COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 105/CENIPA/2016

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-EFQ**
MODEL:	**EMB-820C NAVAJO**
DATE:	**31JUL2016**

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 31JUL2016 accident with the EMB-820 NAVAJO aircraft, registration PT-EFQ. The accident was classified as "[SCF-PP] System/Component Failure or Malfunction Powerplant".

During the approach to land at the Londrina Aerodrome (SBLO), when at approximately 5 NM from threshold 13, the aircraft collided against an electric power grid and then against a shed.

The aircraft was destroyed.

The two pilots and six passengers perished at the crash site.

An Accredited Representative of the National Transportation Safety Board (NTSB) - USA, (State where the engine was manufactured) was designated for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ACC	Area Control Center
ANAC	Brazil's National Civil Aviation Agency
APP-LO	Approach Control - Londrina
ATIS	Automatic Terminal Information Service
AVGAS	Aviation Gasoline
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CINDACTA	Air Defense and Air Traffic Control Integrated Center
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
DLA	Message for Extension of Proposed Time for Takeoff
EOBT	Estimated Off-Block Time
FENATRACOOP	National Federation of Civil Workers in Cooperatives in Brazil
GNSS	Global Navigation Satellite System
IAM	Annual Maintenance Inspection
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
MLTE	Airplane Multi Engine Land Rating
MNTE	Airplane Single Engine Land Rating
NTSB	National Transportation Safety Board
PBN	Performance-Based Navigation
PCM	Commercial Pilot License - Airplane
PLA	Airline Pilot License - Airplane
PMD	Maximum Take Off Weight
PPR	Private Pilot License – Airplane
RNAV	Area Navigation
SBCY	ICAO Locator Designator – Cuiabá Aerodrome - MT
SBLO	ICAO Locator Designator – Londrina Aerodrome - PR
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
TPP	Registration Category of Private Aircraft Service
UTC	Universal Time Coordinated
VRF	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** EMB-820C NAVAJO **Registration:** PT-EFQ **Manufacturer:** EMBRAER	**Operator:** FED.NAC.DOS TRAB.CEL.NAS COOP. NO BRASIL
Occurrence	**Date/time:** 31JUL2016 - 2357 (UTC) **Location:** Londrina **Lat.** 23°18'47''S **Long.** 051°13'02''W **Municipality – State:** Londrina – PR	**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 Marechal Rondon International Airport, Cuiabá - MT (SBCY), to the Governador José Richa Aerodrome, Londrina - PR (SBLO), at about 2100 (UTC) to transport cargo and personnel, with two pilots and six passengers on board.

During approach to land in SBLO, the commander declared emergency, claiming to have lost power on the left engine.

At approximately 5 NM from SBLO's threshold 13, the aircraft crashed into a power grid and then into a building.

The aircraft was destroyed. Pilots and passengers perished on the crash site.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	2	6	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was destroyed.

1.4 Other damage.

The aircraft crashed into an electric power grid and into a transport company's shed.

The impact of the aircraft caused the rupture of two power lines, damage to the sidewall and roof of the shed. The fire generated by the collision burnt a truck that was on the site.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Pilot	Copilot
Total	2.833:40	1.567:10
Total in the last 30 days	unknown	unknown
Total in the last 24 hours	00:00	00:00
In this type of aircraft	unknown	unknown
In this type in the last 30 days	unknown	unknown
In this type in the last 24 hours	00:00	00:00

N.B.: The data related to the flown hours were obtained through the Pilots' Flight Logbook (CIV) records, available at ANAC's website.

1.5.2 Personnel training.

The commander took the Private Pilot course – Airplane (PPR) at the Votuporanga Aeroclube - SP, in 1978.

The copilot took the Private Pilot course – Airplane (PPR) at the São José do Rio Preto Aeroclube - SP, in 2011.

1.5.3 Category of licenses and validity of certificates.

The commander had the PLA License and had valid MNTE, MLTE and IFRA Ratings.

The copilot had the PCM License and had valid MNTE, MLTE and IFRA Ratings.

1.5.4 Qualification and flight experience.

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

The copilot was qualified in that kind of flight, but he did not have experience with the equipment.

At the time, the copilot performed the second flight on that aircraft model.

1.5.5 Validity of medical certificate.

The pilots had valid Aeronautical Medical Certificates (CMA).

1.6 Aircraft information.

The aircraft, serial number 820030, was manufactured by EMBRAER, in 1976, and it was registered in the TPP category.

The aircraft had valid Certificate of Airworthiness (CA).

The airframe, engines and propellers logbook records were outdated since September 2012.

The last inspection of the aircraft, the "1000 hours" type, was carried out on 29APR2016 by the *Vavá Manutenção de Aeronaves* Ltd. shop, in São José do Rio Preto - SP.

According to the registration in airframe logbook nº 03 / PT-EFQ / 03, the aircraft was admitted to the shop to perform the "1,000 hour" type inspection on 13DEC2012 and it was declared in perfect conditions of airworthiness by the shop.

It was released for return to service on 29APR2016, remaining 40 months out of operation. During this period, in addition to the services already mentioned, an overhaul of both engines and accessories was carried out.

