COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-606/CENIPA/2014

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-ART**
MODEL:	**B200**
DATE:	**14JAN2011**

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 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 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. 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.

SYNOPSIS

This is the final report of the 14 January 2011 accident with the B200 aircraft, registration PR-ART, in the municipality of *Senador Canedo*, State of *Goiás*. The accident was classified as “Controlled Flight into Terrain”

After the crew informed Anápolis Control that they had stabilized on the final approach of the VOR procedure, the aircraft collided with Mount *Santo Antonio* at a distance of 5.77 nautical miles from the threshold of runway 32 in SBGO.

The aircraft occupants (five passengers and the pilot) perished in the crash.

The aircraft was completely destroyed.

An accredited representative of the US National Transportation Safety Board (NTSB) – USA, state of design, was designated for participation in the investigation.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AIS	Aeronautical Information Service
ANAC	Brazil's National Civil Aviation Agency
APP-AN	*Anápolis* Control
ATS	Air Traffic Service
CA	Aircraft Airworthiness Certificate
CB	Cumulonimbus
CENIPA	Aeronautical Accident Investigation and Prevention Center
CFIT	Controlled Flight Into Terrain
CG	Center of Gravity
CHE	Enterprise Homologation Certificate
CIAA	Aeronautical Accident Investigation Commission
CIRTRAF	Air Traffic Circular
CMA	Aeronautical Medical Certificate
DLA	Delay message
DME	Distance Measuring Equipment
FL	Flight Level
GEIV	Special In-Flight Inspection Group
GPS	Global Positioning System
IAM	Annual Maintenance Inspection
ICA	Command of Aeronautics' Instruction
IFR	Instrument Flight Rules
IFRA	IFR-rating (airplane category)
mb	Millibar
MDA	Minimum Descent Altitude
METAR	Routine Aerodrome Weather Report
MLTE	AMEL – Airplane, Multi-Engine, Land
MNTE	ASEL – Airplane, Single-Engine, Land
NM	Nautical Miles
PAX	Passenger
PCM	Commercial Pilot License – airplane category
PLA	Airline Transport Pilot License – airplane category
PPR	Private Pilot License – airplane category
SBBR	ICAO location designator – *Brasilia* Airport
SBGO	ICAO location designator – *Goiânia* Airport
SBPJ	ICAO location designator – *Palmas* Airport
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
TCU	Towering cumulus cloud

TPP	Private Air Services
TWR-GO	*Goiânia* Airport Control Tower
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VOR	Very High Frequency Omnidirectional Range

1. FACTUAL INFORMATION.

Aircraft	**Model:** B200 **Registration:** PR-ART **Manufacturer:** BEECH AIRCRAFT	**Operator:** *CMN Construtora Meio Norte LTDA*.
Occurrence	**Date/time:** 14JAN2011 / 20:10 UTC **Location:** Mount *Santo Antônio* **Lat.** 16º41'04"S **Long.** 049º07'19"W **Municipality – State:** *Senador Canedo* – State of *Goiás*	**Type(s):** Controlled flight into terrain

1.1 History of the flight.

The aircraft took off from SBBR at 19:29 UTC on a transport flight destined for SBGO, with the pilot and five passengers on board.

On the final approach, after the crew informed Anápolis Control that they had stabilized on the final of the VOR procedure, the aircraft collided with Mount *Santo Antônio* at a distance of 5.77 NM from threshold of runway 32 in SBGO.

All aircraft occupants perished in the crash.

The aircraft was completely destroyed.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	5	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was completely destroyed by the impact and post-impact fire.

1.4 Other damage.

The impact of the aircraft damaged a wood area of approximately 1,500 square meters, which was under the jurisdiction of the *Senador Canedo* Municipal Government.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown	
	Pilot
Total	2,500:00
Total in the last 30 days	Unknown
Total in the last 24 hours	Unknown
In this type of aircraft	550:00
In this type in the last 30 days	Unknown
In this type in the last 24 hours	Unknown

N.B.: Data provided by the former employer of the pilot (*Heringer Táxi Aéreo* company – Imperatriz, State of Maranhão), updated as of 6 August 2010.

It was not possible to learn about the pilot's recent experience, since the aircraft logbook was destroyed by the post-impact fire, and the pilot's flight logbook was not located by either his relatives or workmates.

1.5.2 Professional formation.

The pilot did his Private Pilot course (airplane category) at the *Aeroclube de Araraquara*, State of *São Paulo*, in 2002.

1.5.3 Category of licenses and validity of certificates.

The pilot held an Airline Transport Pilot license (ATP), as well as valid type-aircraft technical qualifications and IFR-rating.

1.5.4 Qualification and flight experience.

The pilot was qualified and had experience in 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 aircraft (SN BB-806) was manufactured by Beech Aircraft Corporation in 1981, and was registered in the Private Air Services (TPP) category.

The aircraft airworthiness certificate (CA) was valid.

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

The last inspection of the aircraft (Annual Maintenance Inspection) was done by *Sete Táxi Aéreo Ltda*. workshop (CHE 8709-02/ANAC) on 27 July 2010, when the aircraft had 8,696 hours and 55 minutes of flight.

1.7 Meteorological information.

There were meteorological reports available to the pilot at the time of departure from SBBR.

The latest available SBGO METAR (19:00 UTC) reported moderate rain, visibility more than 10 km, ceiling 8,000 ft, and recent rain shower.

The sequence of SBGO weather reports of 14 January 2011 shown below (starting from 18:00 UTC) indicated showers of rain, nebulosity and restricted visibility in the aerodrome at the time of the aircraft arrival. In the highlight, it is possible to observe the weather conditions at the time of the accident.

