COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-082/CENIPA/2020

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-OFI**
MODEL:	**BE 58**
DATE:	**08JUL2020**

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 08July2020 accident with the BE-58 aircraft, registration PR-OFI. The accident was typified as “[SCF-PP] Engine failure or malfunction | In-flight engine failure”.

Upon conducting a ferry flight between the cities of *Ubatuba* and *São Paulo*, in the State of *São Paulo*, close to the “*Itaquera*” position of the REA-SP (Aircraft Special Route of *São Paulo*), the pilot informed that one of the aircraft engines had failed, and requested a single-engine approach to SBMT (*Campo de Marte* Aerodrome, *São Paulo*, SP).

While on the approach for landing on runway 30 of SBMT, the pilot performed a go-around, but the aircraft did not gain enough height, and collided first with trees located just past the end of the runway, and then with the ground on a public road a short distance ahead.

The aircraft was destroyed in the crash.

The pilot suffered fatal injuries.

An Accredited Representative of the NTSB (National Transportation Safety Board from the USA, State of aircraft manufacture) was appointed for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
ANP	Brazil's National Agency for Petroleum, Natural Gas and Biofuels
APP-SP	*São Paulo* Approach Control
ATIS	Automatic Terminal Information Service
CA	Airworthiness Certificate
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIV	Pilot Individual Logbook
CMA	Aeronautical Medical Certificate
DCTA	Department of Science and Aerospace Technology
DECEA	Department of Aerospace Control
IAM	Annual Maintenance Inspection
IFRA	IFR Flight Rating (Airplane)
METAR	Meteorological Aerodrome Report
MLTE	Multi-Engine Land Class Airplane License
MNTE	Single-Engine Land Airplane License
NSCA	Command of Aeronautics' System Norm
NTSB	National Transportation Safety Board (USA)
OM	Maintenance Organization
PCM	Commercial Pilot License – Airplane category
PN	Part Number
PPR	Private Pilot License - Airplane category
RBAC	Brazilian Civil Aviation Regulation
REA	Aircraft Special Routes
ROTAER	Air Routes Auxiliary Manual
SACI	Civil Aviation Information Integrated Center
SBGR	ICAO A/D designator - *Governador André Franco Montoro* Aerodrome, *São Paulo*, SP
SBJD	ICAO A/D designator - *Comandante Rolim Adolfo Amaro* Aerodrome, *Jundiaí*, SP
SBMT	ICAO A/D designator - *Campo de Marte* Aerodrome, *São Paulo*, SP
SDUB	ICAO A/D designator - *Gastão Madeira* State-Aerodrome, *Ubatuba*, SP
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
TMA-SP	*São Paulo* Terminal Area
TWR-MT	*Campo de Marte* Control Tower
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** BE 58 **Registration:** PR-OFI **Manufacturer:** Beechcraft Aircraft.	**Operator:** Private
Occurrence	**Date/time**: 08JUL2020 – 21:09 UTC **Location:** SBMT (*Campo de Marte* Aerodrome. **Lat.** 23°30'26"S **Long.** 046°38'53"W **Municipality – State:** *São Paulo*, SP.	**Type(s):** [SCF-PP] Powerplant failure or malfunction.

1.1. History of the flight.

Around 19:50 UTC, the aircraft took off from SDUB (*Gastão Madeira* State-Aerodrome, *Ubatuba*, SP), bound for SBMT (*Campo de Marte* Aerodrome, *São Paulo*, SP), on a ferry flight with one pilot on board.

Close to *Itaquera* position (along REA-SP), the pilot reported a failure in one of the engines, and requested a single-engine approach towards SBMT.

During the approach for landing on runway 30, the pilot decided to go around, but the aircraft did not gain enough height, colliding first with trees located near the departure end of the runway and, subsequently, with the ground on a public road at a short distance ahead.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The aircraft was destroyed in the crash and post-impact fire.

1.4. Other damage.

There was minor damage to the asphalt and median strip of *Braz Leme* Avenue, *Santana* neighborhood, *São Paulo*, SP.

1.5. Personnel information.

1.5.1. Crew's flight experience.

	PIC
Total	984:17
Total in the last 30 days	00:00
Total in the last 24 hours	00:00
In this type of aircraft	54:54
In this type in the last 30 days	00:00
In this type in the last 24 hours	00:00

N.B.: Both the aircraft logbook and the pilot's physical Logbook (CIV) were destroyed in the post-impact fire, making it impossible to verify the pilot's total flight hours. Part of the hours flown by him were obtained through the records of his digital CIV of the Civil Aviation Information Integrated System (SACI), but the information was out of date.

By means of data provided by TWR-MT (*Campo de Marte* Control Tower), it was possible to verify that there were other flight plans filed by the pilot for the same aircraft after May 2020, the month of the last record logged in his digital CIV.

1.5.2. Personnel training.

The PIC (Pilot in Command) did his PPR (Private Pilot – Airplane) course at the *Aeroclube de São Paulo*, SP, in 2010.

1.5.3. Category of licenses and validity of certificates.

The pilot held a PCM license (Commercial Pilot license – Airplane), and valid ratings for MNTE (Single-Engine Land Airplane), MLTE (Multi-Engine Land Airplane) and IFRA (IFR Flight - Airplane).

1.5.4. Qualification and flight experience.

Although the PIC's digital CIV was out of date, it was possible to confirm by means of TWR-MT records, that the pilot conducted flights of the accident aircraft in the months of May, June and July, attesting his recent experience in multi-engine airplanes, something that made him qualified and experienced for the conduction of the type of flight.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The *SN TH-607* aircraft was manufactured in 1975 by Beechcraft Aircraft in the USA, and was registered in the Private Air Services Registration Category (TPP).

The aircraft CA (Airworthiness Certificate) was valid.

The airframe, engine and propeller logbooks were out of date, and it was found that the last Part-I entry had been logged in October 2019.

On account of the post-impact fire, it was not possible to consult the aircraft logbook. However, based on the maintenance records logged in the aircraft logbooks, one estimates that the aircraft had approximately 10,307 flight hours in total.

The last inspection of the aircraft ("Annual Maintenance Inspection" type) was carried out on 14Nov2019 by *MTX Aviation Importação de Aeronaves Ltda.* Maintenance Organization (Certificate COM no. 1306-41/ANAC). The aircraft flew approximately 9 hours after the said inspection.

In 2017, as per the Service Order no. 986/17, the engines (*PN IO-550C-3F, SN 685166 and 685165*) were removed by the *MTX Aviation Importação de Aeronaves Ltda.* Maintenance Organization for overhauling. At the time, the aircraft had a total flight time of 10,221 hours and 54 minutes.

Both engines were sent on 24Oct2017 to *JL Motores Aeronáuticos Ltda.* Maintenance Organization, (Certificate COM no. 0805-41/ANAC), for a comprehensive overhaul (according to SEGVOO 003 extracts, certificates no. JL 294/2017 and JL 295/2017, detailed below). So, the engines had approximately 86 hours of operation after the overhaul.

1.País (County) BRASIL

2. AGÊNCIA NACIONAL DE AVIAÇÃO CIVIL (BRAZILIAN CIVIL AVIATION AUTHORITY)
CERTIFICADO DE LIBERAÇÃO AUTORIZADA (AUTORIZED RELEASE CERTIFICATE)
ETIQUETA DE APROVAÇÃO DE AERONAVEGABILIDADE (AIRWORTHINESS APPROVAL TAG)
Formulário (Form) F-100-1 SEGVÔO 003

3.Certificado nº (Certificate nº/System Tracking Ref.) JL 294/2017

4.Empresa (Organization) JL Motores Aeronáuticos Ltda - ME
Rua Alcidália dos Santos, 90 – Jd. Ferreira - Sorocaba-SP - CEP18080-620 Tel.: (15) 3418-2528
jlmotores@terra.com.br

5.Ordem de Serviço/Contrato/Nota (Work Order/Contract of invoice) OS 274/17

6.Item (Item)	7.Descrição (Description)	8.Número da Peça (Part Number)	9.Quantidade (Quantity)	10.Número de Série/Lote (Serial/Batch Number)	11.Categoria/Trabalho (Status/Work)
01	MOTOR	IO-550C(3F)	01	685.165	REVISÃO GERAL

1.País (County) BRASIL

2. AGÊNCIA NACIONAL DE AVIAÇÃO CIVIL (BRAZILIAN CIVIL AVIATION AUTHORITY)
CERTIFICADO DE LIBERAÇÃO AUTORIZADA (AUTORIZED RELEASE CERTIFICATE)
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01	MOTOR	IO-550C(3F)	01	685.166	REVISÃO GERAL

Figure 1 – Extracts of the SEGVOO 003 forms issued for the PR-OFI engines.

