COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-515/CENIPA/2016

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PT-WVM**
MODEL:	**BONANZA A36**
DATE:	**10NOV2014**

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 10 November 2014 accident with the Bonanza A-36 aircraft, registration PT-WVM. The accident was classified as “loss of control in flight”.

At 14:45 UTC, the aircraft took off from *Salvador* (SBSV) on a ferry flight destined for *Belo Horizonte* (SBBH) with three persons on board.

Approximately one hour and thirty-five minutes into the flight, the aircraft sustained loss of control in flight, and ended up crashing into the ground in a locality known as *Mata do Passarinho*, located in the municipality of *Maracani*, State of *Bahia*, next to the border with the State of *Minas Gerais*.

The aircraft was destroyed in the crash.

The aircraft occupants (the pilot and two passengers) perished in the crash-site.

The USA, as the State of Design of the aircraft, appointed an accredited representative of the National Transportation Safety Board for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ACC-RE	Recife Area Control Center
AIS	Aeronautical Information Service
ANAC	(Brazil's) National Civil Aviation Agency
ARCC	Aeronautical Rescue Coordination Center
ASSIPACEA	Airspace Control Accident/Incident Investigation Advisory
ATS	Air Traffic Service
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CIAA	Aeronautical Accident Investigating Committee
CINDACTA III	Third Air Defense and Air Traffic Control Integrated Center
CIV	Pilot's Flight Logbook
CM	Registration Certificate
COMDABRA	Brazilian Airspace Defense Command
CPTEC	Weather Forecast and Climate Studies Center
DCTA	Airspace Technology and Science Department
ELT	Emergency Locator Transmitter
FIR-RE	Recife Flight Information Region
IAE	Institute of Aeronautics and Space
IFR	Instrument Flight Rules
INFRAERO	Brazilian Airports Infrastructure Enterprise
Lat	Latitude
Long	Longitude
METAR	Routine Aerodrome Weather Report
MNTE	Airplane, Single-Engine, Land - ASEL
NTSB	US National Transportation Safety Board
PCM	Commercial Pilot License (airplane category)
PPR	Private Pilot License (airplane category)
RBHA	Brazilian Aeronautical Certification Regulation
REDEMET	Command of Aeronautics' Meteorological Network
RELPREV	Prevention Report
RS	Safety Recommendation
SBBH	ICAO location designator – *Pampulha* Aerodrome
SBSV	ICAO location designator – *Salvador* Aerodrome
SERIPA II	2nd Regional Aeronautical Accident Investigation and Prevention Service
SIGWX	Significant Weather Chart
SIPAER	Aeronautical Accident Investigation and Prevention System

SPECI	Special Aerodrome Weather Report
STC	Supplemental Type Certificate
TPP	Private Air Services Aircraft Registration Category
UTC	Universal Time Coordinated
VA	Maneuvering Speed
VFR	Visual Flight Rules
VMO	Maximum Operating Speed

1. FACTUAL INFORMATION.

Aircraft	**Model:** Bonanza A-36 **Registration:** PT-WVM **Manufacturer:** BeechAircraft	**Operator:** Private
Occurrence	**Date/time:** 10NOV2014 / 16:23 UTC **Location:** *Mata do Passarinho* **Lat.** 15°47'21"S **Long.** 044°33'45"W **Municipality – State:** *Maracani - Bahia*	**Type(s):** Loss of control in flight

1.1 History of the flight.

At 14:45 UTC, the aircraft took off from SBSV destined for SBBH, with the pilot and two passengers on board.

At 16:23 UTC, the Aeronautical Rescue Coordination Center was advised of an Emergency Locator Transmitter signal coming from a location in the vicinity of the border between the states of *Minas Gerais* and *Bahia*. A process for gathering information was immediately started, with the summoning of the search capability.

At 22:26 UTC, the occurrence of the accident was confirmed, and the aircraft wreckage was located in the municipality of *Maracani*, State of *Bahia*.

The aircraft wreckage was spread in a rectangular area of 930m x 200m.

The aircraft was destroyed. The pilot and both passengers perished in the crash.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft was destroyed.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown	
	Pilot
Total	100:00
Total in the last 30 days	30:00
Total in the last 24 hours	01:10
In this type of aircraft	50:00
In this type in the last 30 days	30:00
In this type in the last 24 hours	01:10

N.B.: Data obtained from third parties.

1.5.2 Personnel training.

The pilot did his Private Pilot course (airplane category) at the *Curso de Formação de Aeronautas* – CFA – (Aeronauts' Training Course) in *Salvador*, *Bahia*, in 2013.

1.5.3 Category of licenses and validity of certificates.

The pilot held a private pilot license (airplane category). His ASEL technical qualification certificate was valid.

The pilot was not IFR-rated.

1.5.4 Qualification and flight experience.

The pilot had qualification and had accumulated 100 flight-hours.

1.5.5 Validity of medical certificate.

The pilot had a valid aeronautical medical certificate (CMA).

1.6 Aircraft information.

The aircraft (SN E2668) was manufactured by BeechAircraft in1991, and was registered in the Private Air Services (TPP) category.

The aircraft airworthiness certificate (CA) was valid.

The registration certificate (CM) was valid.

The logbooks of the aircraft, airframe, engine, and propeller were not found in the crash-site.

The aircraft was submitted to a Supplemental Type Certificate (STC) AS 3523NM for replacement of its reciprocating engine with an Allison 250-B17F2 turbo-prop engine, serial number CAE-881263.

1.7 Meteorological information.

CINDACTA III prepared a meteorological report showing the prevailing weather conditions in the area under the jurisdiction of *Recife* Area Control Center (Sector 12 of the *Recife* FIR) relative to 10 November 2014, from 15:15 UTC to 16:15 UTC, geographical coordinates 15°48'57"S/040°35'52"W, between FL080 and FL180.

The significant-weather chart (SIGWX SUP) between the surface and FL250 relative to 10 November 2014, time 18:00 UTC, showed a cold front moving towards the Northeast at a speed of 4kt, with a strong influence over the south of *Bahia* and north of *Minas Gerais*. There were also embedded CB clouds over the region considered in the analysis.

