COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-024/CENIPA/2021

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-KQE**
MODEL:	**A36**
DATE:	**13FEV2021**

NOTICE

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

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

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

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

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

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

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

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

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

SYNOPSIS

This is the Final Report of the 13 February 2021 accident with the A36 aircraft, registration marks PT-KQE. The accident received the typification of “[SCF-PP] Engine failure or malfunction | In-flight engine failure”.

While flying between the municipalities of *Novo Progresso* and *Itaituba* in the State of *Pará*, the aircraft sustained engine failure, and made an emergency landing in an area of *Fazenda Beira Rio*, located in the municipality of *Novo Progresso*.

One found out that there was breakage of the crankshaft of the engine in flight, causing the engine to stop.

The aircraft sustained substantial damage.

The pilot suffered minor injuries, while none of three passengers was injured.

There was designation of an Accredited Representative of the NTSB (National Transportation Safety Board) of the United States (State of aircraft design).

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CA	Certificate of Airworthiness
CB	Cumulonimbus cloud
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIV	Pilot logbook
CIMAER	Integrated Center of Aeronautical Meteorology
CMA	Aeronautical Medical Certificate
CPTEC	Center for Weather Forecasting and Climate Research
DA	Airworthiness Directive
DCTA	Department of Science and Aerospace Technology
FIAM	Annual Maintenance Inspection Sheet
FL	Flight Level
IAM	Annual Maintenance Inspection
ICA	Command of Aeronautics' Instruction
IPC	Illustrated Parts Catalogue
IFR	Instrument Flight Rules
IS	Supplementary Instruction
MNTE	Single-Engine Land Airplane Class Rating
NSCA	System Norm of the Command of Aeronautics
NTSB	National Transportation Safety Board (USA)
OM	Maintenance Organization
PIC	Pilot In Command
PN	Part Number
PPR	Private Pilot License (Airplane)
PSI	Pound Force Per Square Inch
RBAC	Brazilian Civil Aviation Regulation
SACI	Integrated Civil Aviation Information System
SB	Service Bulletin
SDUA	ICAO location designator - *Vale do Curuá* Aerodrome, *Novo Progresso*, State of *Pará*
SERIPA I	1st Regional Service for the Investigation and Prevention of Aeronautical Accidents.
SIGWX	Significant Weather Chart
SIPAER	Aeronautical Accidents Investigation and Prevention System
SIL	Service Information Letter
SITT	ICAO location designator - *Independência* Aerodrome, *Itaituba*, State of *Pará.*

SL	Service Letters
SN	Serial Number
TBO	Time Between Overhauls
TPP	Private Air Services Aircraft Registration Category
TSLO	Time Since Last Overhaul
TSN	Time Since New
UTC	Universal Time Coordinated

1. FACTUAL INFORMATION.

Aircraft	**Model:** A36 **Registration:** PT-KQE **Manufacturer:** Beech Aircraft.	**Operator:** Private.
Occurrence	**Date/time**: 13FEV2021 - 18:40 UTC **Location:** Area of *Fazenda Beira Rio* **Lat.** 07°34'16"S **Long.** 056°05'21"W **Municipality – State:** *Novo Progresso - Pará*	**Type(s):** [SCF-PP] Powerplant failure or malfunction

1.1. History of the flight.

At around 18:20 UTC, the aircraft took off from SDUA (*Vale do Curuá* Aerodrome, *Novo Progresso*, State of *Pará*) bound for SITT (*Independência* Aerodrome, *Itaituba*, State of *Pará*), on a private flight, with the PIC (Pilot in Command) and three passengers on board.

About 20 minutes into the flight, an engine failure occurred, and the aircraft made an emergency landing in an area of *Fazenda Beira Rio*, located in the municipality of *Novo Progresso*, PA.

The aircraft sustained substantial damage.

The pilot suffered minor injuries. None of the three passengers was injured.

Figure 1 – The aircraft after the occurrence.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	1	-	-
None	-	3	-

1.3. Damage to the aircraft.

The aircraft sustained substantial damage to its entire structure after colliding with trees and subsequently with the ground.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

	PIC
Total	41:30
Total in the last 30 days	04:00
Total in the last 24 hours	00:00
In this type of aircraft	04:00
In this type in the last 30 days	04:00
In this type in the last 24 hours	00:00

N.B.: data on the hours flown obtained through pilot's statement, corresponding to the information logged in his CIV (pilot logbook).

1.5.2. Personnel training.

The PIC did his PPR course (Private Pilot - Airplane) in 2017, at *Aeroclube de Pará de Minas*, State of *Minas Gerais*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PPR License (Airplane) and had a valid MNTE rating (Single-Engine Land Airplane).

1.5.4. Qualification and flight experience.

The PIC had flown that same route four times in the previous month, and was, thus, qualified. He had a total flying time of just 40 hours, approximately.

1.5.5. Validity of medical certificate.

The PIC held a valid CMA (Aeronautical Medical Certificate).

1.6. Aircraft information.

The SN E639 aircraft was a product manufactured by Beech Aircraft in 1975, and registered in the Private Air Services (TPP) Registration Category.

The Certificate of Airworthiness (CA) was valid.

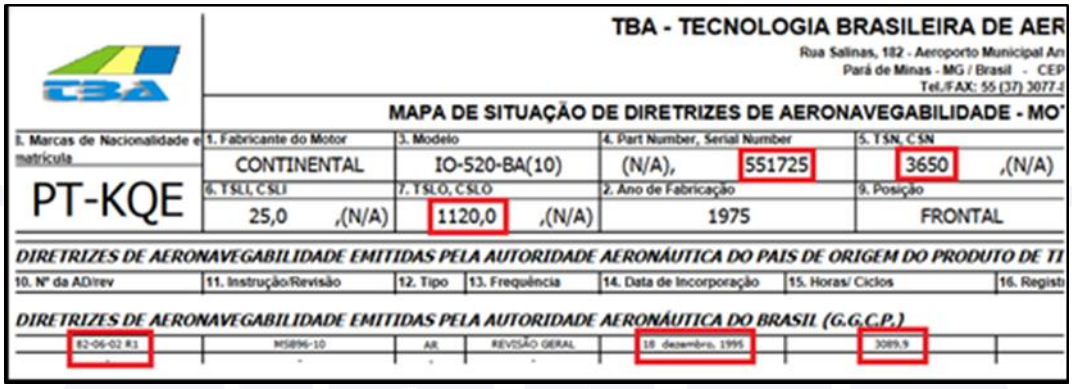
In the Annual Maintenance Inspection Sheet (*FIAM*) issued by the maintenance organization *Tecnologia Brasileira de Aeronáutica S/A* (COM 9212-01) in charge of conducting the *IAM* (Annual Maintenance Inspection), the owner of the aircraft was listed as an operator, differently from the data registered in the files of the ANAC (National Civil Aviation Agency). In the referred Sheet, there was a description of the services performed during the *IAM*, including the verification that the documentation was in compliance with the applicable requirements, something that ensured a satisfactory airworthiness condition.

