COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-075/CENIPA/2020

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-MBV**
MODEL:	**EMB-121A**
DATE:	**14JUN2020**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination, and execution of the activities of investigation and prevention of aeronautical accidents.

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

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

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

This Final Report has been made available to the ANAC and the DECEA so that the technical-scientific analyses of this investigation can be used as a source of data and information, aiming at identifying hazards and assessing risks, as set forth in the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

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

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

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

SYNOPSIS

This Final Report refers to the accident with the EMB-121A aircraft, registration PT-MBV, on 14 June 2020. The accident was typified as “[LOC-I] Loss of control in flight”.

The aircraft was on a private flight from SILS (Big Master Aerodrome, *Tangará da Serra*, State of *Mato Grosso*), bound for SBNV (*Aeródromo Nacional de Aviação*, *Goiânia*, State of Goiás), with two crew aboard (the PIC and a second crewmember).

About four minutes after taking off from SILS runway 20, the aircraft collided with the ground at a high angle of impact. A post-impact fire ensued.

The aircraft was destroyed.

Both crewmembers received fatal injuries.

For being Canada the State of manufacture of the aircraft’s engines, an accredited representative of the Canadian TSB (Transportation Safety Board) was designated for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AMM	Aircraft Maintenance Manual
ANAC	Brazil's National Civil Aviation Agency
CA	Certificate of Airworthiness
CAA	Angle-of-Attack Control
CAVOK	Ceiling And Visibility OK (no clouds below 5000 ft or below the minimum height of the highest sector (whichever the greater) and horizontal visibility above 10 km; no CB's nor significant weather condition for aviation)
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIV	Pilot Logbook
CMA	Aeronautical Medical Certificate
CVA	Airworthiness Verification Certificate
DCTA	Department of Science and Aerospace Technology
ELT	Emergency Locator Transmitter
IAM	Annual Maintenance Inspection
IFR	Instrument Flight Rules
IFRA	IFR Flight Rating – Airplane
INMET	Brazil's National Institute of Meteorology
METAR	Meteorological Aerodrome Report
MLTE	Multi-Engine Land-Airplane Class Rating
PCM	Comercial Pilot License – Airplane
PF	Pilot Flying
PIC	Pilot in Command
PN	Part Number
POH	Pilot's Operating Handbook
PPR	Private Pilot License – Airplane
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
REDEMET	Command of Aeronautics' Meteorology Network
SACI	Integrated Civil Aviation Information System
SERIPA VI	Sixth Regional Service for the Investigation and Prevention of Aeronautical Accidents
SBBH	ICAO location designator - *Carlos Drummond de Andrade* Aerodrome, *Pampulha*, *Belo Horizonte*, State of *Minas Gerais*
SBCY	ICAO location designator - *Marechal Rondon* International Aerodrome, *Cuiabá*, State *of Mato Grosso*
SBGO	ICAO location designator - *Santa Genoveva* Aerodrome, *Goiânia*, State of *Goiás*

SBNV	ICAO location designator - *Aeródromo Nacional de Aviação*, *Goiânia*, State of *Goiás*
SBUL	ICAO location designator - *Ten Cel Av César Bombonato* Aerodrome, *Uberlândia*, State of *Minas Gerais*
SIC	*Second in Command*
SILS	ICAO location designator - *Big Master Aerodrome*, *Tangará da Serra*, State of *Mato Grosso*
SIGWX	Significant Weather
SN	Serial Number
TBO	Time Between Overhauls
TPP	Private Air Services Aircraft Registration Category
TSB	Transportation Safety Board
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** EMB-121A **Registration:** PT-MBV **Manufacturer:** EMBRAER.	**Operator:** *Oeste Veículos Ltda*.
Occurrence	**Date/time**: 14JUN2020 - 12:40 (UTC) **Location:** Fazenda Colorado. **Lat.** 14°40'55"S **Long.** 057°35'44"W **Municipality – State:** *Tangará da Serra – Mato Grosso*.	**Type(s):** [LOC-I] Loss of control - inflight

1.1. History of the flight.

The aircraft took off from SILS (Big Master Aerodrome, *Tangará da Serra*, MT), bound for SBNV (*Aeródromo Nacional de Aviação*, *Goiânia*, GO), around 12:35 UTC, in order to perform a private flight, with the Pilot in Command (PIC) and a second crewmember on board.

About four minutes after taking off from the runway 20 of SILS, the aircraft collided with the ground at a high angle of impact. A post-impact fire followed.

The aircraft was destroyed.

Both crewmembers received fatal injuries.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The crash destroyed the aircraft, which was subsequently consumed by a post-impact fire.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience		
	PIC	2nd crewmember
Total	Unknown	Unknown
Total in the last 30 days	Unknown	Unknown
Total in the last 24 hours	Unknown	Unknown
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	Unknown	Unknown

Obs.: The data concerning the hours flown by the pilots came from the records of the pilots' digital logbooks (CIV) of the Integrated Civil Aviation Information System (SACI).

In the PIC's digital logbook, there were 607 hours and 17 minutes of flight time in total, 41 hours and 41 minutes of which in the EMB-121 model; in the second crewmember's CIV, there were 425 hours and 11 minutes of flight time in total.

It was not possible to obtain accurate information regarding the flight experience of the crewmembers, nor was there access to the physical CIV's and aircraft logbook, since the post-impact fire had destroyed them.

1.5.2. Personnel training.

The PIC did his Private Pilot (Airplane) course in 1983.

The second crewmember did the Private Pilot (Airplane) course in 2014.

1.5.3. Category of licenses and validity of certificates.

The PIC held an Airline Transport Pilot license (Airplane), and had valid MLTE (Multi-Engine Land Airplane) and IFR Flight (Airplane) ratings.

The second crewmember had a PCM license (Commercial Pilot – Airplane), and valid MLTE (Multi-Engine Land Airplane) and IFRA (IFR Flight – Airplane) ratings.

1.5.4. Qualification and flight experience.

The most recent flight of the PIC recorded on his digital CIV was on 22 May 2020. According to reports, he was highly experienced in aviation, but no records were presented to confirm the information.

With regard to his MLTE rating, according to data logged in his digital CIV, the PIC had 198 hours and 50 minutes of flight of registered experience.

The PIC also had 41 hours and 44 minutes of flight recorded with the E121 Type rating (which included the EMB-121A model), necessary to operate the aircraft according to the regulation that had been valid until 18 March 2016, when the No. 6 Amendment to the Brazilian Civil Aviation Regulation No.61 (RBAC-61) was published ("Licenses, Qualifications and Certificates for Pilots").

Upon publication of the referred amendment, the aircraft received the classification of MLTE for qualification purposes, requiring a specific endorsement for operation, as established in the Supplementary Instruction (IS) No. 61-006 – "Procedures for Inclusion of Endorsements in Pilots' Logbooks".

In the case of the PIC, the endorsement was not necessary, considering that the referred Service Instruction specified, as a transitional rule, that:

> The pilots whose *type ratings* changed into *class ratings* in accordance with the Amendment 06 to RBAC nº 61 are considered endorsed in all aircraft models that they have already flown within that type rating.

