COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG-138/CENIPA/2019

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PT-OGH**
MODEL:	**208**
DATE:	**18OUT2019**

NOTICE

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

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

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

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

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

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

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

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

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

SYNOPSIS

This final report relates to the serious incident involving the model 208 aircraft, registration marks PT-OGH, on 18th October 2019. The occurrence was typified as SCF-PP (engine failure or malfunction) and RE (runway excursion).

During the approach for landing at SBJD (*Comandante Rolim Adolfo Amaro* Airport, J*undiaí*, State of *São Paulo*), the aircraft experienced vibration followed by loss of power.

An emergency landing was conducted on runway 36 of SBJD, resulting in runway excursion.

One found that there was a fracture in the internal part of the exhaust duct at the terminal of the Py tubing, followed by loss of engine power.

The aircraft sustained minor damage.

The passenger and both crewmembers did not suffer any injuries.

Being Canada the State of design/manufacture of the engine, the Canadian TSB (Transportation Safety Board) designated an accredited representative for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CA	Certificate of Airworthiness
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CHST	Supplemental Type Certificate
CIV	Pilot Logbook
CMA	Aeronautical Medical Certificate
DCTA	Department of Science and Aerospace Technology
FAA	Federal Aviation Administration
FH	Flight Hours
FCU	Fuel Control Unit
HSI	Hot Section Inspection
IFRA	Instrument Flight Rating - Airplane
METAR	Routine Meteorological Aerodrome Report
MNTE	Single-Engine Land Airplane Rating
MORE	Maintenance On Reliable Engines
OM	Maintenance Organization
PCM	Commercial Pilot License – Airplane
PIC	Pilot in Command
PN	Part Number
POH	Pilot's Operating Handbook
PPR	Private Pilot License - Airplane
P&WC	Pratt & Whitney Canada
RBAC	Brazilian Civil Aviation Regulation
SBAE	ICAO location designator - *Bauru* Aerodrome- *Arealva*, *Bauru*, State of *São Paulo*
SBJD	ICAO location designator - *Comandante Rolim Adolfo Amaro* Aerodrome, *Jundiaí*, State of *São Paulo*
SIC	Second in Command
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
SPECI	Aerodrome Selected Special Weather Report
STC	Supplemental Type Certificate
TBO	Time Between Overhauls
TLV	Lifespan
TPR	Regular Public Air Transport Registration Category
TSB	Transportation Safety Board (Canada)

TSN	Time Since New
TSO	Time Since Overhaul
UTC	Coordinated Universal Time
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** 208 **Registration:** PT-OGH **Manufacturer:** Cessna Aircraft.	**Operator:** Two *Táxi Aéreo Ltda*.
Occurrence	**Date/time**: 18OUT2019 - 20:15 UTC **Location:** SBJD **Lat.** 23°10’54”S **Long.** 046°56’37”W **Municipality – State:** *Jundiaí – São Paulo*	**Type(s):** [SCF-PP] Powerplant failure or malfunction [RE] Runway excursion

1.1. History of the flight.

At about 19:30 UTC, the aircraft departed from SBAE (*Bauru* Aerodrome, *Arealva*, municipality of *Bauru*, State of *São Paulo*) bound for SBJD (*Comandante Rolim Adolfo Amaro* Aerodrome, *Jundiaí*, State of *São Paulo*) on a crewmember operational experience-acquisition flight, with two pilots and a passenger on board.

Approximately 40 minutes into the flight, while on the traffic pattern for landing, the aircraft sustained vibration followed by loss of power.

The pilot feathered the propeller and made an emergency landing on RWY 36 of SBJD.

During the landing run, two tyres of the main landing gear wheels burst. The aircraft overran the longitudinal limits of the runway and came to a stop at a distance of about 10 meters beyond the runway threshold.

The aircraft sustained minor damage.

Figure 1 – View of the aircraft after coming to a complete stop.

Neither of the two crewmembers nor the passenger suffered any injuries.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	2	1	-

1.3. Damage to the aircraft.

The aircraft sustained minor damage restricted to the set of wheels and tyres of the main landing gear and to the engine (Figure 2).

Figure 2 – Left-hand side view of the aircraft. It is possible to observe damage to the wheel-tyre set, and the final position of the aircraft after overrunning the RWY end.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience		
	PIC	SIC
Total	4,827:00	1,135:00
Total in the last 30 days	88:00	05:45
Total in the last 24 hours	09:50	03:45
In this type of aircraft	4,637:00	05:45
In this type in the last 30 days	88:00	05:45
In this type in the last 24 hours	09:50	03:45

N.B.: flight experience data obtained from the pilots' individual logbooks.

1.5.2. Personnel training.

The Pilot in Command (PIC) did his PPR course (Private Pilot – Airplane) in 2003, at the *Aeroclube de Jundiaí*, State of *São Paulo*.

The pilot Second in Command (SIC) did his PPR course in 2011, at *Starflight Escola de Aviação Civil*, *Belo Horizonte*, State of *Minas Gerais*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PCM License (Commercial Pilot – Airplane) and valid ratings for MNTE (Single-Engine Land Airplane) and IFRA (IFR Flight – Airplane).

The SIC held a PCM License and valid MNTE and IFRA ratings.

1.5.4. Qualification and flight experience.

The pilots had qualification and experience for the type of flight.

1.5.5. Validity of medical certificate.

Both pilots had valid CMAs (Aeronautical Medical Certificates).

1.6. Aircraft information.

The SN 2080012 aircraft was a product manufactured by Cessna Aircraft in 1985. The aircraft was registered in the Regular Public Air Transport Registration Category (TPR).

Its Certificate of Airworthiness (CA) was valid.

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

The last inspections of the aircraft (types "200/400 hours") were conducted on 07 October 2019 by the *Two Táxi Aéreo Ltda*. Maintenance Organization in the municipality of *Jundiaí*, State of *São Paulo*. The aircraft flew 32 hours and 30 minutes after the referred inspections.

The PT6A-114/114A engines equipping the Caravan airplanes of the operator were supported by a program known as MORE (Maintenance On Reliable Engines) under the Supplemental Type Certificate SE00002EN issued by the FAA (Federal Aviation Administration) and accepted in Brazil by the ANAC (National Civil Aviation Agency).

The mentioned programme proposed an extension of the TBO (Time Between Overhauls) for the engines of the models PT6A-34, -34AG, -34B, -36, -114, -114A, -116, -135, and -135A, among which was listed the SN PCE-17350 equipping the PT-OGH.

