipped the PT-FLW aircraft was disassembled and inspected at Pratt & Whitney's premises in Sorocaba - SP.

This work was attended by professionals from this company, a P&WC investigator, an engineer from the APA of the Aeronautics Science and Technology Department's IAE and by the Investigators Team.

The initial analysis identified that the engine in question was severely damaged by the fire that followed the crash of the aircraft. Therefore, the reduction and accessory boxes were consumed by the fire.

This was mainly because this engine had magnesium in its composition, which, due to its properties, burns with sufficient heat to cause the rupture of the water molecule, releasing hydrogen and oxygen, which in turn, feed the fire instead of extinguishing it.

Likewise, due to the damage caused by the fire, it was not possible to examine the fuel supply system.

The FCU and the fuel pump were located at the rear of the engine, next to the accessory box, and were consumed by the fire. Similarly, the pneumatic lines could not be inspected either.

Figure 6 - Images of the engine, in which the damage to the sides and rear resulting from the action of fire is observed.

Internally, the bearings and gears showed no discrepancies or damage, indicating that the lubrication system worked properly.

In the hot section of the engine, it was observed that the compressor turbine was subjected to a fusion process and that parts of the vanes melted. A portion of the melted material was centrifuged and deposited on the segmented ring, as shown in Figures 7 and 8.

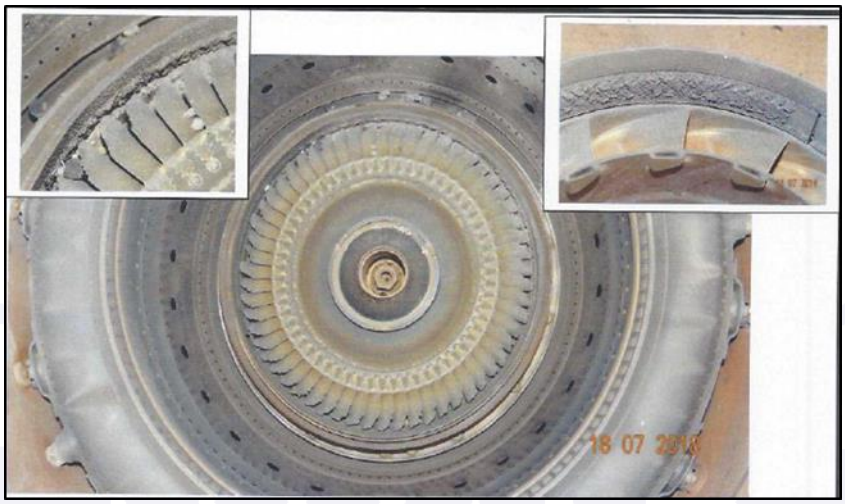


Figure 7 - Images of the engine showing the compressor turbine rotor with the melted vanes. The highlights show the material of the vanes deposited on the segmented ring.

Figure 8 - Images of the compressor turbine rotor. The highlight shows a superior view of the top of the vanes, where part of the material has been melted.

Another part of this material followed the gas flow, damaging the vanes of the power turbine rotor. This may have occurred when part of that material followed the gas flow resulting from combustion to the atmosphere. The impact may have caused the vanes of the power turbine rotor to become weak and result in the observed fractures.

It was not possible to determine the power level of the engine at the moment of impact.

However, the Investigation Report (IR) issued by the APA concluded that the internal signatures showed that the engine still had residual power at the moment the aircraft hit the ground and that the over temperature damage observed in the hot section occurred with the engine working, possibly due to improper handling of the EPL.

In view of the impossibility of collecting fuel on the aircraft, the Investigation Team submitted a sample of Aviation Kerosene (QAv-1) obtained at the point of the plane's last refueling.

The examination performed in an approved laboratory in Manaus - AM, showed that the fuel used by the aircraft was in compliance with the required specifications.

1.17 Organizational and management information.

The *Amazonaves Táxi Aéreo* Company Ltd., whose headquarters were located at the Flores Aerodrome, Manaus - AM, started its activities on 23JUN2003.

Its Operational Specifications (EO) were in revision nº 40, from 15MAY2018 and, according to them, the Operator did not have any type of exemption from regulatory requirements.