1.7. Meteorological information.

The SBMT Aerodrome Meteorological Reports (METAR) contained the following information:

METAR SBMT 082100Z 30008KT CAVOK 10/25 Q1014=

METAR SBMT 082200Z 29005KT CAVOK 11/24 Q1015=

According to the meteorological information transcribed above, the conditions were favorable for VFR flights, with visibility above 10 km, wind speed between 5 kt and 8 kt, and direction varying between 290º and 300º.

In consonance with the SBMT ATIS information “MIKE”, issued at 21:00 UTC, the wind direction was 320°, with an intensity of 11 kt, and gusts of up to 27 kt.

Upon being handed over to the TWR-MT frequency, the PR-OFI was informed that the wind was 320° at 9 kt. Nonetheless, he was advised to be aware of the possibility of gusts up to 27 kt.

After the pilot acknowledged having understood the message, the TWR-MT corrected the information (“gusts up to 10 kt”).

1.8. Aids to navigation.

NIL.

1.9. Communications.

The transcripts of communication audios between the PR-OFI and ATC units made it possible to verify that the pilot maintained radio contact with the APP-SP (*São Paulo* Approach Control) and with the TWR-MT all the way through the flight without any technical abnormalities.

In order to support the analysis of the sequence of events that preceded the attempt to land the aircraft, the Investigation Committee highlighted a number of transmissions that can help to understand the dynamic of the accident. The time reference used is the UTC (Universal Time Coordinated).

- At 20:48:03, the PR-OFI aircraft made the initial call to APP-SP.

- At 21:00:07, the pilot informed the APP-SP that the PR-OFI had an engine fire, and would continue on a single-engine flight to SBMT.

- After that, the PR-OFI pilot was asked about the number of persons on board, presence of dangerous goods, and amount of remaining fuel.

- The pilot answered that the aircraft had only one person on board, and three quarters of fuel remaining in the tanks.

- At 21:07:52, the PR-OFI pilot made an initial call to TWR-MT.

- The tower informed that the aircraft was cleared to land on runway 30, with a surface wind of 320° at 9 kt. and advised the pilot to be aware of gusts up to 27 kt. Shortly later, the controller rectified that the wind at the moment had gusts of up to 10 kt. at the maximum.

-The pilot acknowledged the information.

- At 21:09:49, the PR-OFI reported initiating a go-around.

- At 21:09:51, the TWR-MT asked the PR-OFI to which side the turn would be.

- At 21:09:57, the PR-OFI made the last transmission, informing that the aircraft would turn to the left.

At no time, during the exchange of messages, did the pilot declare a distress or urgency situation, just stating that he had “fire in the engine”.

1.10. Aerodrome information.

SBMT is a public/military aerodrome under INFRAERO administration, operating VFR during day- and night-time.

The asphalt runway measures 1,600 m x 45 m, with thresholds 12/30, at an elevation of 2,371 ft.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The aircraft came to a complete stop on *Braz Leme* Avenue, at a distance of 550 m away from the departure end of the runway 30. The first impact of the aircraft was against high vegetation in the overshoot area.

The distribution of the wreckage was of the concentrated type and, due to its characteristics, the impact occurred with low forward speed.

Figure 2 – Aerial image of Runway 12 threshold (i.e. departure end of rwy 30) and vegetation where the first impact occurred..

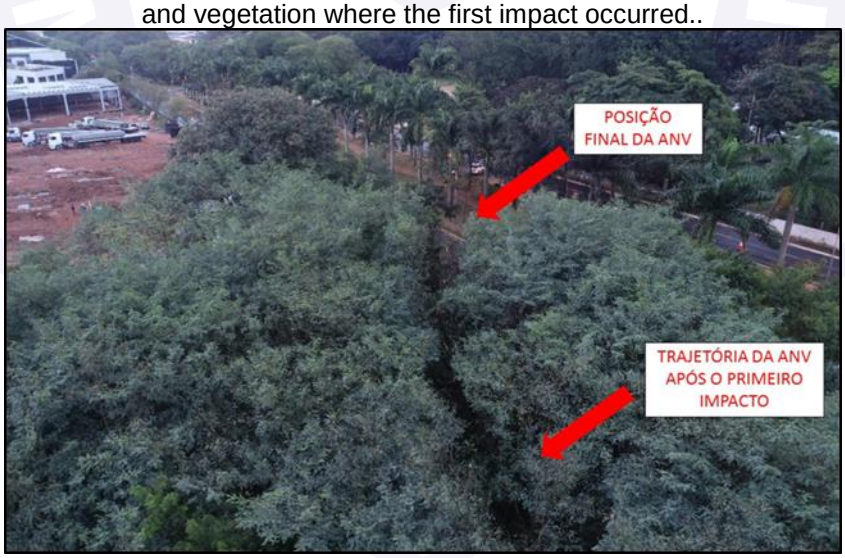


Figure 3 – Aerial image of the aircraft trajectory.

The collision was witnessed by the TWR-MT operator and by pilots of another aircraft that was awaiting at the take-off holding point short of runway 30.

At the analysis of the wreckage, it was possible to observe that the cylinder no. 5 of the right-hand engine was lying approximately 10 m away from the aircraft wreckage.

From the position of the right-hand engine propeller (feathered), and from the evidence found by the Investigation Committee, there were indications that the right-hand engine was not operating (motionless) at the moment of impact, as informed by the pilot.

Figure 4 – Arcraft wreckage in the crash site.

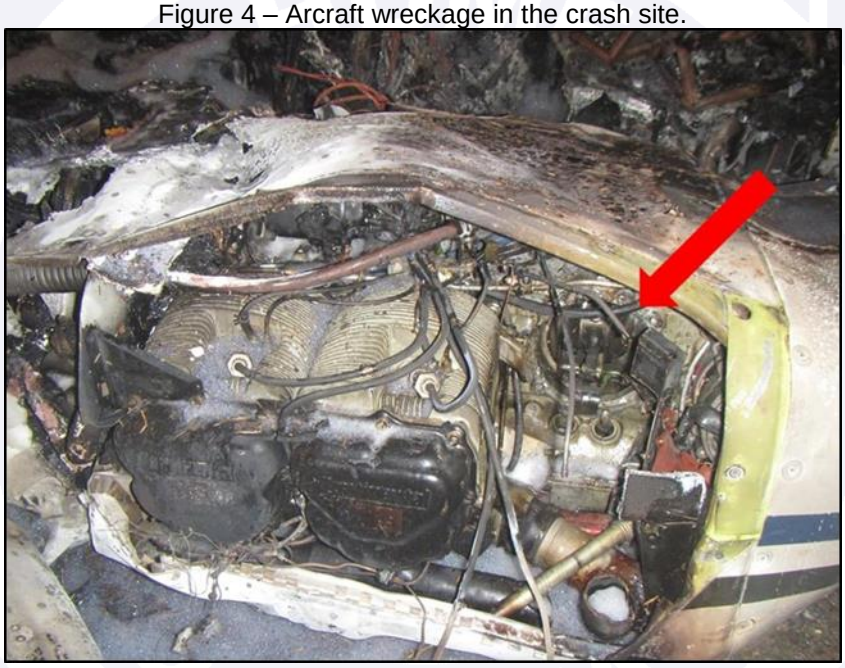


Figure 5 – Detail of the right-hand engine without the cylinder no. 5.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

The autopsy report as well as earlier health inspections were analyzed, showing no evidence that issues of physiological or incapacitating nature might have affected the pilot's performance.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC had a 10-year experience as a pilot, and, according to his wife, flying was his childhood dream that had come true after his retirement as a salesman. Furthermore, the pilot's father was also involved with the aviation activity.

Besides flying aircraft, the PIC also worked as an aeronautical dispatcher (in his own enterprise). His first contact with the owner of the accident aircraft took place while he was working as a dispatcher. He was later hired for the position of aircraft captain.

The pilot was described by family members as a very communicative, helpful and solicitous person. In professional terms, he was described as a responsible and interested professional, with conservative attitudes when it came to flight safety, someone who was attentive to the legislation requirements.

His wife stated that he was enjoying a happy moment in life. They had been married for twenty-three years, and had two children. Their family relationship was harmonious and pleasant.

Also, she said that, for her husband, having been commissioned for the first time as a captain was a matter of great pride and satisfaction.

Before becoming a captain, the pilot had flown for three other air-taxi companies as a copilot.

In those companies, according to reports, he worked without a formal employment relationship. In 2019, after being recommended by a friend, he was hired to fly as a captain of the PR-OFI aircraft.

The relationship between pilot and the owner of the aircraft was described by the latter as very pleasant and straightforward. The pilot had stayed as a guest at the aircraft owner's house a few times after the flights, and was admired by his boss, who valued his dedication and proactivity.

The PIC's wife reported that on the day of the occurrence she found it strange that he had left in the morning without his suitcase and, upon questioning him, received the answer that he believed he would not fly that day, as the plane had a strange noise in the left-hand engine. At around noon, the pilot returned home to get his suitcase, and told her that he was going to fly, since the failure in the left engine had been fixed while the aircraft was still in SBMT.

