

COMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A - 194/CENIPA/2014

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PT-JSM
MODEL:	U206F
DATE:	06DEC2014



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 Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

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

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

N.B.: This English version of the report has been written and published by the CENIPA with the intention of making it easier to be read by English speaking people. 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 06DEC2014 accident with the U206F aircraft, registration PT-JSM. The accident was classified as “[LOC-I] Loss of Control In-Flight”.

After the take-off, the aircraft made contact with the APP-CG and started to exit the Terminal using the Special Aircraft Route (REA) in the North direction.

A few minutes after take-off, the aircraft crashed into the ground 10 nautical miles North of the takeoff Aerodrome.

The aircraft was destroyed.

The pilot and the passenger had fatal injuries.

An Accredited Representative of the National Transportation Safety Board (NTSB) - USA, (State where the aircraft was designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS	5
1. FACTUAL INFORMATION.....	6
1.1 History of the flight.....	6
1.2 Injuries to persons.....	6
1.3 Damage to the aircraft.....	6
1.4 Other damage.....	6
1.5 Personnel information.....	6
1.5.1 Crew's flight experience.....	6
1.5.2 Personnel training.....	6
1.5.3 Category of licenses and validity of certificates.....	7
1.5.4 Qualification and flight experience.....	7
1.5.5 Validity of medical certificate.....	7
1.6 Aircraft information.....	7
1.7 Meteorological information.....	7
1.8 Aids to navigation.....	10
1.9 Communications.....	10
1.10 Aerodrome information.....	10
1.11 Flight recorders.....	10
1.12 Wreckage and impact information.....	11
1.13 Medical and pathological information.....	12
1.13.1 Medical aspects.....	12
1.13.2 Ergonomic information.....	12
1.13.3 Psychological aspects.....	12
1.14 Fire.....	13
1.15 Survival aspects.....	13
1.16 Tests and research.....	13
1.17 Organizational and management information.....	14
1.18 Operational information.....	14
1.19 Additional information.....	15
1.20 Useful or effective investigation techniques.....	17
2. ANALYSIS.....	17
3. CONCLUSIONS.....	18
3.1 Facts.....	18
3.2 Contributing factors.....	19
4. SAFETY RECOMMENDATION.....	20
5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.....	20

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

APP-CG	Approach Control Campo Grande
CA	Airworthiness Certificate
CG	Center of Gravity
CIV	Pilot's Flight Logbook
CA	Airworthiness Certificate
CMA	Aeronautical Medical Certificate
DE	Spatial Disorientation
IFR	Instrument Flight Rules
IFRA	Airplane Flight IFR Rating
INVA	Flight Instructor Rating - Airplane
METAR	Meteorological Aerodrome Report
MLTE	Airplane Multi Engine Land Rating
MNTE	Airplane Single Engine Land Rating
PCM	Commercial Pilot License - Airplane
PPR	Private Pilot License – Airplane
REA	Aircraft Special Routes
RS	Safety Recommendation
RT	Technical Report
SBCG	ICAO locator designator – Campo Grande Aerodrome - MS
SSGH	ICAO locator designator – Capão Verde Farm - MS
SSKG	ICAO locator designator – Santa Maria Estancia - MS
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SERIPA IV	Fourth Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
TMA	Terminal Control Area
TPP	Registration Category of Private Aircraft Service
UTC	Universal Time Coordinated
VRF	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	Model: U206F Registration: PT-JSM Manufacturer: Cessna Aircraft	Operator: Private
Occurrence	Date/time: 06DEC2014 - 1021 UTC Location: Botas Farm Lat. 20°21'48"S Long. 054°29'26"W Municipality – State: Campo Grande - MS	Type(s): [LOC-I] Loss of Control In-Flight Subtype(s): NIL

1.1 History of the flight.

The aircraft took off from the Santa Maria Estancia Aerodrome - MS (SSKG), to the Capão Verde Aerodrome - MS (SSGH), at 1015 (UTC), in order to transport personnel, with a pilot and a passenger on board.

The aircraft lost contact with APP-CG approximately seven minutes after takeoff.

The wreckage was found near the position of the last view of the aircraft by radar.

The aircraft was destroyed.