SBGO 141800Z 26013KT 8000 2000E -SHRA FEW013 BKN020 FEW025TCU BKN080 24/21 Q1013 =

SBGO 141826Z 27008KT 6000 -RA FEW010 FEW025TCU BKN080 24/22 Q1012 RESHRA =

SBGO 141900Z 28004KT 9999 RA FEW010 BKN080 25/22 Q1012 RESHRA =

SBGO 141942Z 23007KT 1000 SHRA SCT013 BKN020 BKN080 25/22 Q1012 =

SBGO 142000Z 20005KT 1600 -SHRA SCT010 BKN020 FEW030TCU BKN080 23/22 Q1012 =

SBGO 142010Z 35002KT 4000 -TSRA FEW010 SCT030 FEW040CB BKN100 23/22 Q1013=

Similarly, the Upper Air Prognostic Chart of 18:00 UTC also forecast nebulosity with *cumulonimbus* clouds (CB) embedded in practically all the Midwest region of the country.

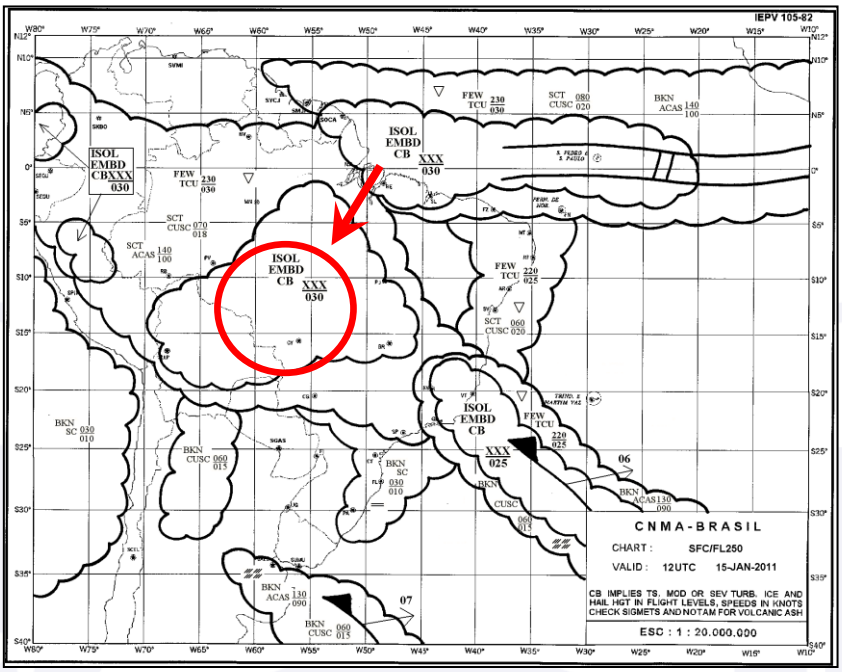

Figure 1 – 18:00 UTC PROG Chart. In highlight, information on nebulosity with embedded CBs in the vicinity of the route between *Brasília* and *Goiânia*.

In addition to these pieces of information, all the significant meteorological variations in *Goiânia* while the aircraft was en route and overhead SBGO were transmitted to the aircraft by *Anápolis* Approach Control (APP-AN) and acknowledged by the PR-ART crewmember, as described below:

- At 19:46 UTC, when the PR-ART was still en route, APP-AN alerted all aircraft destined to SBGO that the aerodrome was operating below the IFR minima, with visibility of 1,000 meters, ceiling 1,500 feet, and moderate rain.
- At 19:56 UTC, while the PR-ART was flying a holding pattern at *GOMAL* position (a fix on the W-10 airway, at a distance of 15 nautical miles from *GOI* VOR), APP-AN informed that the weather conditions had gotten better, and that the aerodrome was operating within the IFR minima, with visibility of 1,600 meters and ceiling of 1,500ft.
- At 20:07 UTC, when the PR-ART was on the approach, APP-AN reported that the visibility (as estimated by SBGO Control Tower) had increased to 3,000 meters.

The investigation commission also verified that, at the moment that the PR-ART crashed into Mount *Santo Antônio*, the *Anápolis* Approach Control primary radar images showed heavy cloud build-ups along the final approach, extending from a distance of 7.4 nautical miles to the vertical of the aerodrome (Figure 2). Such weather conditions were later confirmed by another aircraft (PT-WIT), which was on the approach behind the PR-ART, as may be seen in the final part of the DTCEA-AN recording transcript.

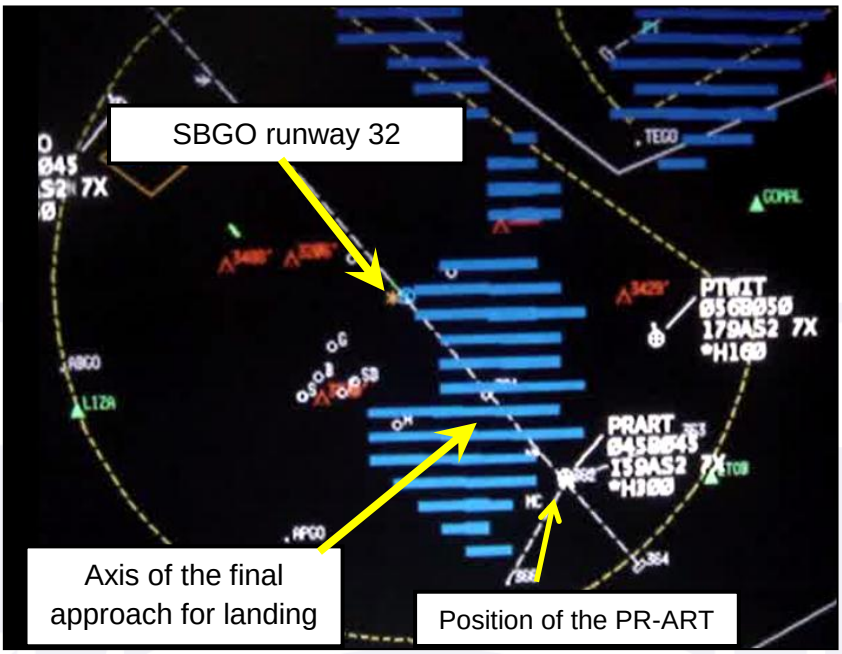

Figure 2 – Radar image showing the PR-ART stabilized on the final approach. The blue stripes indicate the presence of build-ups between the aircraft and the threshold of SBGO runway 32.