In an interview, the owner of the aircraft stated that, on the day of the occurrence, he spoke with the pilot by telephone, and was informed about an abnormal noise in the left-hand engine. The pilot told him that he would ask a mechanic to verify the problem. Later on that day, the pilot got in touch again saying that the problem had been fixed, and that the flight would take place.

After the first leg of the flight, in which the owner was transported to *Ubatuba*, the pilot requested to return so that he could spend the night in *São Paulo*, on account of his wedding anniversary. The request was granted, and the pilot returned alone to SBMT, where the accident occurred.

1.14. Fire.

The aircraft caught fire upon impact with the ground. The fire was controlled and extinguished by the SBMT fire brigade.

1.15. Survival aspects.

The only occupant of the aircraft perished in the crash.

1.16. Tests and research.

At SBMT, the Investigation Committee collected gasoline samples from the truck which refueled the aircraft on the day of the accident.

Those samples of fuel were sent for physicochemical tests, and were in accordance with the Norm no. 5 of the National Agency for Petroleum, Natural Gas and Biofuels (ANP), dated 03Feb2009. The results did not show any signs of contamination.

At the analysis of the wreckage, it was verified that the cylinder no. 5 of the right-hand engine had separated from its assembly, and was found approximately 10 m away from the aircraft. Parts of the *crankcase through bolts* of the cylinder were found in the lower cowling of the engine, as shown in Figure 6, and were sent for analysis at the Department of Science and Aerospace Technology (DCTA).

Figure 6 – Image of the *crankcase through-bolts* of the right-hand engine.

The results of the analysis showed that the ruptured bolt (PN EQ7050) presented a fracture surface perpendicular to the longitudinal axis (item I of Figure 7), with characteristics typical of failure due to fatigue (item II of Figure 7).

Still in Figure 7 (item III), there is an image of a *crankcase through bolt* with plastic deformation in its longitudinal axis.

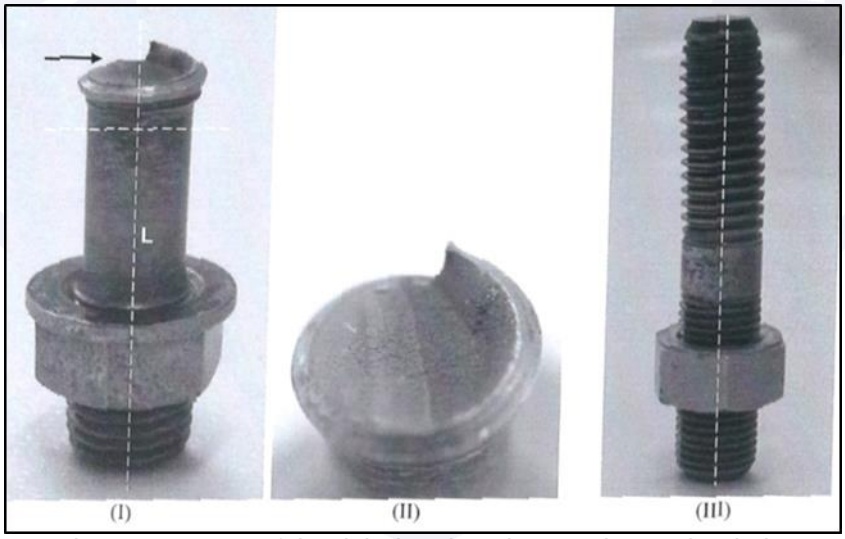


Figure 7 - Image of the right-hand engine *crankcase thru bolts* extracted from the analysis report.

Additionally, it was possible to verify the presence of machining grooves in the thread fillet in the initial region of the fracture (Figure 8).

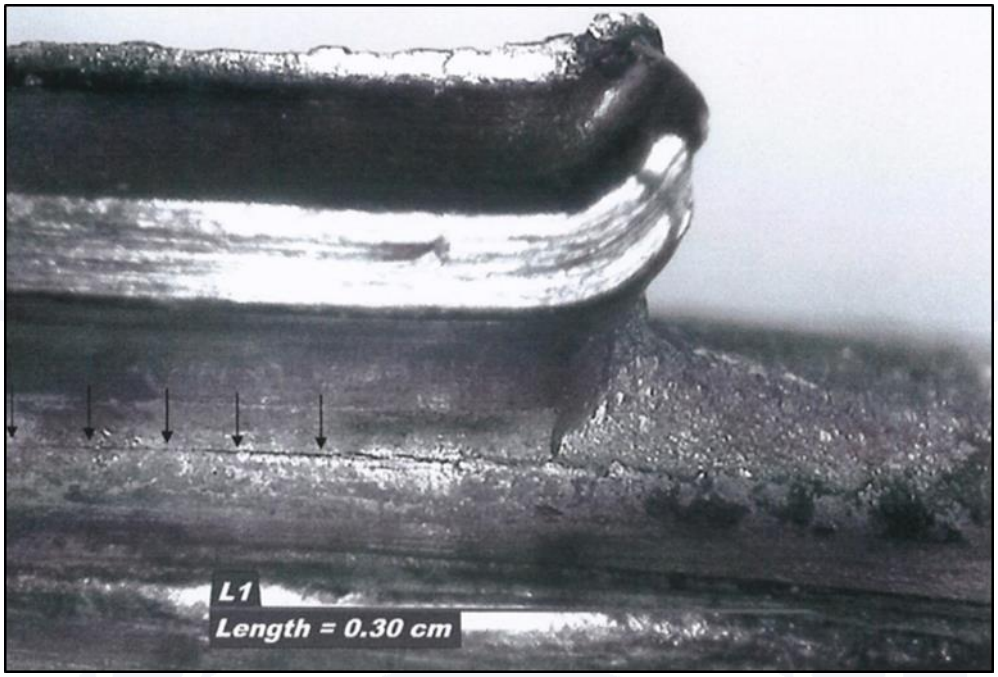


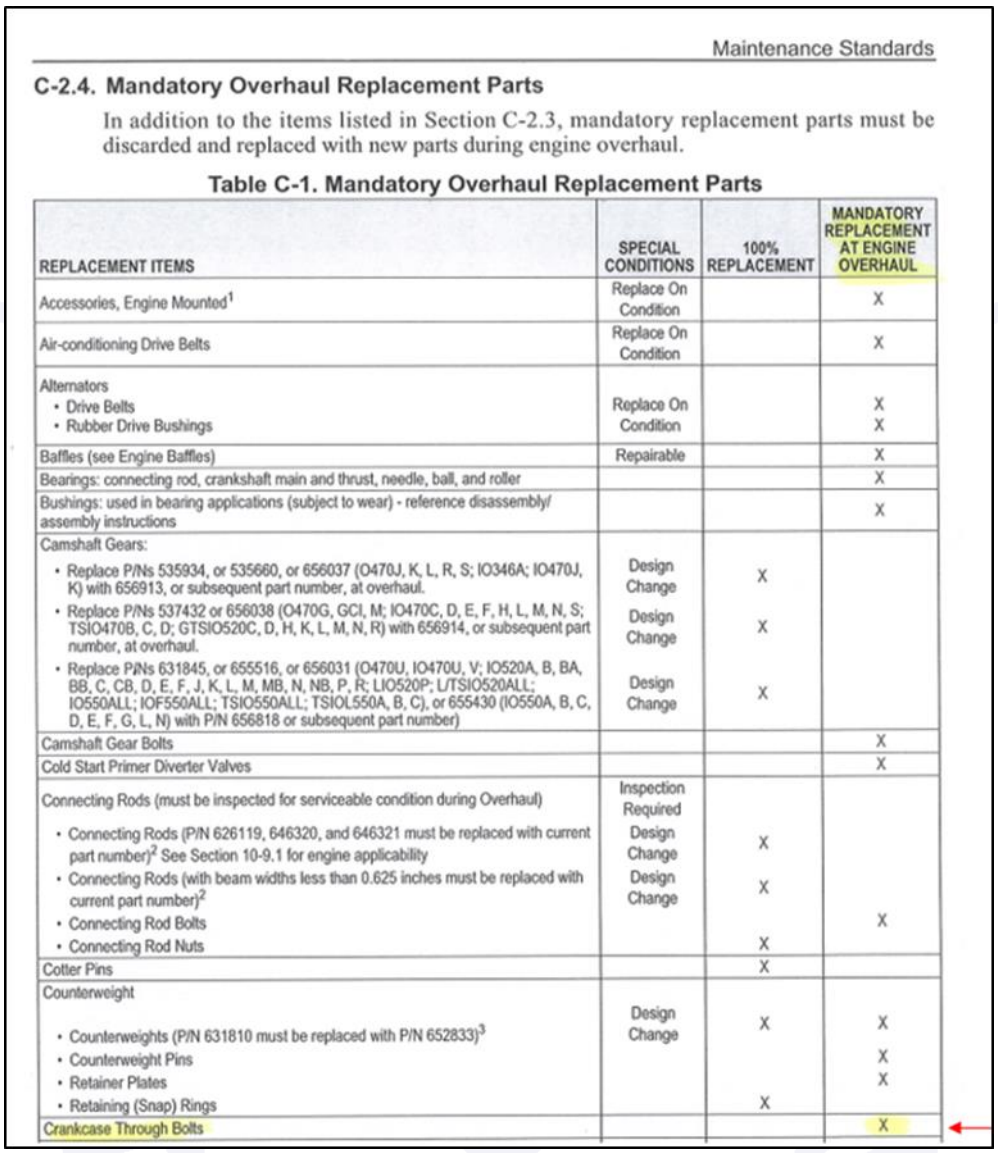
Figure 8 – Detail of a deep machining groove at the root of the fillet of the same plane of the crack (*black arrows*).