According to the winds aloft chart for the flight levels FL100 and FL180, valid for 18:00 UTC of 10 November 2014, the direction of the forecast wind over the point considered was mainly from south-west to west. The speed of the wind gradually increased from 10 kt at FL100 until reaching 35 kt at FL 180. The tendency to increase continued in the upper levels, reaching the speed of 80kt at FL450, confirming a flowing behavior of the wind associated with a front system.

The satellite images of 10 November 2014 (15:15 UTC – 16:15 UTC) provided by the Weather Forecast and Climate Studies Center (CPTEC), showed a large area of instability occupying the south of *Bahia*, north of *Minas Gerais*, and north of *Espírito Santo*. This area of instability, as shown in the satellite images, were the result of the strong influence of a front system near the south coast line of *Bahia* and north of *Espírito Santo*, characterized by lots of nebulosity at practically all levels of the atmosphere.

In view of the forecast and observed conditions, it was possible to verify that the area under analysis was highly influenced by a cold front full of convective clouds (*cumulus*,

towering-cumulus, and *cumulonimbus)* with tops estimated at FL430. Those convective clouds were associated with the occurrence of turbulence, icing, and rain showers. In addition, as can be seen from the satellite images, the point of geographical coordinates 15°48'57"S/040°35'52"W was located in one of the regions with the highest convective instability, suffering the influence of a line of CB clouds over an area to the south/southeast of *Vitória da Conquista*, with tops estimated at FL420.

> Cumulonimbus clouds, also known as storm clouds, area capable of producing every form of precipitation, including large raindrops, hail, heavy rainshower, lightning, and violent gusts. In the interior of such clouds, there are strong updrafts and downdrafts, which explain how hail may be found all the way up and down. Surrounding the clouds, one may find gust of up to 100 km/h , as far as 12 km from the cloud. *(Vianello e Alves, 1991). VIANELLO, R.L.; ALVES, A. R. Meteorologia Básica e Aplicações. Universidade Federal de Viçosa.*

The weather conditions were not favorable for air operations in the region analyzed, since the instability and the line of CBs in the area could generate meteorological phenomena (such as icing and severe turbulence) capable of jeopardizing aircraft safety.

Figures 1 to 4 below have satellite images depicting such conditions in relation to the route flown by the PT-WVM aircraft.

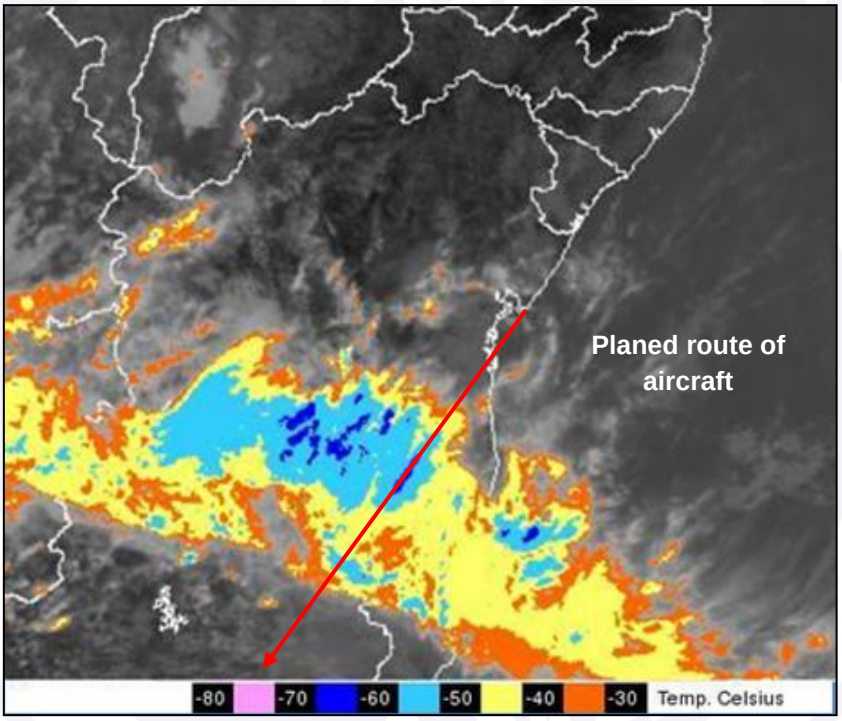

Figure 1 – Satellite image on the day of the accident (15:00 UTC).

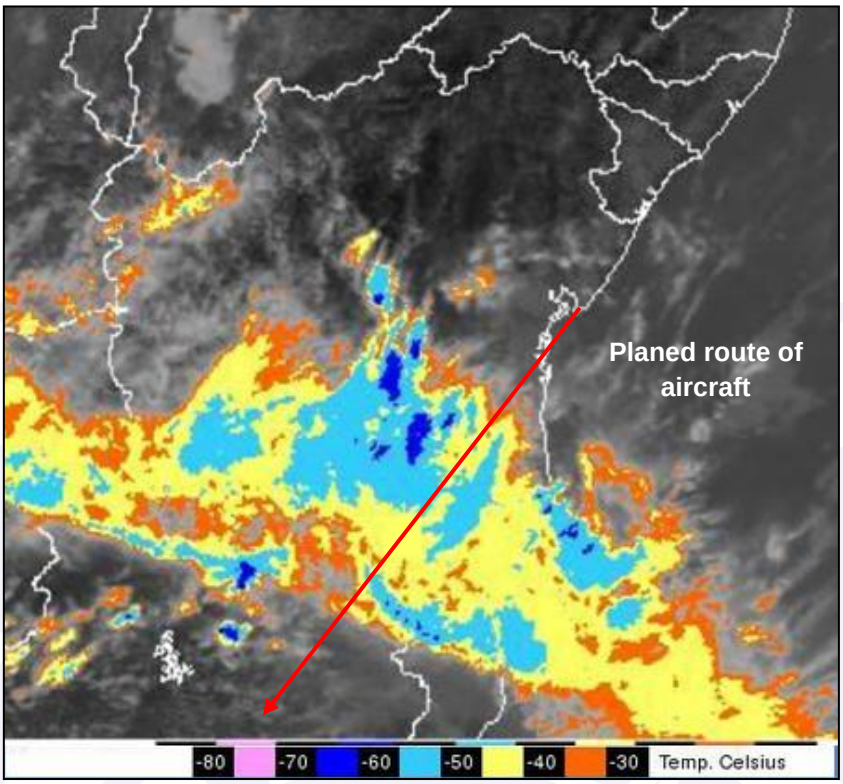

Figure 2 – Satellite image on the day of the accident (16:00 UTC).