The commission also verified that the characteristics of the heavier build-ups existing between the aircraft and the threshold of SBGO runway 32 favored the occurrence of the meteorological phenomenon known as *windshear*.

Windshear is a meteorological phenomenon which may be defined as a local variation of the wind vector, or one of its components, in a given direction and distance. Although it may occur at any portion of the atmosphere, windshear is particularly dangerous for aviation in the lowest layers of the troposphere, from the surface of the ground or water up to approximately 2,000 meters AGL. In this layer, it may cause a considerable loss of lift to aircraft, with a very short time for identification and recovery (sometimes, as short as just a few seconds) (Figure 3).

Studies conducted by aviation authorities worldwide identified a large variety of geographical conditions and meteorological phenomena associated with windshear events, such as topography, mountain waves, thunderstorms or CB clouds, front systems, rain shower, low altitude jet streams, strong surface winds, maritime and land breeze, squall lines, and pronounced temperature inversions.

The *Windshear Pilot Guide*, written by the *Federal Aviation Administration* (FAA), brings an exam of the accidents and incidents reported worldwide between 1953 and 1983, identifying 51 meteorological events related to windshear. These data are shown in the table below.

Windshear events listed in accordance with meteorological condition (Table 1).

Meteorological condition	Quantity of events
Convective formations (rainstorm)	33
Front systems	7
Strong surface winds	2
Turbulent air	2
Strong winds associated with thermal inversion	1
Unknown	6
TOTAL	51

Table 1 – Meteorological conditions and occurrence of windshear (*Windshear Pilot Guide* - FAA, 1988).

Being unpredictable, windshear is difficult to detect, unless Doppler weather radars (not available in SBGO) are used. With short duration (5 to 20 minutes, at the most), windshear events are hard to study. At times, they may occur in association with isolated rain showers or with *virga*.

Studies have demonstrated that approximately 5% of convective formations will produce *microbursts*. When the downdrafts reach the ground, they spread horizontally and may form one or more vortex rings. Typically, the spreading region has diameters varying from 1 to 2 miles, with vortices that may extend upwards as high as 2,000 ft.

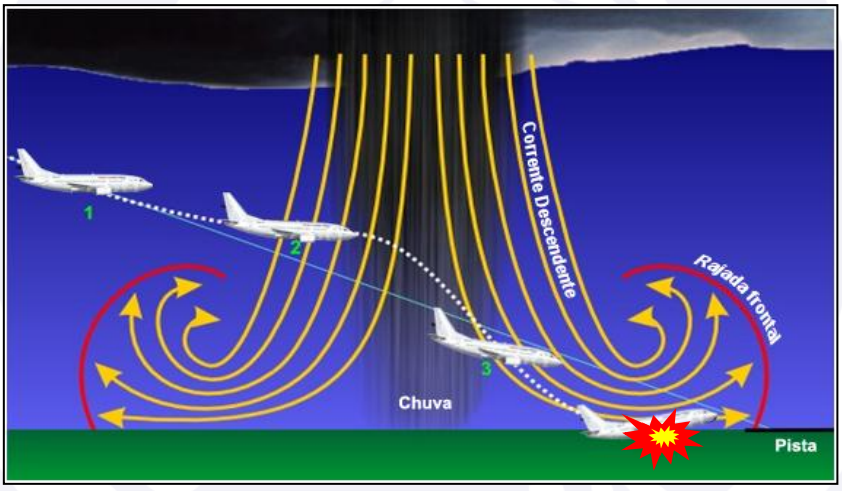

Figure 3 – Occurrence of windshear on the approach.

Measurements taken indicate that the wind speed variation in a region where a microburst is occurring may reach as much as 45 kt at the stage of maximum intensity. However, speed differences of nearly 100 kt have been detected in US airports where aircraft accidents occurred.

1.8 Aids to navigation.

For purposes of compliance with the prescriptions of the Command of Aeronautics' Instruction 63-7 (ICA 63-7) – *SICEAB Organizations' Duties after the Occurrence of an Aircraft Accident or Serious Incident*, the SBGO Runway 32 VOR Procedure was checked by the Special In-Flight Inspection Group (GEIV) two days after the accident. On the occasion, the procedure was considered to be in conformity with the parameters established by the legislation in force.

No signs of problems with the navigation aids were found in association with the approach of the PR-ART to SBGO.

1.9 Communications.

According to the transcript of the DTCEA-AN radiotelephony recordings, at 19:46 UTC, 17 minutes after the PR-ART took off from SBBR, APP-AN alerted all aircraft coming to SBGO that the meteorological conditions were below the minima for IFR operations (1,000 meters of visibility, ceiling of 1,500 meters, and moderate rain).

At 19:50 UTC, there was shift of controllers in the APP-AN workstation and, shortly later, ATC inquired the PR-ART whether they wanted to orbit at *GOI* VOR in order to wait for weather conditions to get better, and the pilot answered affirmatively.