The analysis of the left- and right-hand IO-550C-3F Continental engines (SN 685166 and 685165, respectively) revealed that two *crankcase through bolts* securing the cylinder no. 5 of the right-hand engine had failed due to fatigue. Thus, the nuts of the other *through bolts* of the cylinder no. 5 became overloaded, causing them to break. This allowed the displacement of the cylinder, causing the engine to stop, leaving the aircraft in a single-engine condition.

As for the left-hand engine, the analyses showed that it was operating normally and developing power the moment the aircraft struck the ground.

The Investigation Committee had access to the engines' documentation relative to the maintenance service carried out in 2017, in addition to the Teledyne Continental Motors maintenance manuals.

The maintenance manual *Mandatory Overhaul Replacement Parts* section considered the replacement of the *crankcase through bolts* as mandatory in the General Overhaul (*Mandatory Replacement at Engine Overhaul*), as shown in Figure 9.



Maintenance Standards

C-2.4. Mandatory Overhaul Replacement Parts

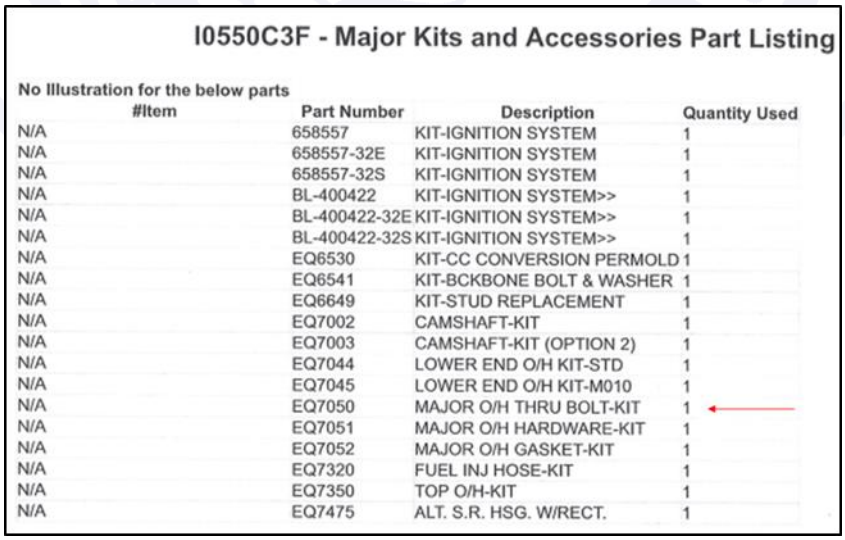
In addition to the items listed in Section C-2.3, mandatory replacement parts must be discarded and replaced with new parts during engine overhaul.

Table C-1. Mandatory Overhaul Replacement Parts

REPLACEMENT ITEMS	SPECIAL CONDITIONS	100% REPLACEMENT	MANDATORY REPLACEMENT AT ENGINE OVERHAUL
Accessories, Engine Mounted[1]	Replace On Condition		X
Air-conditioning Drive Belts	Replace On Condition		X
Alternators • Drive Belts • Rubber Drive Bushings	Replace On Condition		X X
Baffles (see Engine Baffles)	Repairable		X
Bearings: connecting rod, crankshaft main and thrust, needle, ball, and roller			X
Bushings: used in bearing applications (subject to wear) - reference disassembly/ assembly instructions			X
Camshaft Gears: • Replace P/Ns 535934, or 535660, or 656037 (O470J, K, L, R, S; IO346A; IO470J, K) with 656913, or subsequent part number, at overhaul. • Replace P/Ns 537432 or 656038 (O470G, GCI, M; IO470C, D, E, F, H, L, M, N, S; TSIO470B, C, D; GTSIO520C, D, H, K, L, M, N, R) with 656914, or subsequent part number, at overhaul. • Replace P/Ns 631845, or 655516, or 656031 (O470U, IO470U, V; IO520A, B, BA, BB, C, CB, D, E, F, J, K, L, M, MB, N, NB, P, R; LIO520P; LTSIO520ALL; IO550ALL; IOF550ALL; TSIO550ALL; TSIOL550A, B, C), or 655430 (IO550A, B, C, D, E, F, G, L, N) with P/N 656818 or subsequent part number)	Design Change Design Change Design Change	X X X	
Camshaft Gear Bolts			X
Cold Start Primer Diverter Valves			X
Connecting Rods (must be inspected for serviceable condition during Overhaul) • Connecting Rods (P/N 626119, 646320, and 646321 must be replaced with current part number)[2] See Section 10-9.1 for engine applicability • Connecting Rods (with beam widths less than 0.625 inches must be replaced with current part number)[2] • Connecting Rod Bolts • Connecting Rod Nuts	Inspection Required Design Change Design Change	 X X X	 X
Cotter Pins		X	
Counterweight • Counterweights (P/N 631810 must be replaced with P/N 652833)[3] • Counterweight Pins • Retainer Plates • Retaining (Snap) Rings	Design Change	X X	X X X
Crankcase Through Bolts			X

Figure 9 – Image of the *Teledyne Continental Motors maintenance manual*.

According to the Figure 10, a kit of bolts (PN EQ7050 - MAJOR O/H THRU BOLT - KIT) should be used for each engine as mandatory replacement at Engine Overhaul.



I0550C3F - Major Kits and Accessories Part Listing

No Illustration for the below parts

#Item	Part Number	Description	Quantity Used
N/A	658557	KIT-IGNITION SYSTEM	1
N/A	658557-32E	KIT-IGNITION SYSTEM	1
N/A	658557-32S	KIT-IGNITION SYSTEM	1
N/A	BL-400422	KIT-IGNITION SYSTEM>>	1
N/A	BL-400422-32E	KIT-IGNITION SYSTEM>>	1
N/A	BL-400422-32S	KIT-IGNITION SYSTEM>>	1
N/A	EQ6530	KIT-CC CONVERSION PERMOLD	1
N/A	EQ6541	KIT-BCKBONE BOLT & WASHER	1
N/A	EQ6649	KIT-STUD REPLACEMENT	1
N/A	EQ7002	CAMSHAFT-KIT	1
N/A	EQ7003	CAMSHAFT-KIT (OPTION 2)	1
N/A	EQ7044	LOWER END O/H KIT-STD	1
N/A	EQ7045	LOWER END O/H KIT-M010	1
N/A	EQ7050	MAJOR O/H THRU BOLT-KIT	1
N/A	EQ7051	MAJOR O/H HARDWARE-KIT	1
N/A	EQ7052	MAJOR O/H GASKET-KIT	1
N/A	EQ7320	FUEL INJ HOSE-KIT	1
N/A	EQ7350	TOP O/H-KIT	1
N/A	EQ7475	ALT. S.R. HSG. W/RECT.	1

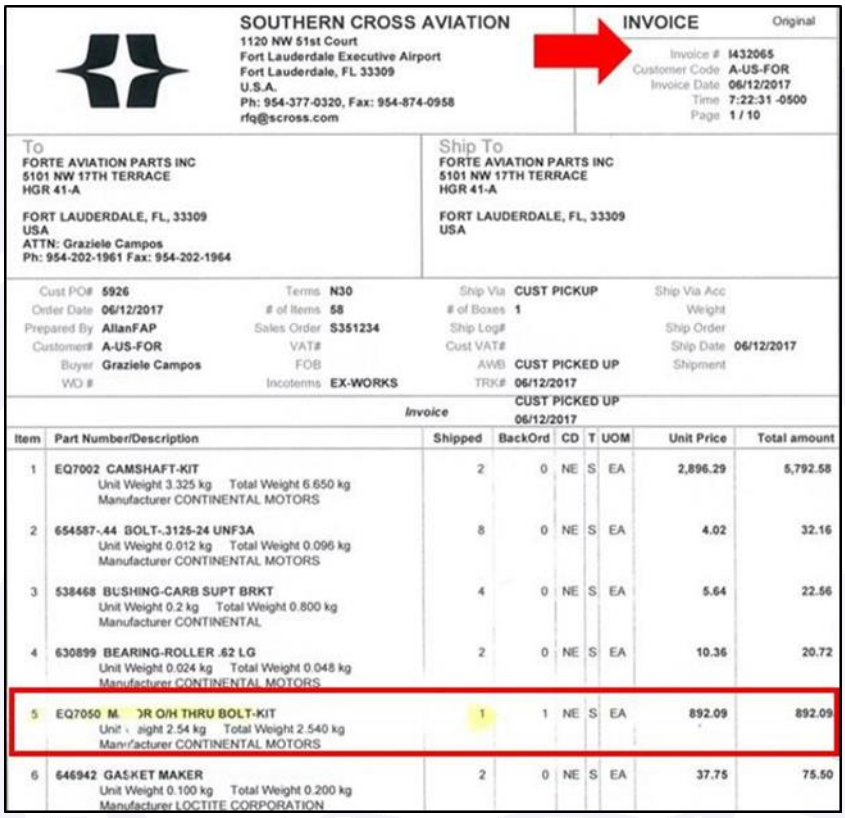
Figure 10 - Image of the *Teledyne Continental Motors* maintenance manual.