From the data collected, the conclusion was that the PIC had the required recent experience, as provided for in the RBAC-61, Amendment 13, Section 61.21:

> 61.21 Recent Experience
>
> (a) Subject to the deadlines established in section 61.19 of this Regulation, a pilot may only operate as pilot-in-command of an aircraft if, within the preceding 90 (ninety) days, he has performed:
>
> (1) for day-time flight operations:
>
> [...]
>
> (ii) In the case of the other aircraft, at least 3 (three) takeoffs and 3 (three) landings in day- or night-time period, during which he has effectively operated the controls of the aircraft belonging to same category and class/type;

As his most recent flight, the second crewmember had logged an operation performed on an EMB-810D model aircraft on 05 December 2019.

As for his MLTE rating, according to data obtained through the records from his digital CIV, the second crewmember had 274 hours and 9 minutes of recorded flight experience.

According to information obtained, the second crewmember had been flying the aircraft of the occurrence for a month, but had no pertinent operating records or endorsement in his digital CIV. Thus, despite holding an MLTE rating, he did not meet the requirements to operate as Second-in-Command (SIC).

Thus, the Investigation Commission considered that the second crewmember was still undergoing a process of qualification, because he had not yet received the endorsement to operate the EMB-121A aircraft.

1.5.5. Validity of medical certificate.

Both crewmembers held valid Aeronautical Medical Certificates (CMA).

1.6. Aircraft information.

The Serial Number 121053 aircraft was a product of EMBRAER, manufactured in 1982, and registered in the Private Air Services Registration Category (TPP).

The Airworthiness Verification Certificate (CVA) of the aircraft was valid.

The records of the airframe and engine logbooks were up to date.

According to the documentation presented, the current owner of the aircraft had purchased it not long before the occurrence. The registered date of purchase/transfer was 14 May 2020, that is, one month before the date of the accident.

As per information collected, the aircraft had remained at SBUL, and had not flown for approximately one year. There was no information on the aircraft's conditions of preservation until the period in which negotiations for the purchase began, circa March 2020.

The last inspection of the aircraft (“Annual Maintenance Inspection”), conducted in advance of the purchase negotiations, started on 16 July 2018 and finished on 30 April 2019. The inspection was performed at the premises of *VOAR* Aviation *Manutenção de Aeronaves* (COM 7701-01/ANAC), in *Uberlândia*, MG. On the date of completion of the inspection, the aircraft had a total flight time of 4,444 hours and 40 minutes.

While the procedures for the purchase of the plane were developing, a pilot, who used to fly the aircraft at the time, reported that the “trimming was not adequate”.

After negotiations, the aircraft was flown to SBBH *(Carlos Drummond de Andrade* Aerodrome, *Pampulha, Belo Horizonte*, MG) to undergo services related to the propeller assembly at *Chamone Indústria Aeronáutica Ltda*. (COM 6512-02/ANAC). On the occasion, the maintenance organization performed the removal and installation of the propeller blades (29 April 2020). The aircraft had 4,446 hours and 5 minutes of flight on that date.

On 01 May 2020, according to a report made by the owner, the two crewmembers of the occurrence flight flew the aircraft from SBBH to SILS, with a stopover in SBNV. On 05 May 2020, they flew the airplane to SBGO (*Santa Genoveva* Aerodrome, *Goiânia*, GO), where the aircraft was expected to undergo the Annual Maintenance Inspection (IAM).

On 08 May 2020, the last registered inspections began (“Airworthiness Verification Certificate (CVA)” and “Annual Maintenance Inspection (IAM)” types, with several services performed on the aircraft (Figure 1).

PARTE II

SERVIÇOS EXECUTADOS:

01- Inspeção Anual de Manutenção – IAM conforme RBHA 91.403(i) e RBAC 43;
02- Inspeções Diária, Semanal e A2 de acordo com o AMM Cap. 05-00-00;
03- Inspeções de 1 Mês, 6 Meses, 12 Meses de acordo com o AMM Cap. 05-00-00;
04- Teste de Capacidade de 300 Horas / 2 Meses da Bateria Principal P/N G6381-E S/N G02999468 de acordo com o AMM Cap. 24-30-03;
05- Pesagem das garrafas de extinção de fogo dos motores P/N 3011102 S/N 06782A1 (peso: 1,896 Kg) e S/N 06802A1 (peso: 1,894 Kg) de acordo com o AMM Cap. 26-20-00;
06- Teste hidrostático do Cilindro de Oxigênio DOT-3HT-1850 P/N 176171-76 S/N 4820-K944339 pela empresa Gespi (SEGVOO 003, Nº GSP45254/20, datado de 18/05/2020);
07- Inspeção de 3 Meses do "Sistema de Comando dos Compensadores" de acordo com a ANAC DA 82-09-01;
08- Teste Funcional de 12 Meses dos Vibradores Dos Manches #01 e #02 de acordo com o AMM Cap. 27-32-00;
09- Teste Funcional de 300 Horas / 3 Meses das Rótulas de Articulação do TPN da Hasle de Travamento do TPN de acordo com o AMM Cap. 32-00-00;
10- Teste De Bancada de 3000 Horas / 12 Meses do Redutor De Pressão de acordo com o AMM Cap. 32-00-00;
11- Compensação de 12 Meses Da Bússola Magnética de acordo com o AMM Cap. 34-20-03;
12- Inspeção de 6 Meses da Bateria P/N 452-6489 S/N 366852-089 do ELT (data de venc: jul/2022) de acordo com o AMM Cap. 25-60-00;
13- Inspeção e Teste de 12 Meses do ELT ME406 P/N 453-6603 S/N 186-07067 de acordo com o RBAC 91.207;

PARTE II

SERVIÇOS EXECUTADOS:

14- Remoção e reinstalação da Hélice LH Modelo HC-B4TN-3C S/N CDA-4259 (TSN 5195,0) após Revisão Geral executada pela empresa Runway Aviation Brasil (SEGVOO 003, Nº RWB-013/2020, datado de 27/05/2020);
15- Remoção e reinstalação da Hélice RH Modelo HC-B4TN-3C S/N CDA-4284 (TSN: 5195,0) após Revisão Geral executada pela empresa Runway Aviation Brasil (SEGVOO 003, Nº RWB-013/2020, datado de 27/05/2020);
16- Inspeção do "Accuracy Tachometer" das Hélices LH / RH de acordo com o AMM Cap. 72-00-00;
17- Compensação de 12 meses dos sistemas de Bússola Giromagnética P/N 066-3045-20 (#1) S/N 50744 e (#2) S/N 50325 de acordo com o AMM Cap. 34-20-01;
18- Efetuada inspeção por Líquido Penetrante nas rodas P/N 37758 (LH) S/N 0388-565 e (RH) S/N 0388-563 do NLG pela empresa Master Ensaios Não Destrutivos Ltda (SEGVOO 003, Nº 0615/MASTEREND/2020, datado de 22/05/2020).
19- Efetuado o teste operacional dos Contactores Manométricos de Embandeiramento Automático de acordo com o AMM Cap. 61-22-00;
20- Efetuada a inspeção do kit de primeiros socorros;
21- Efetuada a remoção dos componentes do sistema ADF, conforme Manual Bendix / King P/N 006-00184-0006 (ADF Receiver P/N 066-1072-00 S/N 4117 e S/N 4038);
22- Efetuada a remoção dos componentes do sistema HF, conforme AMM 121/242 Capítulo 23, Seções 23-10-05, 23-12-00, 23-12-01, 23-12-02, 23-12-03, 23-12-04 e 23-12-05. Realizados os isolamentos elétricos das cablagens, conforme WD 121A-672, Capítulo 20, Seção 20-10-00. (HF Control P/N 622-2885-001 S/N 1573, HF Transceiver P/N 066-2882-001 S/N 1307, HF Power Amplifier P/N 622-2883-001 S/N 1160, HF Antenna Coupler P/N 622-2884-001 S/N 1390);
23- Efetuado o check dos VOR conforme RBAC 91.171(VOR#1 324°, VOR#2 325°na frequência 115.90 MHz , 326°).

Figure 1 - Airframe services performed during the last inspection.

The inspections were completed on 04 June 2020, at *Goiás Manutenção de Aeronaves Ltda.* (COM 2003-61/ANAC), in *Goiânia*, GO. The aircraft had a total of 4,452 hours and 55 minutes of flight time on that date.

On 05 June 2020, one day after delivery, the aircraft performed a private flight from SBNV to SILS.

There were reports that, at the destination, the aircraft engaged in some sporadic flights across the region, making it impossible to specify the number of legs, nor the total number of hours flown until the day of the accident.

It was not possible to determine the exact number of hours flown by the airplane until the time of the accident, in view of the impossibility of accessing the aircraft's logbook. However, based on reports, one estimates that it flew less than 10 hours after the inspection.

According to the information gathered, when landing at SILS, the aircraft presented an oil leak in the nose landing gear, as well as an intermittent failure in one of the fuel pumps. However, there were no records related to such information in the pertinent logbooks.

One of the owners reported that the aircraft's trim tab was operating close to the “8” mark, which was the trim tab’s upper limit. For the reasons aforementioned, the aircraft would return to *Goiânia*, GO, for verification of the failures identified.

After consultation with the manufacturer, information was received that, for takeoff, the correct position of the elevator trim tab was between 0 and 1, within the “green band”. The Pilot’s Operating Handbook prescribed this check of the trim tab position to be carried out before takeoff.

Taking off outside the “green band” could demand greater application of strength in the pertinent control, or the need to apply a non-standard command for the control of the aircraft, a non-recommended procedure. In flight, frequent operation with the trim tab close to the limit would be quite unusual.

The autopilot system consisted of a computer that activated the primary servos (rudder, aileron and elevator) and the elevator-trim tab servo. The latter would be activated to relieve the primary elevator servo load (*off load*), by monitoring the level of the current.

The design of the system was such that a simple failure would not trigger the trim tab.

Thus, in case of inadvertent actuation of the trim tab servo, such actuation would be promptly identified, and the system would discontinue the power supply to the servomotor, preventing the triggering.

A pilot, who used to fly the PT-MBV before the aircraft selling process, informed that he would not operate the airplane with the elevator trim engaged on the autopilot (pitch couple). The reason was that he had previously witnessed a case of momentary loss of control during cruise flight, after an inadvertent activation of the stick pusher. Such activation, in his understanding, would be associated with the angle-of-attack control system, and directly linked to the system of both flight and trim tab controls (trimming).

However, based on the description of the system, one consulted with the aircraft manufacturer. In manufacturer's reply, they affirmed not envisaging a scenario in which the actuation of the elevator trim tab coupled to the autopilot could have led to the activation of the stick pusher.

In relation to the Angle-of-Attack Control (CAA) system, the EMB-121 *Xingu* Aircraft Maintenance Manual (AMM), Cap. 27 - 32 - 00, page 1, read that:

> [...]
>
> it is based on the principle of lift measure, having the angle of attack as a reference, to provide the pilot with safety and accurate controls during low-speed operations. The system permanently displays visual information regarding the ratio of the actual lift to the maximum available lift. It displays a constant lift indication despite changes in stall speed, due to variations in the airplane weight, power adjustment or flap/gear configuration. The system prevents the plane from reaching high angles of attack that might result in loss of the controls, in which recovery might not be possible.

Provision of protection would take place in two stages initiating at pre-calibrated angles of attack.

The first stage consisted of a control-stick shaker; the second one consisted of a control-stick pusher, which commanded the airplane to a "nose-down" attitude.

The system was composed of two subsystems that operated independently to activate the shakers of the control sticks and, together, activate the servo of control-stick pusher.

The subsystem 1 referred to the left-hand side of the aircraft, which had a stick shaker and a servomotor that pushed the control stick. The subsystem 2 referred to the right-hand side, which only had the control-stick shaker.

Each subsystem contained a lift transducer (located on the leading edge of each wing), an indicator, a control-stick shaker, and a computer, whereas in subsystem 2, the indicator and the computer constituted a single unit.

The subsystem 1 also had a servomotor for controlling the elevator, and a clutch for controlling the lowering of the elevator, and for pushing the stick in order to put the plane on a pitch-down attitude.

In Figure 2, it is possible to identify the components of the angle-of-attack control system of the subsystems 1 and 2.