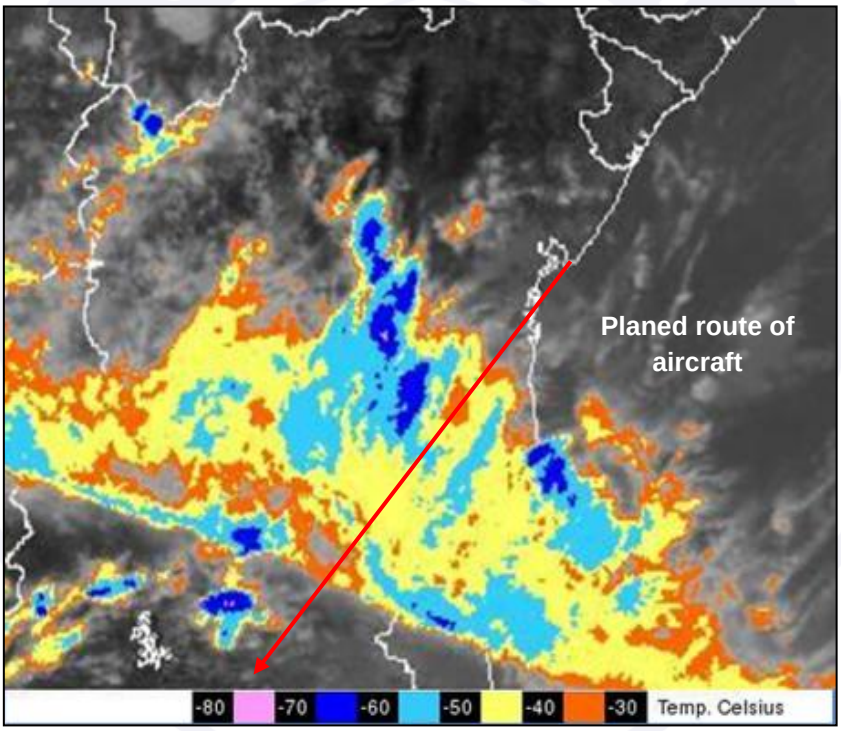

Figura 3 – Satellite image on the day of the accident (16:30 UTC).

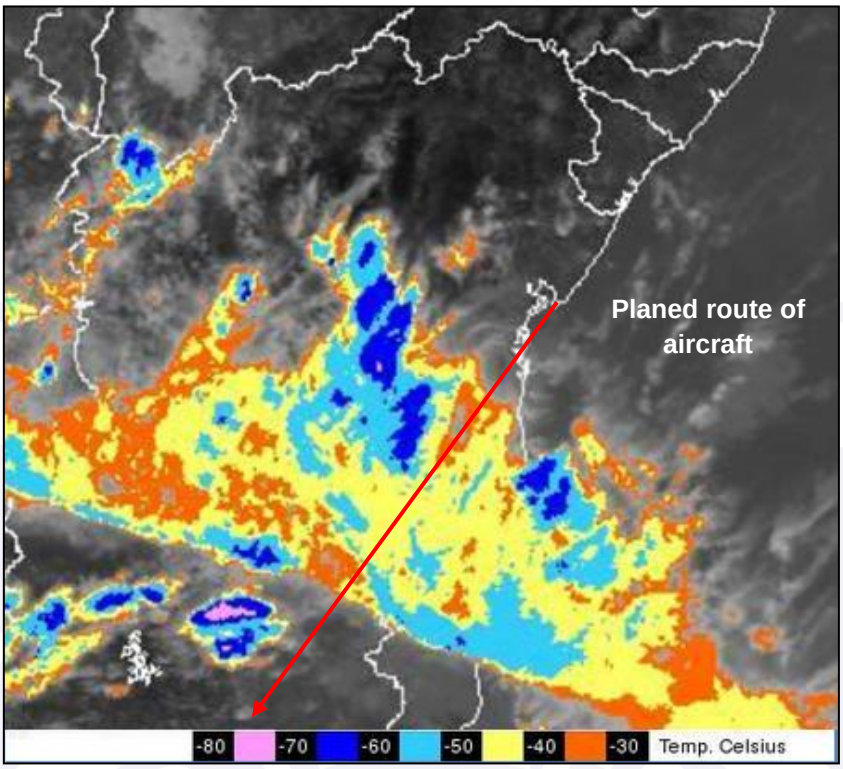

Figure 4 – Satellite image on the day of the accident (17:00 UTC).

According to the REDEMET, the weather conditions on the aerodromes of *Porto Seguro* and *Ilhéus* at the time of the accident were as follows:

> SBPS 101535Z SPECI SBPS 101535Z 02007KT 1200 RA BKN005 BKN020 BKN070 24/23 Q1011.
>
> SBPS 101550Z 13007KT 0800 +RA BKN005 BKN020 FEW025TCU BKN070 24/23 Q1011.
>
> SBIL 101500Z 03006KT 9999 VCSH SCT025 FEW030TCU BKN070 27/23 Q1011.

1.8 Aids to navigation.

The flight plan submitted to the AIS office of *Salvador* Airport, and approved by ATC, informed that the aircraft would depart SBSV via the south-east sector and climb to FL125 under VFR.

Initially, the aircraft was being coordinated by the Approach/Departure Control of *Salvador*. Later, it changed to the frequency of *Recife* Area Control Center (ACC-RE)

At the moment of aircraft departure, all aids to navigation in SBSV were operating normally.

1.9 Communications.

The ATC frequencies along the route flown by the accident aircraft were fully available and in operating order.

The two-way radio communications between the pilot and ATC were uneventful.