It was not possible to specify the number of total airframe hours (model EMB 820C, S / N 820030), engines (model TIO-540-J2BD, S / N L-3999-61A and model LTIO-540-J2BD, S / N L-769-68A) and propellers (model HC-E3YR-2ATF, S / N D-12213-B and model HC-E3YR-2ALTF, S / N D-12222D) installed in the aircraft, since the aircraft's logbook was consumed by fire at the time of the accident.

However, it is estimated that the aircraft has flown approximately 37 hours after the "1,000 hour" inspection, which was completed on 29APR2016, according to the report of another pilot of the same operator.

In this way, the aircraft would be with 3,674 hours and 35 minutes and the engines and propellers with 3,679 hours and 20 minutes flown, approximately.

1.7 Meteorological information.

The weather conditions were favorable for the visual flight.

SBLO meteorological bulletins (METAR), distant 5 nautical miles from the scene of the accident, provided the following information:

METAR SBLO 312300Z 15004KT CAVOK 22/14 Q1020

METAR SBLO 010000Z 14004KT CAVOK 21/14 Q1020

METAR SBLO 010100Z 15003KT CAVOK 20/13 Q1020.

1.8 Aids to navigation.

All navigation and landing aids operated normally at the time of approaching the aircraft.

The Aerodrome, at the time of the accident, operated VFR and IFR, with RNAV (GNSS) RWY 13 being the procedure in use for approaching aircraft.

1.9 Communications.

According to the transcripts of the communication audios between the PT-EFQ and the control bodies, it was verified that the crew maintained radio contact with the Londrina Approach Control (APP-LO) until the moment of the accident, and there was no technical in-flight communication abnormality.

In order to support the analysis of the sequence of events prior to the aircraft collision, the Investigation Team highlighted some transmissions that helped to understand the dynamics of the accident. For the record of the schedules described in this field, the Coordinated Universal Time (UTC) was used as reference.

At 23h:42min:54s, PT-EFQ made an initial call to APP-LO.

At 23h:42min:55s, APP-LO responded to the initial PT-EFQ call and reported that the Automatic Terminal Information Service (ATIS) information was "X" and requested that the aircraft reported its radial, distance and flight level.

At 23h:43min:15s, PT-EFQ reported that it was approaching the 357° radial, away 40 NM, complementing, at 23:43:17, being flying in FL070.

At 23h43min21s, PT-EFQ requested to continue the descent, being questioned by APP-LO if it was able to carry out the RNAV procedure for runway 13. PT-EFQ then informed that the aircraft was not certified for Performance-Based Navigation (PBN), but could perform it under visual conditions for crew training, if authorized by APP-LO.

At 23h43min53s, APP-LO informed PT-EFQ that it could not authorize the procedure as requested and that it should cancel the instrument flight plan and carry out a visual approach to landing.

At 23h:48min:34s, PT-EFQ reported being 30 NM away from Londrina.

At 23h:48min:40s, APP-LO informed PT-EFQ about the existence of additional traffic, which would carry out the RNAV procedure for runway 13, approaching the southwest sector of Londrina.

At 23h:50min30s, PT-EFQ reported being at 18 NM, requesting to continue the descent, being allowed to descend to 5,000ft.

At 23h:52min15s, the PT-EFQ reported being at 13 NM, passing 4,700 ft., being alerted by APP-LO that it had been authorized its descent to 5,000ft.

At 23h:52min:38s, PT-EFQ requested the cancellation of the IFR flight plan, which was canceled by APP-LO, that directed it to descend to the traffic altitude at 23h:52min:44s.

At 23h:54min:13s, PT-EFQ reported being 9 NM away from Londrina, being reprimanded by APP-LO, at 23h:54min19s, according to copy of the transcript: "eco fox quebec negative, we saw you in our TARIS visualization. It is about thirteen miles from Londrina, now enter the upwind leg of runway one three descending to the altitude of traffic. Your direct landing will not be allowed, otherwise you will disturb the alpha tango seven two in the approach of one three. "

At 23h:55min:13s, the APP-LO authorizes another aircraft to initiate the RNAV procedure of runway 13, requesting it to report position LO012.

At 23h:55min:27s, PT-EFQ requests priority landing for being in an emergency.

At 23h:55min:35s, the APP-LO questions the aircraft if it is in an emergency.

At 23h:55min:38s, the PT-EFQ confirms that it is in an emergency and reports that it is losing engine power.

At 23h:55min:49s, the APP-LO questions the aircraft about its endurance, alternative and presence of dangerous cargo.

At 23h:55min:53s, the PT-EFQ reports that it still has two hours of endurance, losing power on the left engine.

At 23h:56min:06s, the APP-LO requests that the aircraft report at the final approach of runway 13.

At 23h:56min:10s, the PT-EFQ informs that it will report in the final of 13.

At 23h:57min:30s, the APP-LO questions the aircraft about how many minutes it estimate to land.

At 23h:57min:35s, the PT-EFQ informs that it estimates about two minutes to the landing.

At 23h:57min:40s, the PT-EFQ reports the word emergency twice.

At 23h:57min:43s, the APP-LO informs that it is aware and asks how many miles the aircraft is from the threshold.

At 23h57min49s, the PT-EFQ reported that it was 2.4 NM from the runway.

At 23h:57min:51s, the APP-LO informs to call the tower in 118.4.