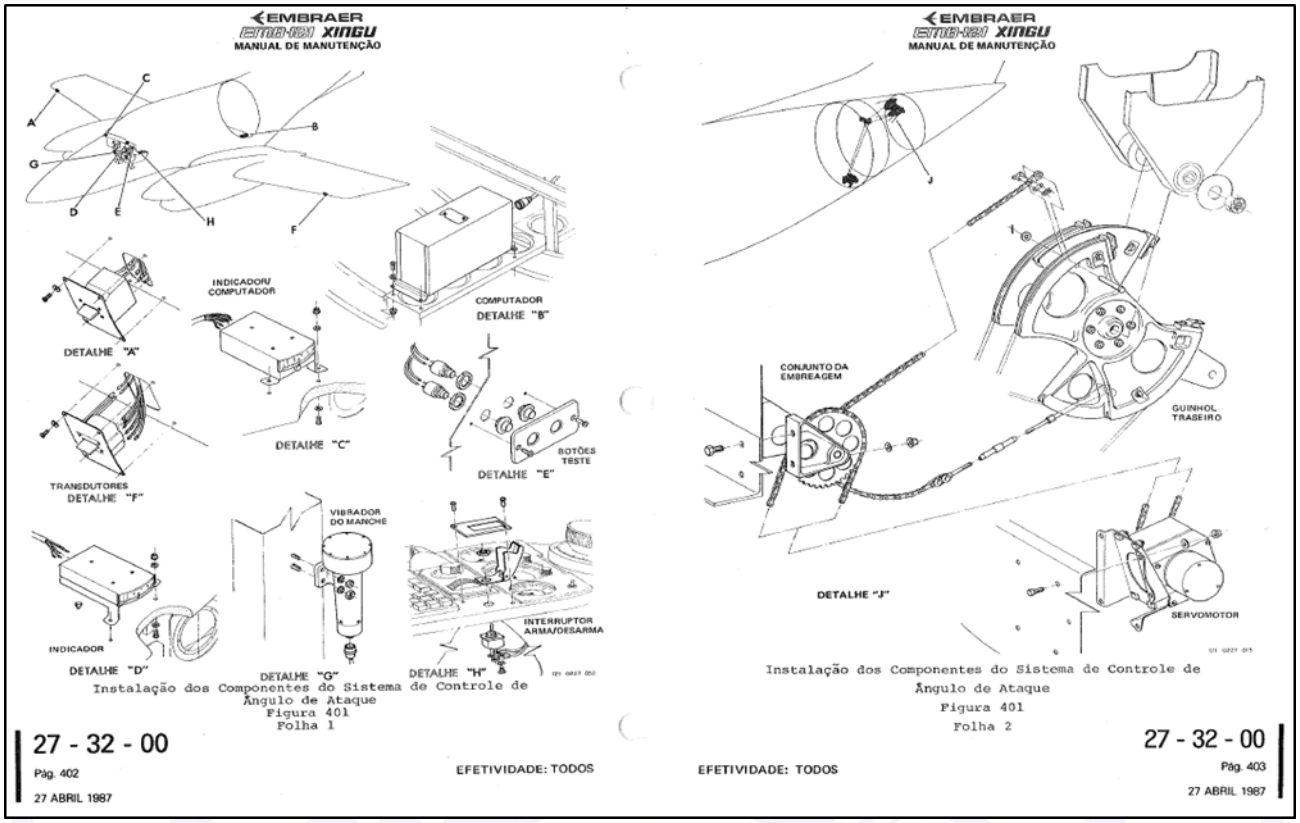


Fig. 2 - Visual description of components of the angle-of-attack control system, subsystems 1 and 2.

The servomotor received the command from the subsystem-1 computer. The function of the clutch was to transmit the power of the servomotor to the control stick and allow it to slide at a torque level that the pilot would not have difficulty overcoming.

There was also an arm/disarm switch on the pedestal of the levers that allowed disabling the servomotor if necessary. The servomotor and the clutch had the function of commanding the elevator, after receiving a signal from the computers.

In case of a computer failure, the system had a monitoring circuit, which detected the loss of power supply, and a “CAA” warning light would illuminate on the multiple alarm panel.

There was also a safety test, performed before the first flight of the day, in which one pressed self-test buttons at each piloting station. Such action would check each indicator/computer of the pertinent piloting station, in which the pointer would normally shift to the left.

In the PIC’s piloting station, specifically, there were two buttons: CAA TEST 1 and CAA TEST 2. Pressing the CAA TEST 1 would check the indicator/computer, and activate the subsystem-1 stick shaker; and pressing the TEST CAA 2 button would activate the subsystem-2 stick shaker.

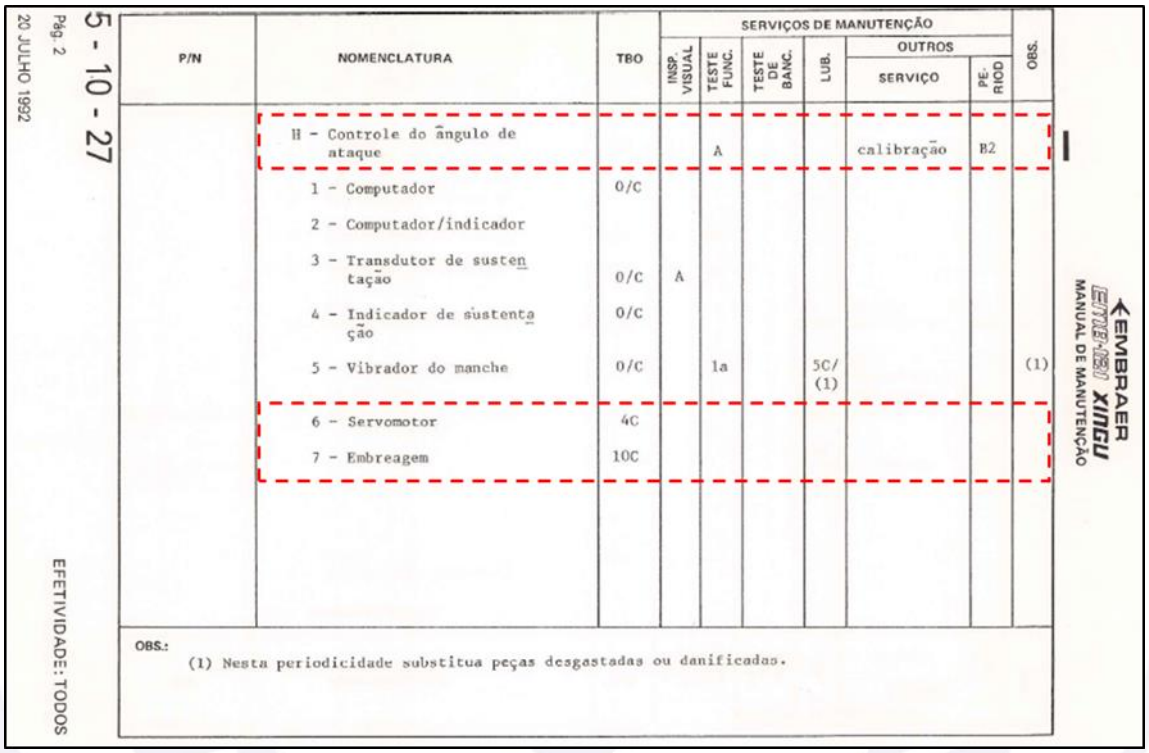
Upon pressing both buttons simultaneously, one would activate the stick shakers, with the corresponding pilot’s indicator moving to the left-hand side and activating the servomotor (stick pusher).

The procedure for calibration/verification of the Angle-of-Attack Control system would include the following: calibration of the stick shakers of the subsystems 1 and 2; calibration of the center mark of the subsystems 1 and 2 (with specific procedures for lift transducers of different Part Numbers); calibration of the control-stick pusher, with flaps extended and retracted. Verification of the intercoupling between the subsystems 2 and 1; verification of the CAA switch on/off; verification of the shock-absorber’s self-test and microcontactors;

verification of the heating of the CAA system; verification of the alarm, automatic disengagement of the autopilot, lighting, and stick pusher diode.

The tests of the subsystem 1 were different from those of the subsystem 2: there was modification of the applied forces, actuation on potentiometers and accesses, as detailed in the EMB-121 *Xingu* Maintenance Manual (AMM), Chapter 27 - 32 - 00 “Angle of Attack Control System - Description and Operation”.