The Investigation Commission did not have access to all the information of the logbooks, and the few pages that were sent attested that the records were out of date, with the last loggings dating from 2008.

The Airworthiness Directives' Situation Map, issued on 19 MAY 2020 by the same OM that conducted the *IAM*, contained the information that, on 18 DEC 1995, the Airworthiness Directive (DA) No. 82-06-02R1 had been incorporated into the SN 551725, model IO-520-BA (10)*Teledyne Continental* engine, when it had 3,089 hours and 55 minutes of operation.

The Figure 2, below, shows a copy of a part of the map, in which the following pieces of information are highlighted in red: the engine serial number (551725); Time Since New

(3,650 hours); Time Since Last Overhaul (1,120 hours); the AD that was incorporated with the date of 18DEC1995; and the engine hours at the time (3,089 hours and 55 minutes).



TBA - TECNOLOGIA BRASILEIRA DE AER

Rua Salinas, 182 - Aeroporto Municipal An
Pará de Minas - MG / Brasil - CEP
Tel./FAX: 55 (37) 3077-4

MAPA DE SITUAÇÃO DE DIRETRIZES DE AERONAVEGABILIDADE - MO

1. Marcas de Nacionalidade e matrícula	1. Fabricante do Motor	3. Modelo	4. Part Number, Serial Number	5. TSN, CSN
PT-KQE	CONTINENTAL	IO-520-BA(10)	(N/A), 551725	3650 ,(N/A)
	6. TSLI, CSLI	7. TSLO, CSLO	2. Ano de Fabricação	9. Posição
	25,0 ,(N/A)	1120,0 ,(N/A)	1975	FRONTAL

DIRETRIZES DE AERONAVEGABILIDADE EMITIDAS PELA AUTORIDADE AERONÁUTICA DO PAIS DE ORIGEM DO PRODUTO DE TI

10. Nº da AD/rev	11. Instrução/Revisão	12. Tipo	13. Frequência	14. Data de Incorporação	15. Horas/ Ciclos	16. Regist
82-06-02 R1	MSB96-10	AR	REVISÃO GERAL	18 dezembro, 1995	3089.9	

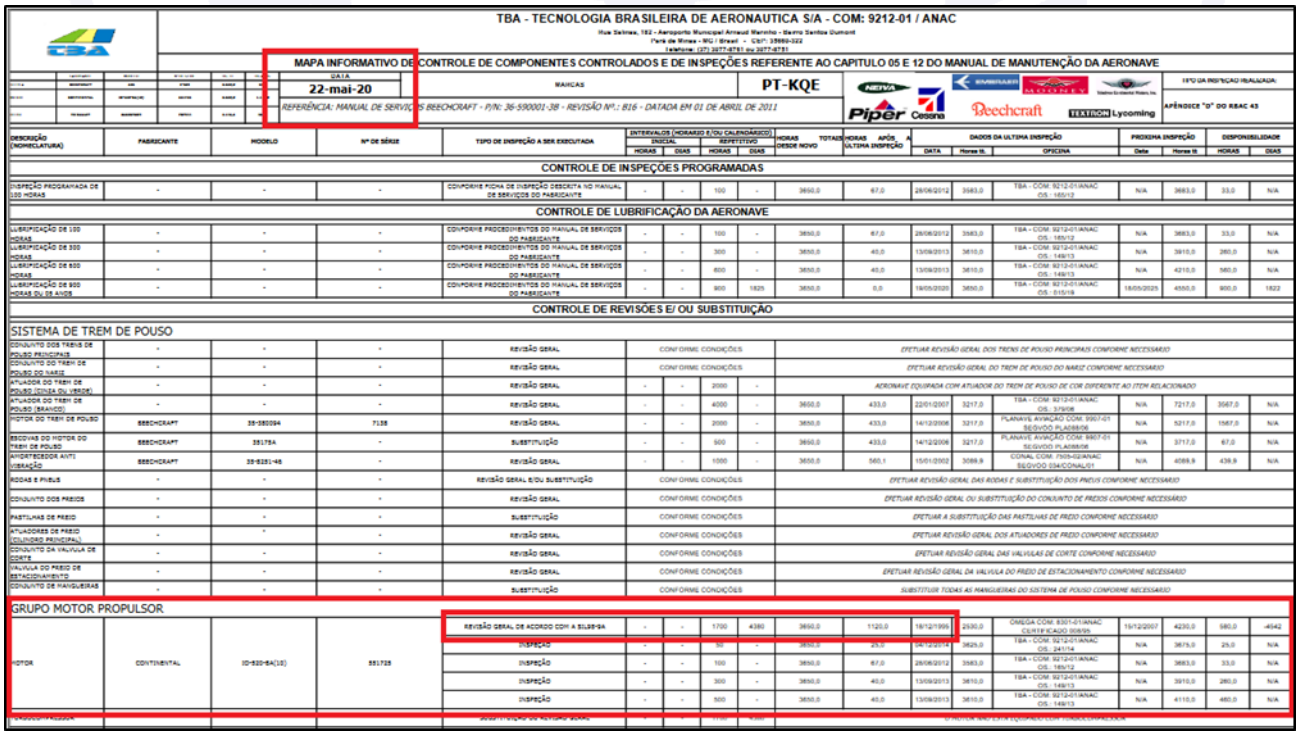
DIRETRIZES DE AERONAVEGABILIDADE EMITIDAS PELA AUTORIDADE AERONÁUTICA DO BRASIL (G.G.C.P.)

Figure 2 - AD Situation Map.

This AD had a prescription that, when overhauling the engine or for any reason requiring the removal of the crankshaft, it was mandatory to inspect, via ultrasound, the region of the concordance radii of the main bearing of the crankshaft, in accordance with the inspection procedures described in the Teledyne Continental Motors Crankshaft Ultrasonic Inspection Procedure, Form X30554.

The forecast inspections for this engine, as per the Service Information Letter no. 98-9A issued by Continental Motors Aircraft Engine on 17 NOV 1998, were due every 12 years or 1,700 hours (whichever came first), and the next estimate for opening the engine was scheduled for 2007 or when the engine reached 4,789 hours.