Nevertheless, at 19:52, since the meteorological conditions were better at *GOMAL* position, the PR-ART requested to make a holding pattern with left turns over that position, and was cleared by APP-AN to do so.

At 19:56 UTC, APP-AN informed that SBGO was operating within the IFR minima (with visibility of 1,600 meters and ceiling of 1,500 ft.) and, three minutes later, inquired whether the PR-ART wished to proceed with the approach.

The PR-ART pilot answered that he would remain holding while the other aircraft made their approaches. APP-AN acknowledged and asked the pilot to make the next orbit via the right side.

At 20:01 UTC, another aircraft (PP-MID), which was on the approach, reported having sighted the runway from an altitude of 3,200 ft at a distance of 2.5 miles from the threshold of runway 32. Two minutes later (20:03 UTC), the PR-ART requested approach for landing in SBGO. APP-AN asked the pilot whether he wanted to perform the RNAV procedure or would rather receive vectors for joining the VOR final. The pilot answered that he would rather be vectored, and was then instructed to turn left to heading 180º and descend to FL060.

Then, the PR-ART was given vectoring instructions for joining the VOR procedure final approach, and was informed that visibility, as reported by TWR-GO, had improved to 3,000 meters.

At 20:08 UTC, APP-AN instructed the PR-ART to turn right to heading 300º, descend to 4,500 ft, and report when stabilized on the VOR procedure final approach.

At 20:10 UTC, APP-AN inquired whether the PR-ART was stabilized on the VOR final approach. When the PR-ART confirmed stabilized on the VOR procedure final approach, APP-AN instructed it to report when runway in sight or starting the missed approach procedure.

At 20:11:35 UTC, APP-AN lost radar contact with the PR-ART and, 20 seconds later, informed the aircraft about the loss of radar contact, asking it to report sighting the runway. The aircraft acknowledged the request from the control right away.

At 20:12:54 UTC, APP-AN called the PR-ART but got no reply. In the moments that followed, APP-AN made three calls to which no answer was given.

In the analysis of the recordings, it was possible to observe that the five last transmissions of the PR-ART were made by the passenger sitting on the right seat.

1.10 Aerodrome information.

Not applicable.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The first impact occurred when the right wing hit a few trees on top of the Mount *Santo Antônio*, with detachment of the right flap. The right wing was found 150 meters ahead of the point of first impact, with other parts of the aircraft getting spread downhill along a stretch of 400 meters (Figure 4).

Figure 4 – View of the aircraft wreckage downhill.

Figure 5 – Aircraft crash-site along the alignment of the SBGO runway 32 axis.

The analysis of the wreckage showed that the aircraft was configured for landing, with the landing gear down and locked. The fractures of the propeller shafts were an indication that the engines were developing power at the moment of the collision with the ground. The altimeter was set for the landing in SBGO (1,011 mb), with the ailerons and elevator moving freely and unlocked.

The navigation instruments were rather damaged on account of the post-impact fire, but it was possible to observe that the VOR was correctly set to the *GOI* VOR frequency (112.70 MHz).

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Although the pilot was not used to wearing the recommended corrective lenses, there was no evidence that spatial disorientation and visual illusion might have affected him, considering the trajectory of the flight and the altitude of the aircraft at the moment of impact.

The activity of flying an aircraft belongs in the context of highly complex relations which involve operational and individual factors. If adverse conditions affect these factors, there is degradation of the decision making process and deterioration of task quality.

Among these factors, one may cite the amount of information and tasks related to the procedures of descent, approach, and landing. This phase of flight gathers 60% of the accidents involving aircraft.

In this accident flight specifically, the commission observed that tasks were shared with a passenger, since in the final moments of the approach, the radiotelephony exchanges with the approach control (APP-AN) were not performed by the aircraft pilot. This fact reinforces the thesis of exasperation of the flight demands, making it necessary to divide the tasks with someone else. The increase in the number of RT exchanges on the approach on account of the meteorological conditions and presence of other traffic added to the complexity of the task execution. The decision to accept assistance from the passenger for doing the RT communication may be understood as an attempt to relieve workload.

The degraded meteorological condition made the execution of the task more complex.

In addition to the high workload context, an obesity condition had been identified in the last health checkup done by the pilot. Obesity is a progressive chronic disease characterized by excessive accumulation of bodily fat which exceeds the structural and physical standards of the body, affecting the physical and psychological health of the individual, besides generating reduction of life expectancy due to the development of other diseases.

An interview with relatives of the pilot revealed the presence of sedentariness in him. In spite of the importance of previous rest in the diagnosis of fatigue, the activity of flying an aircraft requires physical fitness from the pilot, and it is a known fact that physical activity is a healthy habit which contributes directly to fostering health and tolerability to the routine day-to-day physical demands.

As the workday develops, physical deterioration is a natural thing, which may be intensified with the presence of the factors mentioned above, and the final moments of the task may be affected by a deficit of quality, a condition which will result in reduction of the flight safety margin.

The figure below serves as a good illustration of this situation. One may observe that the lines corresponding to pilot capabilities and task requirements may sometimes intersect.