According to the AMM, Chapter 05 - 10 - 27 “Time Limits” - “Maintenance Checks - Time between Overhauls - TBO”, the time limits for overhauls and maintenance services for the subsystem 1 (Servomotor and Clutch) were provided as per Figure 3.



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P/N	NOMENCLATURA	TBO	SERVIÇOS DE MANUTENÇÃO						OBS.
			INSP. VISUAL	TESTE FUNC.	TESTE DE BANC.	LUB.	OUTROS SERVIÇO	OUTROS PERIOD	
	H - Controle do ângulo de ataque			A			calibração	B2	
	1 - Computador	0/C							
	2 - Computador/indicador								
	3 - Transdutor de sustentação	0/C	A						
	4 - Indicador de sustentação	0/C							
	5 - Vibrador do manche	0/C		1a		5C/ (1)			(1)
	6 - Servomotor	4C							
	7 - Embreagem	10C							

OBS.:
(1) Nesta periodicidade substitua peças desgastadas ou danificadas.

EFETIVIDADE: TODOS

EMBRAER EMB-121 XINGU MANUAL DE MANUTENÇÃO

Figure 3 - Table of time between overhauls for Flight Controls – Angle-of-Attack Control, highlighting Subsystem 1 (Servomotor and Clutch).

The Item 5 of the same chapter of the AMM - "Definition of Maintenance Services and Frequency", read:

> A - The maintenance program established in this chapter consists of the following types of inspection:
>
> [...]
>
> B - Intermediate Inspections;
>
> [...]
>
> C - Progressive Periodic Inspections;
>
> [...]
>
> B2 intermediate inspections carried out every 300 flight hours (+ or - 5%);
>
> [...]
>
> Periodic inspections (C) carried out every 600 flight hours (+ or - 5%).
>
> [...]
>
> The progressive conduction of supplementary inspections in multiples of inspection C are:
>
> 2C - every 2 C-inspections (1,200 h);
>
> 3C - every 3 C-inspections (1,800 h); and

6C - every 6 C-inspections (3,600 h).

In Figure 3, it is possible to verify that the maintenance program prescribed the functional test of the Angle-of-Attack Control at the daily inspections (A), that is, in the pre-flight; there was also a periodic calibration service prescribed for the B2 inspection, i.e. every 300 hours.

According to information contained in the airframe logbook, the last calibration services of the CAA system were provided on 13 July 2015 and 22 July 2016.

The records concerning the CAA system calibration service were not identified in the airframe logbook for the most recent maintenance services. The last calibration service identified in the airframe logbook dated from 13 July 2015.

The "12-month" functional test of the control-stick shakers 01 and 02, identified in item 5 of Figure 3, took place in the last Annual Maintenance Inspection completed on 04 June 2020, and duly registered in the airframe logbook.

The Item 6 - "Servomotor", had a 4C TBO, that is, it should be replaced every 4 type "C" inspections (600 hours), totaling 2,400 hours (+ or - 5%, according to the manual). The records concerning replacement of the item were not identified in the logbook made available, which had an opening date of 12 October 2009, with a total flight time of 4,075 hours and 30 minutes.

The Item 7 - "Clutch", had a 10C TBO, that is, it should be replaced every 10 type "C" inspections (600 hours), totaling 6,000 hours (+ or - 5%, according to the manual).

With regard to controllability characteristics, the model EMB-121 aircraft was certified with the control-stick shaker and pusher system to ensure adequate stall conditions, being activated below the natural stall-angle of the aircraft, in accordance with the certification requirements. These artificial devices would warn the pilot of an upcoming stall.

Thus, before the aircraft entered a stall, the device (control-stick shaker) was activated making the control stick shake, giving the pilot the impression that the aircraft was "stalling".

Upon receiving the warning from the control-stick shaker, the pilot should proceed with the recovery of the aircraft, moving the control stick forward, decreasing the angle of attack, and returning to normal flight conditions.

Should the pilot not perform the recovery maneuver and should he continue to increase the angle of attack, getting nearer the actual angle of stall and, consequently, approaching a deep stall condition, a second device, known as control-stick pusher would be activated, with the control stick being hydraulically pushed forward, regardless of pilot action.

1.7. Meteorological information.

SILS did not have a meteorological station. The data below (recorded by the National Institute of Meteorology - INMET) came from the A902 station of *Tangará da Serra*, MT, located at a distance of 18 km from the accident site (Figure 4):

DATA	HORA (UTC)	TEMPERATURA	VENTO (DIR.)	VENTO (INT.)
14JUN2020	11:00	21,2 ºC	236º	7 kt
14JUN2020	12:00	20,7 ºC	236º	8 kt
14JUN2020	13:00	21,1 ºC	236º	8 kt

Figure 4 - Data from A902 Station, *Tangará da Serra*, State of Mato Grosso.
Source: https://mapas.inmet.gov.br/

The estimated temperature at the time of the accident was close to 21ºC; there was a constant wind with a southwesterly direction (236º) at approximately 8 kt.

The enhanced satellite image of 14 June 2020, generated at 12:30 UTC, shows the presence of clouds near the locations of SILS and SBCY, possibly with similar conditions (Figure 5).

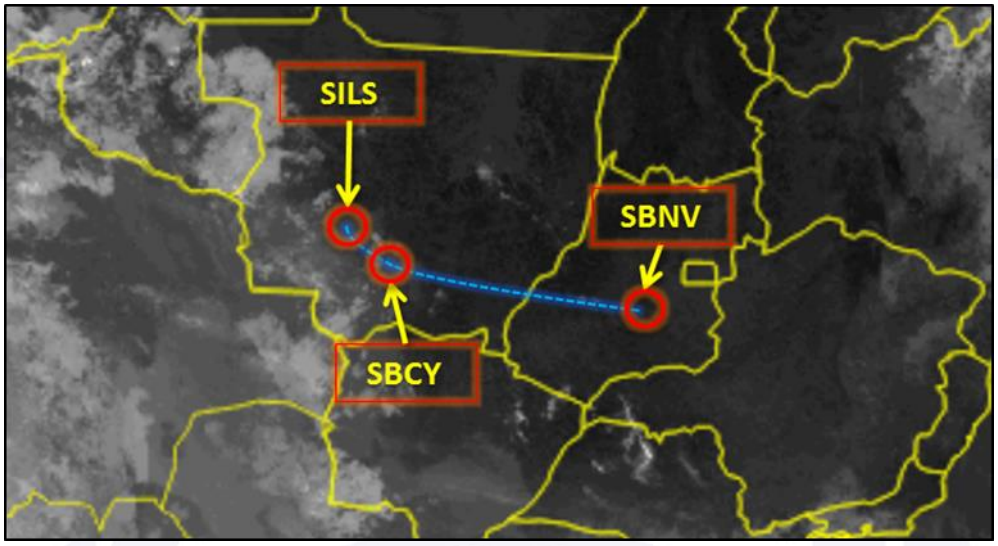

Figure 5 - Enhanced satellite image 14JUN2020, 12:30 UTC. Highlight for the locations of SILS, SBCY and SBNV, in addition to the intended route. Source: REDEMET.