Among the established procedures for this purpose, Annex 6.2 of the *Two Táxi Aéreo Ltda.* Programme included the 450 Flight-Hour Inspection Form. It covered various topics, including item 10: "Perform in Exhaust Duct & ITT system inspection (Ref. 72-50-05 Exhaust Duct - Maintenance Practices, item 6, MM P&WC)" (Figure 3).

ANEXO 6.2
FICHA DE INSPEÇÃO DE 450 HORAS

TWO TÁXI AÉREO LTDA	FICHA DE INSPEÇÃO INSPECTION FORM	DATA DATE __/__/____

PT6A-114/114A			1/1
INSPEÇÃO DE 450 HORAS	MORE Program Rev. 4 de 06/05/2015		

DESCRIÇÃO		
1. Install Vibration pickup bracket on engine.		
2. Perform PT6A initial performance run & initial engine vibration analysis.		
3. Check the engine oil level. (ref 72-00-00 Servicing, item 5.B, MM P&WC).		
4. Inspect the oil filter and collect a filter and engine oil samples (ref 79-20-02 Oil Filter, Housing and Check Valve – Maintenance Practices, item 6 MM P&WC)		
5. Perform a continuity inspection of the oil system chip detector (ref 79-20-02 Oil Filter, Housing and Check Valve – Maintenance Practices, item 8.B, MM P&WC)		
6. Perform a chip detector functional inspection.		
7. Inspect the fuel pump filter (ref. 73-10-02 Fuel Pump – Maint. Practices, item 5, MM P&WC).		
8. Perform Hot Section Boroscope Inspection (ref. 72-00-00 Engine Insp., item 11, MM P&WC).		
9. Perform compressor inspection.		
10. Perform in exhaust duct & ITT system inspection (ref 72-50-05 Exhaust Duct – Maintenance Practices, item 6, MM P&WC).		
11. Perform a compressor performance wash (ref 71-00-00 Power Plant – Cleaning, item 6, MM P&WC).		
12. Perform a compressor desalination wash (ref 71-00-00 Power Plant – Cleaning, item 6.A, MM P&WC).		
13. Perform a turbine desalination wash (ref 71-00-00 Power Plant – Cleaning, MM P&WC).		
14. Perform an engine external wash (ref 71-00-00 Power Plant – Cleaning, item 7, MM P&WC).		
15. Perform an engine general condition inspection (ref 71-00-00 Power Plant – Adjustment/Test, item 3, MM P&WC).		
16. Inspect and clean the P3 filter (if installed) (ref 73-10-07 Pneumatic Line (P3) – Maintenance Practices, MM P&WC).		
17. Verify correct operation of cockpit instruments (ref the appropriate aircraft manual).		
18. Balance the propeller.		
19. Perform an engine vibration analysis.		
20. Compare readings with initial vibration analysis to see any changes. **NOTE: Changes in readings must be the same if ok show an improvement. Any degrade in the reasings must be investigated.**		
21. Perform post inspection performance run (ref 71-00-00 Power Plant – Adjustment/Test, item 13, MM P&WC).		
22. Make appropriate engine record keeping entries.		
23. Update the scheduled inspection status sheet.		
24. Confirm reciept of the oil analysis results.		

Figure 3 - 450 flight-hour Inspection Form of the MORE programme.
Item 10 is highlighted in red.

In turn, the PT6A-34, -34AG, -34B, -36, -114, -114A, -116, -135, -135A, Revision 2, Maintenance on Reliable Engines programme outlined, among other topics, the following inspection routine:

> *12. ITEM: VISUAL INSPECTION OF POWER TURBINE BLADES AND INTERIOR OF EXHAUST DUCT.*
>
> *Frequency: Every 450 flight hours.*
>
> *References:*
>
> *A. PT6A-34 series maintenance manual, section 72-03-09 and 72-53-04.*
>
> *Specifics:*
>
> *Remove exhaust stack (exhaust stub). (See appropriate airframe maintenance manual). Use a bright light and a hand held mirror to perform the inspection.*
>
> *A. Inspect power turbine blades for condition.*
>
> *B. Inspect exhaust duct ski jump for condition.*
>
> *C. Inspect the number 3 bearing cover for condition.*
>
> *The general objective is:*
>
> *A. To examine the power turbine and exhaust duct to see if they are in a condition suitable for continued operation.*
>
> *B. To identify engine problems while in the preliminary stages and to initiate corrective action at this time, in order to avoid more costly repair at a later time.*
>
> *The specific objective is to perform a power turbine and exhaust duct visual inspection without further disassembly in accordance with the inspection requirements of section 72-03-09 of the maintenance manual.*

Therefore, the document prescribed removal of the exhaust for a visual inspection of the interior of the Exhaust Duct for verification of its condition every 450 flight-hour period.

According to the aircraft's maintenance records, the engine on the PT-OGH underwent inspections for the "150/300/450 FH (MORE Inspection)" types on 12 April 2019, when it had a TSN (Time Since New) of 16,006 hours and 50 minutes, and a TSO (Time Since Overhaul) of 6,926 hours and 55 minutes.

The interventions took place when the engine was on the PT-OGP airplane (Fig. 4).

VOAR Aviation COM 7701-01/ ANAC	OFICINA DE MANUTENÇÃO, MODIFICAÇÃO E/OU REPAROS, HOMOLOGADA SEGUNDO O RBAC 145 NAS CATEGORIAS: CÉLULA CLASSE 1, 3 e 4/ MOTOR CLASSE 3/ HÉLICE CLASSE 2/ ACESSÓRIO CLASSE 1, 2 e 3/ SERVIÇOS ESPECIALIZADOS CLASSE ÚNICA (INSP. LÍQ. PENETRANTE E PART. MAGNÉTICAS)	
MOTOR: PT6A-114	TSN: 16.006,8	TSO: 6.926.9
S/N: PCE-17350	CSN: 14.137	CSO: 4.791
AERONAVE: PT-OGP	ANV TSN: 21.800,6	ANV CSN: 18.107
INÍCIO: 12/ABR/2019	TÉRMINO: 12/ABR/2019	

SERVIÇOS REALIZADOS:

1) *150/450FH MORE INSPECTION (REF. MM MORE SE00002EN) (OS. ITEM 01);*
2) *300FH MORE INSPECTION (REF. MM MORE SE00002EN) (OS. ITEM 02);*
3) *MINOR INSPECTION (150FH) (REF. MM 72-00-00) (OS. ITEM 01);*
4) *BORESCOPE INSPECTION (VOAR AVIATION LAUDO Nº CS028/2019-01) (REF. MM 72-00-00) (450FH) (OS. ITEM 01).*

O EQUIPAMENTO OU AERONAVE AO QUAL SE REFERE ESTE REGISTRO ESTÁ AERONAVEGÁVEL NO QUE DIZ RESPEITO AO SERVIÇO EXECUTADO. DETALHES DESTE SERVIÇO ESTÃO ARQUIVADOS SOB A **ORDEM DE SERVIÇO CS074/2019.**

Figure 4 – Records of the last 450 flight-hour inspection as per the aircraft's engine logbook.