Seven aircraft were part of the company's fleet, with six Cessna 208B and one Embraer 110P1 aircraft.

At the time of the accident, the company had seventeen pilots on its staff, three of whom held administrative functions. The commander involved in this accident did not participate in these activities, dedicating himself exclusively to the flight.

In that organizational context, flights were performed on demand. According to the data obtained, the pilot performed, on average, 60 flight hours per month, according to the company's needs.

The organizational processes related to the hiring of new crewmembers were formally described in procedures that met the requirements established by the ANAC. In addition, the company had updated PTO and CRM Training Programs.

According to the information obtained, the training was carried out annually, on the revalidation of qualifications occasion, and followed the programs prepared by the organization.

With regard to the management of aircraft failures, it was found that the discrepancies observed used to be reported by pilots in the flight logbook. In an interview, the maintenance inspector mentioned that, in addition to the records made, the pilots also had the habit of verbally reviewing any abnormalities.

1.18 Operational information.

The pilot involved in this occurrence was familiar with the operation of the crashed aircraft. As reported, on the flights he had taken in the days before the accident, he had not noticed any abnormality on the plane.

The flight on which this accident occurred had the purpose of transferring the plane from SBEG, where it stayed over the night, to SWFN, where it would depart for another mission.

The mechanic who performed the last maintenance on the aircraft said in an interview that there were no reports of previous failures.

The last refueling of the plane took place the day before the accident, in São Gabriel da Cachoeira - AM. The PT-FLW was filled with 389 liters of QAv-1, according to the supply receipt, and proceeded to SBEG that same day.

On this flight, there were on board the pilot involved in this accident and a second crewmember. Both said in an interview that they saw nothing unusual about the aircraft.

The commander informed that before starting the flight in which this accident occurred, he performed the pre-flight and did not detect any abnormality.

There was in the “Weight and Balance Manifesto”, filled out by the pilot moments before taking off from SBEG, a weight of 180 pounds for the crew, 4 pounds of luggage/cargo and 1,020 pounds of fuel.

According to this document, the basic operational weight, 5,200 pounds, added to the weight of the crew, checked baggage/cargo and fuel resulted in a total of 6,404 pounds, a value within the limits established by the manufacturer for the maximum take-off weight.

The FPL presented by the commander at 12h52min (UTC) indicated an EOBT at 13h45min (UTC), taking off from SBEG, under visual flight rules, maintaining 140kt and 4,500 feet, on a direct route to the Flores Aerodrome.

However, at 13h21min (UTC), during contact with the TWR-EG, the commander was informed that SBEG was operating under IMC. The pilot then informed by radio that he would provide the FPL for that condition.

At 13h26min (UTC), he presented a new Flight Plan, this time with “Y” flight rules.

The aircraft took off at around 13h40min (UTC) and, according to the new FPL, the flight started under IFR rules. After an initial contact, the APP-MN authorized the PT-FLW to maintain 2,000 feet in visual contact with the ground and to turn right into the SWFN traffic circuit. At that moment, the pilot informed the control that he was completely visual.

The commander's last contact with the control took place when he informed that he was entering the wind leg for landing on SWFN runway 11.

According to the pilot's report, the flight proceeded normally until the SWFN final, when there was a power drop and an increase in drag. He also observed the lights on the alarm panel; however, he was able to identify only the Oil Press light.

The commander also informed that, the moment he noticed the abnormal behavior of the aircraft, he commanded the flap collection. According to his judgment, the height and speed were insufficient to reach the runway.

Since the engine did not respond to the throttle command, it used the EPL in an attempt to regain control of the thruster, but was unsuccessful. The pilot did not report whether he had reduced the throttle to a minimum before triggering the EPL, as provided in the aircraft manual.

Unable to regain control of the engine, the commander opted to make a forced landing on an unprepared field, located about 300 meters from the runway's threshold.

A fire started a few seconds after the pilot left the aircraft.