The wind and temperature chart of 14JUN2020, for flight level 050, generated at 12:00 UTC, made it possible to identify the prevalence of wind direction between 120° and 150°, with intensity from 10 to 15 kt in the region of the localities of SILS and SBCY (Figure 6).

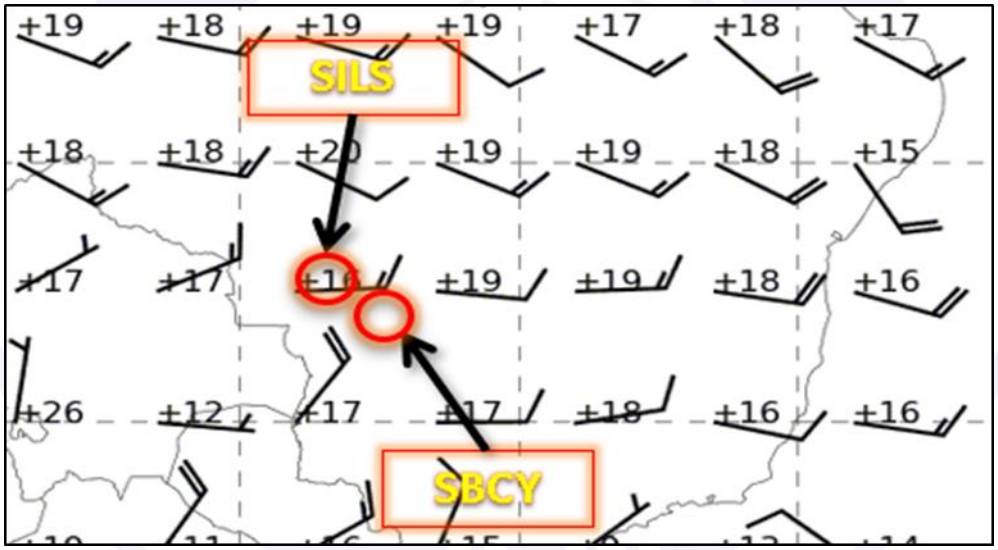

Figure 6 - Wind and temperature chart for 14JUN2020, for FL050, generated at 12:00 UTC. Source: REDEMET.

The Significant Weather chart (SIGWX - significant weather) of 14JUN2020, from the surface to flight level 250 (FL250), valid until 18:00 (UTC), allowed to identify scattered clouds, cumulus and stratocumulus types, with base at 1,700 ft and top at 7,000 ft, with isolated showers of rain (Figure 7).

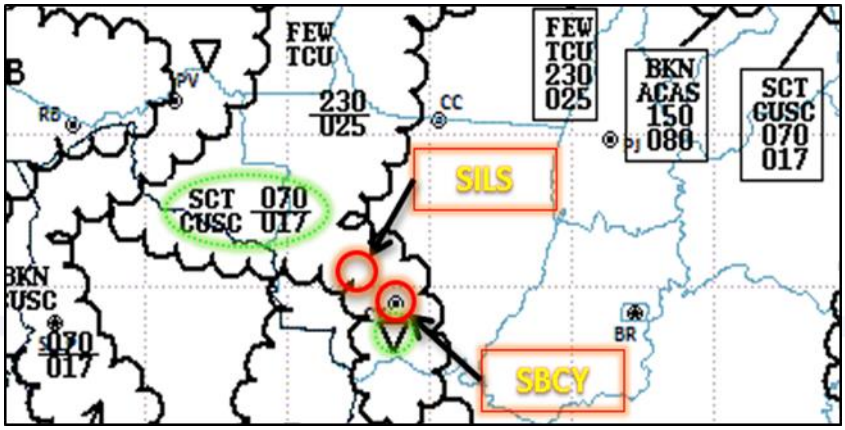

Figure 7 - SIGWX chart of 14JUN2020 from the surface to FL250 with validity until 18:00 UTC. Source: REDEMET.

Additionally, according to reports, there was good visibility, with scattered to overcast clouds. Thus, based on the information gathered, the weather conditions were consistent with the type of flight.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

SILS (Big Master Aerodrome, *Tangará da Serra*, MT) is a private aerodrome, operating under Visual Flight Rules, during day- and night-time. It has an asphalt runway, with thresholds 02/20, measuring 1,400m x 22 m, at an elevation of 1,138 ft.

1.11. Flight recorders.

Not required and not installed.

1.12. Wreckage and impact information.

There were no records concerning the activation of the ELT (Emergency Locator Transmitter) after the accident.

The distance between the accident site and the threshold of the takeoff runway (RWY 20) of SILS, was approximately 5,810 m (3.14 NM) along a straight line, azimuth 006° (Figure 8).

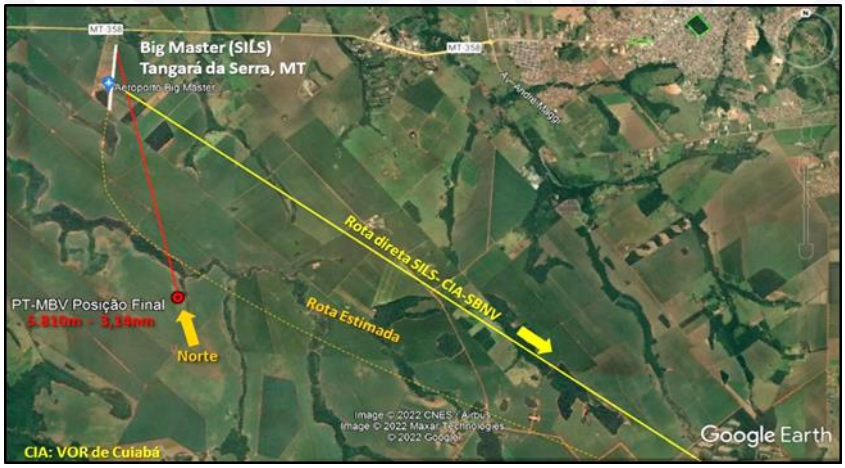

Figure 8 - Sketch of the aircraft's estimated trajectory for the intended route. Source: Adapted from Google Earth.

The crash site, in a rural area, was a corn plantation. The main wreckage was concentrated at the point of impact, with its center at coordinates 14°40'55"S / 057°35'44"W. The remainder of the aircraft debris spread within a radius of up to 100 meters.

The engines had penetrated the ground at a depth between 1.5 and 2 meters, with the right-hand engine buried underneath the left-hand one.

In addition, there was no sign of ground scars before the point of impact, a factor that demonstrates the high angle of impact against the ground, as shown in the aerial view in Figure 9.