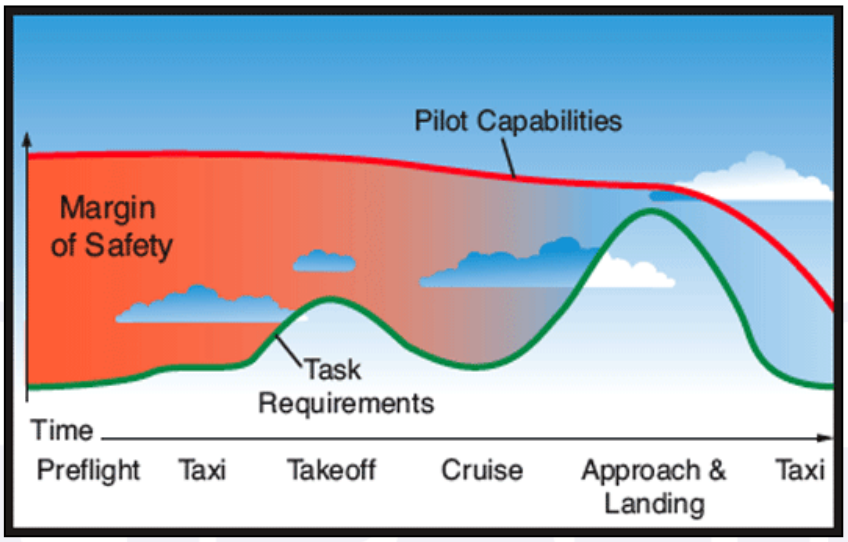

Figure 6 – Margin of Safety: Pilot capabilities x Task requirements.

The accident occurred at the eventide, a moment at which the human eye needs to adapt to indexes of high and low luminosity. Known as *Mesopic* Vision, it is characterized by reduction of visual acuity and color distinction capability. If one also considers the pilot's need to wear corrective lenses, as recommended in his last health checkup, there is the possibility of greater demand on his sight during the approach that culminated in the impact..

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot was happy with his family environment and professional activity. He was particularly glad for his job opportunity in *Palmas* city, State of *Tocantins*. He had been recently hired by the company (owner of the PR-ART), and, together with his family was moving from *Imperatriz*, State of *Maranhão*, to *Palmas*.

In the week before the accident, he had returned from *Imperatriz* to *Palmas*. He had not been flying any aircraft for seven days. He had had enough rest and did not have any complaints with regard to his health.

He was considered a very dependable person by his bosses, who delegated to him the management of all the tasks related to the operation and maintenance of the aircraft.

He was a calm and humble person, who got along well with everyone at work. As a pilot, he was looked up by his peers on account of his competence.

According to information, the pilot was once praised by the other pilots of the company for having been able to land on the landing strip of the aircraft owner ranch.

1.14 Fire.

The aircraft caught fire immediately after the final impact with the hill. According to witnesses, the flames spread quickly.

The main combustion material was the kerosene present in the aircraft tanks. The ignition source was, probably, the strong friction of the aircraft with the ground, and the contact of the fuel with hot parts of the engine.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

The portable 96C Garmin GPS, found amid the wreckage of the PR-ART, was submitted to readout procedures. On account of the damage sustained by the equipment, it was not possible to retrieve data concerning altitude, speed and position of the aircraft relative to the moments that preceded the collision with the ground.

Nevertheless, due to the fact that the aircraft was on track 320º (instead of 325º) on the final approach, there is the possibility that the pilot could be using this non-homologated equipment for assistance in the approach procedure.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

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

The planned flight included departure from SBPJ, a stop in SBBR, and final landing in SBGO.

The first part of the flight was uneventful, and, at 19:02 UTC, the aircraft landed in SBBR, where a passenger disembarked.

The flight plan for the leg SBBR-SBGO was also IFR. It had been filed in *Palmas*, and then transmitted by the AIS Office at 17:18 UTC. In it, the pilot estimated departure from SBBR at 19:30 UTC, flying en route on the W14 airway at FL120, for a forecast landing in SBGO 30 minutes after departure.

Due to poor weather in SBGO, other aircraft were waiting for the meteorological conditions to get better, orbiting in the surroundings of the airport.

APP-AN informed the aircraft which were flying holding patterns that the aerodrome was already operating within the IFR minima, and coordinated the approach of two holding aircraft. Then the ATCO inquired the PR-ART whether it wished to join the sequence for landing. The PR-ART pilot replied that he would remain orbiting in order to wait all the other aircraft land.

After the PP-MID and TAM 3579 (first and second aircraft on the approach, respectively) reported having reached visual contact with runway 32 in altitudes below 3,500 ft (3,200 ft and 3,400 ft, respectively), the PR-ART aircraft requested approach for landing, and received vectors from APP-AN for intercepting the final segment of the runway 32 VOR approach procedure.

Vectoring service was provided uneventfully and, when the aircraft was on radial 140 at a distance of 10 nautical miles from the runway threshold, it was instructed to report either visual with the runway or starting the missed approach procedure.

At a distance of 7.4 NM from the runway, maintaining an altitude of 3,500 ft AGL, and stabilized on track 320º, the PR-ART entered an area of heavier clouds. Subsequently, radar contact with the aircraft was lost. About 20 seconds later, the approach control informed the aircraft of the radar contact loss, and requested it to report when sighting the runway.

The PR-ART aircraft acknowledged the message by saying it would do as instructed. One minute later, at 20:13 UTC, APP-AN began a series of three radio calls in an attempt to contact the aircraft, but did not succeed.

Based on a detailed analysis of the communications, the investigation commission verified that the last five calls from the PR-ART to ATC were made by the passenger who was occupying the right seat. This passenger was himself a pilot, and was in the process

of being hired by the company, but was not qualified for performing functions aboard B200 aircraft with passengers or cargo.

1.19 Additional information.

Information relative to the passenger who took over RT in the final moments of the flight

As described in the item 1.18 (Operational Aspects), the passenger sitting on the right seat was also a pilot, and took over RT in the final moments of the flight which culminated in the accident, having made the last five calls from the aircraft to *Anápolis* Control. It is probable that such decision was made with the intent of relieving the pilot's workload, since the aircraft was facing adverse meteorological conditions.