After the inspections above, the engine was removed from the PT-OGP and installed on the PT-OGH. On this latter aircraft, the engine accumulated 223 hours and 30 minutes until the time of the occurrence.

Between 01 July and 13 August 2019, the engine underwent a 150-hour inspection of the MORE programme. This intervention only involved a general engine-condition check, without detailing aspects related to internal components.

On 07 October 2019, the airplane underwent ground tests, in which the engine parameters under “low idle”, “full power”, and cruise conditions were checked and logged. No abnormalities were found, and the aircraft was released for flight by the mechanic and by the inspector responsible for the referred checks.

On the date of the incident in question, the engine equipping the PT-OGH had operated 7,150 hours and 25 minutes after the overhaul conducted on 15 December 2007

1.7. Meteorological information.

The weather conditions were consistent with visual flights. The 20:00 UTC Routine Meteorological Aerodrome Report (METAR) contained the following information:

METAR SBJD 182000Z 23004KT 9999 TS SCT040 FEW050CB 32/14 Q1015=

The visibility was above 10 km, the wind was 230° at 4 kt, with the presence of thunder and cumulonimbus clouds.

A Special Selected Aeronautical Meteorological Report (SPECI) published at 20:33 UTC (approximately 20 minutes after the aircraft landed) reported visibility of 5,000 m, existence of thunder, rain, and the presence of cumulonimbus clouds with base at FL050:

SPECI SBJD 182033Z 23011KT 5000 TSRA SCT040 FEW050CB SCT100 26/16 Q1015=

There was also an aerodrome warning for the period between 19:58 UTC and 21:58 UTC forecasting storms, widespread surface winds ranging between 10 kt and 27 kt, and expected to intensify:

SBGR/SBJD/SBBP AD WRNG 1 VALID 181958/182158 TS SFC WSPD 10KT MAX 27 FCST INTSF=

Images recorded by a security camera showed the airplane approaching meteorological formations near the aerodrome (Figure 5).

Figure 5 – The aircraft on the final for landing on RWY 36 of SBJD.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The aerodrome was public, under the administration of *VOA São Paulo*, operating VFR during day- and night-time.

The runway was asphalt-paved, with thresholds 18/36, measuring 1,400 m x 30 m, at an elevation of 2,484 ft.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

There were no impacts prior to the emergency landing.

The aircraft touched down approximately 670 m past the threshold 36. Therefore, approximately 700 m were available for the aircraft to come to a complete stop.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

There was no evidence that issues of physiological nature or incapacitation might have affected the performance of the crew.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

There was no evidence that issues of a psychological nature could have affected the performance of the crew.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

NIL.

1.16. Tests and research.

During the preliminary exams carried out at *Two Táxi Aéreo Ltda.* OM, the engine exhaust was removed to allow for a visual inspection of the engine's internals. Straightaway, a large damaged area was observed, with material missing from the internal part of the Exhaust Duct, in the region where it would receive gases from the power turbine (PT Disk) and would deflect them towards the exhaust (Figures 6, 7 and 8).

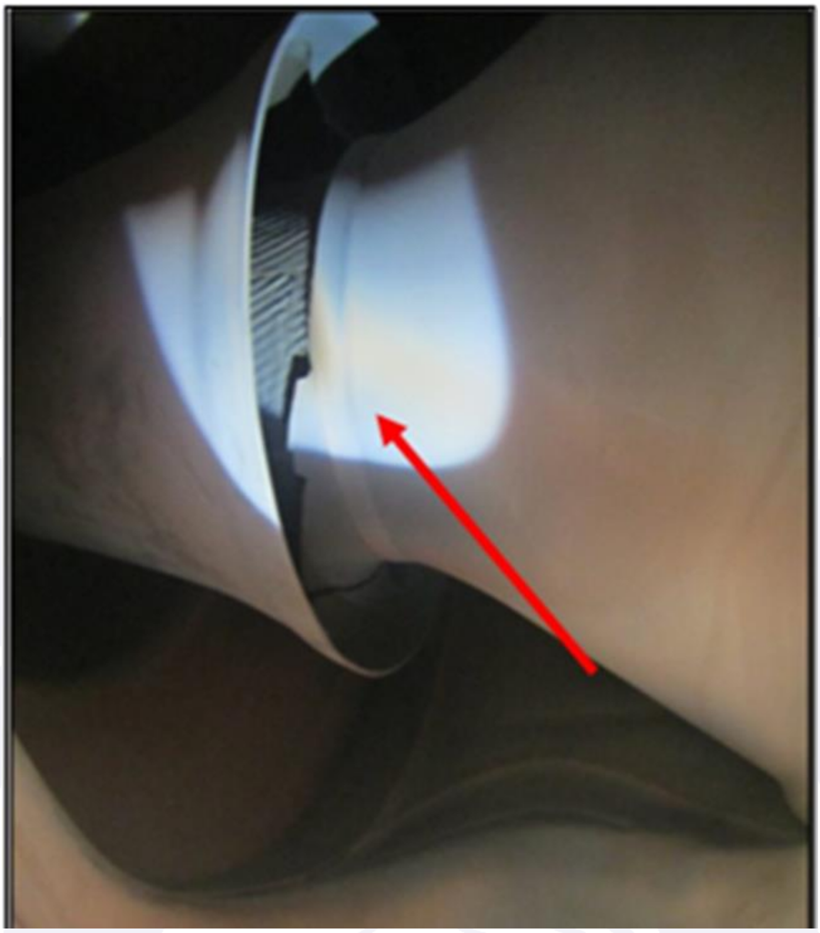

Figure 6 - Image of the Exhaust Duct. The arrow indicates the damaged region.

