COMMAND OF AERONAUTICS AERONAUTICAL ACCIDENT INVESTIGATION AND PREVENTION CENTER



FINAL REPORT IG - 007/CENIPA/2014

OCURRENCE: AIRCRAFT: MODEL: DATE:

OCURRENCE: SERIOUS INCIDENT

PR-GAB

TBM700N

07 OCTOBER 2011



NOTICE

According to the Law n° 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

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

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

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

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree n° 21713, dated 27 August 1946.

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

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

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

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SYNOPSIS

This is the Final Report of the 7 October 2011 serious incident with the TBM700N aircraft, registration PR-GAB. The serious incident was classified as inflight engine failure.

While the aircraft was flying en route, there was a loud noise coming from the aircraft engine, together with loss of power and an increase in temperature.

The crew made an emergency descent and landed safely in SBLO.

The four passengers and the two crewmembers got out unhurt.

The aircraft sustained substantial damage to the engine.

There was designation of an accredited representative of Transportation Safety Board of Canada and of the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile of France.

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ACC-CW	Curitiba Area Control Center
ANAC	Brazil's National Civil Aviation Agency
APP-LO	Londrina Approach Control
ATS	Air Traffic Services
CA	Airworthiness Certificate
CG	Center of Gravity
CMA	Aeronautical Medical Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CHT	Technical Qualification Certificate
DCTA	Department of Science and Airspace Technology
FL	Flight Level
IAE	Institute of Aeronautics and Space
IFR	Instruments Flight Rules
INFRAERO	Brazilian Airports Infrastructure Enterprise
ITT	Interstage Turbine Temperature
Lat	Latitude
Long	Longitude
MNTE	Airplane Single Engine Land (ASEL)
PCM	Commercial Pilot – Airplane category
PLA	Airline Transport Pilot – Airplane category
PLEM	Aerodrome Emergency Plan
PPR	Private Pilot – Airplane category
QRH	Quick Reference Handbook
SBCY	ICAO location designator – Cuiabá Aerodrome
SBFL	ICAO location designator – Florianópolis Aerodrome
SBLO	ICAO location designator – Londrina Aerodrome
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
RFFS	Rescue and Fire Fighting Service
SIPAER	Aeronautical Accident Investigation and Prevention System
TWR-LO	Londrina Control Tower
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VOR	VHF Omni Directional Radio Range

AIRCRAFT	Model: TBM700N Registration: PR-GAB Manufacturer: SOCATA	Operator: Private
OCCURRENCE	Date/time: 07OUT2011/ 14:30 UTC Location: SBLO (Londrina Aerodrome) Lat. 29°36'45"S – Long. 055°22'16"W Municipality – State: Londrina-PR	Type: Inflight Engine Failure

1 FACTUAL INFORMATION

1.1 History of the occurrence

The aircraft departed from SBCY at 13:00 UTC, destined for SBFL, with two pilots and four passengers on board.

The aircraft was cruising at FL270 and crossing Londrina VOR, when a loud noise came from the engine, followed by a total loss of power and an increase in temperature (ITT) to, approximately, 850 degrees centigrade.

The crew made an emergency descent and a safe landing in SBLO.

1.2 Injuries to persons

Injuries	Crew	Passengers	Third parties
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
Unhurt	02	04	-

1.3 Damage to the aircraft

The engine sustained substantial damage to the first stage axial compressor blades.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Information on the crew

HOURS FLOWN		
	PILOT	COPILOT
Total	15,000:00	850:00
Total in the last 30 days	26:20	26:20
Total in the last 24 hours	05:40	05:40
In this type of aircraft	1,100:00	375:00
In this type in the last 30 days	26:20	26:20
In this type in the last 24 hours	05:40	05:40

NB.: Flight hour data provided by the pilots.

1.5.1.1 Professional formation

The pilot did his Private Pilot Course (Airplane category) at the Flying School of São Leopoldo (State of Rio Grande do Sul) in 1984.