According to the ANAC's Civil Aviation System (SACI), the passenger in question was a Commercial Pilot license holder (airplane category) with valid ASEL and AMEL technical qualification certificates, besides being IFR-rated. As part of his profile, there was a restriction stating that he could fly Beech aircraft only in training flights without passengers or cargo (*EM INSTRUÇÃO SEM PAX/CARGA – BECH 06/2011*).

CIRTRAF 100-30

The Traffic Circular publication (CIRTRAF 100-30) of 9 December 2008, with provisions regarding the Standardization for the Elaboration of Air Navigation Procedures, had the following *control obstacle* definition in its item 2.3:

> 2.3 Control Obstacle
>
> An obstacle (existing in every segment of an air navigation procedure) which determines the minimum obstacle clearance altitude of the respective segment.

Still according to the CIRTRAF 100-30, Chapter 5 – General Criteria, item 5.4:

> 5.4 The control obstacles of every segment of the procedure or sector of a specific area shall be indicated in the procedure charts (Example: hold; initial approach; intermediate approach; final approach; missed approach, approach to circle by category; departure route segments; sectors of Radar Minimum Altitude Chart).

SBGO runway 32 VOR Procedure

The VOR procedure for the runway 32 of SBGO (Figure 7) prescribed, after the aircraft passed overhead *GOI* VOR at 5,000 ft., an outbound leg of three minutes followed by a turn to the left to track 325º with descent to 4,500 ft. In the sequence, after stabilizing on track 325º, the aircraft had to make a descent restricted to 3,500 ft as far as 3.6 NM from *GOI* VOR. Finally, after reaching 3.6 NM DME, a 700 ft/min descent (B200 aircraft) had to be made toward the MDA at 3,040 ft.

As can be seen in Figure 7, the control obstacle relative to the final approach (Mount *Santo Antônio*), whose elevation is 3,146 ft., was not represented in the chart. Nonetheless, based on the records of the elaboration of the procedure, the commission verified that such elevation was taken into consideration for calculation of the minimum altitude to be maintained on the final approach (Table 2). The execution of this procedure within the correct parameters would allow lateral and vertical separation with the hill (.5 NM and 350 ft., respectively).

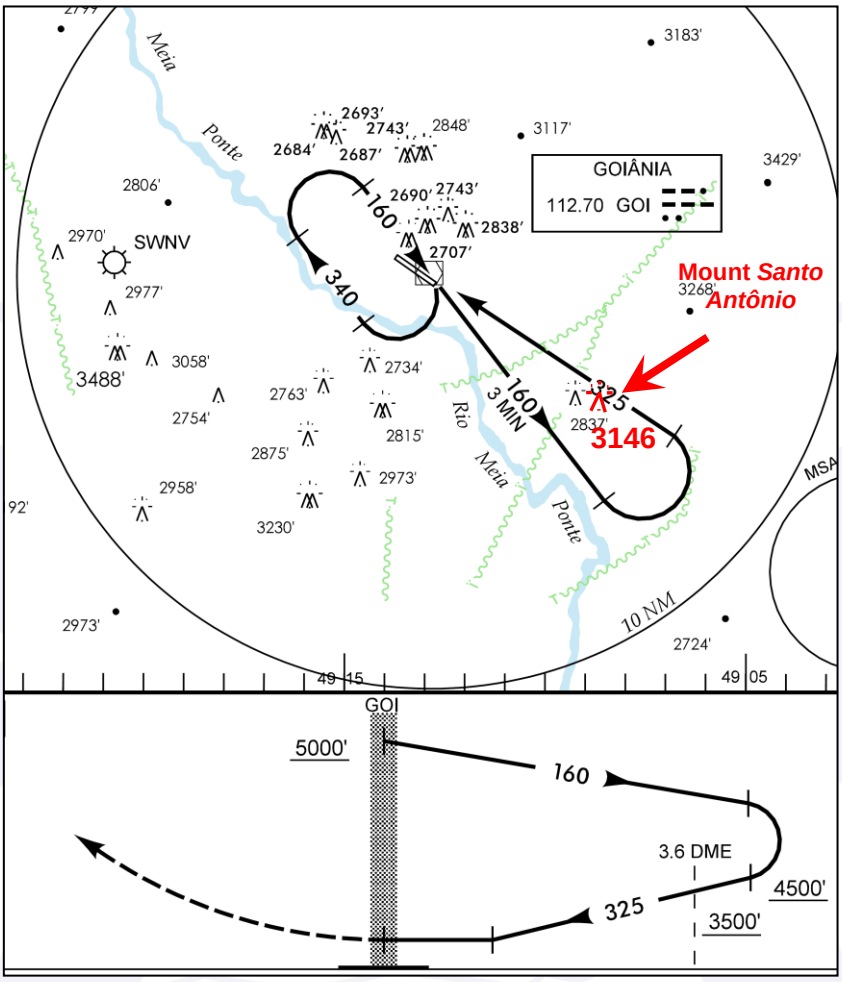

Figure 7 – Part of the VOR procedure for the runway 32 of SBGO. In the highlight, the approximate location of Mount *Santo Antônio* is indicated.

Data extracted from the images of the APP-AN primary radar show that the PR-ART made the final approach on track 320º instead of track 325º (which is the correct one). The former track put the aircraft in a flight trajectory which passed exactly on the vertical of the hill.

	OBSTACLE					MOC (FT)	OCH (FT)
	REF.	X (m)	Y (m)	Altitude (FT)	Surface (P/S)		
STEPDOWN	079	10,113	295	3,146	P	300	991

Table 2 – Part of the calculation of the minimum altitude to be maintained on the final approach of the SBGO RWY 32 VOR procedure. The highlight shows the altitude of Mount *Santo Antônio* (3,146 ft.). Source: DECEA.