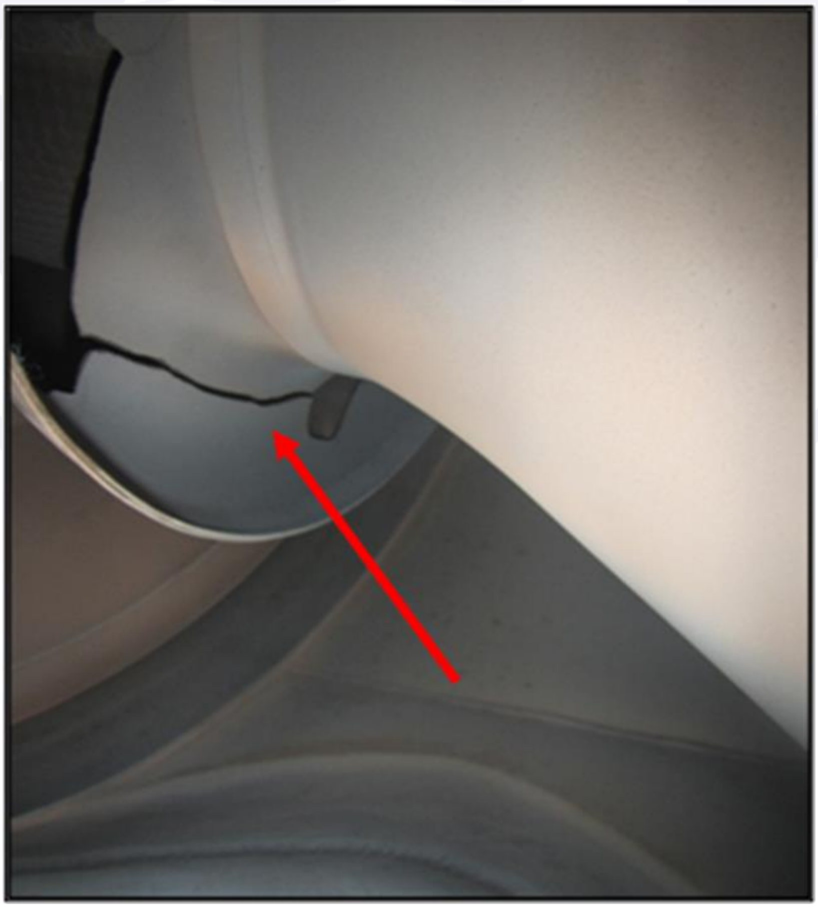

Figure 7 - Approximate image of the interior of the Exhaust Duct.
The arrow indicates the damaged region.

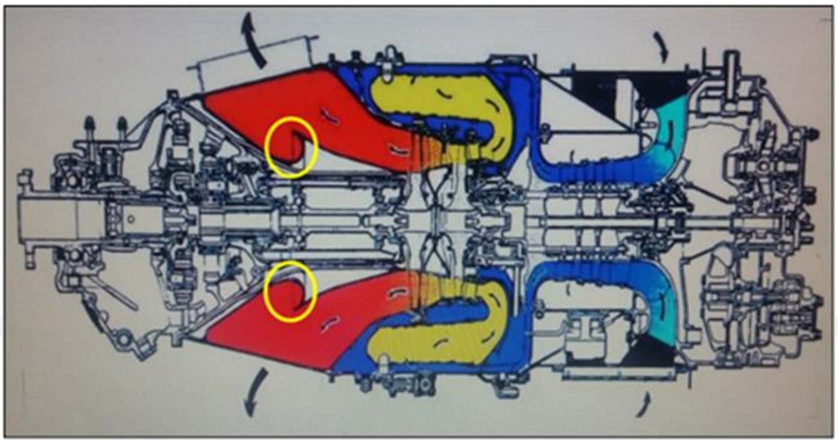

Figure 8 - Schematic diagram of the air flow in the engine.
The highlights (yellow circles) show the fracture region.

Subsequently, the engine was opened at the “C” flange in the presence of P&WC technicians from Canada and from the unit of *Sorocaba*, State of *São Paulo*.

With the access obtained after the opening of the engine, one could observe rubbing (friction) marks on the rear part of the Exhaust Duct (Figure 9).

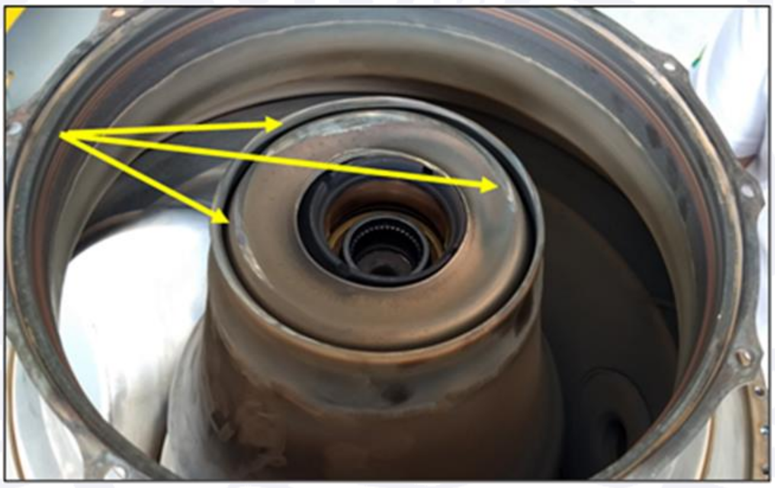

Figure 9 - Rear part of the Exhaust Duct with friction/rubbing marks, highlighted by yellow arrows

There were also friction marks on the PT Disk.

After separation of the Exhaust Duct from the Gearbox, one found that there had been loss of material from its structure (Figure 10).

Figure 10 - Internal damage with loss of material in the Exhaust Duct.

During the visual inspection of the external parts of the engine, one observed damage to the Py piping terminal (Figure 11).