In turn, the Control Information Map of Controlled Components, issued by the same Organization that conducted the *IAM*, updated on 22 MAY 2020, contained the information that, on 18 DEC 1995, the engine had been inspected in accordance with the SIL No. 98-9A, when it had 2,530 hours of operation, with the forecast that the next engine overhaul was to take place in 2007 or when it reached 4,230 hours of operation (Figure 3);



TBA - TECNOLOGIA BRASILEIRA DE AERONAUTICA S/A - COM: 9212-01 / ANAC

MAPA INFORMATIVO DE CONTROLE DE COMPONENTES CONTROLADOS E DE INSPEÇÕES REFERENTE AO CAPITULO 05 E 12 DO MANUAL DE MANUTENÇÃO DA AERONAVE

DATA 22-mai-20 — MARCAS PT-KQE

REFERÊNCIA: MANUAL DE SERVIÇOS BEECHCRAFT - P/N: 36-590001-3B - REVISÃO Nº.: 816 - DATADA EM 01 DE ABRIL DE 2011

DESCRIÇÃO (NOMECLATURA)	FABRICANTE	MODELO	Nº DE SÉRIE	TIPO DE INSPEÇÃO A SER EXECUTADA	INTERVALOS (HORARIO E/OU CALENDARIO) INICIAL HORAS	INICIAL DIAS	REPETITIVO HORAS	REPETITIVO DIAS	HORAS TOTAIS DESDE NOVO	HORAS APÓS ÚLTIMA INSPEÇÃO	DADOS DA ULTIMA INSPEÇÃO DATA	Horas tt.	OFICINA	PROXIMA INSPEÇÃO Date	Horas tt	DISPONIBILIDADE HORAS	DIAS
CONTROLE DE INSPEÇÕES PROGRAMADAS																	
INSPEÇÃO PROGRAMADA DE 100 HORAS	-	-	-	CONFORME FICHA DE INSPEÇÃO DESCRITA NO MANUAL DE SERVIÇOS DO FABRICANTE	-	-	100	-	3650,0	67,0	28/06/2012	3583,0	TBA - COM: 9212-01/ANAC OS.: 165/13	N/A	3683,0	33,0	N/A
CONTROLE DE LUBRIFICAÇÃO DA AERONAVE																	
LUBRIFICAÇÃO DE 100 HORAS	-	-	-	CONFORME PROCEDIMENTOS DO MANUAL DE SERVIÇOS DO FABRICANTE	-	-	100	-	3650,0	67,0	28/06/2012	3583,0	TBA - COM: 9212-01/ANAC OS.: 165/13	N/A	3683,0	33,0	N/A
LUBRIFICAÇÃO DE 300 HORAS	-	-	-	CONFORME PROCEDIMENTOS DO MANUAL DE SERVIÇOS DO FABRICANTE	-	-	300	-	3650,0	40,0	13/09/2013	3610,0	TBA - COM: 9212-01/ANAC OS.: 149/13	N/A	3910,0	260,0	N/A
LUBRIFICAÇÃO DE 600 HORAS	-	-	-	CONFORME PROCEDIMENTOS DO MANUAL DE SERVIÇOS DO FABRICANTE	-	-	600	-	3650,0	40,0	13/09/2013	3610,0	TBA - COM: 9212-01/ANAC OS.: 149/13	N/A	4210,0	560,0	N/A
LUBRIFICAÇÃO DE 900 HORAS OU 05 ANOS	-	-	-	CONFORME PROCEDIMENTOS DO MANUAL DE SERVIÇOS DO FABRICANTE	-	-	900	1825	3650,0	0,0	19/05/2020	3650,0	TBA - COM: 9212-01/ANAC OS.: 515/19	18/05/2025	4550,0	900,0	1822
CONTROLE DE REVISÕES E/ OU SUBSTITUIÇÃO																	
SISTEMA DE TREM DE POUSO																	
CONJUNTO DOS TREIS DE POUSO PRINCIPAIS	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DOS TREIS DE POUSO PRINCIPAIS CONFORME NECESSARIO								
CONJUNTO DO TREM DE POUSO DO NARIZ	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DO TREM DE POUSO DO NARIZ CONFORME NECESSARIO								
ATUADOR DO TREM DE POUSO (ESQUERDA OU DIREITA)	-	-	-	REVISÃO GERAL	-	-	2000	-	AERONAVE EQUIPADA COM ATUADOR DO TREM DE POUSO DE COR DIFERENTE AO ITEM RELACIONADO								
ATUADOR DO TREM DE POUSO (BRANCO)	-	-	-	REVISÃO GERAL	-	-	4000	-	3650,0	433,0	22/01/2007	3217,0	TBA - COM: 9212-01/ANAC OS.: 379/06	N/A	7217,0	3567,0	N/A
MOTOR DO TREM DE POUSO	BEECHCRAFT	35-380094	7138	REVISÃO GERAL	-	-	2000	-	3650,0	433,0	14/12/2006	3217,0	PLANAVE AVIAÇÃO COM: 9907-01 SEGVOO PLA0806	N/A	5217,0	1567,0	N/A
BIELOVAS DO MOTOR DO TREM DE POUSO	BEECHCRAFT	35-178A	-	SUBSTITUIÇÃO	-	-	500	-	3650,0	433,0	14/12/2006	3217,0	PLANAVE AVIAÇÃO COM: 9907-01 SEGVOO PLA0806	N/A	3717,0	67,0	N/A
AMORTECEDOR ANTI VIBRAÇÃO	BEECHCRAFT	35-8201-46	-	REVISÃO GERAL	-	-	1000	-	3650,0	560,1	15/01/2002	3089,9	CONAL COM: 7505-02/ANAC SEGVOO 034/CONAL/01	N/A	4089,9	439,9	
RODAS E PNEUS	-	-	-	REVISÃO GERAL E/OU SUBSTITUIÇÃO	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DAS RODAS E SUBSTITUIÇÃO DOS PNEUS CONFORME NECESSARIO								
CONJUNTO DOS FREIOS	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL OU SUBSTITUIÇÃO DO CONJUNTO DE FREIOS CONFORME NECESSARIO								
PASTILHAS DE FREIO	-	-	-	SUBSTITUIÇÃO	CONFORME CONDIÇÕES				EFETUAR A SUBSTITUIÇÃO DAS PASTILHAS DE FREIO CONFORME NECESSARIO								
ATUADORES DE FREIO (CILINDRO PRINCIPAL)	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DOS ATUADORES DE FREIO CONFORME NECESSARIO								
CONJUNTO DA VALVULA DE CORTE	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DAS VALVULAS DE CORTE CONFORME NECESSARIO								
VALVULA DO FREIO DE ESTACIONAMENTO	-	-	-	REVISÃO GERAL	CONFORME CONDIÇÕES				EFETUAR REVISÃO GERAL DA VALVULA DO FREIO DE ESTACIONAMENTO CONFORME NECESSARIO								
CONJUNTO DE MANGUEIRAS	-	-	-	SUBSTITUIÇÃO	CONFORME CONDIÇÕES				SUBSTITUIR TODAS AS MANGUEIRAS DO SISTEMA DE POUSO CONFORME NECESSARIO								
GRUPO MOTOR PROPULSOR																	
MOTOR	CONTINENTAL	IO-520-BA(10)	551725	REVISÃO GERAL DE ACORDO COM A SIL98-9A	-	-	1700	4380	3650,0	1120,0	18/12/1995	2530,0	OMEGA COM: 8301-01/ANAC CERTIFICADO 008/95	15/12/2007	4230,0	580,0	-4642
				INSPEÇÃO	-	-	50	-	3650,0	25,0	04/12/2014	3625,0	TBA - COM: 9212-01/ANAC OS.: 241/14	N/A	3675,0	25,0	N/A
				INSPEÇÃO	-	-	100	-	3650,0	67,0	28/06/2012	3583,0	TBA - COM: 9212-01/ANAC OS.: 165/12	N/A	3683,0	33,0	N/A
				INSPEÇÃO	-	-	300	-	3650,0	40,0	13/09/2013	3610,0	TBA - COM: 9212-01/ANAC OS.: 149/13	N/A	3910,0	260,0	N/A
				INSPEÇÃO	-	-	500	-	3650,0	40,0	13/09/2013	3610,0	TBA - COM: 9212-01/ANAC OS.: 149/13	N/A	4110,0	460,0	N/A
				SUBSTITUIÇÃO DO RETENTOR DIANT	-	-	1700	4380									