Controlled Flight Into Terrain (CFIT)

Accidents involving impact with obstacles in the terrain are typical of an occurrence identified as CFIT, a situation in which the aircraft on a controlled flight collides with the terrain, water, or obstacle, without previous perception on the part of the crew. The most remarkable characteristic of CFIT is the fact that the flight period preceding the collision develops in a fully controlled manner.

Investigations of several cases have shown that the main factors leading to CFIT events are associated with loss of situational awareness, piloting errors, inaccurate

navigation, excessive confidence in automation, ATC failures, and deliberate inobservance of established minima in procedures, usually in situations of unfavorable weather.

Known Precedents

The Final Report 1793 issued by the Aircraft Accident Investigation Bureau (AAIB-Switzerland), which investigated the factors that contributed to the collision of the AVRO 146-RJ100 (Registration HB-IXM) with a hill in Basseldorf, Switzerland, in a situation similar to the one of the PR-ART, brought (as highly relevant results for the investigation in question) the fact that elevations not shown in the approach chart may have influenced the decision made by the captain to descend to an altitude below the MDA of the procedure, without dependable visual references.

The Swiss agency recommended the elevations immediately below the glide path to be included in the approach charts, and this recommendation was accepted (and complied with) by providers of route manuals, such as Jeppesen and Lido.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The flight in question had the purpose of transporting passengers from SBBR to SBGO.

The aircraft entered a holding pattern in the vicinity of the aerodrome in order to wait for the meteorological conditions to get better. The aircraft was opportunely vectored to the final approach of the runway 32 VOR procedure, but ended up colliding with Mount *Santo Antônio*, at an altitude of 350 ft. below the altitude to be maintained in that phase of the procedure.

From the analysis of the wreckage and onboard equipment, the investigation commission concluded that the aircraft was in perfect operating conditions and had been correctly prepared for landing, with the landing gear down and locked, the altimeter duly set, and with the *GOI* VOR frequency (112.70 MHz) inserted in the VOR panel. By means of later research, it was verified that the PR-ART was compliant with the prescribed inspections and overhauls.

In the moments preceding the collision with the hill, no report was made by the pilot concerning any problems with the aircraft. Nor did the investigation find any evidence of aspects associated with the material factor or maintenance that might have contributed to the occurrence.

The runway 32 VOR procedure was inspected two days after the accident by the Special In-Flight Inspection Group (GEIV), which verified that it was in conformity with the parameters established by the legislation in force.

However, the investigation commission observed that Mount *Santo Antônio* was not depicted in the runway 32 VOR procedure approach chart, in spite of indicating the final approach control obstacle. Relatively to this aspect, in a way similar to what occurred in the HB-IXM accident (see item 1.19 – Known Precedents), one cannot rule out the possibility that the pilot would re-consider a possible decision to descend below the MDA without sufficient visual references if this obstacle had been represented in the approach chart.

Taking into consideration the records of the procedure elaboration, the commission verified that this elevation was taken into account for the calculation of the minimum altitude to be maintained on the final approach. The execution of the procedure within the

correct parameters allowed the maintenance of a lateral and vertical clearance with the hill of .5 NM and 350 ft., respectively.

In relation to this clearance, the attention of the investigators was drawn to the fact that the aircraft flew the final approach on track 320º, instead of track 325º.

The precision with which the PR-ART aircraft maintained track 320º led the investigation commission to believe in the possibility that the pilot might have incorrectly used a non-homologated portable GPS as his primary reference for maintaining the track that would take the aircraft to the threshold of runway 32, but, at the same time, would make it pass directly above the hill top.

As for the analysis of the meteorological conditions on 14 January 2011, there was information of rain showers, nebulosity and restricted visibility in the aerodrome for the time of landing. At the moment of the collision of the PR-ART with Mount *Santo Antônio*, the *Anápolis* Control radar images showed the presence of heavy clouds on the final approach from a distance of 7.4 NM up to the vertical of the aerodrome, with characteristics which favored the occurrence of windshear.

The investigation of accidents resulting from windshear shows the existence of strong concentrated downdrafts known as *microbursts*. Approximately 5% of storms produce this meteorological phenomenon.

Due to the swiftness with which this phenomenon forms and disperses, the passing of an aircraft through a microburst in the initial stages of its formation may be something not significant to the pilot, whereas a few minutes later it could produce speed variations two or three times bigger. Downdrafts in this phase may literally force aircraft in a landing or departure procedure towards the ground or obstacles.

According to the weather information and the report of the aircraft proceeding for landing after the PR-ART, there was heavy rain and turbulence on the final approach to runway 32. Thus, one of the hypotheses that could explain the collision of the PR-ART with Mount *Santo Antônio* is the aircraft encounter with windshear conditions on the final approach of the runway 32 VOR procedure, with downdrafts and turbulence causing flight altitude variation which led the aircraft to the collision.

A second hypothesis to be considered is that the PR-ART would have been flown on a controlled flight into Mount *Santo Antônio*, characterizing a CFIT – Controlled Flight into Terrain.

Investigations of other similar occurrences show that the main factors leading to CFIT events are associated with loss of situational awareness, piloting errors, imprecise navigation, overconfidence in automation, ATC failures, and deliberate inobservance of the minima established for the procedure, usually in unfavorable meteorological conditions.

However, even if the aircraft approached on track 320º, a collision with any obstacles would not be possible in a radius of 14 NM if the minimum safe altitude had been complied with. It is worth pointing out that, up to the moment that radar contact was lost; the aircraft complied with the 3,500 ft. altitude restriction for the approach to runway 32 of SBGO. From this point of radar contact loss, there is the possibility that, on account of adverse meteorological conditions, the pilot intentionally descended further in an attempt to reach visual conditions.