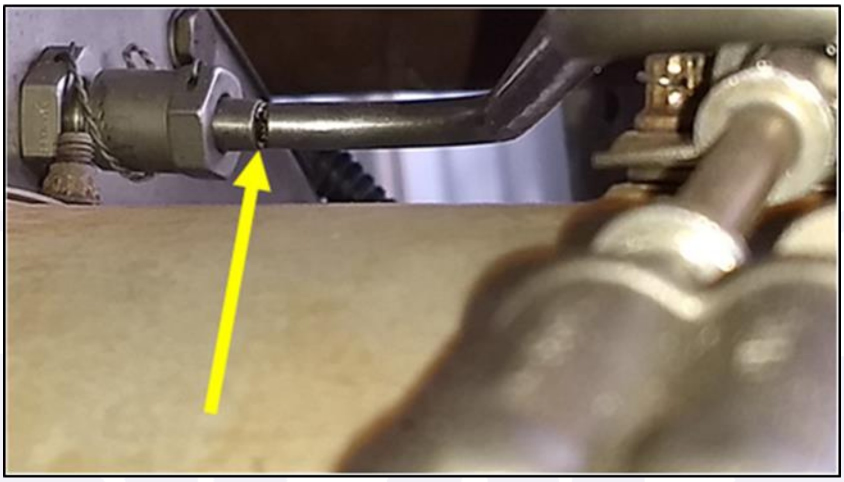

Figure 11 - Image of the Py pipe. The yellow arrow indicates the damaged part.

The said piping was fixed to the structure of the engine, at the point of separation between the *Gas Generator Case* and the *Exhaust Duct*.

The function of the PY pressure, is to modulate the fuel flow in accordance with the requested power. A loss of Py pressure, (i.e., a leak in the Py tube), will results in a fuel flow reduction leading to a loss of engine power. Without Py pressure the only way to modulate the fuel flow would be via the emergency power lever (EPL).

The Exhaust Duct and the Py piping were sent to the DCTA (Department of Science and Aerospace Technology) for analysis of the failure mechanisms of the said components.

Visual and stereoscopy analyses of the Exhaust Duct indicated that erosion had occurred on the fracture surface as a result of the flow of hot air originating from the engine's internal combustion process (Figure 12).

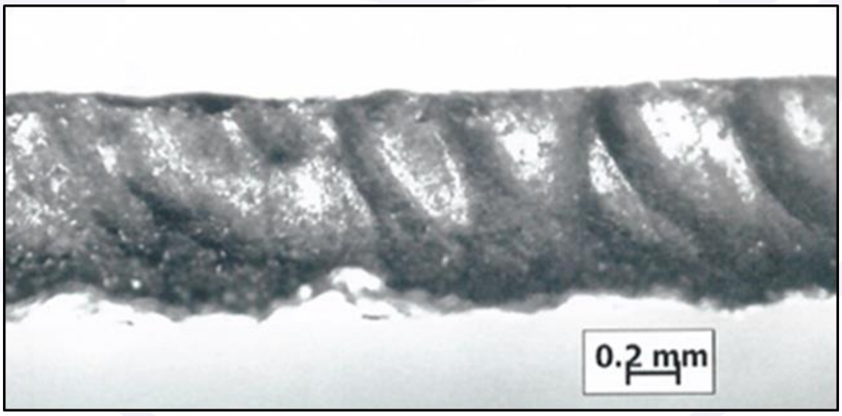

Figure 12 - Wavy Exhaust Duct fracture surface,
indicating erosion by hot gases.

The Metallographic exam of the internal and external surfaces of the fracture region also showed the presence of corrosion pits. (Figure 13).

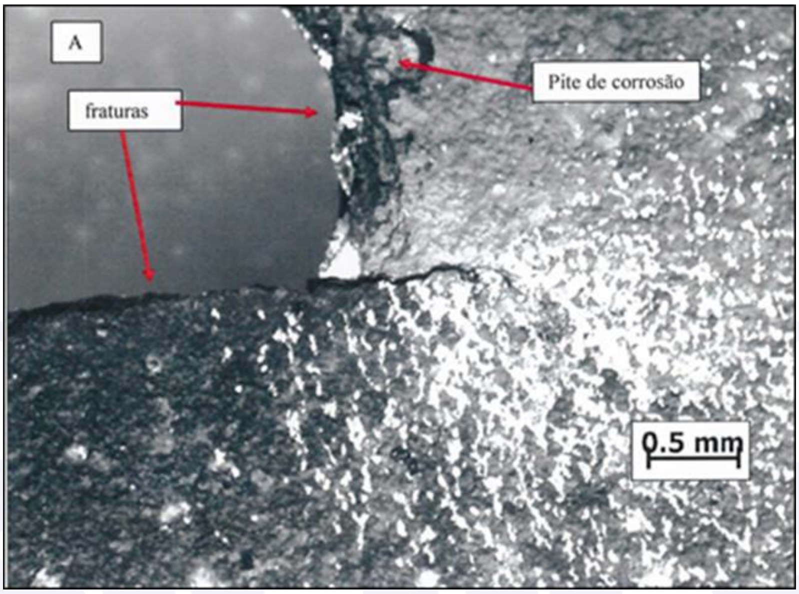

Figure 13 - Photostereoscopy of the fracture region showing the existence of corrosion pits.

The analysis of the Py piping showed widespread corrosion on its internal surface, close to the fracture, in addition to intergranular corrosion and pitting in the fracture region (Figures 14, 15, and 16).

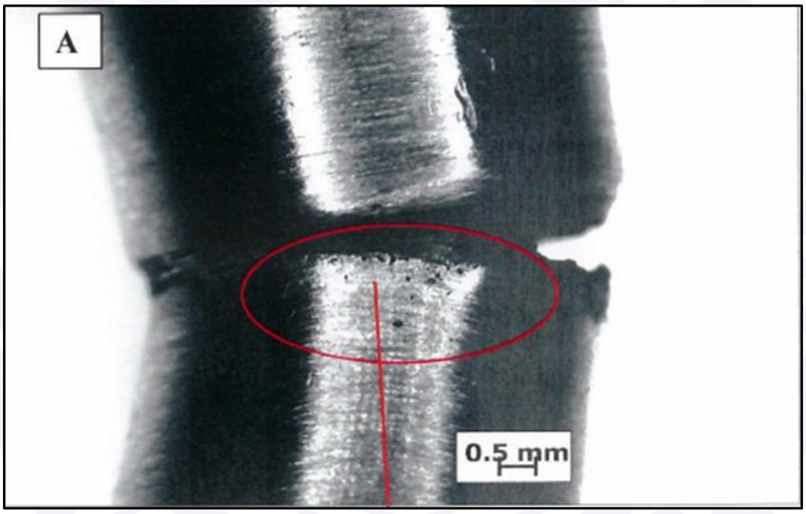

Figure 14 - Image of the Py Tube fracture showing the corrosion pits.