The Investigation Committee found out that the *MTX Aviation Importação de Aeronaves Ltda.* performed maintenance services on the airframe items, and mediated the

owner's contact with the *JL Motores* maintenance organization for the overhaul of the aircraft engines.

Upon analysis of the documentation forwarded by the owner of the aircraft, by the *JL Motores Aeronáuticos Ltda*., and by the *MTX Aviation Importação de Aeronaves Ltda,* it was possible to verify the existence of conflicting information.

The *MTX Aviation Aircraft Maintenance Ltda.* handed in the Invoice (I432065) of *Southern Cross Aviation* (company responsible for importing the parts). From the invoice, it was observed that only one kit of MAJOR O/H THRU BOLT (PN EQ7050) was dispatched, as shown in Figure 11.



SOUTHERN CROSS AVIATION
1120 NW 51st Court
Fort Lauderdale Executive Airport
Fort Lauderdale, FL 33309
U.S.A.
Ph: 954-377-0320, Fax: 954-874-0958
rfq@scross.com

INVOICE Original
Invoice # I432065
Customer Code A-US-FOR
Invoice Date 06/12/2017
Time 7:22:31 -0500
Page 1 / 10

To
FORTE AVIATION PARTS INC
5101 NW 17TH TERRACE
HGR 41-A
FORT LAUDERDALE, FL, 33309
USA
ATTN: Graziele Campos
Ph: 954-202-1961 Fax: 954-202-1964

Ship To
FORTE AVIATION PARTS INC
5101 NW 17TH TERRACE
HGR 41-A
FORT LAUDERDALE, FL, 33309
USA

Cust PO# 5926 | Terms N30 | Ship Via CUST PICKUP | Ship Via Acc
Order Date 06/12/2017 | # of Items 58 | # of Boxes 1 | Weight
Prepared By AllanFAP | Sales Order S351234 | Ship Log# | Ship Order
Customer# A-US-FOR | VAT# | Cust VAT# | Ship Date 06/12/2017
Buyer Graziele Campos | FOB | AWB CUST PICKED UP | Shipment
WO # | Incoterms EX-WORKS | TRK# 06/12/2017

Invoice CUST PICKED UP 06/12/2017

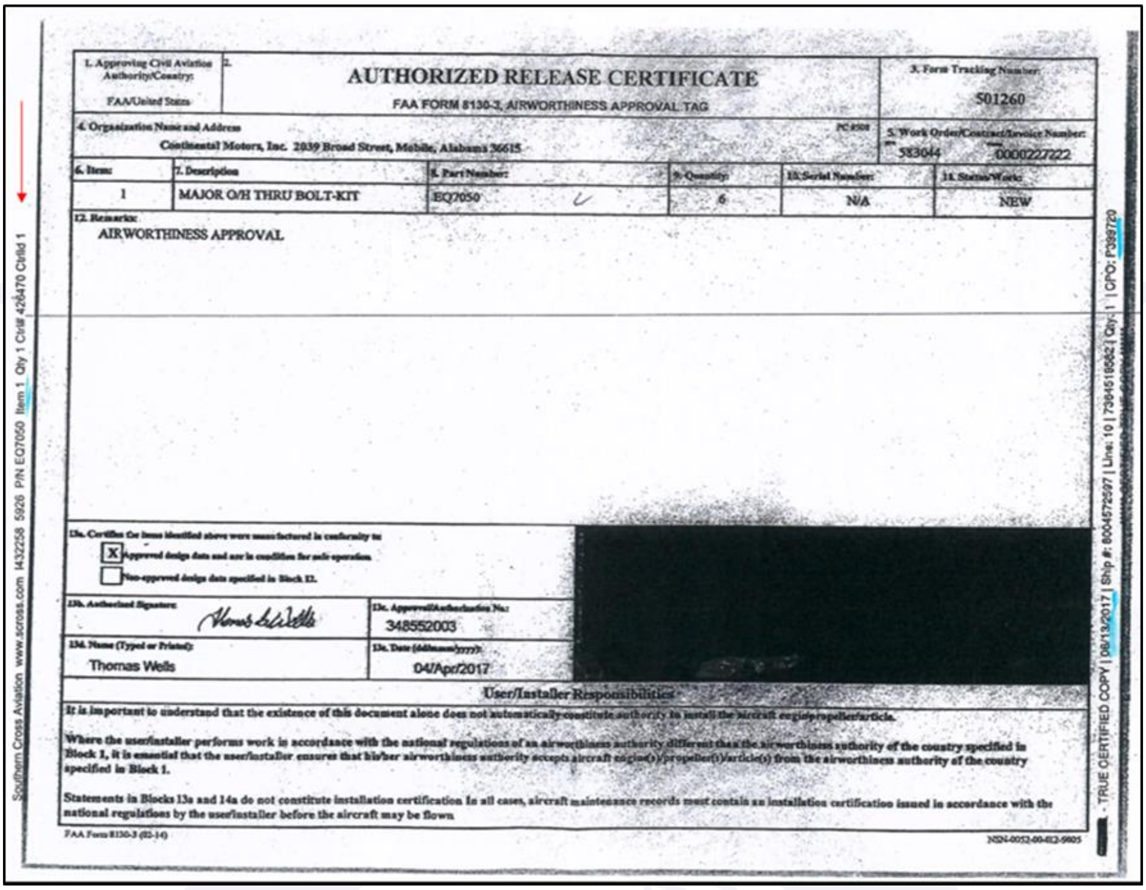
Item	Part Number/Description	Shipped	BackOrd	CD	T	UOM	Unit Price	Total amount
1	EQ7002 CAMSHAFT-KIT Unit Weight 3.325 kg Total Weight 6.650 kg Manufacturer CONTINENTAL MOTORS	2	0	NE	S	EA	2,896.29	5,792.58
2	654587-.44 BOLT-.3125-24 UNF3A Unit Weight 0.012 kg Total Weight 0.096 kg Manufacturer CONTINENTAL MOTORS	8	0	NE	S	EA	4.02	32.16
3	538468 BUSHING-CARB SUPT BRKT Unit Weight 0.2 kg Total Weight 0.800 kg Manufacturer CONTINENTAL	4	0	NE	S	EA	5.64	22.56
4	630899 BEARING-ROLLER .62 LG Unit Weight 0.024 kg Total Weight 0.048 kg Manufacturer CONTINENTAL MOTORS	2	0	NE	S	EA	10.36	20.72
5	EQ7050 M. OR O/H THRU BOLT-KIT Unit ight 2.54 kg Total Weight 2.540 kg Manufacturer CONTINENTAL MOTORS	1	1	NE	S	EA	892.09	892.09
6	646942 GASKET MAKER Unit Weight 0.100 kg Total Weight 0.200 kg Manufacturer LOCTITE CORPORATION	2	0	NE	S	EA	37.75	75.50

Figure 11 - *Invoice* I432065 of *South Cross* showing dispatch of one *MAJOR O/H THRU BOLT - KIT.*

The *JL Motores Aeronáuticos Ltda.* maintenance organization provided the Investigation Committee with the Form 8130-3, a document used for confirmation of airworthiness approval for export. In other words, it ensured that the aircraft part or product, in this case the *MAJOR O/H THRU BOLT* kit (PN EQ7050) had safe-operation conditions, besides being consistent as a means of determining identification, liability and traceability within the global aviation network.

The left side of the FORM 8130-3 showed a batch breakdown by *Southern Cross Aviation* of one unit of the MAJOR THRU BOLT KIT, PN EQ7050, out of a total of six units. The invoice number informed by the *JL Motores Aeronáuticos Ltda.* maintenance organization, through which the mandatory replacement material was purchased, was I432258. Nonetheless, such invoice I432258 was not presented.