The two occupants suffered fatal injuries.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	1	-
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	7.000:00
Total in the last 30 days	Unknown
Total in the last 24 hours	Unknown
In this type of aircraft	Unknown
In this type in the last 30 days	Unknown
In this type in the last 24 hours	Unknown

N.B.: The data related to hours flown were based on information obtained from the pilot's relatives and colleagues, since his Flight Logbooks (CIVs) were not located.

1.5.2 Personnel training.

The pilot took the Private Pilot Course – Airplane (PPR), in 1996.

1.5.3 Category of licenses and validity of certificates.

The pilot had the Commercial Pilot License – Airplane (PCM) and had valid MLTE, MNTE and INVA Ratings, but his IFRA Rating was overdue since April 2014.

1.5.4 Qualification and flight experience.

The pilot had experience in that type of flight, but it was not possible to confirm his recent experience.

1.5.5 Validity of medical certificate.

The pilot had valid Aeronautical Medical Certificate (CMA).

1.6 Aircraft information.

The aircraft, serial number U20602424, was manufactured by Cessna Aircraft, in 1974, and it was registered in the TPP category.

The aircraft had valid Certificate of Airworthiness (CA).

The airframe, engine and propeller logbook records were outdated.

The last inspection of the aircraft, the "200 hours" type, was carried out on 03JUL2014 by the Tacape Aircraft Recovery and Maintenance shop, in Campo Grande – MS.

The aircraft had an accident on 26FEB2005, where there was sectioning of the left wing's distal part, damage to the propeller and engine, kneading in all the extension, besides other malfunctions.

The aircraft had its CA suspended by the National Civil Aviation Agency (ANAC) for this occurrence and later, due to the time elapsed, the aircraft had its CA canceled.

On 09JUN2007 the Maintenance Organization Hora - Hangar, *Oficina e Recuperação de Aviões LTD.* requested authorization from ANAC to begin repair, and it started to re-operate after being inspected by that Regulatory Agency.

During this recovery, a "200 hour" type inspection and compliance with several Airworthiness Directives (AD) were also carried out at the Maintenance Organization Hora - Hangar, *Oficina e Recuperação de Aviões LTD.* on 06JUN2008.

It was not found in the aircraft's logbooks notes on the recovery of the aircraft; only notes referring to periodic inspections and the Special Technical Inspection (VTE) were recorded.

The documentation relating to the recovery of the aircraft, due to the 2005 crash, only came into the hands of this Investigation team four years after the occurrence and yet it was incomplete, hampering the investigators' work.

1.7 Meteorological information.

The following meteorological observations were taken from the Campo Grande International Airport (SBCG), the closest to the take-off location, between 0900 (UTC) and 1100 (UTC).

METAR SBCG 060900Z 11011KT 9999 FEW 010 21/19 Q1013

METAR SBCG 061000Z 09015KT 9999 SCT 010 22/19 Q1013

METAR SBCG 061100Z 09014G27KT 9999 SCT 010 23/20 Q1014

According to the meteorological opinion of the DTCEA-CG, the synoptic situation was as follows:

According to the images and information available and attached to this opinion, there was the presence of a cold front extending from the North coast of Rio de Janeiro to the adjacent Atlantic Ocean.

Associated with this system, there was a large post-frontal anticyclone covering the South-Central portion of the states of Mato Grosso do Sul and São Paulo, as well as the states of Paraná, Santa Catarina and Rio Grande do Sul.

There was also, at high levels of the atmosphere, the presence of a low-cut with an axis between the Northwest of Mato Grosso do Sul and the South coast of São Paulo, continuing along the Atlantic and engaging the frontal low-cut.