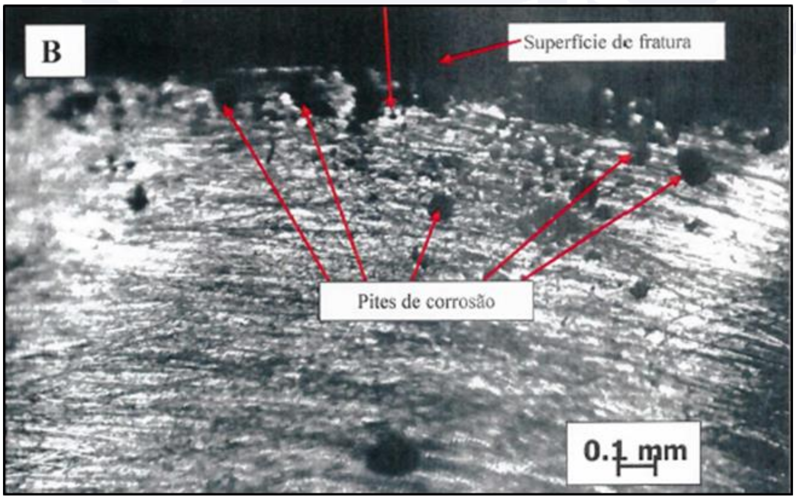

Figure 15 - Close-up image of the Py Tube fracture showing the pits of corrosion.

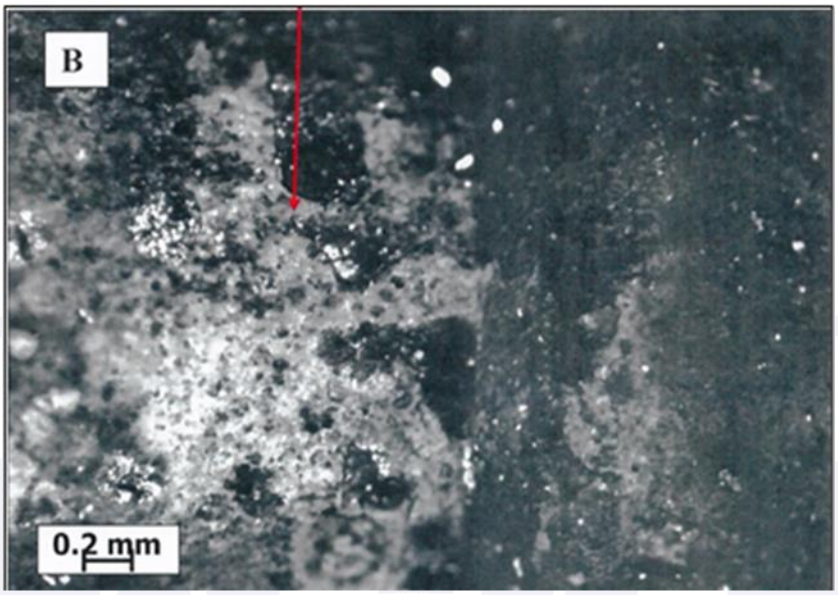

Figure 16 - Image of the internal part of the Py Tube showing widespread corrosion.

With respect to the Exhaust Duct, the laboratory exam concluded that the fracture was facilitated by the presence of hot corrosion. It was not possible to determine the failure mechanism due to erosion of the fracture surface caused by the flow of hot gases from the engine's internal combustion process.

Based on the results of the analyses, one concluded that the Py tube presented a fracture that had started in corrosion pits.

1.17. Organizational and management information.

Two Táxi Aéreo Ltda. operated in the segment of regular public passenger and cargo air transport under the Brazilian Civil Aviation Regulation nº 135 (RBAC-135), Amendment 06 (Operational Requirements: Complementary and On-Demand Operations), and was present in 26 locations in Brazil with a fleet of 18 Cessna 208 and 208B aircraft.

With the objective of maintaining the technical proficiency of its crew members, the company had a flight simulator.

In addition to charter flights, the company had regular cargo transport contracts.

The *TWO* company also had a Maintenance Organization Certificate (COM nº 1908-31/ANAC), and performed different levels of service on PT6A-114 and 114A engines, with the exception of the Hot Section Inspection (HSI).

1.18. Operational information.

It was a flight between SBAE and SBJD for acquisition of operational experience by the crew.

The aircraft was within the weight and balance limits specified by the manufacturer.

According to reports gathered, the airplane on the approach to SBJD joined the traffic circuit to land on runway 36. Moments before the aircraft turned to the base leg, the engine failed. The procedures for feathering the propeller and shutting down the engine were carried out, and the crew proceeded for an emergency landing.

The procedure prescribed in the aircraft manual for a powerless-engine emergency landing established a speed of 100 KIAS on final, with the engine shut down and the propeller feathered, in addition to disconnecting the battery when the landing was assured. The touchdown was to be performed with the tail “slightly low”, followed by a heavy application of the brakes (Figure 17).

EMERGENCY LANDING WITHOUT ENGINE POWER

1. Seats, Seat Belts, Shoulder Harnesses -- SECURE.
2. Airspeed -- 100 KIAS (flaps UP)
3. Power Lever -- IDLE.
4. Propeller Control Lever -- FEATHER.
5. Fuel condition Lever -- CUTOFF.
6. Fuel Boost Switch -- OFF.
7. Ignition Switch -- NORM,
8. Standby Power Switch (if installed) -- OFF.
9. Non-essential Equipment (if installed) -- OFF.
10. Fuel Shutoff -- OFF (pull out).
11. Fuel Tank Selectors -- OFF (warning horn will sound).
12. Crew Doors -- UNLATCH PRIOR TO TOUCHDOWN.
13. Battery Switch -- OFF when landing is assured.
14. Touchdown -- SLIGHTLY TAIL LOW.
15. Brakes -- APPLY HEAVILY.

Figure 17 - Procedure for emergency landing without engine power extracted from the aircraft's POH (Pilot's Operating Handbook).

The aircraft touched down approximately at the midpoint of the runway.

During the braking, the main landing gear tires burst (Figures 18 and 19).

Figure 18 – Croquis of the occurrence.

Figure 19 - Image showing the smoke produced by the locking of the main landing gear wheels.

After traveling for about 700 m, the aircraft stopped 10 m past the end of the runway.