Figure 3 - Control Information Map of Controlled Components. In red, total aircraft and engine hours.

In the detail taken from the Control Information Map of Controlled Components, it was possible to verify the information that the engine had a total of 3,650 hours at the time of elaboration of the map, and 1,120 hours since the revision, meaning, therefore, that it had 2,530 hours when the revision was conducted on 18 DEC 1995 (Figure 4).

	FABRICANTE	MODELO	Nº DE SÉRIE	HS .TT.	HS APÓS
CELULA	BEECHCRAFT	A36	E-639	3.650,0	67,0
MOTOR	CONTINENTAL	IO-520-BA(10)	551725	3.650,0	1.120,0
HELICE	Mc CAULEY	3A32C76SM	787944	2.145,5	433,0

Figure 4 - Detail taken from the Control Information Map of Controlled Components. In red, total aircraft and engine hours.

Therefore, there is a discrepancy between the information contained in both maps, because, while the Airworthiness Directives Control Map informed that the engine, at the time (18 DEC 1995), had 3,089.9 hours TSN, the Control Information Map of Controlled Components had the information that, on the same date, the engine had 2,530 hours TSN.

At the time of the elaboration of these maps, the aircraft had, according to the information contained in them, a total of 3,650 hours and, thus, taking into account the information expressed in the Map of Controlled Components, there would still be 580 hours available before the next inspection, as prescribed by the SIL No. 98-9C.

Additionally, although the Map of Controlled Components dated 22 MAY 2020, had records concerning compliance with the SIL No. 98-9A at that time, such SIL had already been superseded by the version No. 98-9C issued on 17 JULY 2013, which kept the same deadlines (12 years or 1,700 hours).

Despite the provision in the SIL 98-9C stating that the engine should be overhauled every 12 years or 1,700 hours, the Supplementary Instruction (IS) No. 91.409-001, Rev. B, item 5.1.9, of ANAC, valid at the time of the accident, had the following information about the Time Between Overhauls (TBO):

> TBO periods or deadlines are usually transcribed in Service Bulletins (SB), Service Letters (SL), Service Information Letters (SIL) and similar documents. Even if manufacturers indicate TBO periods or deadlines as mandatory in these documents, these are considered mandatory only when approved by the aeronautical authority.

The same IS (item 5.2.2), dealt with the following aspects of the overhaul:

> This question is of great relevance, for example, in the case of the engines. The owner/operator of an aircraft operating under the rules of the RBAC-91 may have an engine exceeding, for example, the calendar period of 12 (twelve) years - referring to the calendar period in some conventional engines - and still not have accumulated total hours of operations recommended for removal of the engine for overhauling. In this case, one can choose to comply with the manufacturer's recommendation for an overhaul within the calendar period or perform the overhaul only when necessary, considering an operational assessment performed in accordance with the manufacturer's instructions, which may exceed the calendar time of 12 (twelve) years and even the accumulated period of hours of operation mentioned above. Thus, after exceeding any of the recommended limits, if the aircraft is still safe and has good performance (confirmed through assessment of its general condition in accordance with the manufacturer's instructions), operational continuity is possible.

Note - Daily inspections, pre-flight inspections, 25-, 50-, 100-hour inspections, annual inspections, etc. cannot be postponed or extended as if it were the case with the recommended TBO. It is even through these very inspections that safety and performance may result in measurable data to support the decision not to follow the recommended TBO. In addition, discrepancies that eventually appear between inspections must be solved, in accordance with the RBAC 91.405.

Considering the context established by the IS 91.409-001, Rev. B, item 5.2.2, one should note that neither the engine manufacturer nor the aircraft manufacturer established criteria for the operational assessment of the engine with a view to exceeding the deadlines for accumulated hours and calendar time.

On 19 May 2020, when the aircraft had 3,650 hours, an *IAM* was performed in which the engine showed compression ratio values for the cylinders from 1 to 6, respectively, of 73, 72, 72, 72, 70 and 73 PSI. Such values were considered to be within the prescribed parameters.

Based on the operator's interpretation of the ANAC legislation in force at the time, in addition to the fact that the compression ratio results were in accordance with the normal operating parameters provided by the manufacturer, the operator/owner considered that there were no anomalies in the engine and that the aircraft still showed adequate operational performance.

1.7. Meteorological information.

The satellite image generated at 18:20 UTC by CPTEC (Center for Weather Forecasting and Climate Research) showed the existence of significant meteorological formations along the route (Figure 5).