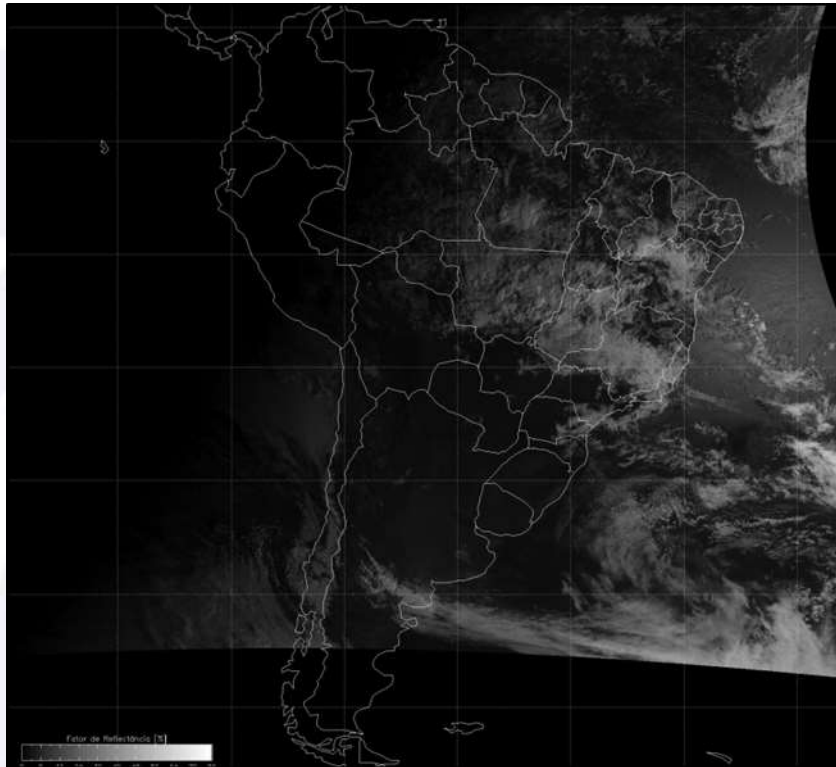


Figure 1 - South America Satellite Image from 1030 UTC on 06DEC2014 - Visible Channel.

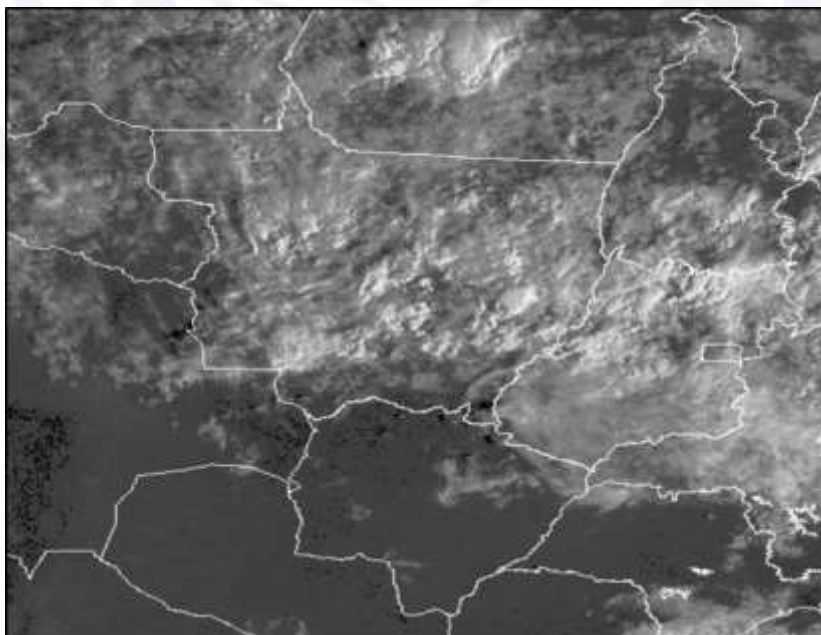


Figure 2 - Central West Region Satellite Image at 1030 UTC on 06DEC2014 - Visible Channel.