At 23h:57min:55s, the PT-EFQ informs that it is in emergency and that it will land.

At 23h:57min:59s, the APP-LO informs that the landing is authorized, the wind is 105° with 3kt and the altimeter setting is 1020.

At 23h:58min:06s, the PT-EFQ reported that it was 1.2 NM from the runway, stating that it could not reach the runway and that it would land.

At 23h:58min:15s, the APP-LO informs that the control is aware.

At 23h:59min:29s, the PT-EFQ questioned APP-LO about its position.

At 23h:59min:38s, the APP-LO calls the aircraft.

At 23h:59min:41s, the PT-EFQ again asked APP-LO about its position regarding the runway.

At 23h:59min:46s, the APP-LO informs the aircraft that the tower is not seeing its traffic, this being the last contact between the aircraft and the control.

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 first impact occurred against a power grid, being the aircraft with a slightly downward trajectory and with leveled wings. The airplane's propellers cut the power cable into two different locations.

After the first impact, the aircraft drifted to the left, colliding with a building, with a lateral slope of approximately 45°, and then it caught fire.

The landing gear, the retractable type, was in the "up" position. The flaps were also retracted. It was not possible to verify the position of the flight control surfaces (primary and secondary) or other equipment and instruments because of the destruction degree and carbonization of the aircraft.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

According to previous medical histories in the health inspections of the crew and through reports of the relatives, no physiological or incapacitating evidences that could have affected the performance of the crew were found.

In addition, toxicological investigations of the crew, carried out by the Legal Medical Institute of Curitiba, did not detect any substance that evidenced the use of drugs (cocaine and crack), ethyl alcohol or even the consumption of substances with antidepressive, benzodiazepine, anticonvulsant effects, non-opioid analgesics and neuroleptics.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

According to the information collected, the flight commander was known as a careful aviation professional in his region. Socially, he was considered by his family to be a reserved person with few friends, but despite his more reserved posture, he had a good relationship with his employer and other colleagues.

He consumed alcoholic beverages in social events without excess, presenting healthy eating habits and an active routine.

According to reports, he was an experienced pilot. He had been an airline pilot and flight instructor in a flying club. He had been working for five years as a pilot for the National Federation of Cooperative Workers in Brazil (FENATRACOOP).

However, he still had little familiarity with the new panel of the airplane that he flew on the day of the accident, newly installed during the overhaul of the aircraft.

In the last two years, he personally accompanied the reform of the airplane at a maintenance company in São José do Rio Preto. In this period while the aircraft was reformed, he was doing freelance work.

The copilot, according to family reports, slept well, did not smoke, did not drink and did not use medication for continuous use. He used to present himself as a careful pilot regarding flight safety criteria, but when he encountered an in-flight problem, he exhibited expressive signs of anxiety.

On the day of the accident, the copilot performed his second flight on the aircraft, having flown, after his training as copilot, in an air taxi company in the Northern region of Brazil.

His return to São José do Rio Preto happened because of personal needs. According to reports, he had approximately 1,500 flight hours.

The copilot had accepted his work without being paid by the company. His intention was, with that opportunity, to gain more experience in the type of airplane and to become better known in the region.

Informally, the commander of the aircraft made him a proposal to replace him at FENATRACOOP when he retired, which made him even more motivated to fly and train.

According to his wife's report, the copilot would have mentioned a red light on the dash near the landing in Cuiabá. The commander, however, was calm, taking the aircraft safely to the landing, and the copilot did not feel safe about questioning the actual airworthiness of the airplane.

Reports have reported that after the landing, the reason for lightening mentioned above was not identified and there was no search for technical assistance to understand it.

Thus, the take-off from Cuiabá to Londrina may have occurred without such checks and without the certainty that the abnormality had been extinguished.

According to information received, commander and copilot established little dialogue with each other regarding aircraft and operating conditions.

The Investigation Team was also able to observe, through reports received, that the PT-EFQ commander had a habit of informing, when in his approach to landing, in relation to the runway, a shorter distance than the real one, conferred by the air traffic control. His intention was to get priority landing over other aircraft.

1.14 Fire.

The aircraft caught fire after the collision against a building, being destroyed and carbonized.

1.15 Survival aspects.

There were no survivors.

1.16 Tests and research.

Since the emergency declaration was due to an apparent loss of power on the left engine, as reported by the crew to the APP-LO, the Investigation Team requested analysis of the powerplant (engines and propellers) to verify its operation at the time of accident.

During the analysis performed on the Lycoming LTIO-540-J2BD right engine, L / 769-68A, it was found that the upper clamp securing the bypass valve to the turbocharger transition duct was not properly adjusted; there was a gap in its attachment, as shown in Figures 1 and 2.

Figure 1 - Detail of the upper clamp installed in the bypass of the turbocharger without adequate adjustment.