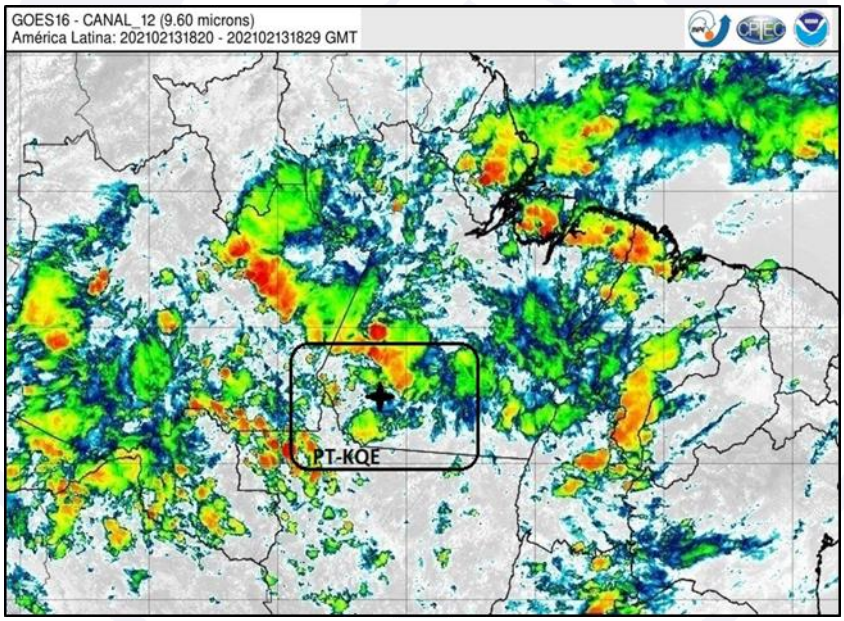


Figure 5 - Enhanced satellite image of 18:20 UTC, showing the meteorological conditions around the take-off time. Source: CPTEC.

Additionally, the Significant Weather Chart (SIGWX) generated by CIMAER (*Centro Integrado de Meteorologia Aeronáutica*), issued at 18:00 UTC on the day of the occurrence, showed the presence of CB clouds, both isolated and embedded in layers of other clouds, with base at 3,500 ft and top above 25,000 ft (Figure 6).

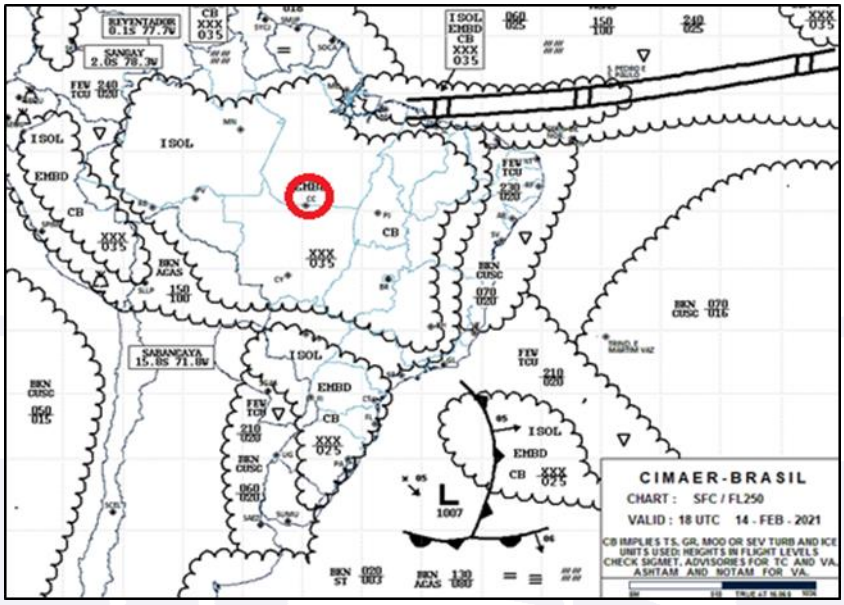


Figure 6 - SIGWX, valid until 18:00 UTC of 14 FEB 2021, with the approximate location of the occurrence. Source: CIMAER.

Also, according to reports from the PIC, the aircraft maintained FL045, with clouds forming a ceiling below the aircraft, preventing sighting of the ground at the time of the engine failure.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The accident happened outside of aerodrome area.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

NIL

1.13. Medical and pathological information.

1.13.1. Medical aspects.

NIL.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC, 26, was born in *Alta Floresta*, State of *Mato Grosso*, and had been residing in *Novo Progresso*, State of *Pará*, since 2019.

He graduated as a pilot in 2017 and, in 2020, began conducting sporadic flights, without a formal employment relationship and, as he stated, without remuneration, for the owner of the PT-KQE, with the purpose of gaining experience and new job opportunities in aviation.

According to reports, the PIC had the objective of growing professionally in aviation, aiming to operate executive or airline aircraft.

In interviews, his profile was described as reserved in relation to personal matters in the work environment, however, he was attentive and cautious in the face of demands, having said to be easily adaptable to the environment and to social relationships.

According to reports from other professionals, he sought to keep up to date with the regulations, and customarily sought to get qualified.

The PIC reported that he received information about the aircraft stating that it had undergone maintenance and was compliant.

He said he had enjoyed a regular night's sleep the day before the accident, having slept around 8 hours, starting his activities at 10:00 UTC on the day of the occurrence.

In his own perspective, he maintained a good routine concerning physical activities and food, and was used to having a peaceful and restful sleep. He also considered that there were no health issues that could affect his performance.

The PIC also said that he stayed calm during the aircraft failure. He spotted a place that he considered safe and accessible for the landing, and remained firm to perform his duties in the face of the emergency.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

The aircraft landed in a pasture area of *Fazenda Beira Rio*, which facilitated the job of farm employees and passers-by to approach the site of the occurrence and rescue the occupants of the aircraft.

1.16. Tests and research.

The engine and a few other components of the aircraft were analyzed at a maintenance organization certified by ANAC. Such analysis was monitored by members of the Investigation Commission.

One observed that the engine had external damage resulting from the collision with a palm tree and with the ground, featuring breakage, cracks, excessive wear, to name but a few, making it impossible to turn the engine manually.

The ignition and power systems were checked for functioning and nothing abnormal was found.

The injector nozzles, a total of 6, were individually inspected for their general condition and functioning.

No external damage was found in the injector nozzles of cylinders numbers 2, 4, and 5, which showed satisfactory physical integrity, that is, without breaks, cracks, excessive wear, etc. However, on the bench test, they presented flow rates above the ones specified in the manual.

Due to breakage of the injector nozzles of the cylinders 1 and 3, as well as warping of the nozzle of the cylinder 6 probably on account of the impact, it was not possible to test them on the bench.