The copilot did his Private Pilot Course (Airplane category) at the Flying School of Londrina (State of Paraná) in 2008.

1.5.1.2 Validity and category of licenses and certificates

The pilot had an Airline Transport Pilot License (Airplane Category). His ASEL (airplane, single-engine, land) technical qualification and IFR rating were valid.

The copilot had a Commercial Pilot License (Airplane category). His ASEL technical qualification and IFR rating were valid.

1.5.1.3 Qualification and flight experience

The pilots were qualified and had enough experience for the type of flight.

1.5.1.4 Validity of medical certificate

The pilots had valid Aeronautical Medical Certificates.

1.6 Aircraft information

The aircraft (S/N 418) was manufactured by SOCATA in 2007.

The Airworthiness Certificate was valid.

The airframe, engine and propeller logbooks were up-to-date.

The last aircraft inspection (type "100 hours") was carried out on 2 May 2011 by the *Oficina Algar* workshop, in Uberlandia, State of Minas Gerais. The aircraft flew 97 hours and 10 minutes after the inspection.

The last overhaul, type "600 hours", was made on 6 March 2010, by the *Oficina Algar* workshop, in Uberlandia, State of Minas Gerais. The aircraft flew 487 hours and 25 minutes after being overhauled.

1.7 Meteorological information

The meteorological conditions were favorable for the type of flight proposed.

The meteorological information concerning the departure, destination, and alternate aerodromes had no indication of icing.

1.8 Aids to Navigation

Nil.

1.9 Communications

Nil.

1.10 Aerodrome information

SBLO is a public aerodrome under the administration of INFRAERO, with day- and nighttime VFR/IFR operation.

The runway is paved with asphalt, thresholds 13/31, measuring 2,100m x 45m, at an elevation of 1,867ft.

1.11 Flight recorders

Neither required nor installed.

1.12 Wreckage and impact information

Nil.

1.13 Medical and pathological information

1.13.1 Medical aspects

Not investigated.

1.13.2 Ergonomic information

Nil.

1.13.3 Psychological aspects

Not investigated.

1.13.3.1 Individual information

Nil.

1.13.3.2 Psychosocial information

Nil.

1.13.3.3 Organizational information

Nil.

1.14 Fire

There was no fire.

1.15 Survival aspects

Nil.

1.16 Tests and research

On 8 October 2011, the engine parameters were downloaded. According to the SHADIN equipment that was used for monitoring the engine, no abnormality was found as for the maximum parameters.

During the Initial Action in the parking area of SBLO, the investigation team verified that there was damage to the first stage axial compressor blades.

Since the damage could not be repaired by Pratt & Whitney – Brasil, in Sorocaba, State of São Paulo, the engine was sent to Canada.

According to the Investigation Report RI APA 02/2012 of 16 February 2012 written by the Institute of Aeronautics and Space (IAE) of the Department of Science and Airspace Technology (DCTA), the following tests were performed in the engine of the aircraft by Pratt & Whitney – Canada:

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a) During the external inspection, no sign of damage was observed in the engine. Then, the engine was separated in the flange "C" for access to the Hot Section. In this section, the compressor turbine and the power turbine were inspected. Deposited fragments were found on the leading edge of the power turbine rotor blades, which had an overheated condition. The figure below shows in detail the erosion caused by the passage of the fragments through the compressor turbine rotating blades.



Figure 1 – Blades of the compressor turbine rotor.

b) The next step was to identify the source of the fragments found in the whole Hot Section of the engine. In the air inlet of the compressor, several marks of impact were identified on the screen in a direction from the inside out. Marks of impact were also found on the framework of the gearbox near the compressor air inlet.



Figures 2 and 3 – Marks of impact on the compressor air inlet.

c) It was observed that one of the first stage compressor rotor blades was bent forward, and that the other blades had dents caused either by impact or rubbing. When this rotor was removed, one of the first stage stator blades was found broken. The other stator blades of this stage had serious damage, such as cracks, cuts, dents and deformation caused by the passing of the fragments through them.