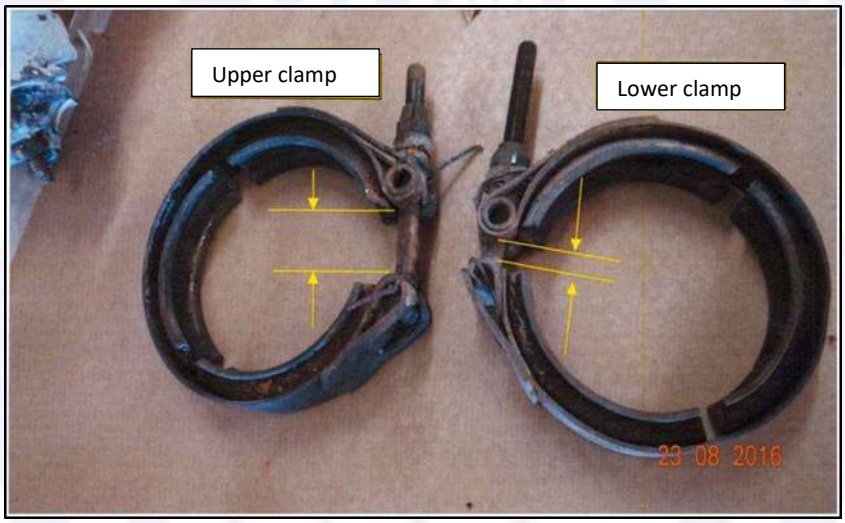

Figure 2 - Comparison between the upper and lower clamp adjustments of the turbocharger bypass valve.

It was further noted in this engine that the fuel tube nut, which exited from the distributor to cylinder No. 3, was not properly tightened. The loosening of the tube fixing nut was corroborated by the presence of soot deposited on the last threads of the nut, due to the fire caused during the collision of the airplane against the building (Figure 3).

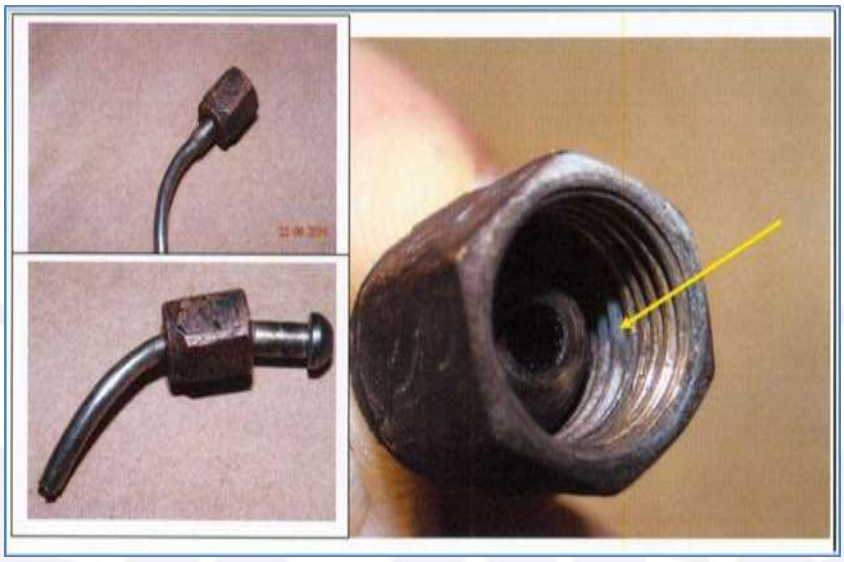

Figure 3 - Detail of the connection of the distributor's fuel outlet pipe to the cylinder # 3 with presence of soot in the last threads of the nut.

The presence of a white colored material deposited on the piston head, valves and inside the combustion chamber of the odd cylinders indicated that the engine was operating at high temperatures.

The right-hand propeller had a dent in the leading edge of one of the blades, as well as the soft folding facing forward on another blade, proving that the engine was running at power on impact.

In the left engine analysis, Lycoming TIO-540-J2BD, n / s L-3999-61A, it was observed that in nozzles no. 2, 4 and 6 there was the deposit of strange material on its external surfaces, causing obstruction of the side holes. This residue was collected to perform a laboratory test.

Figure 4 - View of the even injector nozzles, of the left engine, with lateral contamination.

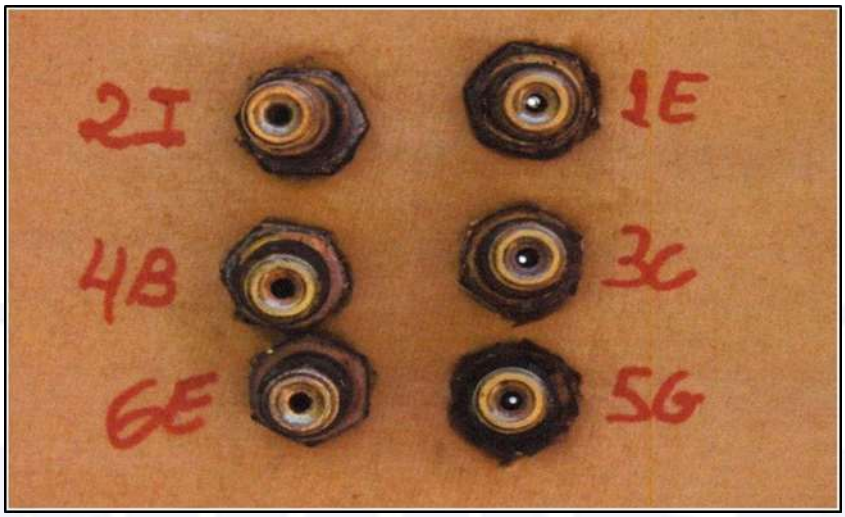

Figure 5 - Detail of the obstruction of the injector nozzles of the left engine.