One verified that the injector nozzle of cylinder 6 had a Part Number different from the one provided for in the IPC (Illustrated Parts Catalog) of the engine, showing a fuel flow lower than expected for the model IO-520-BA (10) Teledyne Continental engine.

The functioning of the engine with the use of injector nozzles with flow/pressure different from the specified values or with nozzles not prescribed by the manufacturer cause an inadequate distribution of flow/pressure of the fuel sent for burning, altering the air/fuel mixture.

In addition, such unexpected alteration may generate forces on the crankshaft different from the ones designed for the component, degrading its operation and causing overloads and vibrations.

The lubrication system had no malfunctions, broken connections, nor oil leaks capable of compromising the operation of the engine. However, filings were found in the oil pump's internal gears and on the pump fisherman's screen, inside the crankcase. At the bottom of the engine block, there were several chips of metallic material.

In the examination of the engine block and its components, one verified that the dynamic counterweights were intact, however, there was fragmentation of the crankshaft next to the second trunnion, close to the connecting rod of the cylinder number 2. Due to such fragmentation, the broken shaft degraded the bearing of the second trunnion, as well as its housing in the block (Figure 7).

Figure 7 - Fracture in the crankshaft.

Such flaws explain the presence of filings and chips distributed by the block and gears of activation of the accessories. Likewise, the broken crankshaft damaged the actuation tappet of the intake valve of the cylinder no. 1, besides warping the camshaft.

During the disassembly of the rocker arms and control rods of the intake and exhaust valves of the cylinders, filings were found on the rocker arm of the exhaust valve of the cylinder no. 3, as well as chips on the control rod of the intake valve of the cylinder no. 5, and filings on the exhaust valve of the control rod of the cylinder no. 6.

Upon examining the cylinders, pistons and connecting rods, one verified that the cylinder no. 2 had both external damage (dents) and internal damage (grooves), as well as fractures on its base. Its piston had intact ring segments; however, the piston showed damage (grooves) and burn marks on the face, fracture on the base, presence of large amounts of filings, carboniferous deposits (charring) both internally (skirt) and on the upper face (head). The connecting rod of this piston presented fractures on both faces of its connection to the crankshaft journal.

The cylinders from no. 3 to no.6 had external damage (dents), but sustained no internal damage. The pistons had intact segment rings, however, they showed carbon deposits (charring) both internally (skirt) and on the upper face (head). The connecting rods were intact.

Due to deformation on the base of the piston of the cylinder no. 1 (detected after one opened the engine block), it was not possible to remove it along with its respective connecting rod.

The crankshaft was sent for analysis at the DCTA (Department of Science and Aerospace Technology) in order to identify the failure mechanism and determine whether the fragmentation occurred during operation or as a result of the impacts.

In the visual exams of the crankshaft, one observed that the fracture occurred in the region of the concordance radius, the place of stress concentration. The damage observed on both sides of the fractures, such as friction-related wear-off, and discoloration from overheating, indicated that the fracture occurred during the operation of the aircraft (Figure 8).

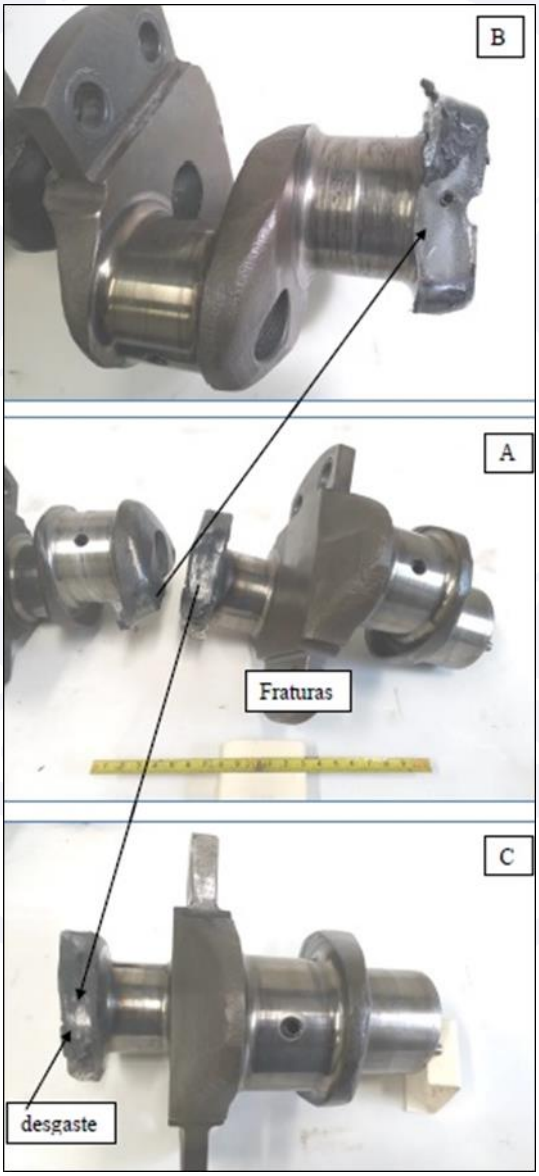


Figure 8 - General view of the fracture region (A).
Details of fracture regions (B and C).

In the stereoscopic examinations performed on the crankshaft, one observed beach marks indicative of failure resulting from the fatigue mechanism (Figure 9).

Figure 9 - Examination by means of stereoscopy. In the detail of the fracture surface, one observes beach marks indicative of fatigue (arrows).

From the results obtained, one may affirm that the crankshaft failed due to a fatigue mechanism. It was not possible to determine, however, the origin of the fatigue, on account of the damage sustained by the component after the fracture.

1.17. Organizational and management information.

According to reports from the operator, the airplane was purchased in mid-July 2019 and was utilized for occasional demands. The operator also affirmed that the aircraft fleet was under his personal administration, including the airplane of the occurrence.

On those days, the PIC was normally flying as a freelancer and, when requested, he would respond promptly.

Also, according to information gathered, in the weeks leading up to the flight, the aircraft did not undergo any maintenance services.

The aircraft maintenance records presented were incomplete and out of date, and the aircraft logbook was not an exception, with its last record dating back to 28 January 2021.

The records obtained from the ANAC's Integrated Civil Aviation Information System (SACI) totaled 100 hours of operation in the last 9 years.

1.18. Operational information.

The PIC started his career in aviation in 2017, with the theoretical part of the private pilot course being done at a flying school based in the municipality of *Sinop*, State of *Mato Grosso*. The practice classes were done at the *Aeroclube of Pará de Minas*, State of *Minas Gerais*.