The re-run images made available by CINDACTA III allowed to verify that the mode C of the aircraft transponder was not functioning.

At 15:50 UTC, the PT-WVM aircraft called ACC-RE to request a 20-degree deviation to the left of the route to avoid a build-up, and reported maintaining FL125.

At 15:56:35 UTC, the aircraft target disappeared from the radar screens.

1.10 Aerodrome information.

The accident occurred outside of aerodrome area.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The aircraft wreckage was found at approximately 6 km to the left of the planned route in the locality known as *Mata do Passarinho* in the municipality of *Maracani*, State of *Bahia*. The aircraft components were distributed in a linear fashion (Figure 5) in an area of about 930m x 200m, without indication of an earlier collision with any obstacles.

The bodies of the pilot and of the passenger who had been occupying the right front seat of the aircraft were located near each other, at a distance of approximately 530 meters from the aircraft wreckage. The body of the passenger who had been seating in the back seat of the aircraft was found in a place that was distant from the one where the other two occupants were found.

Figure 5 - Croquis of the crash-site.

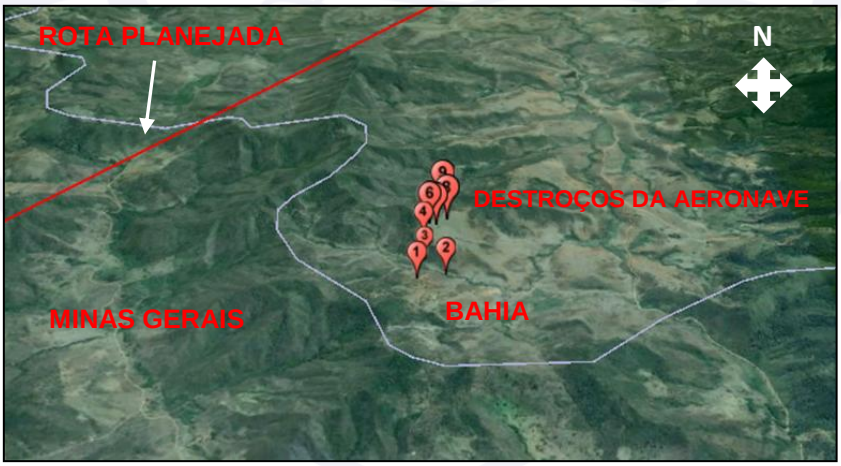

Figure 6 – Position of the crash-site in relation to the planned route of the aircraft.

The evidence found in the crash-site indicated that the main components of the aircraft hit the ground at a pronounced angle and at high vertical speed.

The three-blade propeller assembly had one of the blades broken and detached from the engine. The two other blades remained attached to the hub, being one bent backwards

and the other with minor damage. There was evidence that at the moment of the impact with the ground the aircraft engine was not developing power.

Figure 7 – Aircraft engine/propeller assembly.

A *Wing Forward Spar Carry* (the one connecting the wings) had been severed. (Figure 8)

Figure 8 – Point of rupture of the Wing Forward Spar Carry (left wing).

1.13 Medical and pathological information.

1.13.1 Medical aspects.

No evidence was found that problems of physiological nature could have affected the pilot's performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot of the accident aircraft began his private pilot course in a flying school of *Salvador*, *Bahia*, when he was serving the Brazilian Army. It took him two years to finish the course. At the time of the accident, he was studying Aeronautical Sciences at college, and was interested in pursuing a career in aviation.

The two passengers were also pilots. The one sitting on the right front seat held a private pilot license, and used to fly the accident aircraft. He was younger and had more flight-hours than the very aircraft captain, but, like the captain, he was not IFR-rated.

The other passenger was a helicopter pilot. He was on the flight because he would do an ANAC exam the next day.

According to pilots that had worked for the aircraft owner before, he had the custom of pressing them to operating flights which they considered to be discrepant with acceptable limits.

The objective of the ferry flight that culminated in the accident was to take the aircraft to *Sorocaba*, State of *São Paulo*, where it would undergo a periodic inspection.

According to information obtained in interviews given to the Investigating Committee on the morning of the day of the accident, the pilot was aware of the unfavorable weather conditions along the route when he left home that day, and even commented with his wife that he would rather not fly.

Upon arriving at the boarding location, the pilot communicated his intention of not flying, a fact that annoyed one of the passengers (the helicopter pilot), who had influence before the operator of the aircraft.

The situation, according to the pilot's wife, who was observing from a distance, gave rise to an uneasy climate, which culminated with the pilot's decision to fly the mission, despite the adverse meteorological conditions and the fact that he was not IFR-rated.

The pilot seemed motivated with his work in aviation, and strived to obtain more and more operational experience, as a way to provide his family with a better quality of life.

1.14 Fire.

No signs of either inflight or post-impact fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

The Materials Division of the Aeronautics and Space Institute (IAE) did an analysis of the failure in the structural parts of the PT-WVM aircraft. Technicians of the SERIPA II and of the IAE participated in the analysis.

For the analysis, the wreckage was arranged as shown in Figure 9.

Figure 9 – Arrangement of the wreckage for analysis.

A visual analysis showed the presence of fracture due to overload applied to the material of the left wing, as can be seen in Figure 10.