Laboratory tests indicated that the material collected was likely to be composed of an agglomerated soil and fuel which, when deposited in the orifices of the injector nozzles, obstructed the passage of the fuel.

In the blades of the left engine propeller, several dents and scratches were observed, indicating that it was not stopped at the moment of the collision against the building.

Therefore, the powertrain analysis indicated that both engines had power failure for different reasons. However, it was not possible to quantify the portion of the power that would be developed under normal operating conditions.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

The aircraft was not within the weight and balance parameters specified by the manufacturer at takeoff.

The crashed aircraft had recently undergone a 1,000-hour inspection, during which the two engines were overhauled, as well as the revitalization of their interior and the exchange of panel instruments, with the installation of more modern equipment such as the system GARMIN GTN-650.

The aforementioned services were performed at the *Vavá Manutenção de Aeronaves* Ltd. shop, located in São José do Rio Preto - SP. The aircraft entered in the shop on 13DEC2012 and the review was declared closed on 29APR2016, with the test flight being performed on 18MAY2016.

It was stated that after checking out of the shop, the aircraft was operating with the cylinder temperature of both engines above ideal, as well as present failure on the right engine turbo.

The shop reported that it had adjusted the engines and adjusted the turbocharger, leaving them fully operational.

The aircraft then took off on 29JUL2016 from São José do Rio Preto (SBSR) to Londrina (SBLO), with the purpose of embarking six passengers to Cuiabá (SBCY).

According to information from the fuel supply company employees in Londrina, the PT-EFQ commander requested the aircraft to be fully supplied, adding a total of 565 liters of aviation gasoline (AV GAS), according to the company's supply document.

They then proceeded to Cuiabá (SBCY), taking off at approximately 1325 (UTC).

According to radar images provided by the CINDACTA II, the flight occurred normally on FL080 and with cruising speed (GS) around 165kt.

During the approach to landing in Cuiabá (SBCY), the right engine fuel flow light turned on in the alarm panel. However, the landing was done safely. This information was provided by the copilot's wife, and was later confirmed by a friend of his, who attended the Cuiabá Airport on 30JUL2016.

On this occasion, it was observed that the commander was investigating the possible reason for the emergency light being turned on in the aircraft manual and appeared to be concerned.

Also on July 30th, there was the wedding of the FENATRACOOP President's son. Only the commander of the aircraft went to the event. According to information, he did not consume alcohol and returned early to the hotel, in order to rest to take off the next day.

On the day of the return to Londrina (SBLO), according to a report from the fuel supply company's employee, the aircraft was refuelled to its full capacity, with a total of 638 liters on the supply receipt, being the total capacity of the fuel tanks of the EMB -820C of 931 liters.

The flight plan presented by the aircraft commander established a trajectory marked by geographical coordinates in FL090 and cruising speed of 180kt.

The estimated off-block time (EOBT) was initially at 1900 (UTC), however, two extensions of the take-off time (DLA) were presented, one for 1945 (UTC) and one for 2030 (UTC), being the take-off effectively done at 2100 (UTC), with two pilots and six passengers on board.

By means of information obtained from people who were with the passengers on the boarding moment in Londrina, on 29JUL2016 and of estimates about the weight of the occupants of the airplane and their luggage, it is believed that the aircraft took off from Cuiabá with a weight of 3,416, 4kg. As a result, the aircraft was approximately 241.4 kg above the maximum take-off weight (PMD) provided in the Aircraft Operating Manual, which was 3,175 kg.

According to the route radar images provided by CINDACTA II, the aircraft complied with the flight plan profile, entering the Londrina terminal at 23h42min54s, when it made the first contact with APP-LO, informing that it was approaching the 357° radial and 40 NM from the destination Aerodrome.

On this occasion, the aircraft was already in FL070 and continued descending without reporting any malfunction to APP-LO. The voice of the pilot who made the initial communications seemed calm and no sound alarm anywhere on the plane was heard in the available recordings.

The procedure that was in use in SBLO at the time was RNAV (GNSS) RWY13. Although the PT-EFQ was not PBN-approved, the commander asked APP-LO to perform the same, under visual conditions, for crew training.