He started the theoretical part of his commercial pilot training in 2018, but had not yet earned the license by the date of the occurrence.

The PIC reported that he routinely made use of the checklist in operations, and he always sought to follow the existing norms so as to minimize risks, especially in that region. He said that he was used to acting in a controlled and preventative manner with regard to flight safety, which, according to him, contributed to the success of the landing in question.

The flight of the occurrence was private, and would be the first transport of the day, aimed at transporting miners and goods to a gold mine.

Also according to him, the aircraft was fueled with approximately 220 liters of aviation gasoline, thus providing sufficient fuel endurance for the intended flight.

The aircraft took off at 18:20 UTC. Due to lack of the pertinent data, it was not possible to determine whether the airplane was within the weight and balance limits specified by the manufacturer, since the Investigation Commission was not presented with the weight-and-balance sheet for that flight.

The aircraft's planned route would be from SDUA to SITT. During the flight, there was a drift to the left, and aircraft struck the ground at a lateral distance of approximately 13 NM away from the intended route.

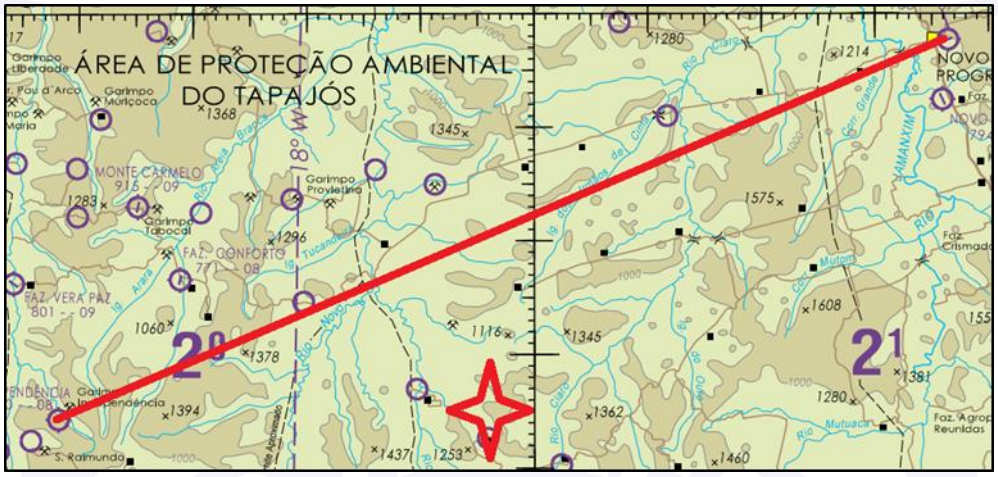


Figure 10 - Croquis of the route (red line) and site of occurrence (star).

Concerning the flight of the occurrence, the PIC reported that the takeoff was uneventful and, approximately 20 minutes into the flight, an engine failure occurred, followed by a complete stop of the propeller. He informed having subsequently performed the procedures for restarting the engine in flight, to no avail.

1.19. Additional information.

Regarding the conditions to be observed by pilots intending to conduct flights under visual conditions, the ICA 100-12 (Command of Aeronautics' Instruction) established:

> 5 VISUAL FLIGHT RULES
>
> 5.1 GENERAL CRITERIA
>
> 5.1.1 Except when operating as a special VFR flight, VFR flights must be conducted in such a way that the aircraft fly in conditions of visibility and distance from clouds equal to or greater than those specified in the table 1.
>
> 5.1.2 Notwithstanding the provisions of 5.1.1 above, VFR flights will only be performed when simultaneously and continuously they can meet the following conditions:
>
> a) maintain reference to the ground or water, so that meteorological formations below the flight level do not obstruct more than half of the pilot's area of sight;
>
> [...]

Tabela 1

Classe de Espaço Aéreo	B	C D E	FG	
			Acima de 900 m (3000 pés) AMSL ou acima de 300 m (1000 pés) sobre o terreno o que for maior	A 900 m (3000 pés) AMSL abaixo ou 300m (1000 pés) acima do terreno, o que for maior
Distância das Nuvens	Livre de Nuvens	1500 m horizontalmente 300 m(1000 pés) verticalmente	1500 m horizontalmente 300m verticalmente	Livre de nuvens e avistando o solo
Visibilidade	8 km se voando no ou acima do FL100	8 km se voando no ou acima do FL100	8 km se voando no ou acima do FL100	5 km
	5 km se voando abaixo do FL100	5 km se voando abaixo do FL100	5 km se voando abaixo do FL100	
Limite de Velocidade	380 kt	250 kt IAS se voando abaixo do FL100		
		380 kt IAS se voando acima do FL100		

Figure 11 - ICA 100-12 Table with ceiling and visibility conditions for VFR flights.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

In the occurrence in question, one verified that, while flying en route, the PIC encountered unfavorable weather conditions. According to information, the aircraft was flying at FL045 and there was a layer of clouds covering more than half of his field of sight underneath the PT-KQE, preventing him from having visual contact with the ground, which led the pilot to deviate from the originally planned route.

Thus, despite having horizontal visibility above the layer, the PIC did not have visual references to the ground, thus experiencing conditions that required operation under IFR, without being rated to fly such flight profile as specified in the ICA 100-12.

That condition also contributed to the PIC failing to identify several runways more suitable for an emergency landing on both sides of the route, something that would have avoided or mitigated the consequences of a landing in an unprepared location.

The PIC reported having made an attempt to restart the engine before the forced landing, but without success. Such fact led the Investigation Commission to check the technical conditions of the aircraft.

During the investigation, evidence was found that the engine failed during flight due to breakage of the crankshaft, an event that also caused the deformity of the cylinder no. 1.

After the complete opening of the engine, it was possible to verify the fragmentation of the crankshaft next to the second trunnion, next to the connecting rod of the cylinder no. 2. Such fragmentation explained the presence of filings and chips spread throughout the block and gears of activation of the accessories.

The analysis of the fragmented crankshaft established that the failure was the result of a fatigue mechanism, but it was not possible to determine its origin due to the damage sustained by the component after the fracture.

The analysis also showed that the fracture in the crankshaft occurred during the operation of the aircraft, that is, it was not caused by the impact with the ground.

The verification of the fuel supply system identified a non-compliance in relation to the fuel flow/pressure value of the injector nozzles. Thus, it was found that the injector nozzle of cylinder no. 6 had a PN that differed from the one prescribed in the engine's IPC, with a fuel flow that was lower than the value specified.