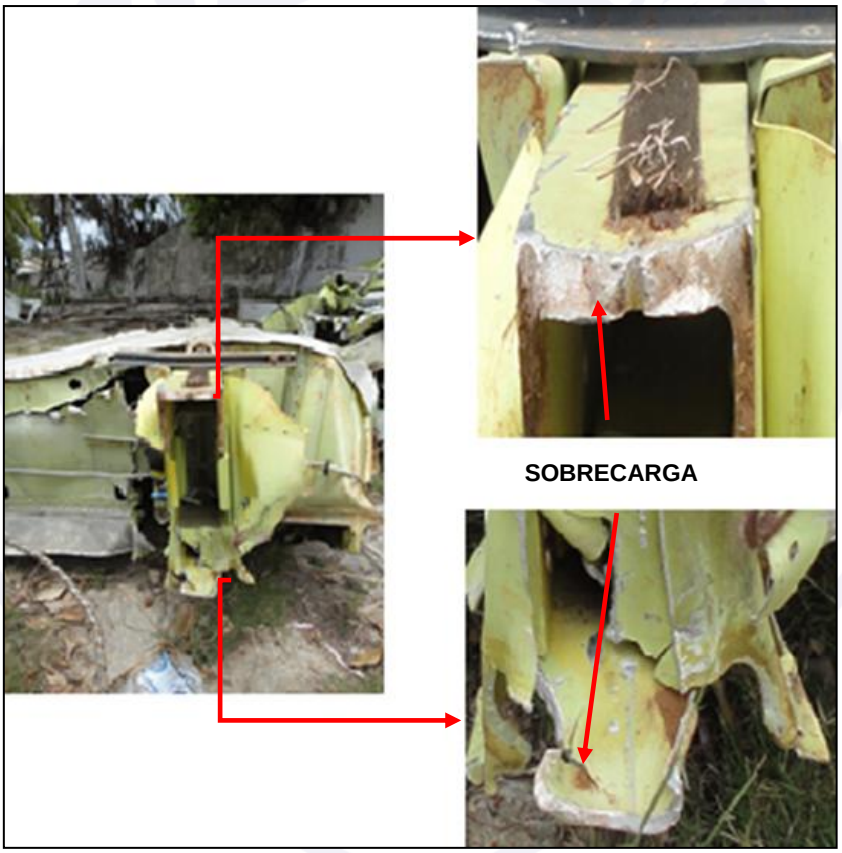

Figure 10 – Left wing structure (*Wing Forward Spar Carry*), with fracture characteristics typical of overload applied to the material.

There was also overload on the aircraft surface metal covering, as can be seen in detail in Figure 11.

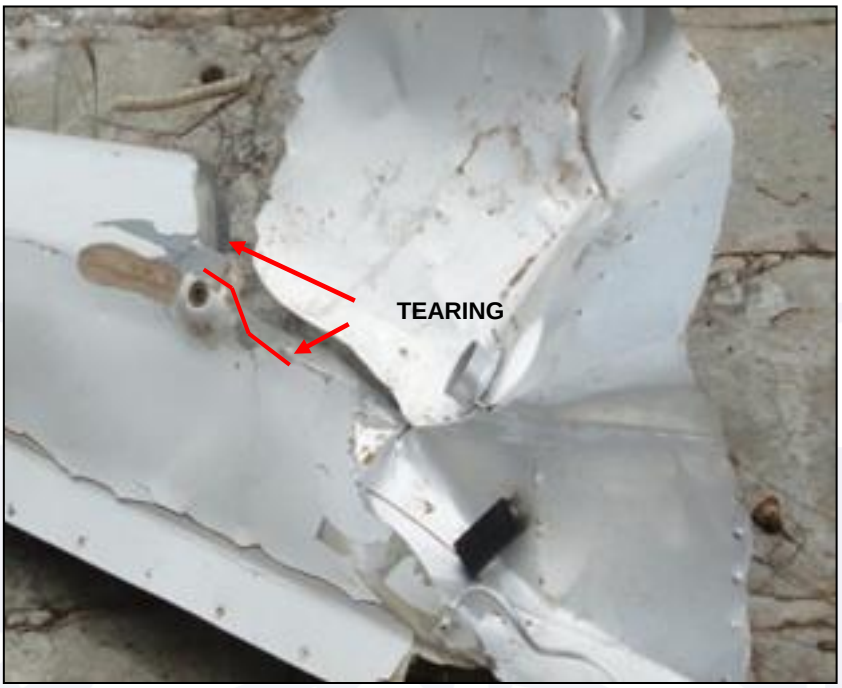

Figure 11 – Aircraft coating surface showing characteristics of fracture due to tearing with the presence of angles (shown by the red arrows).

Figure 12 shows the right wing with its tip-tank broken on account of overload.

Figure 12 – Right wing and tip-tank.

The analysis of the control cables by means of stereoscopy revealed the presence of fractures on account of overload (Figure 13).

Figure 13 – Aspect of the control cable with fracture resulting from overload.

Thus, the result of the analysis was that the structural elements, the metal coating, and the control cables presented failures typical of overload applied to the material, without evidence of failure caused by fatigue or corrosion.

1.17 Organizational and management information.

According to information gathered, there was an informal work-contract between the pilot and the owner of the aircraft, in which the pilot, despite his short experience in the air activity, would be responsible for the administrative issues and for monitoring the maintenance of the aircraft.

Such informal condition of work had possibly been accepted by the pilot for being an opportunity of accumulating flight hours and gaining experience in the air activity.

The owner of the A-36 Bonanza involved in the accident also had an R-44 Robinson helicopter and a twin-engine BE-58 Baron airplane for accommodating his personal and professional needs.

The management of these aircraft took place in a scenario of informalities, without a clear definition of the responsibilities of the pilots and the division of tasks among them. The fact that the aircraft owner did not have roots in aviation, nor any experience and knowledge in relation to the air activity, fostered the creation of an environment of flexible rules, with the decision-making process relative to the flights being affected by personal interests.

1.18 Operational information.

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

In accordance with the *Supplemental Type Certificate* (STC) SA 3523NM, the following speed limits were to be observed in relation to the A-36 aircraft:

Maximum Operating Speed (V_{MO}) = 167kt

Maneuvering Speed (V_A) = 141kt

Maximum Operating Speed (V_{MO}): the speed limit for operating the aircraft.

Maneuvering Speed (V_A): the maximum speed for full application of the flight controls.

The reference for compliance with the aforementioned speed limits is provided in terms of calibrated airspeed as indicated by the aircraft speedometer.

From the "*album of rerun images"* provided by the CINDACTA III, it was possible to determine the ground speed of the aircraft in the final moments preceding the accident (Table 1).

TIME (UTC)	SPEED (KT)
15:16:03	190
15:28:54	192
15:37:54	191
15:46:05	187
15:52:33	194
15:56:16	192

Table 1 – Aircraft ground-speed as obtained moments before the aircraft target disappeared from the radar screens.