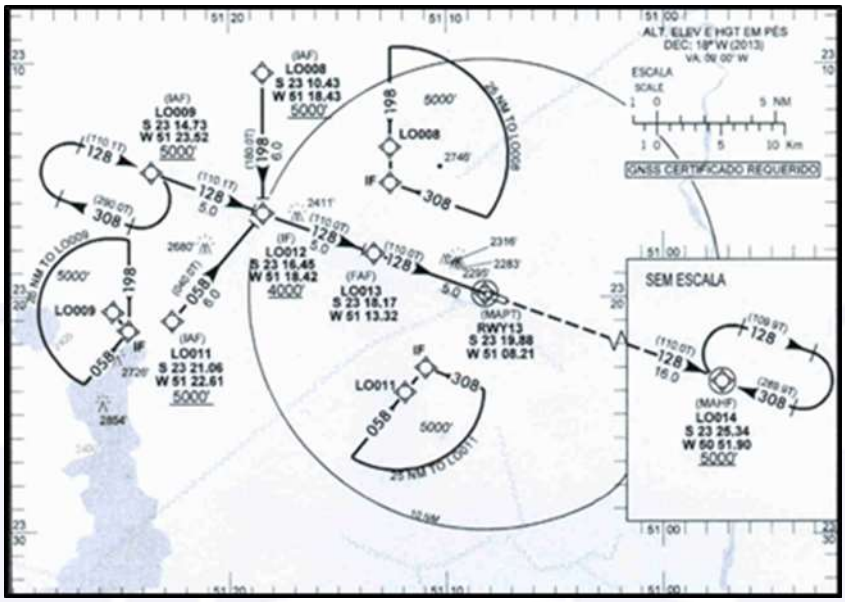

Figure 6 – RNAV procedure (GNSS) SBLO RWY13.

The request was denied by the controller, informing the need for cancellation of the IFR plan, when closer to the Aerodrome, for the visual approach (VFR).

Concomitantly with the arrival of the PT-EFQ, another airplane had entered the terminal of Londrina and would carry out IFR approach, executing the RNAV procedure (GNSS) RWY13.

As the PT-EFQ would perform visual approximation and was of lower performance, the other aircraft was allowed to initiate the instrument procedure.

The PT-EFQ was questioned three times by APP-LO about its distance from the airport. At 23h48min34s (UTC), PT-EFQ reported that it was 30 NM away, then at 23h50min42s (UTC), it reported being at 17.5 NM and at 23h54min13s (UTC), it reported being at 9 NM.

The APP-LO was in the process of certification and would soon start its operation with the aid of the approach radar.

Although they were operating conventionally (not radar) on the day of the accident, the controllers already had a radar repeater from the Area Control Center (ACC) Curitiba, through which it was possible to follow the flight path in approach to Londrina, as well as check altitude, speed, radial and distance of aid.

It was possible to verify, through the recorded images of the radar, that the distance information reported by PT-EFQ was not correct. Specifically when the aircraft reported to be 9 NM away, the controller corrected the pilot stating that, in fact, the aircraft was at approximately 13 NM.

In addition, through the radar images, it was possible to verify that, although APP-LO did not authorize the PT-EFQ to perform the approach following the profile of the RNAV procedure, the airplane navigated to intercept a long final and not towards the Aerodrome to enter visual traffic.

Upon realizing this trajectory of the PT-EFQ, the controller warned the pilot that the direct landing would not be authorized, as it would hinder the approach of the other traffic, which had already initiated the RNAV procedure (GNSS) RWY13.

The PT-EFQ was then instructed to enter the upwind leg of runway 13.

Shortly after receiving guidance to enter the upwind leg, the PT-EFQ, at 23h55min27s (UTC), requested priority for landing because it was in an emergency. The pilot said he was losing power on the left engine.

From that moment on, APP-LO asked the other aircraft to wait on position LO011, prioritizing the approach of the PT-EFQ, which intercepted the long final to landing.

At 23h57min43s UTC, PT-EFQ was questioned by APP-LO about its distance from threshold 13, reporting that it was 2.4 NM. Then, at 23h58min06s (UTC), the pilot reported that he was 1.2 NM away and could not get to the runway.

At 23h59min41s UTC, PT-EFQ made their last contact with APP-LO, questioning its position regarding the runway.

Since there were no conditions to support the level flight, PT-EFQ collided with a low voltage grid and later, against a building, burning immediately.

The location where the aircraft crashed was practically in the RNAV procedure (GNSS) RWY 13, located 0.5 NM from position LO013 and 4.65 NM from threshold 13.

Figure 7 - Displacement of PT-EFQ in the approach for SBLO.

Taking into account the average fuel consumption of the previous flights, the investigators estimated that the aircraft had approximately 361 liters of fuel in the tanks and a total weight of 3,006 kg at the time of the accident, so within the limits of its operation.

1.19 Additional information.

Nil.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a passenger transport flight between SBCY and SBLO Aerodromes.

The right engine of the aircraft had a clearance in the upper clamp that fixed the bypass valve to the transition duct of the turbocharger.

This valve was responsible for dosing the amount of exhaust gases that would act on the turbine of the turbocharger, thereby determining an increase in engine power and efficiency.

This increase in power and efficiency was possible, due to the supply of compressed air to the engine intake, allowing it to develop maximum rated power at higher altitudes than an engine that simply aspirates the outside air.

As the bypass valve clamp was loose, it allowed air to escape from the exhaust, reducing the amount of air that would be directed to the turbine, thereby reducing the efficiency of the turbocharger and, consequently, not allowing the engine to reach its maximum performance.

It was not possible to determine the decrease in power and efficiency of the engine caused by the bypass valve clamp clearance. However, according to the EMB-820C Operation Manual, if the turbocharger failed and the engine only aspirated the outside air, its maximum continuous power delivered would be of approximately 75% or 262hp at sea level.

Still on the right engine, it was identified that the fuel tube nut leaving the distributor for No. 3 cylinder was not properly tightened and that odd cylinders had characteristics that they were working at high temperatures.

The characteristics of the combustion residues found inside the odd cylinders indicated that they worked at high temperatures, possibly due to the impoverishment of the air / fuel mixture caused by a leakage of fuel in the nut of the tube that was improperly fixed.