Similar damage was also found in the subsequent compression stages. The intensity of the damage was lower in these stages, since the fragments became smaller as they traveled inside the compressor (due to a process of grinding).

d) The first stage compressor stator blade was sent to the manufacturer's material laboratory for identification of the origin of the failure. The conclusion was that the breaking

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of the stator blade had occurred on account of fatigue. In other stator blades that had cracks and deformation at this same stage of compression, fatigue was also identified as the cause.

e) The fatigue process may have been triggered by a dynamic stimulation caused by the bending of the first stage compressor rotor blade. This happened on account of the fluctuation of pressure and air flow, when this blade passed by the stator blades. The chemical analysis showed that the material was compatible with the design requirements. The other fractures were caused by overload and impact with fragments.

f) After a meeting involving Pratt & Whitney investigators, DCTA representatives and SERIPA V investigators, a consensus was reached that the bending of the rotor blade was compatible with ice impact. Such ice may have built in the engine inlet case. When it was released, it collided with the blade, causing the deformation observed in the pictures below.



Figures 4 and 5 – Close view of the deformation and impact on the other blades.

1.17 Organizational and management information

The aircraft was normally used for transporting the owner in business trips and, occasionally, members of his family in leisure trips. Its base was in the city of Florianopolis, and it would be stored in a hangar of the *Golden Air Taxi Aéreo* company.

The operational issues were under the responsibility of the two pilots, and the maintenance services were performed by the *Algar* Aviation company/workshop in Uberlandia, State of Minas Gerais.

1.18 Operational information

The aircraft was on a passenger transport flight between SBCY and SBFL.

When it was crossing LON VOR at FL270, a loud noise came from its engine, together with a bump.

At the same time, the crew noticed that the engine was losing power and that the ITT temperature had risen to about 850 degrees centigrade.

In face of the situation, the crew declared emergency to the Curitiba Area Control Center (ACC-CW), setting the transponder to 7700, and requested descent for landing in SBLO.

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The crew reduced the power lever to the IDLE position, and commenced descent. The coordination for the landing in SBLO was made by Londrina Approach Control and Londrina Control Tower.

The aircraft landed VMC on the runway 13 of SBLO after activation of the Aerodrome Emergency Plan (PLEM).

The aerodrome emergency assistance team (SESCINC) and the Mobile Coordination Post (PCM) were ready beside the runway threshold when the aircraft landed.

The aircraft taxied up to the remote position number 6, with the engine in IDLE. The crew informed that the ITT indication light on the Advisory Panel remained illuminated until the complete stop of the aircraft.

The aircraft was within the limits of weight and center of gravity specified by the manufacturer.

1.19 Additional information

In the aircraft *Quick Reference Handbook* (QRH) - *Emergency Procedures*, the following procedure was prescribed for the case of ITT indication light illumination:

RED WARNING LIGHT ITT ON

DURING FLIGHT

1. ITT INDICATOR ... CHECK

2. REDUCE POWER AND CORRECT DISPLAY ACCORDING TO "ENGINE OPERATION" TABLES - REFER TO POH, CHAPTER 5

IF ITT REMAINS > 840°C

3. REDUCE POWER TO MAINTAIN ITT < 840°C

4. SHORTEN THE FLIGHT

5. RECORD THE AIRPLANE AND ENGINE PARAMETERS READ IN CASE OF OVERTEMPERATURE

6. INFORM MAINTENANCE DEPARTMENT AT THE END OF THE FLIGHT

1.20 Utilization of other investigation techniques

Nil.

2 ANALYSIS

In view of the engine loss of power and the increase in the ITT temperature, the crew performed the procedures prescribed in the checklist: they reduce the engine power in order to keep ITT below 840 degrees centigrade, and landed the aircraft in the nearest airfield.

The available weather information concerning the departure, destination and alternate aerodromes showed no possibility of icing.