1.19. Additional information.

MORE (Maintenance on Reliable Engines) Program

According to the descriptive manual MORE Company Inc., Rev. 2, dated 16 August 1995, MORE was a supplementary program to the PT6A-34, -34AG, -34B, -36, -114, -114A, -116 Engine Overhaul Manuals , -135 and -135A, Maintenance Manual, Illustrated Parts

Catalog, and Service Bulletins, and should be used as a complementary program to the referred documents.

Through the application of the elements prescribed in the program, the aim was, in the first place, to identify and correct problems in their initial stages, in order to avoid higher maintenance costs, should the engine continue to operate in those conditions. As a result, the manual described that the engine would remain in proper operating condition for longer periods, making it possible to extend the intervals between inspections.

The program was based on the integration of the following elements:

- normal maintenance procedures previously specified by P&WC (Pratt & Whitney Canada) for engines of the PT6A-34 series;
- more frequent inspection intervals than those specified by P&WC;
- spectrometric analysis of the oil;
- monitoring of engine performance trends;
- reduction of engine vibration; and
- periodic borescopic inspection.

The MORE program was implemented at the *Two Táxi Aéreo Ltda* company by means of specific documentation approved by its Maintenance Manager and accepted by the ANAC (Maintenance Program Part Number TWO - 001 - Ver. IV, dated 06 May 2015).

The company's program was developed in accordance with the requirements established in section 135.419 of RBAC-135, based on the changes to the inspection intervals defined in P&WC manuals in accordance with the MORE's Supplemental Type Approval Certificate (CHST), extending the TBO from 3,600 hours to up to 8,000 hours or 50% of the lowest Lifespan (TLV) in cycles of the rotating components of each engine module, whichever occurred first.

Two's program was based on a combination of four basic maintenance tools:

> Vibration analysis: it is a powerful tool to assist in discovering unbalance of rotating components, preventing more extensive damage and even complete engine shutdown in flight. Through vibration analysis, erosion and cracking problems in the blades of compressor or turbine discs can be discovered even before a potential for failure is created, allowing correction in its initial stage, increasing engine reliability and reducing maintenance costs;
>
> Oil analysis: oil analysis allows an assessment of the wear suffered by internal engine components such as bearings, seals, and gears, allowing early corrective measures to be taken;
>
> Continuous monitoring: readings of flight parameters are essential for monitoring trends in engine operation. Through such analysis, the need for HSI-type inspections, FCU reviews, or simply the need to check engine instruments and transmitters can be evidenced;
>
> Borescopic inspection: monitoring through boroscopic inspections of the hot section and the engine compressor allows a satisfactory visualization of the wear of vanes, combustion chamber, and stators.

According to the program, “engines maintained in this fashion have more careful monitoring of wear and performance, allowing greater reliability in operation”.

The document also read that the program was an integral and inseparable part of the maintenance program and should be available to all maintenance personnel responsible for carrying out the services listed therein. With respect to overhaul intervals and extension of the TBO, the manual provided that:

The intervals for overhauls of accessories and replacement of rotating components remain as provided in P&W SB 1703 Rev. 11 and SB 1002 Rev. 29 for the PT6A-114/114A engine or in its approved subsequent revisions.

The extension of the TBO up to 8,000 hours or 50% of the lowest TLV in cycles of the rotating components for each module based on this manual is not a guarantee of the normal operation of the engines over the period, and HSI-type interventions or even an overhaul may be necessary in function of operating parameters, oil analysis, or vibration analysis collected during the interventions defined herein.

Two's program was authorized by MORE Inc. by means of the CHST 9609-06, which specified the registration marks of the aircraft and the serial numbers of the engines submitted to it.

The maintenance requirements established in the P&WC Maintenance Manual referring to the inspection and maintenance procedures for the Exhaust Duct of the PT6A-114 engine during periodic inspections is limited to visual inspections. For hot section, or unscheduled inspections such as engine sudden-stoppage, additional inspection may be applicable as per appropriate workscope.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

It was a flight in the segment SBAE - SBJD for acquisition of operational experience by the crew.

Although the prevailing weather conditions were consistent with visual flights, the METAR and Aerodrome Warning information in force at the time of landing, showed winds of 230° with intensity between 4 kt and 10 kt, gusting to 27 kt, as well as the image of heavy weather formations to the rear of the airplane during the approach, suggesting the possibility of a tailwind component during landing.

Therefore, it is possible that these conditions resulted in a landing that ended up being longer than expected by the pilot, contributing to the need for aggressive braking that resulted in the blowout of the airplane tires'.

Nonetheless, the fact that, during the emergency landing, the aircraft touched down approximately at the midpoint of the runway indicated that inadequacy in the use of flight controls resulted in a long landing, which, for leaving a distance of just around 700 m available for the aircraft to stop, contributed to the runway excursion.

In this scenario, the heavy application of pressure on the brake pedals, motivated by the proximity of the end of the runway, resulted in the main-landing-gear tires' burst, a circumstance that impaired the controllability of the plane on the ground, and also played a role in the occurrence in question.

Thus, the inadequate assessment of the parameters concerning the operation under those circumstances led to an approach point beyond the 1,000-foot mark, which resulted in the need for aggressive braking, which culminated in the bursting of tires and runway excursion.

Considering that the exams of the aircraft's engine showed that a large area of the Exhaust Duct had been damaged, and that material was missing from the internal part of the component, it is possible that the vibration moments before the loss of power was due to the disturbance of the exhaust-air flow from the aircraft resulting from the changes in the geometry of the very Exhaust Duct.

With respect to the failure identified in the Py piping, given that the said component was fixed to the engine structure at the point of separation between the Gas Generator Case and the Exhaust Duct, it is possible that the vibration resulting from the loss of material from the exhaust system structure caused the rupture of the pipe. Such failure was facilitated by the weakening of the material due to the presence of intergranular corrosion and pitting in the fracture region, and was responsible for the loss of engine power.

Relatively to the Exhaust Duct, although the analyses in the laboratory led to the conclusion that it was not possible to determine the failure mechanism due to the erosion of the fracture surface caused by the flow of hot gases originating from the engine's internal combustion process, the presence of the corrosion surface in the region of the fractures suggested the possibility that the degradation of the material of this component was already under way on the date of the 450 flight-hour inspection (12 April 2019), and that the referred process culminated in the fracture of the equipment.