This leakage, besides having caused irregular burning in the cylinders, caused excess temperature and loss of efficiency of the engine.

About the information collected through reports that the right engine fuel flow light would have lit in the approach to landing in Cuiabá, it was not possible to associate this abnormal condition of the fuel system operation with the deficiencies pointed out in the analysis of that engine.

According to the EMB-820C Operation Manual, a sensor installed near the outlet of each internal tank activated the low fuel flow light. If the fuel flow near this outlet fell to a point where there could be a flow interruption, the sensor would turn on the corresponding alarm light, which would remain illuminated for at least ten seconds or until the cause had been corrected.

In addition, the Operation Manual did not provide fuel-flow light-up parameters, nor did the company responsible for the design of the aircraft knew how to inform them.

However, it is believed that the possible leakage, through the No. 3 cylinder feed tube nut, would not be able to sufficiently reduce the flow to cause the low fuel flow light to illuminate.

On the left engine, there was a residue adhered to the outer surface of the nozzles No. 2, 4 and 6, which was probably composed of a fuel and soil agglomerate, which migrated into the nozzles, clogging the side holes and blocking the fuel passage.

In this way, it is possible that, with the clogging of the related injector nozzles, the left engine had abnormal operation and consequent loss of power.

This failure, associated with the malfunction of the right engine, has degraded the performance of the airplane, which may have hindered the maintenance of the controlled flight.

It was not possible to determine the origin of the soil found in the affected nozzles. However, PT-EFQ is known to have been in a shop for forty weeks during an overhaul.

Therefore, although the investigation team has no records on how the aircraft was stored and protected from the external environment during this maintenance period, there

is a possibility that the impurity has been deposited in the injector nozzles and other components during its passage through the shop.

Also, the possibility of this material having been deposited in the nozzles after the collision was ruled out, for two reasons: first, the engine stopped immediately after the accident and, secondly, the pilot declared emergency due to loss of power on the left engine.

The aircraft commander only declared an emergency, with power loss on the left engine, at the time that its direct approach to landing was denied by the controller, since the other aircraft, which performed instrument approach, had priority on arrival.

The distance information passed on by PT-EFQ to APP-LO was incompatible with the airplane performance and did not match the radar display data.

Taking into account the reports of 40 NM, 30 NM and 18 NM available in the audio recordings, and the time taken between them, it was noticed that the PT-EFQ first covered 10 NM in a 4-minute interval and 53 seconds. It then navigated for 12 NM in just 1 minute and 50 seconds, requiring a speed of approximately 390kt, totally incompatible with the operating performance of that aircraft model.

However, observing the PT-EFQ navigation profile, fitting into a long landing final and the commander's attempts to report a forward position in his approach, with the probable goal of having priority over the other aircraft, it’s possible that the crew was already aware that something was wrong, but tried to delay the emergency declaration as much as possible, in order to avoid future repercussions.

Observers’ reports corroborated this hypothesis by commenting that the PT-EFQ commander used to pass on incorrect information to controllers to take advantage on the approach.

Even so, it is not possible to affirm that the information provided by the crew showed a tendency to think and react as to the pursuit of priority over the other aircraft destined for Londrina.

It may be assumed, however, that the commander's decision-making process was influenced by possible financial and professional repercussions, declaring emergency only after being denied priority landing.

Regarding the final moments of the flight, it was verified that the crew, already being in emergency and at low altitude, apparently, lost the situational awareness of its position in relation to the runway.

Initially, when asked by the APP-LO about its position, they answered to be at 2.4 NM and 1.2 NM at two different moments, and then questioned the controller about the position of the aircraft.It is suspected that the pilots believed to be near the landing threshold, when in reality the final impact occurred at approximately 4.65 NM from threshold 13 and 0.5 NM from position LO013.

Thus, knowing that the GARMIN GTN 650 navigation system had recently been incorporated into the aircraft and that the crew was not familiar with it, it is possible that the pilots have navigated to position LO013, believing they were navigating to position RWY13, which was threshold 13 of SBLO.

It is therefore possible that an erroneous interpretation of the data provided by the new navigation equipment could justify the incorrect distance information reported to APP-LO.

On the other hand, the similarity between the names of the adjacent approach fixes, both terminated at 13, could have induced pilots to misinterpret, especially during an

emergency, when the work overload in the cabin is enhanced, reducing the time available to carry out the tasks on board.

The PT-EFQ crew made their second flight together and had different experiences. The copilot had little more than 1,500 hours of flight, while the commander, having already flown, including Airline, had extensive flight experience, with more than 15,000 hours, according to his family.

It was observed, therefore, that the disparity of experience among pilots; the possible motivation of the copilot to show the commander that he was able to replace him in command of the aircraft, favored even by the inexistence of a formal work contract between the copilot and the company; and the difficulty of dialogue between pilots on issues related to the operation of the aircraft, may have culminated in a prejudicial scenario to the expression of assertiveness in communication between the cabin pilots.

In this context, it was assumed that a possible more passive posture of the copilot, combined with the decisions and actions issued by the commander from the presentation of the abnormal condition in flight, possibly interfered with the integration quality and cabin dynamics efficiency during the occurrence.

These aspects were evident when the copilot demonstrated to his wife and a friend concern about the warning light on the panel during the approach in Cuiabá.