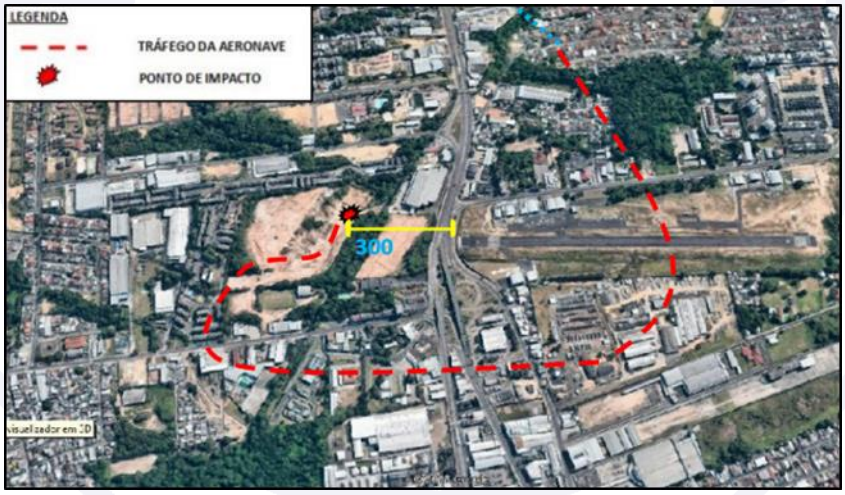


Figure 9 - Sketch of the accident showing the aerial view of the impact site and its position in relation to the threshold 11 of SWFN. The red dashed line represents the aircraft trajectory until the moment of impact.

1.19 Additional information.

Flaps are devices assembled on the trailing edges of the wings that promote increased lift and drag, as well as reduced aircraft stall speed when deployed.

Its use during takeoffs reduces the required runway length and, on the other hand, hinders acceleration after leaving the ground.

During landings, the use of flaps allows for better control of the plane at low speeds and its reduction for landing, requiring, however, the availability of power to compensate for the increase in drag.

Conversely, the retraction of the flaps in flight requires an increase in speed to compensate for the loss of lift, which can be achieved by reducing the pitch angle and/or applying power.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a transfer flight between SBEG and SWFN, in which there was only the pilot on board.

After taking off from SBEG, at about 13h40min (UTC), the pilot informed the APP-MN that he was completely visual in the sector and conducted the aircraft in order to enter the traffic for landing in SWFN.

Based on the pilot's report that during the final frame, the engine failed and did not respond to the control of the throttle or the EPL, the investigation sought to identify what could have caused a loss of power in the engine that equipped the PT- BYE.

Considering that the examination performed on the QAv-1 sample collected at the last refueling point of the aircraft showed that it was in compliance with the required specifications, the hypothesis that an engine failure occurred due to fuel contamination was ruled out.

A dry crash was also not considered because, according to the weight and balance manifest, the aircraft had approximately 1,020 pounds of fuel on board when taking off from SBEG.

The disassembly and analysis of the engine showed that the internal signatures showed that it had residual power at the time of the accident. Therefore, there was no engine shutdown or engine locking.

However, doubts remained as to the functioning of the fuel system, especially the FCU, since the fire that followed the accident completely consumed this unit, which prevented a detailed analysis of its components or the performance of a bench test.

The damage observed in components of the hot engine section indicated the occurrence of an extrapolation of the ITT limits, which may have caused the melt observed in the blades of the compressor turbine.

Thus, in view of the expected reactions of the engine during the use of the EPL, it is possible that there has been an inappropriate use of this resource and, consequently, there has been an extrapolation of the engine limits, especially in relation to the temperature.

However, since the propellant had residual power at the time of the accident, if the failure originated from a problem in the FCU, even though the pilot had used the EPL more forcefully and the ITT limit had been exceeded, it was understood that the engine would probably show some response, even for a short period of time.

Thus, it was not possible to conclude what led to the loss of power reported by the pilot.

Nevertheless, it is possible that a failure occurred that could not be detected by the analysis made on the wreckage of the damaged engine, which, even with the use of the EPL, made it impossible to recover traction and continue the flight to the SWFN runway.

The retraction of the flaps was an action previsted in the checklist after an engine failure in flight. However, the same support system recommended the flaps to be positioned in “FULL” for a forced landing.

In the specific case of this occurrence, the aircraft was framing the final for landing in SWFN at the time of the engine failure. Therefore, it was at a low height and had no additional power available.