Therefore, it is possible that the technicians responsible for carrying out the last 450 flight-hour inspection were unable to identify a latent condition that contributed to the in-flight engine failure.

On the other hand, the maintenance requirements in force at the time of the occurrence, referring to the procedures related to the Exhaust Duct, solely instructed the execution of visual and dimensional inspections. These procedures do not allow the identification of internally nucleated material degradation processes, such as intergranular corrosion or fatigue.

The failure mechanisms associated with these processes only become apparent when they emerge to the surface and can be observed through visual inspections and, at this stage, the propagation speed of the discontinuity is significantly higher. At this point, the structural function is already compromised and on the verge of failure.

In such context, the deterioration of the Exhaust Duct would only be noticed when it was close to a collapse. It is also possible that the outbreak of a crack on the surface, up to the separation from the structure, would occur within an interval of less than 450 hours of operation.

In such scenario, inadequate supervision by the OM management relatively to execution activities of a technical scope may have contributed to the lack of detection of the Exhaust Duct degradation in time to interrupt the chain of events that led to this incident. However, the available research elements did not allow one to corroborate this hypothesis.

With regard to the failure of the Py tube, in view of the laboratory analysis' conclusion that the fracture began in corrosion pits, one concluded that such process weakened the material and facilitated its rupture due to the abnormal vibration that occurred after the failure of the Exhaust Duct.

Still, considering the widespread corrosion observed, it is possible that the degradation of the material was already under way on the date of the last engine inspections (07 October 2019), eleven days before the incident in question.

Therefore, it is possible that the technicians responsible for performing such interventions were not able to identify an ongoing corrosion process in a component that was important for the engine's operation, something which would characterize aircraft maintenance as a factor contributing to this incident.

In the case in question, inadequate supervision by the OM management regarding execution of technical activities may also have contributed to the fact that the condition was not identified and corrected early enough to prevent the occurrence of the incident.

On the other hand, if one assumes that all recommended procedures have been performed in accordance with P&WC maintenance manuals, the longevity of the engine in service (which had accumulated 7,150.4 hours since its latest overhaul, practically doubling the original TBO of 3,600 hours) may have produced normal wear and tear not identified by the monitoring activities listed in the MORE program. This would characterize this support system as a factor contributing to the occurrence in question.

However, the unavailability of data relative to similar failures in other engines submitted to the program, which might indicate possible trends in this direction, made it impossible to further study the hypothesis mentioned above.

3. CONCLUSIONS.

3.1. Findings.

a) the pilots held valid CMAs (Aeronautical Medical Certificates);

b) the pilots held valid MNTE (Single-Engine Land Airplane) and IFRA (IFR Flight - Airplane) ratings;

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

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

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

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

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

h) images recorded by a security camera showed the plane approaching meteorological formations close to the aerodrome;

i) on the traffic pattern for landing, the aircraft experienced vibration followed by loss of power;

j) during the emergency landing, two tires on the main-landing-gear wheels burst;

k) the airplane overran the departure end of the runway and stopped approximately 10 m beyond the runway threshold;

l) during exams of the Exhaust Duct, a large damaged area was observed, with material missing from its internal part;

m) metallographic exams of the internal and external surfaces of the fracture region in the Exhaust Duct showed that they had corrosion pits;

n) the analysis of the Py tubing showed that there was widespread corrosion on its internal surface close to the fracture, besides intergranular corrosion and pitting in the fracture region;

o) the aircraft sustained minor damage; and

p) none of the aircraft occupants (two crewmembers and one passenger) was hurt.

3.2. Contributing factors.

Adverse meteorological conditions – undetermined.

It is possible that a tailwind component caused by heavy weather formations behind the plane during approach led to a longer-than-expected landing, contributing to the need for aggressive braking, resulting in the airplane's tires’ blowout and runway excursion.

Handling of aircraft flight controls – a contributor.

The fact that the touchdown during the emergency landing took place approximately at the midpoint of the runway indicated that inadequacy in the use of flight controls resulted in a long landing, leaving just approximately 700 m of the runway available for the aircraft to come to a complete stop, and contributed to the runway excursion.

In this scenario, the energetic application of pressure on the brake pedals, motivated by the proximity of the end of the runway, resulted in the burst of the main landing gear tires, a circumstance that impaired the controllability of the plane on the ground and also played a role in the occurrence in question.

Piloting judgment – a contributor.

Inadequate assessment of all the parameters related to the operation in the circumstances present during the emergency landing led the approach to a point beyond the 1,000-foot mark. This resulted in the need for aggressive braking, culminating in tire bursts and runway excursion.

Aircraft maintenance – undetermined.

Considering the widespread corrosion observed during the exams carried out on the Py tube, it is possible that the degradation of the material was already under way on the date of the last engine inspections (07 October 2019, eleven days before the incident in question).

Therefore, it is possible that the technicians responsible for such interventions were not able to identify an ongoing corrosion process in a component that was important for the engine's operation, something which would characterize aircraft maintenance as a contributing factor to this incident.

Support systems – undetermined.

Assuming that all recommended procedures have been carried out in accordance with P&WC maintenance manuals, the longevity of the engine in service, which accumulated 7,150.4 hours, practically twofold its original TBO of 3,600 hours, may have produced natural wear and tear not identified by the monitoring activities included in the MORE program, which would characterize this support system as a contributing factor to the occurrence in question.

Managerial oversight – undetermined.

It is possible that inadequate supervision on the part of the OM management concerning execution activities of a technical scope has contributed to the failure to identify and correct corrosion processes existing in the Exhaust Duct and Py tube in time to prevent the occurrence of the incident in question.

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):

IG-138/CENIPA/2019 - 01 **Issued on 03/27/2024**

Assess the level of adequacy of the Maintenance On Reliable Engines (MORE) Program applied to the PT6A-114/114A engines installed on aircraft owned by *Two Táxi Aéreo Ltda*, with regard to the maintenance tasks defined in the P&WC manuals and their capability to ensure adequate levels of safety by extending the overhaul intervals of these engines and respective components to values higher than those recommended by the manufacturer.

IG-138/CENIPA/2019 - 02 **Issued on 03/27/2024**

Work with *Two Táxi Aéreo Ltda.* Maintenance Organization so that the referred OM demonstrates that the company’s management supervision mechanisms guarantee the quality of the services performed, particularly with regard to inspections of the PT6A-114/114A engines, respective accessories, and related systems.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On March 27th, 2024.