However, the copilot did not feel safe in questioning the commander about the actual airworthiness of the airplane, taking off from Cuiabá to Londrina without certainty that the abnormality had been extinguished. This behavior was possibly repeated in the other phases of the flight that preceded the accident, causing damage to the management of the abnormal condition presented.

It is also known that situations that escape the normal flight routine tend to raise the level of anxiety, also potentiated by a possible overload of work and the reduced time to carry out the procedures in cabin, in this case, more complex, because it was a landing approach. In this sense, it is not possible to discard the hypothesis that a more anxious emotional state of the pilots contributed to an inaccurate assessment of the operational context experienced, favoring ineffective judgments, decisions and actions to manage the abnormal condition presented.

Finally, the most probable hypothesis for the occurrence was the malfunction of both engines. The right one, due to the deficiency presented in the turbocharger and to the fuel leakage by the locking nut of the tubing that left the distributor for cylinder No. 3. The left one, by clogging the nozzles nº 2, 4 and 6.

Due to the discrepancies identified in the engines, the aircraft was not able to develop enough power to keep the flight level, initially colliding with a power grid and later against a building.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid Aeronautical Medical Certificates (CMA);

b) the pilots had valid MNTE, MLTE and IFRA Ratings;

c) the pilots were qualified and had experience in that kind of flight;

d) the copilot had little experience in that aircraft model;

e) the aircraft had valid Airworthiness Certificate (CA);

f) during take-off, the aircraft was above the maximum weight limit;

g) the airframe, engines and propellers logbook records were outdated;

h) the aircraft took off from SBCY to SBLO with two pilots and six passengers on board;

i) during the approach to landing in SBLO, the crew declared emergency, claiming power loss on the left engine;

j) as the level flight was not possible, the aircraft collided with a power grid and, later, against a building;

k) the aircraft was completely destroyed; and

l) the pilots and passengers perished at the site of the accident.

3.2 Contributing factors.

- **Communication – undetermined.**

It is possible that difficulties for the dialogue between pilots on matters related to the operation of the aircraft have favored a prejudicial scenario to the expression of assertiveness in the communication in the cabin, interfering in the effective management of the presented abnormal condition.

- **Team dynamics – undetermined.**

It is possible that a more passive posture of the copilot combined with the commander's decisions and actions from the presentation of the abnormal condition in flight interfered with the quality of the team's integration and in the efficiency of the cabin dynamics during the occurrence, bringing losses to the emergency management presented.

- **Emotional state – undetermined.**

It is not possible to discard the hypothesis that a more anxious emotional state of the pilots contributed to an inaccurate evaluation of the operational context experienced, favoring ineffective judgments, decisions and actions to manage the abnormal condition presented.

- **Aircraft maintenance – a contributor.**

On the right engine, it was found that the fuel tube fixing nut that left the distributor for No. 3 cylinder was loose, favoring the fuel leakage, as well as the bypass valve clamp of the turbocharger that was bad adjusted, providing leakage of gases from the exhaust that would be directed to the compressor and, later to the engine, to equalize its power.

On the left engine, impurity composed of an agglomerate of soil and fuel were found on the side of the nozzles n° 2, 4 and 6, which migrated to the inside of these nozzles, causing them to become clogged.

It was not possible to determine the origin of this material, but there is a possibility that it may have been deposited during the long period the aircraft spent in the maintenance shop, undergoing general overhaul and the revitalization of its interior (13DEC2012 until 29APR2016).

- **Insufficient pilot’s experience – undetermined.**

The pilots had little experience with the GARMIN GTN 650 navigation system. The lack of familiarity with this equipment may have favored the misidentification of the approach fixes for Londrina. This way, it is possible that they have calculated their descent to the final approach fix (waypoint LO013), believing that it was the position relative to threshold 13 (waypoint RWY13).

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

The decision to take off from Cuiabá to Londrina without the identification of the reason for the warning light to be ON in the alarm panel and the possible late declaration of the emergency condition showed little adequate decisions that may have increased the level of criticality of the occurrence.

- **Support systems – undetermined.**

The similarity of the waypoints names in the RNAV procedure, associated with the lack of familiarity of the pilots with the new navigation system installed in the aircraft, may have confused the pilots as to their real position in relation to the runway.

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-105/CENIPA/2016 - 01 Issued on 01/29/2019

Act together with *Vavá Manutenção de Aeronaves* Ltd. shop (COM No 8004-02 / ANAC), in order to verify that the organization possesses and applies all the resources necessary for the proper provision of the maintenance services, especially in the EMB-820C Navajo aircraft, in accordance with the legislation in force, the respective manuals and the Company Capabilities List.

A-105/CENIPA/2016 - 02 Issued on 01/29/2019

Disseminate the lessons learned in the present investigation, in order to alert Brazilian civil aviation pilots, operators and maintainers about the risks arising from inadequate maintenance services and failure to comply with the manufacturer's maintenance manuals during the aircraft failure surveys.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

The Airspace Control Department (DECEA), on 24JAN2018, updated the chart RNAV (GNSS) Z RWY 13 - Londrina (SBLO), at which time it changed the name of the fixed final approach of the procedure from LO13 to LO132.

On January 29th, 2019.