Still, in the same context of the records related to the traceability of the material used in the overhaul of the engines, the invoice no. I432065 presented by the *MTX Aviation Manutenção de Aeronaves Ltda.* maintenance organization, did not appear in the FORM 8130-3 presented by the *JL Motores Aeronáuticos* maintenance organization. In short, the invoice no. I432258, registered on the FORM 8130-3, was not the same as the one provided by the *MTX Aviation Aircraft Maintenance* (I432065), as shown in Figures 12 and 13.



Southern Cross Aviation www.scross.com I432258 5926 P/N EQ7050 Item 1 Qty 1 Ctrl# 426470 Ctrlld 1

1. Approving Civil Aviation Authority/Country: FAA/United States
2.

AUTHORIZED RELEASE CERTIFICATE
FAA FORM 8130-3, AIRWORTHINESS APPROVAL TAG

3. Form Tracking Number: 501260

4. Organization Name and Address: Continental Motors, Inc. 2039 Broad Street, Mobile, Alabama 36615

5. Work Order/Contract/Invoice Number: 583044 0000227222

6. Item:	7. Description:	8. Part Number:	9. Quantity:	10. Serial Number:	11. Status/Work:
1	MAJOR O/H THRU BOLT-KIT	EQ7050	6	N/A	NEW

12. Remarks: AIRWORTHINESS APPROVAL

13a. Certifies the items identified above were manufactured in conformity to:
[X] Approved design data and are in a condition for safe operation.
[ ] Non-approved design data specified in Block 12.

[redacted]

13b. Authorized Signature:
13c. Approval/Authorization No.: 348552003
13d. Name (Typed or Printed): Thomas Wells
13e. Date (dd/mmm/yyyy): 04/Apr/2017

User/Installer Responsibilities

It is important to understand that the existence of this document alone does not automatically constitute authority to install the aircraft engine/propeller/article.

Where the user/installer performs work in accordance with the national regulations of an airworthiness authority different than the airworthiness authority of the country specified in Block 1, it is essential that the user/installer ensures that his/her airworthiness authority accepts aircraft engine(s)/propeller(s)/article(s) from the airworthiness authority of the country specified in Block 1.

Statements in Blocks 13a and 14a do not constitute installation certification. In all cases, aircraft maintenance records must contain an installation certification issued in accordance with the national regulations by the user/installer before the aircraft may be flown.

FAA Form 8130-3 (02-14) NSN: 0052-00-012-9005

TRUE CERTIFIED COPY | 06/13/2017 | Ship #: 8004572597 | Line: 10 | 7364519882 | Qty: 1 | CPO: P399720

Figure 12 - Image of the FORM 8130 provided by JL Motores.

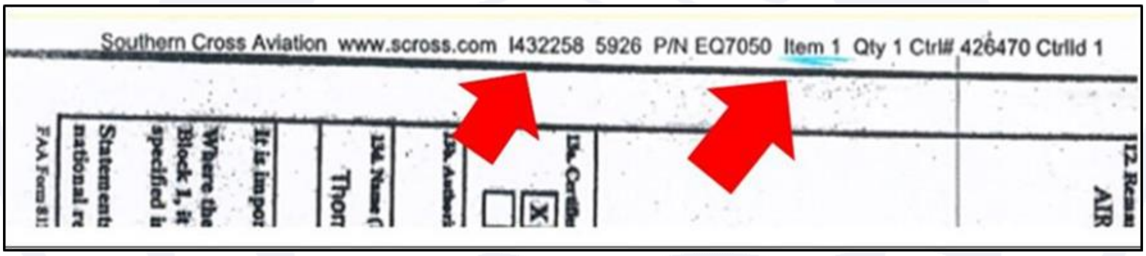


Figure 13 – Detail of the above enlarged image of the FORM 8130 batch break provided by JL Motores.

The Brazilian Civil Aviation Regulation 145 (RBAC-145), Amendment 00, dealing with Aeronautical Product Maintenance Organizations, and in force at the time of the overhaul services performed on the engines, prescribed that a maintenance organization was to maintain, for at least five years, the records of the various procedures that the organization adopted to maintain the traceability and airworthiness of raw materials and articles that entered the OM, and that were applied in the maintenance services. Such records were requested to *JL Motores Aeronáuticos Ltda*., but were not presented.

Likewise, the *MTX Aviation Importação de Aeronaves Ltda.* maintenance organization (the company responsible for importing the parts), presented data that diverged from those provided by the *JL Motores Aeronáuticos Ltda.* maintenance organization.

Since the *JL Motores Aeronáuticos Ltda.* OM did not present the data related to the entry/exit movement of items in its stock/workshop that were applied to the engines, the Investigation Committee did not have access to records confirming the traceability of the MAJOR O/H THRU BOLT kit installed in the engines, resulting that it was not possible to prove that, in fact, the fatigued item was replaced, as required in the Mandatory Overhaul Replacement Parts section of the maintenance manual.

1.17. Organizational and management information.

NIL.

1.18. Operational information.

The aircraft was performing a ferry flight back to SBMT after transporting a passenger between the cities of *São Paulo* and *Ubatuba*.

The aircraft took off at 19:50 UTC. The flight plan indicated SBJD (*Comandante Rolim Adolfo Amaro* aerodrome, *Jundiaí*, SP) as the alternate aerodrome.

During the cruise flight along the VFR corridors, and close to the *Itaquera* position, the pilot called the APP-SP to report that one of the engines was on fire.

The pilot maintained a single-engine cruise flight from *Itaquera* position up to SBMT.

Itaquera position is at a distance of 6.7 NM away from SBGR (*Governador André Franco Montoro* Aerodrome, *Guarulhos*, SP), which has two runways, one of which measuring 3,700 m x 45 m, and the other measuring 3,000 m x 45 m.

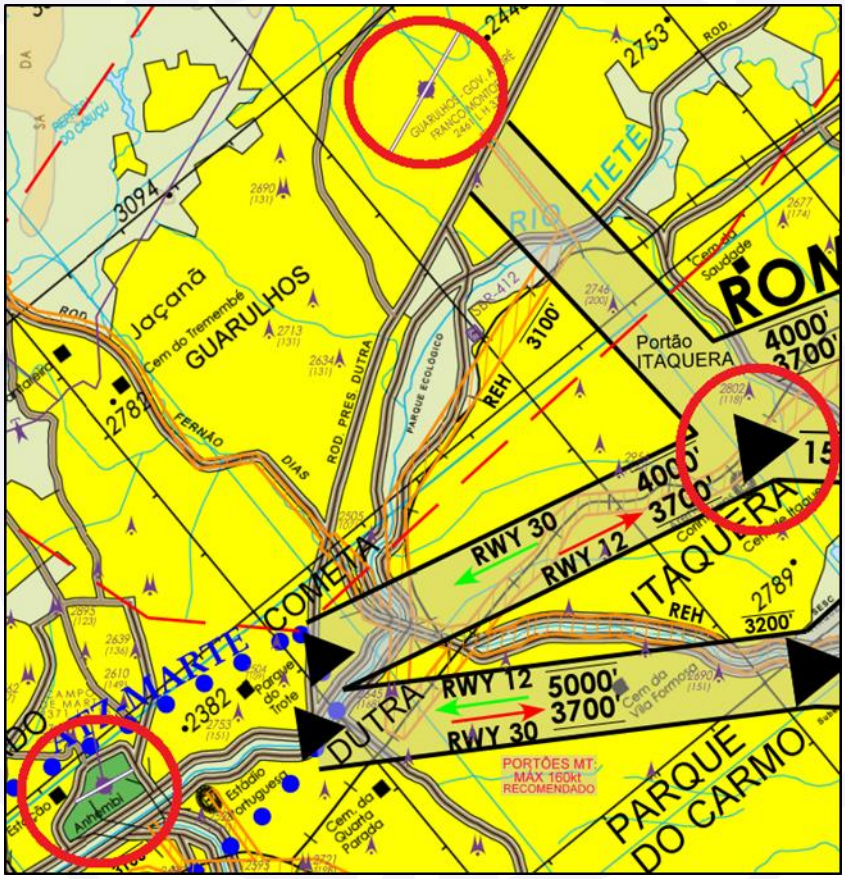


Figure 14 - REA TMA-SP 2 with *Itaquera*, SBMT and SBGR positions.

In accordance with the ROTAER, SBGR could not be used as a diversion option by fixed-wing aircraft flying VFR.

Relatively to that aspect, the Section 91.3 of the RBAC 91 defined the following requirements in the case of an in-flight emergency:

> 91.3 Responsibility and authority of the pilot in command
>
> (a) The pilot-in-command of an aircraft has ultimate authority and responsibility for the operation and safety of the flight.
>
> (b) In an emergency requiring immediate action, the pilot-in-command is allowed to deviate from any requirement of this Regulation to the extent required to deal with the emergency.

(c) Each pilot-in-command who deviates from a requirement pursuant to paragraph (b) of this section must log the occurrence in the aircraft logbook, and send a written report to ANAC describing and justifying such deviation.