It is worth pointing out that the ground speed does not represent the speed to which the structure of the aircraft is exposed in terms of aerodynamic load.

1.19 Additional information.

The airplane involved in the accident had a monocoque structure, in which the coating had the purpose of providing structural support, with the efforts sustained by the aircraft being distributed throughout the fuselage, wings, and empennage.

The fuselage was the basic structure, built with strengthened bulkheads, spars, crossbars, and coating panels.

The whole wing assembly was made of metal, including the wing tips, the ailerons, the fuel tanks, as well as the forward main spars and rear counterparts.

The wings of the aircraft were attached to the fuselage by means of the main forward spar and the rear one. When assembled, such spars formed a structure connecting each wing to the main spar - *Wing Forward Spar Carry* (Figures 14 and 15).

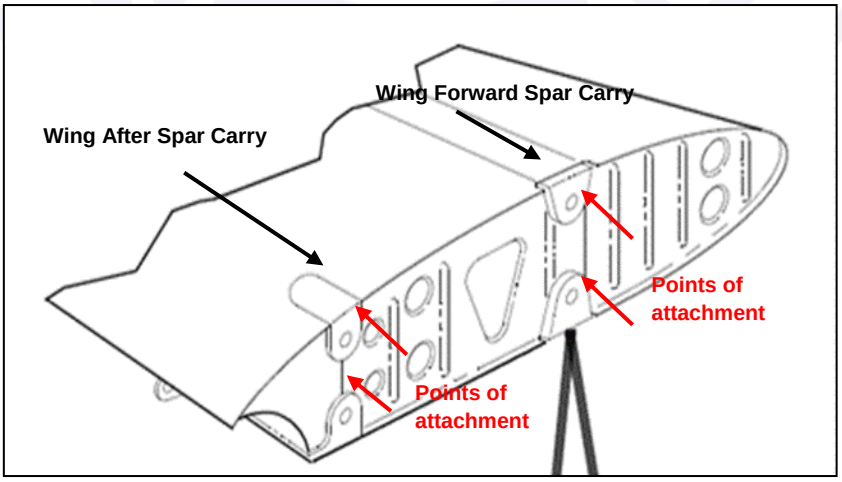

Figure 14 – Forward and rear points of attachment of the left wing.

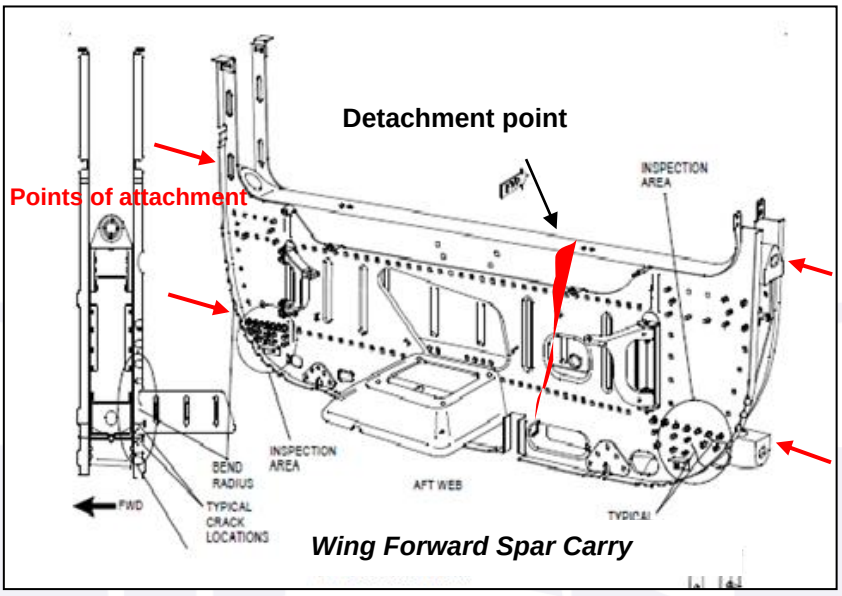

Figure 15 – Points of attachment of the *Wing Forward Spar Carry*.

The horizontal and vertical stabilizers were built around two spars covered with panels, which provided rigidity to the assembly.

Each one of the surfaces was attached to the fuselage by means of forward and rear spars (Figure 16).

The elevators and the rudder were built with a main spar and other secondary ones.

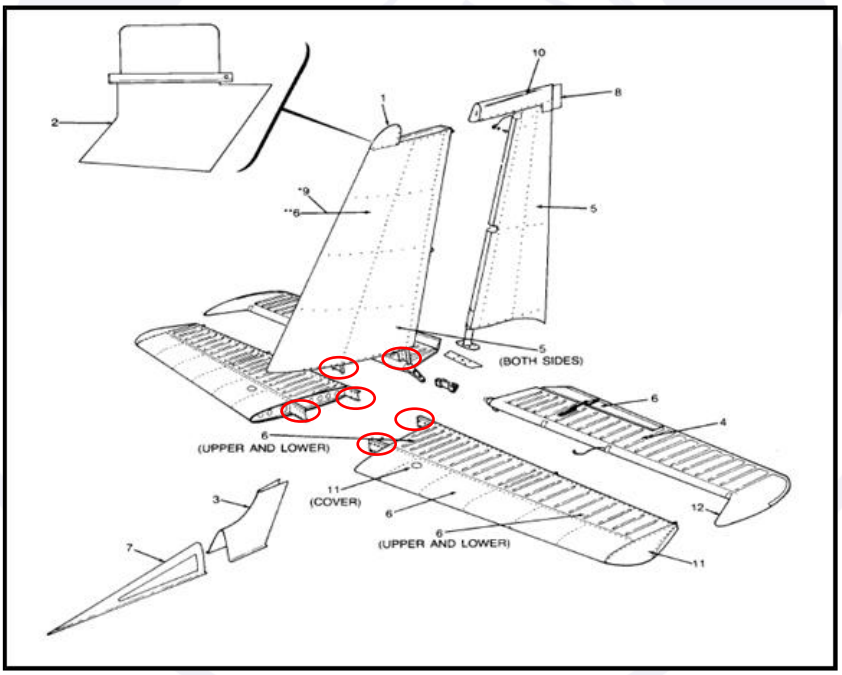

Figure 16 - Points of attachment of the stabilizers to the fuselage.