In view of the nonconformities found in the fuel system, more specifically with regard to the inadequate flow to the injector nozzles, a hypothesis was raised that it had contributed to the outset of vibrations and overloads, facilitating the degradation of internal engine

components and the nucleation of material fatigue points, as was the case with the crankshaft.

The last flight record entered in the aircraft logbook referred to 28 January 2021. Besides, the maintenance records were not up-to-date in the pertinent logbooks, making it clear that the operator did not maintain a culture of standardized safety procedures, especially in relation to the control of maintenance processes.

In this sense, the investigation verified that in the last 9 years only 100 flight hours were logged for the aircraft, although there were indications of about 3,650 hours.

Such lack of records in the logbook and the lack of logging control led to the hypothesis that the aircraft flew more hours than those recorded in its airframe, engine, and propeller logbooks, with underestimated data on the total hours in relation to the last *IAM*.

The Investigation Commission also verified that there was an AD determining the conduction of an ultrasonic inspection in the region of the concordance radii of the main bearing of the crankshaft, in accordance with the inspection procedures described in the Crankshaft Ultrasonic Inspection Procedure, Form X30554, by Teledyne Continental Motors, when overhauling the engine or in the case of any other reason that required the crankshaft to be removed.

The forecast inspections of the engine, in accordance with the SIL nº 98-9A (issued on 17 November 1998 by Continental Motors Aircraft Engine) was every 12 years or 1,700 hours, whichever came first, and the next estimate for opening the engine should have taken place in 2007 or when the aircraft reached 4,789 hours.

According to the aircraft's technical records, the last engine opening had been carried out on 18 December 1995. In other words, the aircraft had been operating over 25 years without undergoing the aforementioned overhaul.

That was made possible because the operator had been postponing the Engine Overhaul based on the provision of the item 5.2.2 of the IS nº 91.409-001, Rev. B, of ANAC, in force at the time, which allowed the option of not carrying out the calendar inspection (12 years) while the number of hours had not been reached (1,700 hours), provided that an operational assessment was carried out. However, there were no objective criteria, established by either the engine manufacturer or the aircraft manufacturer, serving as a reference for such assessment.

One found out that, on 19 May 2020, the aircraft had undergone an *IAM* (when it had 3,650 flight hours). At that inspection, the engine showed compression ratio values for the cylinders from 1 to 6 of, respectively, 73, 72, 72, 72, 70, and 73 PSI, within the parameters and, therefore, the engine was considered operational.

Thus, in consonance with the Informative Map for the Control of Components, the PT-KQE would have, at the time, more than 580 hours available before the next overhaul of the engine. However, during the investigation, one observed the vulnerability of the controls related to the flight records, with the possibility that the aircraft’s hour-based inspections had expired.

This hypothesis is further strengthened by the finding that the engine overhaul records were logged with two different values concerning the total hours: in the Informative Map of Component Control the engine would have 2,530 hours on 18 December 1995, while in the Control Map of Airworthiness Guidelines, elaborated on 22 May 2020, the information was that the engine had, at the time, 3,089 hours and 55 minutes TSN.

Thus, the ineffective control of total engine hours may have led the operator to operate the aircraft exceeding the amount of hours/time between engine overhauls, namely 1,700 hours or 12 years.

Furthermore, there was a discrepancy in the preparation of the Component Control Map by the OM, when they entered the information that the engine would be inspected in accordance with the SIL nº 98-9A upon reaching 4,230 hours, when, in fact, the referred service information letter had already been superseded by the SIL nº 98-9C. Although both SIL's maintained the same conditions concerning the engine overhaul (1,700 hours or 12 years), this demonstrates that there were inconsistencies in the notes entered by the OM on the said map, indicating possible inadequacies in its managerial oversight.

The inaccuracy of the technical notes, particularly in relation to the number of hours flown, contributed to the engine being used beyond the limits specified by the manufacturer's maintenance program, without being properly inspected.

Therefore, it should be noted that the failure to comply with a maintenance procedure that can negatively affect the airworthiness of an aircraft is a failure related to the organizational processes necessary for the effective control of the aircraft airworthiness condition.

3. CONCLUSIONS.

3.1. Findings.

a) the PIC held a valid CMA (Aeronautical Medical Certificate);

b) the PIC had a valid MNTE rating (Single-Engine Land Airplane);

c) the PIC was qualified and had about 40 total flight hours;

d) the aircraft had a valid CA (Certificate of Airworthiness);

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

f) the records of the airframe, engine, and propeller logbooks were not up to date;

g) the weather was not consistent with conduction of the flight in visual conditions;

h) 20 minutes after takeoff, an engine failure occurred;

i) there was fragmentation of the engine crankshaft;

j) the aircraft made an emergency landing in an area of *Fazenda Beira Rio*;

k) the aircraft collided with trees and with the ground;

l) the aircraft's engine had been overhauled for the last time on 18 December 1995;

m) the control of the aircraft's engine hours was not coherent;

n) the aircraft sustained substantial damage; and

o) the PIC suffered minor injuries, while the passengers were not injured

3.2. Contributing factors.

- **Attitude – a contributor.**

Flying without visual references with the ground denoted an attitude of non-observance of safety procedures and air traffic rules, contributing to the aggravation of the consequences of the occurrence.

- **Piloting judgment – undetermined.**

There was inadequate evaluation of the parameters related to the operation of the aircraft, leading the PIC to experience conditions that required operation under IFR, despite not being qualified for that flight profile, as specified in the ICA 100-12.

- **Aircraft maintenance – a contributor.**

The constant postponements of the inspection provided for by the DA 82-06-02R1 caused the engine to operate outside the manufacturer's inspection program, leading to its failure.

- **Decision-making process – a contributor.**

Failure to faithfully comply with maintenance procedures denoted an inadequate assessment and management of the risks present in the operation of the PT-KQE.

4. SAFETY RECOMMENDATIONS

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident.

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

To Brazil's National Civil Aviation Agency (ANAC):

A-024/CENIPA/2021 - 01 **Issued on 12/29/2023**

Work together with *Tecnologia Brasileira de Aeronáutica S/A*, so that the referred maintenance organization refines its mechanisms of inspection and control, notably in what refers to the verification of the services delivered, as well as the due record-keeping of such services relatively to aircraft maintained by the OM.

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Evaluate the pertinence of establishing objective criteria for the operational evaluation of the engines contemplated in item 5.2.2 of the IS 91.409-001, Rev. B, in order to provide safe references so that operators may have the option of exceeding the deadlines concerning the hours and the calendar time recommended.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On December 29th, 2023.