(d) The report dealt with in the paragraph (c) of this section must be forwarded to ANAC within a maximum period of 20 (twenty) working days from the occurrence, unless a different period is required or authorized by the ANAC.

In the images of SBMT forwarded to the Investigation Committee, it was possible to observe the approach of the aircraft, which touched the runway three times and, after that, started a go-around. After gaining a few meters in altitude, the aircraft remained in level flight, close to the runway, and then lost altitude, colliding with vegetation past the departure end of runway 30.

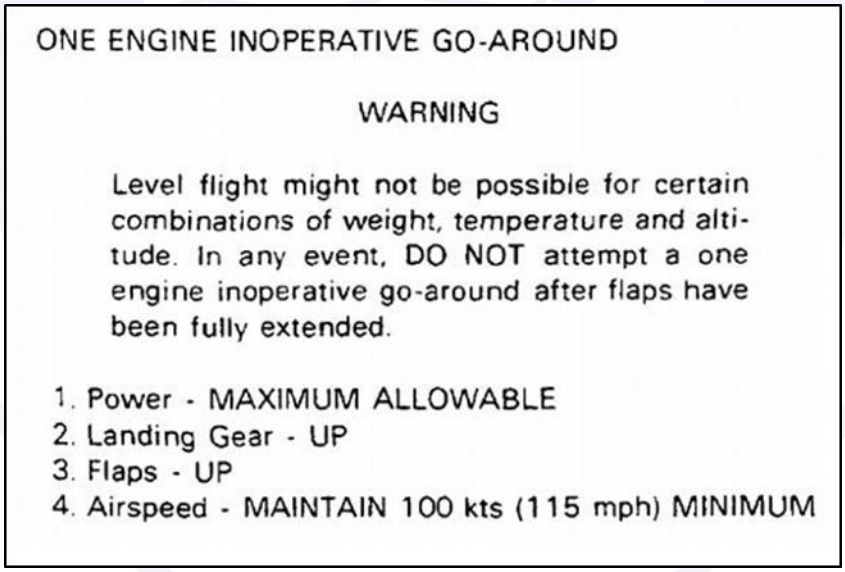
From accounts made by observers located in the TWR-MT, and by pilots who were awaiting at the holding point of the runway 30 threshold, the aircraft approached at a speed that seemed higher than usual. According to the manufacturer's manual, the recommended speed on the final approach was 90 kt.

The analysis of the images also revealed that the aircraft initiated the go-around procedure, roughly at the mid-point of the runway.

After the impact with the vegetation, the aircraft did not keep flying, and crashed into the asphalt-paved ground of *Braz Leme* Avenue, about 60 m ahead of the point where it had impacted the trees.

Due to the low degree of lighting at the time of the video recordings, it was not possible to distinguish the flap settings during the approach and go-around.

The go-around procedure with failure in one of the engines (recommended in the Pilot Operation Handbook - POH - of the aircraft) is depicted in Figure 15.


ONE ENGINE INOPERATIVE GO-AROUND

WARNING

Level flight might not be possible for certain combinations of weight, temperature and altitude. In any event, DO NOT attempt a one engine inoperative go-around after flaps have been fully extended.

1. Power - MAXIMUM ALLOWABLE
2. Landing Gear - UP
3. Flaps - UP
4. Airspeed - MAINTAIN 100 kts (115 mph) MINIMUM

Fig. 15 – *ONE ENGINE INOPERATIVE* GO-AROUND. Source: Aircraft POH.

According to the manufacturer's manual, the aircraft would be capable of performing a single-engine go-around, depending on the conditions of weight, temperature, and elevation of the aerodrome. Furthermore, it emphasized that a go-around should not be attempted with the flaps fully lowered.

Through the analysis of the communications exchange between the APP-SP and the pilot, information was found that, shortly before the accident, the aircraft had approximately three quarters (¾) of fuel in the tanks. The temperature at the aerodrome was 25°C, and the aerodrome elevation was 2,371 ft.

Thus, analyzing the *Takeoff Climb Gradient - One Engine Inoperative* diagram (Section V of the aircraft POH), and estimating an aircraft weight of approximately 5,000 pounds (2,267 kg.), one would obtain a gradient of 3%, according to the graphic projection in Figure 16.

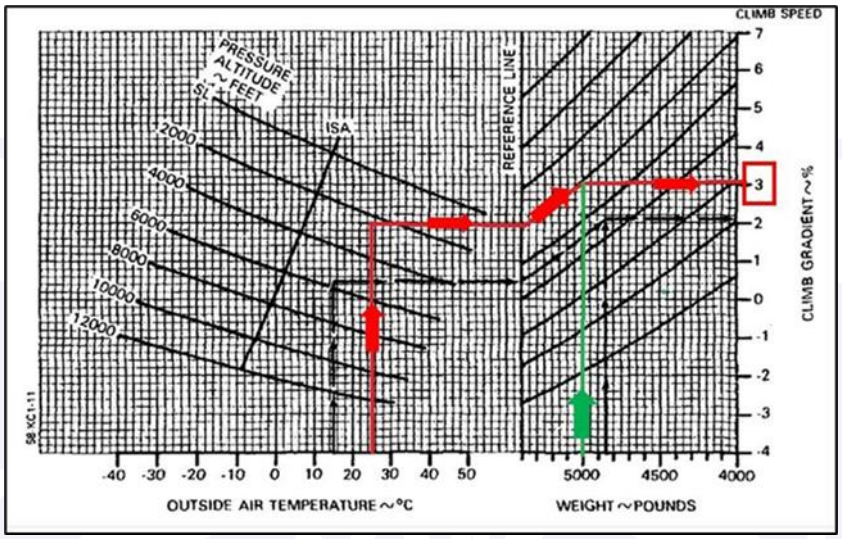


Figure 16 - Extract from the *Take-off Climb Gradient - One Engine Inoperative* of the aircraft POH.

Considering the only operating engine adjusted for takeoff power, with the aircraft landing gear and flaps retracted, inoperative engine with its propeller feathered, at a speed of 94 kt. recommended by the POH, a 282 ft/min rate of climb would be obtained.

Considering that the go-around maneuver would have initiated at the mid-point of the runway, it is possible to affirm that the aircraft would have a distance of 1.2 NM to the highest obstacle along the takeoff axis of the runway 30 (i.e. a hill located in the *Casa Verde* neighborhood), at an elevation of about 200 ft. (61 m). Maintaining the prescribed speed of 94 kt., the aircraft would travel 1.2 NM to the obstacle in 46 seconds, and would be able to climb approximately 220 ft.

Should the pilot have chosen to apply the brakes from the middle of the runway onwards, and if one analyzes the Landing Distance diagrams in Section V, assuming that the aircraft was subjected to a headwind of 10 kt (as informed via radiotelephony by the control tower) with landing gear extended and the flaps down, at an approach speed of 91 kt., and fully applying the brakes, the aircraft would be able to stop in 1,350 ft (412 m), as per the performance diagram illustrated in Figure 17. The SBMT runway was 1,600 m long.

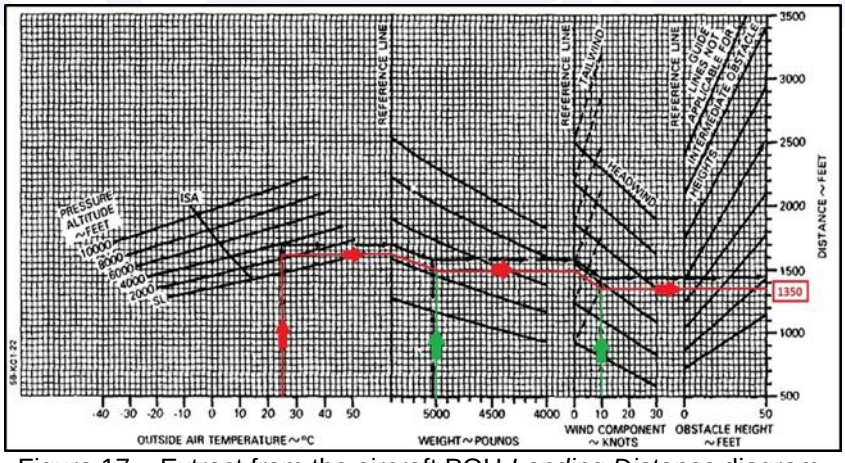


Figure 17 – Extract from the aircraft POH *Landing Distance* diagram.

However, it was not possible to determine the speed of the aircraft on the approach, nor the pilot's real motivation in choosing the single-engine go-around.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

The aircraft was engaged on a ferry flight back to SBMT, after a private flight to transport a passenger to Ubatuba, SP.

According to reports from family members and from the owner of the PR-OFI aircraft, the pilot reported that the airplane had undergone maintenance on the left-hand engine in SBMT on the morning of the day of the accident, thus allowing the flight to be conducted on the afternoon of the same day.