During the investigation, professionals who had earlier operated the aircraft involved in the accident reported that both artificial horizons (the main and reserve ones) were inoperative on the day of the accident. However, it was not possible to confirm this piece of information, since the aircraft logbooks were not found. They also said that the aircraft did not have a weather-radar for the crew to detect meteorological build-ups.

The loss of the aircraft documentation made it impossible to determine whether the aircraft had all the equipment necessary for an IFR flight.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The aircraft took off from SBSV at 14:45 UTC, destined for SBBH.

The airplane was being ferried to a workshop located in the municipality of Sorocaba, State of São Paulo.

The VFR flight plan was cleared as filed. The proposed cruise level was FL125 up to SBBH.

The pilot of the aircraft was not IFR-rated.

Although not performing any functions on board, the person occupying the front right seat was a private pilot with some experience in flying Bonanza A-36 aircraft. He was not IFR-rated, either. The other passenger was a helicopter pilot, who had, before the operator, some kind of influence on issues related to the conduction of the flights.

The satellite images corresponding to the time of the accident showed that the Weather conditions along the route were not favorable. Analyses indicated that the planned route was strongly influenced by a cold front with lots of convective clouds (Cumulus, TCUs, and CBs) associated with the occurrence of turbulence, icing, and rain showers.

The conversation between the crew and ATC (ACC-RE), in the minutes preceding the disappearance of the aircraft target from the radar screen made it clear that the pilot was concerned with avoiding a weather area ahead of him.

In such scenario, the aircraft entered instrument meteorological conditions, with a pilot that was not IFR-rated.

The analysis of the events which occurred during the process of decision-making between the pilot and the passengers regarding the feasibility of operating that flight, as well as of the work-organization established between them, suggested that the decision to continue with the flight, even under adverse meteorological conditions, could have been influenced by factors of psycho-social and organizational order.

Despite the fact that the pilot was aware of the adverse meteorological conditions along the route, there were personal interests on the part of the passengers, who needed to arrive in São Paulo on that same day. These passengers also worked for the owner of the aircraft, and one of them even had more influence and power of decision in relation to the planning of the flights of the fleet aircraft.

Moreover, the discussion on the feasibility of the flight took place in a troubled fashion. Since there was not a clear definition of the role played by the pilots in the context of the company, which had a spread culture that valued personal interests more than the planning of the air activities, the pilot may not have been able to take a stand against the passengers' interests in view of the risks involved.

Neither the pilot nor the passengers (pilots themselves) were IFR-rated. Thus, it is possible that their lack of experience and practical knowledge of the influences under which one stays when flying in instrument meteorological conditions (with significant degradation of the situational awareness and possible spatial disorientation) may have affected their analysis of the risks involved.

It is worth pointing out that the pilot was starting his career in aviation. He had motivation to keep his bonds with the air activity, to the point of accepting an informal work-contract. One cannot rule out the hypothesis that he accepted to operate that flight

despite being aware of the adverse meteorological conditions so as not to displease anyone in relation to his professional performance in order to guarantee his keeping of the job.

The informality within the organization allowed the emergence of unclear leadership processes, favoring undue interference on the pilot's decision making process. Such condition fostered the maintenance of poor quality interpersonal relationship, since the lack of a clear definition of the roles played by the ones involved was a source of distrust and competition.

The accident occurred right in the middle of a region with convective instability, influenced by a line of CB clouds located to the S/SE of Vitória da Conquista, State of Bahia.

The aircraft disappeared from the radar screens at 15:56:35 UTC, when it was flying near the border between the States of Minas Gerais and Bahia.

The wreckage was found in the locality of *Mata do Passarinho*, at a distance of approximately six kilometers to the left of the planned route, without indication of a prior collision with any obstacles.

The location where the aircraft wreckage was found is consistent with the deviations that had been requested by the pilot in view of the bad weather conditions prevailing in the region.

The analysis of the aircraft parts, as well as the position of the bodies on the ground, indicated that there was fragmentation of the aircraft in flight before it crashed into the ground.

Also, based on evidence found in the wreckage and in the vegetation existing in the crash-site, the investigating committee observed that the collision the detached parts of the aircraft with the terrain occurred at a pronounced angle and at high vertical speed.

Similarly, the observed pieces of evidence showed that at the moment of impact with the ground, the engine of the aircraft was not generating power, probably on account of the inflight separation of the aircraft components which interrupted the flow of fuel.

Technical analyses of the wreckage showed that the Wing Forward Spar Carry (see Figure 10) sustained rupture on account of overload, and, also, that there were no signs of corrosion or fatigue in the referred component.

The separation of aircraft parts in flight, as observed in the Wing Forward Spar Carry, indicated that the aerodynamic load applied to the airplane had exceeded its structural limit.

According to the aircraft radar signal in the four minutes preceding the accident, the aircraft ground speed was approximately 190 kt.

From the dynamics of the facts observed, the following hypotheses were considered:

In the first hypothesis, the aircraft would be cruising at a speed well above the Maneuvering Speed (V_A), 141kt, when it entered a region of atmospheric instability, with strong influence from a cold front full of convective clouds, such as cumulus, TCUs, and CBs. Such nebulosity was associated with the occurrence of turbulence, icing, downdrafts, updrafts, and rain showers. At a given moment, the aircraft would have been destabilized by the action of updrafts and downdrafts. In the attempt to keep control of the aircraft, abrupt deflections may have been applied to the flight controls, resulting in a high "bending" momentum on the wings after the margins of the positive load factor ("G" load) were exceeded. The incompatibility between the applied aerodynamic load ("G" load) and the aircraft structural ability to withstand such loads may have resulted in breakage of the

parts on account of overload, leading to the separation of the right wing and other components.

The second hypothesis has to do with the phenomenon of spatial disorientation. It is as fact that the pilot started a deviation to the left to avoid build-ups. Such deviation was indication of the presence of clouds capable of hindering visual contact with the ground. In this scenario, a mere turn at a low angle of bank would have the potential of generating spatial disorientation. The situation may have worsened as the turn became tighter, leading the pilot to losing control of the aircraft, and resulting in efforts that might have caused the structural failure of the aircraft.