According to the equipment utilized for monitoring the engine, no abnormality was found relatively to the maximum parameters.

In the initial action that was taken by the investigators while the aircraft was still in the parking area of SBLO, it was possible to verify, by means of a visual inspection of the compressor, that the first stage axial compressor rotating blades had been damaged.

After analysis of the engine by Pratt & Whitney – Canada, the following results were obtained:

1) The loss of engine power during the flight was caused by a failure of the compressor, which had a broken stator blade on account of fatigue.

2) The fatigue may have been triggered by a dynamic stimulation caused by the bending found in the first stage compressor rotating blade, due to the fluctuation of pressure and air flow when the blade passed by the stator blades.

3) The bending on the first stage compressor rotating blade was compatible with ice impact. The ice had probably built in the engine inlet case and was later released.

4) The deformation of the referred blade may have taken place in flights before the day of the occurrence, and normal operation of the engine may have led the compressor to its collapse.

It was not possible to determine in which flight the deformation of the first stage compressor rotating blade occurred.

It is possible that, in previous flights, the crew may have encountered conditions of icing, without performing the pertinent procedures. This may have generated the impact which resulted in the bending of the first stage compressor rotating blade.

3 CONCLUSIONS

3.1 Facts

a) The pilots had valid Aeronautical Medical Certificates;

b) The pilots had valid technical qualification certificates;

c) The pilots were qualified, and had enough experience for the type of flight;

d) The aircraft had a valid airworthiness certificate;

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

f) The weather conditions were favorable for the type of flight;

g) It was a passenger transport flight between SBCY and SBFL;

h) With the aircraft en route, crossing the vertical of LON VOR at FL270, there was a loud noise coming from the engine, followed by a bump and an increase of the ITT;

i) The crew reduced the power lever to the IDLE position, and commenced descent for landing in SBLO;

j) The land was made in VMC conditions on runway 13 of SBLO;

k) The crew informed that the ITT indication light on the Advisory Panel remained illuminated until the complete stop of the aircraft;

I) There was substantial damage to the aircraft engine; and

m) The pilots and passengers got out unhurt.

3.2 Contributing factors

3.2.1 Human factor

3.2.1.1 Medical Aspect

Nil.

3.2.1.2 Psychological Aspect

Nil.

3.2.1.2.1 Individual information

Nil.

3.2.1.2.2 Psychosocial information

Nil.

3.2.1.2.3 Organizational information

Nil.

3.2.2 Operational Factor

3.2.2.1 Concerning the operation of the aircraft

a) Adverse meteorological conditions – undetermined

It is possible that in previous flights the crew may have encountered icing conditions, but failed to perform the pertinent procedures, something that caused the impact and, consequently, resulted in the bending of one of the rotor blades of the compressor first stage.

3.2.2.2 Concerning ATS units

Not a contributor.

3.2.3 Material Factor

3.2.2.1 Concerning the aircraft

Not a contributor.

3.2.2.2 Concerning ATS technology systems and equipment

Not a contributor.

4 SAFETY RECOMMENDATION

A safety recommendation is the establishment of an action which the Aeronautical Authority or SIPAER-Link issues to their respective area of responsibility, aiming at eliminating or mitigating the risk of a latent condition or the consequence of an active failure.

From a SIPAER perspective, a safety recommendation is essential for the safety of flight, refers to a specific hazard, and has to be complied with by a certain deadline.

Safety Recommendations made by the CENIPA:

To the National Civil Aviation Agency (ANAC):

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Issued on 02/Jun/2014

Publicize the contents of this report at seminars, lectures and similar activities aimed at aircraft owners, operators and explorers.

5 CORRECTIVE/PREVENTATIVE ACTION ALREADY TAKEN

Nil.

6 DISSEMINATION

- -National Civil Aviation Agency (ANAC)
- -SERIPAV
- -Transportation Safety Board of Canada
- -Bureau d'Enquêtes et d'Analyses (BEA France)

7 APPENDICES

Nil.

On 02 June 2014.