Before the collision of the PR-ART with the obstacle, two other aircraft had managed to complete the approach to SBGO successfully, and both of them reported reaching visual contact with runway 32 at altitudes below 3,500 ft. This may have induced the PR-ART pilot to believe that he would encounter better flight conditions if he descended a little bit further.

By considering the hypothesis of CFIT, it is possible to suppose that the management of the situation encountered on the final approach to SBGO suffered influence from factors which affected the pilot's performance. Among these factors, was the high pilot's self-confidence in face of the situation, reinforced by the success obtained on previous approaches, leading the pilot of the latter to descend below the minimum safe altitude.

It is suspected that, during the workday, physical degradation may have occurred, which may have been intensified by the presence of obesity and sedentariness on the part of the pilot, resulting in a deficit of quality in the flight management capability. Besides, it is possible to suppose that the adverse conditions encountered in the final phase of the flight aggravated the level of tension in the cockpit on account of the workload generated, compromising the management of the situation by the pilot, who then chose to delegate responsibility for the RT communication to the passenger seated in the right seat in the moments which preceded the accident.

3. CONCLUSIONS.

3.1 Facts.

a) The pilot held a valid aeronautical medical certificate (CAM);

b) The pilot held a valid type-aircraft technical qualifications and IFR-rating;

c) The pilot was qualified and had experience for the flight in question;

d) The records of the aircraft, engine, and propeller logbooks were up-to-date;

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

f) The weather information available indicated rain showers, nebulosity, and restricted visibility in SBGO;

g) Upon arriving in SBGO, the PR-ART pilot requested to hold at *GOMAL* position, in order to wait for the weather to get better;

h) After the PP-MID aircraft reported visual contact with the runway at an altitude of 3,200 ft., the pilot of the accident aircraft requested approach for landing;

i) The aircraft was vectored for the runway 32 VOR procedure;

j) With the aircraft on the final approach on track 320° and at an altitude of 3,500 ft., radar contact was lost;

k) APP-AN informed loss of radar contact with the aircraft, and asked the PR-ART to report when sighting the runway;

l) The aircraft read back the message, and then collided with Mount *Santo Antônio* at an altitude of approximately 3,100 ft.;

m) According to meteorological information obtained after the accident, the conditions on the final approach to runway 32 included heavy rain and turbulence;

n) The aircraft was completely destroyed; and

o) The pilot and the five passengers perished in the crash.

3.2 Contributing factors.

- **Obesity – undetermined.**

Factors, such as obesity and sedentariness, associated with the high workload in the moments preceding the collision with the hill, may have contributed for the task demand to exceed the margins of safety, resulting in wrong decision-making by the pilot.

- **Attitude – undetermined.**

Upon facing adverse meteorological conditions and being aware that aircraft which landed before him had reached better visibility in altitudes below 3,500 ft. on the final approach of the VOR procedure, the pilot may have increased his level of confidence in the situation, to the point of descending even further, without considering the risks involved.

- **Emotional state – undetermined.**

The weather conditions encountered in the final phase of the flight may have aggravated the level of tension in the aircraft cabin to the point of compromising the management of the situation by the pilot, who delegated responsibility for radiotelephony communication to a passenger.

- **Decision-making process – undetermined.**

If one considers that the pilot may have decided to descend below the minimum safe altitude in order to achieve visual conditions, one may suppose that his decision, probably influenced by the experience of the preceding aircraft, was made without adequate evaluation of the risks involved, and without considering the option of flying IFR, in face of the local meteorological conditions.

In addition, the pilot's decision-making process may have been compromised by lack of information on Mount *Santo Antonio* in the approach chart.

- **Adverse meteorological conditions – a contributor.**

The primary radar images obtained by *Anápolis* Control (APP-AN) indicated the presence of thick nebulosity associated with heavy cloud build-ups on the final approach of the VOR procedure. Such meteorological conditions influenced the occurrence, which culminated in the collision of the aircraft with Mount *Santo Antônio*, independently of the hypotheses raised during the investigation.

- **Navigation deviation – a contributor.**

The final approach on the course 320º, instead of 325º, made the aircraft align with the hill with which it collided.

- **ATS publication – undetermined.**

Mount *Santo Antonio*, a control obstacle on the final approach in which the collision occurred, was not depicted in the runway 32 VOR procedure approach chart, in discordance with the prescriptions of the CIRTRAF 100-30, a fact that may have contributed to a possible decrease of the situational awareness.

4. SAFETY RECOMMENDATION.

A measure of preventative/corrective nature issued by a SIPAER Investigation Authority or by a SIPAER-Link within respective area of jurisdiction, aimed at eliminating or mitigating the risk brought about by either a latent condition or an active failure. It results from the investigation of an aeronautical occurrence or from a preventative action, and shall never be used for purposes of blame presumption or apportion of civil, criminal, or administrative liability.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational 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".

Recommendations issued at the publication of this report:

To the National Civil Aviation Agency (ANAC):

A-606/CENIPA/2014 - 01 Issued on 24/11/2016

Promote the dissemination of lessons learned on this aircraft accident to civil aviation operators and pilots, in order to remind the crews of the risks associated with the non-compliance with the operating minimums established for IFR procedures.

A-606/CENIPA/2014 - 02 Issued on 24/11/2016

Provide guidance and foster health and overweight control programs, in order to instruct the crews as to the risks posed by windshear conditions.

To the Department of Airspace Control (DECEA):

A-606/CENIPA/2014 - 03 Issued on 24/11/2016

Identify Mount *Santo Antonio* in the SBGO runway 32 VOR procedure approach chart, in order to raise pilots' awareness of the collision risks associated with this obstacle, in accordance with the prescriptions of the CIRTRAF 100-30.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On November 24th, 2016.