However, the Investigation Committee, besides not finding any notes in the aircraft's documentation, was also did not manage to confirm such information with the maintenance service providers at the aerodrome, giving rise to the possibility that the service, if at all performed, was not logged.

In any way, it was possible to confirm, during analysis of the wreckage, that the left-hand engine was operating normally and developing power at the moment of the aircraft collision with the vegetation and with the ground.

As for the right-hand engine, it was confirmed that the *crankcase through-bolts* of the cylinder no. 5 ruptured in flight due to fatigue when the engine had approximately 86 hours of flight after the overhaul.

The analysis of the engines revealed that two *crankcase through-bolts* securing the cylinder no. 5 on the right-hand engine failed due to fatigue. Thus, the nuts of the other through-bolts in that cylinder became overloaded, causing them to break and come off in flight, leading the right-hand engine to stop.

Despite requests made by the Investigation Committee, the *JL Motores Aeronáuticos Ltda.* maintenance organization did not provide, at least by the closing of this Final Report, the necessary data to confirm the origin of the fatigued item. In addition, according to the analysis of the components, the part had signs of machining and unusual “beach marks”. The investigators could not determine the reason for such machining. The very beach marks, revealing an ongoing fatigue process, would be the result of inappropriate machining.

The pilot had reported noise in the left-hand engine, expressing his concern about the condition of the aircraft. Thus, it is possible that, upon noticing that the left-hand engine no longer made that noise, the pilot’s situational awareness decreased, and he did not perceive any possible signs of failure in the right-hand engine of the aircraft, the one that failed in the occurrence.

The Investigation Committee also considered the hypothesis that the source of the noise described by the pilot would be in the right-hand engine instead of the left-hand one, and would be related to the total or partial rupture of one or more bolts, on account of the ongoing fatigue process. However, as it was not possible to verify the place where the maintenance intervention was performed, the hypothesis could not be confirmed.

Those pieces of evidence raised doubts as to the compliance of the maintenance service performed on the engine in question at the time of the overhaul, which might constitute a contributing factor to the chain of events that culminated in the accident.

After the failure of the right-hand engine in flight, the pilot correctly identified it, and feathered the propeller. Despite the single-engine condition, the aircraft continued flying from the *Itaquera* position toward SBMT.

When in contact with the APP-SP to report the engine failure, the pilot informed about his intention to proceed for a landing in SBMT, and stated that he had about ¾ of fuel remaining in the tanks. During such communication, the option of landing in another location was not considered.

Although the ROTAER contained the information that SBGR was not to be used as a diversion option for fixed-wing aircraft flying VFR in case of emergency, it would be a very viable alternative, since it was close to the aircraft in question, and had longer runways with few obstacles along their extensions.

The possibility of landing in SBGR was supported by the requirements of the RBAC-91, which provided for the possibility of deviations from the regulations in the case of in-flight emergencies.

Thus, the Investigation Committee concluded that the decision to proceed to SBMT, which was more restricted, with a smaller runway, and obstacles near the thresholds, showed lack of an accurate assessment of the options capable of offering a greater probability of success in the management of the emergency.

The aircraft performed a single-engine approach to the runway 30 of SBMT, touched the runway three times in sequence and, after that, initiated a go-around procedure. Initially, the aircraft left the ground and gained lift, kept flying level and, shortly later, lost height. Meanwhile, the pilot retracted the landing gear, but one was not able to specify the flap configuration due to the degree of destruction of the aircraft after the crash.

The most likely hypothesis is that the pilot chose the single-engine go-around procedure from the ground due to the high speed used on the final approach for landing, and the fact that he had already touched down the runway halfway down its length.

The landing took place at night-time, something that may reduce the human ability of in-depth vision. Such circumstances certainly increased the workload in the cockpit, and may have caused a reduction of the pilot's situational awareness, leading to inappropriate application of flight controls during the descent procedure, and contributing to an unstabilized final segment.

The Investigation Committee considered that the decision to return to São Paulo, close to the night period, may have been influenced by the pilot's motivation, on account of his wedding anniversary.

From the analysis of the climb gradient performance diagrams during the aircraft's single-engine takeoff, for the PR-OFI flight conditions, one verified that there was little margin of aircraft performance to conduct a single-engine go-around procedure, in which the aircraft would obtain a rate of climb in the order of 282 ft. /min in a clean configuration, at a speed 94 kt., and with the inoperative engine propeller feathered.

In such case, the aircraft would be able fly over the *Casa Verde* hill by only 20 ft., since it would have reached approximately 220 ft. since the moment of rotation. That hypothesis also does not take into account the presence of obstacles (trees and buildings). In addition, the lack of determination of the flaps position at the time of the go-around procedure would also affect the aircraft's climb performance.

In the event that the pilot might have chosen to remain on the ground, even after the three successive touches on the runway, the landing distance calculation indicated that the aircraft could stop completely in 412 m, still within the runway limits, considering the headwind condition of 10 kt, landing gear and flaps down, approach speed at 91 kt., and maximum brake application.

At that point, the choice between going around in a single-engine condition and trying to stop the aircraft on the ground proved to be a hard decision that had to be made in a short

period of time. For unknown reasons, the pilot chose to perform a single-engine go-around and, during the procedure, the aircraft ended up colliding with the ground.

3. CONCLUSIONS.

3.1. Findings.

a) the pilot had a valid Aeronautical Medical Certificate (CMA);

b) the pilot had valid Multi-Engine Land Airplane (MLTE) and IFR Flight - Airplane (IFRA) ratings;

c) the pilot had both qualification and experience for the type of flight;

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

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

f) the records of the airframe, engine, and propeller logbooks were out of date;

g) the meteorological conditions were consistent with the flight;

h) it was reported that there had been maintenance performed on the left-hand engine just a few hours before the first takeoff;

i) there was failure of the right-hand engine on the return flight from Ubatuba to SBMT;

j) the cylinder of the right-hand engine disconnected from the block due to fatigue-related rupture of *crankcase through-bolts*;

k) the *crankcase through-bolts* showed signs of machining and “beach marks”;

l) the *JL Motores* maintenance organization did not provide the SIPAER investigation authority with the necessary documents to prove the origin of the c*rankcase through-bolts* installed in the right-hand engine of the aircraft;

m) the aircraft performed the approach for landing in SBMT, touched the runway three times, and started the go-around procedure on the ground;

n) Shortly after leaving the ground, the aircraft collided with trees past the departure end of runway 30, crashing into the asphalt of *Braz Leme* Avenue;

o) the aircraft was destroyed by the impact and fire; and

p) the pilot suffered fatal injuries.

3.2. Contributing factors.

- **Handling of aircraft flight controls – a contributor.**

The fact that the aircraft performed an unstabilized approach, above the recommended speed, leading to an attempt to make a go-around from the ground, showed a failure in the application of flight controls.

- **Piloting judgment – a contributor.**

The pilot opted for a single-engine approach, even with a borderline condition for that, under penalty of not being able to overcome the existing obstacles after the departure end of the runway.

- **Aircraft maintenance – undetermined.**

The aircraft right-hand engine failed in flight approximately 86 hours after its last overhaul. It was proven that the failure occurred due to fatigue-related breakage of the *through-bolts* of the cylinder no. 5. The said *through-bolts* were analyzed, and the existence of machining signs and “beach marks” was verified. The maintenance organization

responsible for the service did not provide the Investigation Committee with the necessary documents to prove the origin of the fatigued items.

Thus, doubts were raised as to the compliance of the maintenance service performed on the relevant engine at the time of the overhaul, something that could become a contributing factor in the chain of events that culminated in the accident.

- **Motivation – undetermined.**

It is possible that, due to the fact that the day of return coincided with his wedding anniversary, the pilot had a decrease in his situational awareness, impairing his perception of the signs of aircraft engine failure, or even his decision-making by not choosing to land in another aerodrome.

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

Both the decision to proceed to SBMT for landing under the circumstances and, after an unstabilized approach, the decision to perform a single-engine go-around procedure on the ground proved to be wrong.

The risks related to an emergency landing would have been substantially lower in an alternate aerodrome with larger runway dimensions.

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-082/CENIPA/2020 - 01 **Issued on 08/15/2023**

Work with the *JL Motores Aeronáuticos Ltda.* Maintenance Organization (Certificate COM no. 0805-41/ANAC), so that the referred OM demonstrates possession and application of all the necessary resources, in accordance with the relevant regulations, for the adequate provision of services and keeping of engine maintenance records during both preventative and corrective maintenance procedures.

A-082/CENIPA/2020 - 02 **Issued on: 08/15/2023**

Work with the *MTX Aviation Manutenção de Aeronaves Ltda.* Maintenance Organization (Certificate COM no.1306-41/ANAC), so that the referred OM demonstrates possession and application of all the necessary resources in accordance with the relevant regulations, for the adequate provision of services and keeping of engine maintenance records during both preventative and corrective maintenance procedures.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On August 15th, de 2023.