The possibility that the pilot flew the aircraft into a region of atmospheric instability with turbulence, as well as upward and downward winds, may have generated swift changes of attitude and banking of the aircraft, with episodes of acceleration and deceleration. A flight condition like this, without external references, mainly with a pilot that was not IFR-rated, may cause alteration of the inner-ear vestibular systems (balance system of the human body), thus contributing to a possible spatial disorientation.

In such situation, the pilot may lose his notion of space entirely. He may become dizzy, have illusions and false impressions, and believe to be flying under certain conditions (leveled off, at an angle of bank, accelerating, etc.) when, in reality the aircraft is flying in conditions that are totally different form the ones perceived.

In addition, it is worth considering that there are situations capable of raising one's level of anxiety, which may get worse when one lacks enough knowledge and skill for dealing with the circumstances, making it difficult for the pilot to analyze the scenario and adopt appropriate measures.

Finally, the climate of informality existing between the pilots and the owner of the aircraft, as well as the lack of supervision of the technical and operational aspects in the utilization of the airplanes point toward the inexistence of formal rules aligned with the principles and culture of flight safety.

The barriers that could have prevented this accident from happening were gradually disabled and the sequence leading to the accident started with the inadequate evaluation of the feasibility of continuing with a flight in which both the aircraft and the pilot lacked the basic requirements for flying on a route with meteorological conditions unfavorable for the safety of the operation.

3. CONCLUSIONS.

3.1 Facts.

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

b) The pilot held a valid ASEL technical qualification certificate;

c) The pilot had qualification for the flight in VMC;

d) The pilot did not have qualification for the flight in IMC;

e) The aircraft had a valid airworthiness certificate (CA);

f) The aircraft was within the prescribed weight and balance parameters;

g) The aircraft had been submitted to a *Supplemental Type Certificate* (STC) SA 3523NM, for replacing its reciprocating engine with an *Allison* 250-B17F2 turboprop engine, serial number CAE-881263;

h) The aircraft took off from SBSV on a VFR flight plan, proposed cruise level FL125, destined for SBBH, with three persons on board;

i) The two-way radio communication between the pilot and the ATC units were uneventful;

j) The significant weather chart (SIGWX SUP) between the earth surface and FL250 of 10 November 2014 (18:00 UTC) showed a cold front advanced to NE at a speed of 4 kt, with a strong influence over the south of Bahia and north of Minas Gerais.

k) The accident occurred in a region of convective instability, which was influenced by a squall line of CBs located to the S/SE of Vitória da Conquista, State of Bahia;

l) The conditions of instability and the squall line of CBs prevailing at the time of the accident caused meteorological phenomena such as turbulence, icing, and rainshowers, capable of jeopardizing the safety of the aircraft along their route;

m) In the four minutes preceding the accident, the aircraft ground-speed was approximately 190 kt;

n) Moments before the radar blip vanished from the radar screen, the pilot requested a deviation to the left of the route in order to avoid adverse weather;

o) The aerodynamic overload applied to the aircraft exceeded teh limits of its structural capability, leading to an in-flight detachment of its main components;

p) The aircraft wreckage was found in a localtiy known as Mata do Passarinho, at a distance of about 6 km to the left of the route;

q) The aircraft was destroyed; and

r) All aircraft occupants (two passengers and the pilot) perished in the crash site.

3.2 Contributing factors.

- **Attitude – a contributor.**

The insistence on operating a flight in unfavorable meteorological conditions revealed a complacent attitude which prioritized the fulfillment of commitments scheduled by the passengers.

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

The loss of control of the aircraft in flight was associated with the presence of meteorological phenomena along the route, identified as a line of convective clouds, such as Cumulus, TCUs, and CBs, together with the occurrence of turbulence, icing, updrafts, downdrafts, and rain showers.

- **Organizational culture – a contributor.**

The decisions taken in relation to the flight that culminated in the accident were associated with informal rules which prevailed in the utilization of the airplane, characterized, among other aspects, by the lack of formal rules or principles of action compatible with a flight safety culture capable of guiding the pilots' conduct.

- **Disorientation – undetermined.**

The deviation to the left to avoid build-ups was indication of the presence of clouds capable of hindering visual contact with the ground. In such scenario, a mere turn to the left with a small angle of bank had the potential to cause spatial disorientation and lead the aircraft to a flight condition which exceeded its structural limits.

- **Handling of aircraft flight controls – undetermined.**

In the attempt to keep control of the aircraft, there may have been abrupt deflections of the controls, generating a high deflection momentum on the wings after the margins of the positive load factor ("G-load") were exceeded. The incompatibility between the aerodynamic load applied ("G-load") and a possible speed above VMO may have caused rupture of the aircraft structural parts on account of overload.

- **Motivation – undetermined.**

It is possible that the pilot's interest in gaining experience in the air activity and in keeping his job may have led him to decide to conduct the flight, even in adverse meteorological conditions.

- **Work organization – undetermined.**

The informality in the organization of the work on the part of the pilots, without a clear definition of the functions performed by every one of them in the organization context, may have fostered undue interference of the passengers on the pilot's decision concerning the conduction of the flight.

- **Flight planning – a contributor.**

The preparation for the flight proved inadequate, since the pilot, even being aware of the unfavorable meteorological and operational conditions, chose to proceed with the flight in accordance with his initial plan.

- **Insufficient pilot's experience – undetermined.**

The short experience of the pilot (in the air activity, in the operation of the aircraft, and in the circumstances involving the flight) may have led him to not consider other possibilities in relation to his initial planning.

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

The decision taken regarding the operation of a flight in adverse meteorological conditions, with a pilot that was not IFR-rated, reflected an inadequate judgment as to the risks involved in that operation.

- **Interpersonal relationship – undetermined.**

The animosity existing between the pilot and the passengers may have inhibited him in relation to imposing his standpoint of cancelling the flight, in detriment to the evaluation of the risks involved in that operation.

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".

Nil.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Nil.

On February 08th, 2017.