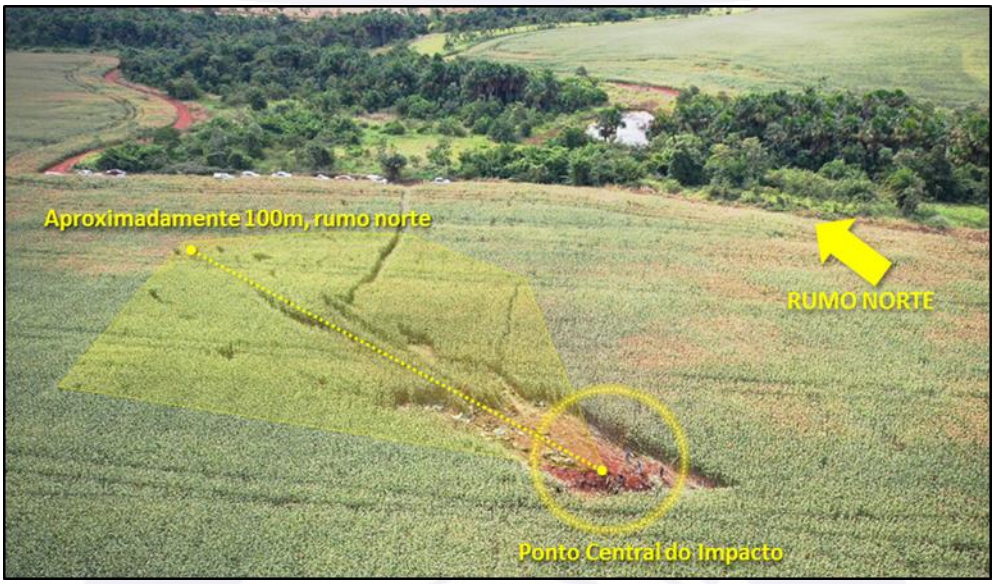

Figure 9 - Aerial view of the crash site.

The degree of destruction and charring of the aircraft hindered the verification of equipment and instruments. A post-impact fire consumed most of the wreckage, which remained concentrated at the central point of impact.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

NIL.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

NIL.

1.14. Fire.

There was no evidence of and in-flight fire. The post-impact fire, having fuel as its combustion material, consumed practically the entire aircraft.

1.15. Survival aspects.

The aircraft occupants did not survive the crash.

1.16. Tests and research.

The engines, Model PT6A-135, SN PC-E 92161 and SN PC-E 92160, were subject to analysis at the facilities of Pratt & Whitney Canada *do Brasil*, located in *Sorocaba*, State of *São Paulo*. Professionals from the following institutions participated in the referred analysis: Sixth Regional Service for the Investigation and Prevention of Aeronautical Accidents

(SERIPA VI), Pratt & Whitney, and Department of Science and Aerospace Technology (DCTA).

The exams indicated that both engines had internal marks consistent with the development of power in the moment of impact against the ground.

The low-pressure fuel filters had their interiors clean, with no visible indication of contamination, but with a distinct smell of fuel, as they contained residual liquid. The fuel found was light in color, without phase separation (Figure 10).

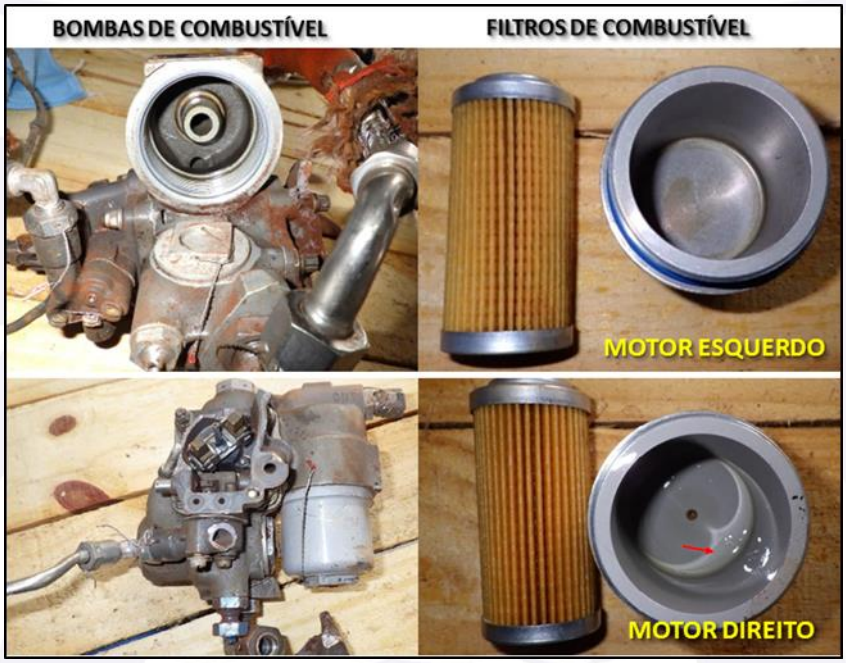

Figure 10 - General condition of the pumps, filters, and fuel.

There was no evidence that could be associated with a malfunction of the engines.

1.17. Organizational and management information.

NIL.

1.18. Operational information.

The aircraft would fly from SILS to SBGO in order to undergo maintenance services at the destination.

The owner reported that the crew seemed relaxed; the aircraft tanks had been drained in the pre-flight, and filled with 422 liters of aviation kerosene.

The aircraft was within its weight and balance limits; the start-up of the engines, the taxi, and takeoff from runway 20 were uneventful. After takeoff, the aircraft turned left before setting heading towards *Cuiabá*, State of *Mato Grosso*.

Both crewmembers had flown the route in May on a ferry flight of the aircraft.

According to the owner, the PIC occupied the left-hand seat, but it was not possible to confirm which of the pilots was performing the function of Pilot Flying after the takeoff.

The aircraft certification allowed operation with a minimum of one crewmember, and the airplane was equipped with an autopilot, which enabled it to operate under Instrument Flight Rules with that prescribed minimum crew, as provided for in the RBAC nº 91, Amendment No. 01, section 91.5:

> 91.5 Requirements for crews
>
> (a) The operation of a civil aircraft registered in Brazil is allowed only if:

(1) The flight crew complies with the aircraft's minimum-crew requirements as set out in the certificate of airworthiness of the aircraft;

(2) the operator designates a pilot to fly as pilot-in-command; and

(3) the operation is conducted by properly licensed/certified crewmembers qualified for the aircraft in accordance with RBAC-61 or RBHA-63, or another superseding RBAC for the function the crewmembers perform on board, with recent experience, and holding valid aeronautical medical certificates (CMA), issued in accordance with RBAC-67.

(b) In addition to the requirements of the paragraph (a) of this section, if the operation involves an IFR flight:

(1) The aircraft must be certified for IFR flights, and the crew must conduct the operation in accordance with the procedures for IFR flights established by the approved flight manual or aircraft operating manual (AOM);

(2) for aircraft with an approved passenger configuration with 9 or fewer seats:

(i) equipped with an operating autopilot, the crew must be composed of an IFR-rated pilot; and

(ii) not equipped with an autopilot, the crew must consist of two IFR-rated pilots;

[...]

The owner of the aircraft also reported that the utilization of the autopilot was routine during flights, and that there were no reported discrepancies.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a ferry flight from SILS to SBGO, where the aircraft would undergo maintenance services.