Thus, it is possible that the loss of lift produced by the flap retraction has resulted in a sinking that prevented the plane from reaching the SWFN runway with the residual power that the engine still provided. In this case, an inadequate assessment of the effects of such action on the aircraft performance under those conditions would be characterized.

On the other hand, since the plane did not have a flight data recorder, it was not possible to establish what were the changes resulting from the collapse of the flaps in the aircraft performance during that particular approach.

In this scenario, a great loss of altitude after the flaps were retracted would explain why the pilot did not lower them again in the moments before the forced landing, as recommended by the aircraft checklist.

It is also possible that the decisions made were a consequence of the pilot's difficulty in adequately remembering the correct procedures for those circumstances, since they were actions to be memorized (memory items).

Thus, even though the *Amazonaves Táxi Aéreo* Company was complying with the requirements of its training program, the investigation of this accident identified issues related to the operation of the aircraft that could be related to the quality and/or frequency of emergency training with engine failure.

In the course of the investigation, the data gathered on the TBO extension procedure implemented by the *Amazonaves Táxi Aéreo* Ltd. indicated that it was an effective practice. No evidence was found that the TBO extension operation contributed to the PT-FLW propeller failure.

Finally, it was concluded that, during the approach for landing, there was a failure of the engine, with loss of power, ignition of the oil pressure light and internal damage to the propellant, due to over temperature in the compressor turbine.

However, because of the high degree of destruction, it was not possible to identify the sequence of events that triggered the malfunction of the engine and led to a forced landing.

3. CONCLUSIONS.

3.1 Facts.

a) the pilot had valid CMA;

b) the pilot had valid MNTE and IFRA Ratings;

c) the pilot was qualified and had experience in the kind of flight;

d) the aircraft had valid Airworthiness Certificate;

e) the aircraft was within the weight and balance limits specified by the manufacturer;

f) the airframe, engine and propeller logbooks records were updated;

g) according to the pilot’s statements, the weather conditions were favorable for the visual flight;

h) the aircraft was being operated with extensions of the general engine overhaul (TBO);

i) there was no history of engine failure flying with TBO extension when the operator complied with the parameters prevised in the relevant Service Bulletin;

j) the engine had residual power at the time of the accident;

k) there was damage by over temperature in the turbine vanes of the engine compressor prior to the impact against the ground;

l) there was loss of engine power during the traffic for landing on SWFN;

m) the pilot commanded the flap retraction after identifying the engine failure;

n) the pilot used the emergency power lever;

o) the pilot made a forced landing, on an unprepared field, close to the threshold 11 of SWFN;

p) the aircraft caught fire after impact and total stop;

q) the aircraft was destroyed; and

r) the pilot suffered minor injuries

3.2 Contributing factors.

- **Control skills – undetermined.**

The damage observed in the hot engine section components indicated the occurrence of an extrapolation of the ITT limits, which may have caused the melt observed in the blades of the compressor turbine.

Thus, in view of the expected reactions of the engine during the use of the EPL, it is possible that there has been an inappropriate use of this resource and, consequently, an extrapolation of the engine limits, especially in relation to the temperature.

- **Training – undetermined.**

The investigation of this accident identified issues related to the operation of the aircraft that could be related to the quality and/or frequency of emergency training with engine failure.

- **Piloting judgment – undetermined.**

It is possible that the loss of lift produced by the flap retraction resulted in a sinking that prevented the plane from reaching the SWFN runway with the residual power that the engine still provided. In this case, an inadequate assessment of the effects of such action on the aircraft performance under those conditions would be characterized.

- **Memory – undetermined.**

It is possible that the decisions made were the result of the pilot's difficulty in properly recalling the correct procedures for those circumstances, since these were actions to be memorized (memory items).

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-094/CENIPA/2018 - 01 Issued on 02/12/2021

Work with the *Amazonaves Táxi Aéreo* Company Ltd., so that this operator ensures that its crewmembers are receiving adequate training, as well as that they are familiar with the emergency procedures of the C-98 Caravan aircraft, including memory items, especially for emergency situations with engine failure in flight and forced landing.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On February 12th, 2021.