According to data collected by the Investigation Commission, the PIC was qualified and had the required recent experience for the flight, while the second crewmember was still undergoing a process of qualification, since he had not yet received endorsement to operate the EMB-121A aircraft.

Considering the owner's report that the crew had participated in every flight since the receipt of the aircraft, one estimates that they had between 5 and 10 hours of flight in the PT-MBV, and had flown at least 7 legs as a joint crew.

The aircraft was within the weight and balance limits. The start-up of the engines, the taxi, and the takeoff from runway 20 were uneventful. After the aircraft took off, there was a planned turn to the left before setting heading towards *Cuiabá*, State of *Mato Grosso*.

According to the owner of the aircraft, the PIC occupied the left seat, but it was not possible to confirm which of the two crewmembers was performing the function of Pilot Flying after the takeoff.

The weather conditions were consistent with the type of flight proposed.

With regard to the PT-MBV aircraft, there was a report made by one of the owners that the trim tab was operating close to the number “8” marking (the upper limit). In addition, the aircraft presented an oil leakage in the nose landing gear, as well as an intermittent failure in one of the fuel pumps. Those were the reasons for the ferry flight to SBGO, where the aircraft would undergo maintenance for the correction of the problems identified.

It should be noted that, for takeoff, the correct position of the elevator trim tab would be between 0 and 1 (within the “green band”), and that the POH prescribed verification of its position before takeoff.

Taking off outside the “green band” would require application of greater strength on the control column, or the need to apply an atypical command for the control of the aircraft, being, thus, not recommended.

A pilot, who used to fly the PT-MBV before the selling of the aircraft, reported that he would not fly the airplane with the elevator trim coupled to the autopilot (pitch couple). The reason was that he had once witnessed a momentary loss of control during the cruise phase of a flight, on account of an inadvertent activation of the stick pusher, which, in his understanding, would be associated with the angle-of-attack control system, and directly linked to the flight control and trim control system (trimming).

However, based on the description of the system, one consulted with the aircraft manufacturer. The manufacturer answered that they did not envisage a scenario in which the actuation of the elevator trim coupled to the autopilot could have led to the activation of the stick pusher.

Due to the degree of destruction of the aircraft, it was not possible to analyze the components of the aircraft's trimming system. However, one has to consider that the flight without a control margin for one of the piloting axes could affect the aircraft controllability during configuration changes or during any maneuver that required greater amplitude of control inputs.

In the maintenance records, the calibration service of the CAA system, in consonance with the required inspections, used to be provided during “B2” inspections, i.e. every 300 flight hours. In that context, the last calibration services of the CAA system logged in the airframe logbook were provided on 13 July 2015 and 22 July 2016.

In the specific case of the services scheduled for the aircraft on the occasion of the last IAM and obtainment of the CVA (completed on 04 June 2020), when one considers the prescriptions of the AMM, the provision of the service in question was not mandatory, since there would be a credit of hours, taking into account the last service provided on 22 July 2016.

The servomotor had a “4C” TBO, that is, replacement was mandatory every fourth “C” type inspection of 600 hours, totaling 2,400 hours (+ or - 5%, according to the AMM). However, the records of the aircraft airframe logbook, whose opening date was 12 October 2009, with a total flight time of 4,075 hours and 30 minutes, included only the services performed from that date onwards, resulting that it was not possible to track whether the item replacement had taken place in accordance with the specifications.

It is worth noting, however, that in approximately 300 flight hours’ time, the aircraft would undergo its second “4C” type inspection, and the servomotor would have to be replaced again.

The clutch, with a “10C” TBO, was still within its period of validity in accordance with the prescribed inspections.

In the most recent Annual Maintenance Inspection of the aircraft, the maintenance organization performed the “12-month” functional test of the control-stick shakers 01 and 02 in accordance with AMM 27-32-00. However, one verified that, for checking the shakers of the subsystems 1 and 2, the procedures were different from each other, and had specific procedures for sustainment transducers of different Part Numbers (PN).

In the wreckage, it was not possible to identify which PN was equipping the aircraft. However, when consulting the service order related to the latest annual maintenance

inspection, one verified that the maintenance organization carried out the functional test in the inspection they completed on 04 June 2020.

In such context, that was a very important service, as it guaranteed the correct calibration of the central mark of the subsystems 1 and 2, considering that the calibration of the subsystem 1 directly interfered with the sensitivity and performance of the control-stick pusher, which still required adjustments with the flaps extended and retracted.

According to the owner, the utilization of the autopilot was routine on the flights, and there were no perceived discrepancies.

Information obtained from the wreckage revealed that the engines penetrated the ground at a depth between 1.5 and 2 meters, with the right-hand engine found underneath the left-hand engine, indicating that the aircraft was in a downward turn to the right.

From the identification of the high angle of impact against the ground, the concentration of the wreckage, and the analyses of the engines (which were developing power at the time of the collision with the ground), it was possible to infer that control of the aircraft had been lost in flight.

Given the characteristics of the impact, and in face of the impossibility of analyzing the components of the trimming and CAA systems, one inferred that the accident in question might be associated with an inadvertent activation of the control-stick pusher, due to an erroneous reading of the aircraft's angle of attack following a possible failure of a component.

However, it was not possible to gather sufficient elements for the endorsement of such hypothesis, since it presumes simultaneous failures of both angle-of-attack sensors, something unlikely to occur. Furthermore, in case of activation of the control-stick pusher, the pilot would be able to overcome it, applying an opposite-direction force on the control stick.

3. CONCLUSIONS.

3.1. Findings.

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

b) the crewmembers had valid MLTE and IFR Flight ratings;

c) the PIC was qualified and experienced in the type of flight;

d) the Investigation Commission considered that the second crewmember was still undergoing a process of qualification, since he had not yet received endorsement to operate EMB-121A aircraft;

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

f) the aircraft was within its weight and balance limits;

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

h) a pilot who had previously operated the PT-MBV reported having witnessed a momentary loss of control, during the cruise phase of a flight, on account of an inadvertent activation of the control-stick pusher;

i) the last inspection of the PT-MBV aircraft included the inspection of the trim tabs' control system, along with the functional test of the control-stick shakers numbers 01 and 02;

j) the last calibration services of the CAA system were provided on 13 July 2015 and 22 July 2016;

k) the engines were developing power in the moment of the collision with the ground;

l) the collision with the ground occurred at a high angle of impact;

m) the right-hand engine was found buried underneath the left-hand engine;

n) the aircraft was destroyed; and

o) the aircraft occupants did not survive the crash.

3.2. Contributing factors.

Aircraft maintenance - undetermined.

One should not rule out the hypothesis of a possible malfunction of the aircraft's angle-of-attack control system, considering that the records related to the provision of the calibration service (a necessary condition for the proper functioning of the referred system, and prescribed in the aircraft's maintenance manual) were not identified in the pertinent control documents.

4. SAFETY RECOMMENDATIONS

None.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

NIL.

On December 29th, 2023.