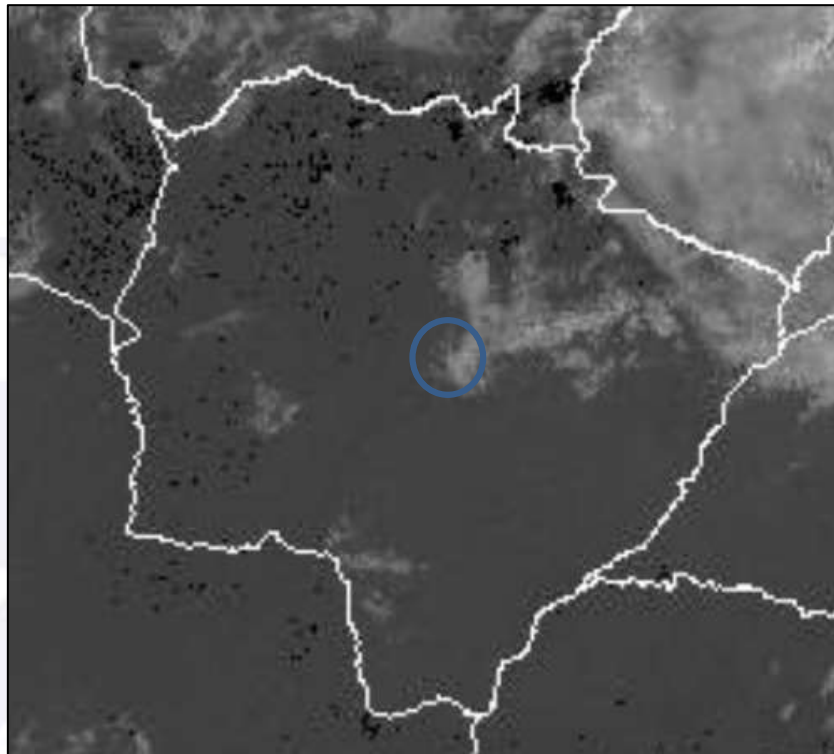


Figure 3 - Enlarged Satellite Image of the Central West Region at 1030 UTC on 06DEC2014 - Visible Channel. The circle marks the location of the Aerodrome.

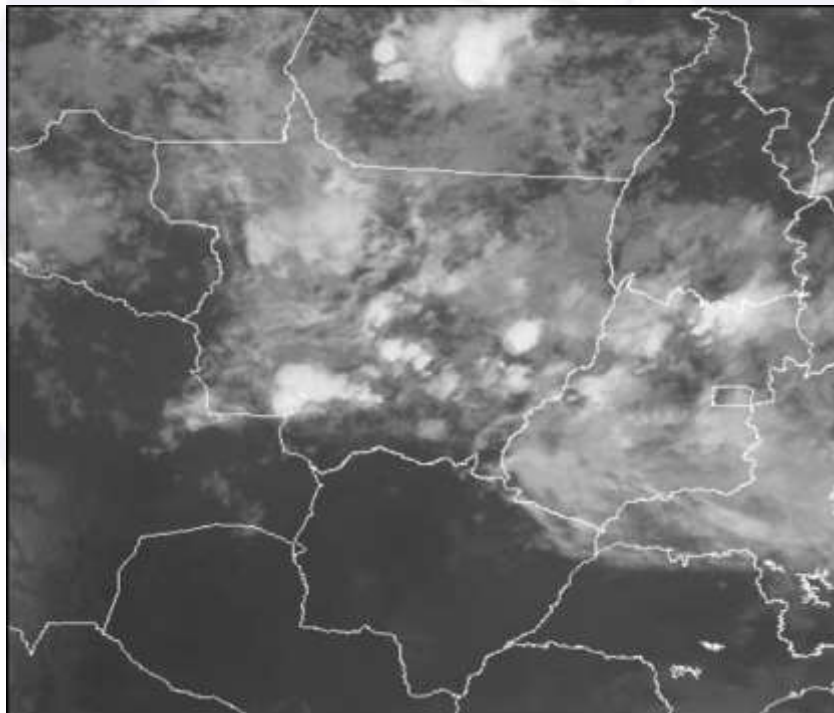


Figure 4 - Satellite Image of the Central West Region at 1030 UTC on 06DEC2014 Infrared Channel.

The conclusion of the meteorological report was as follows:

According to the presented synoptic situation, low cloudiness was expected in the South-Central portion of Mato Grosso do Sul in the morning, due to the presence of the

post-frontal anticyclone, high relative humidity and relatively lower temperatures (METAR messages).

It was also prevised that there would be convective cloud formation with isolated rainfalls in the afternoon, in the North-Central portion of the State, due to the presence of a low-cut at high levels and favorable thermodynamics.

The aircraft took off from Santa Maria Estancia Aerodrome, 9 nautical miles away from SBCG.

In the take-off Aerodrome there was no provision of meteorological service, thus, the only information was those obtained by testimony of people who were in the locality in the morning of the accident, besides the report above.

The witnesses indicated that the aircraft took off in visual conditions, but soon after disappeared in a cloudbank.

The description of the ceiling conditions and visibility at that Aerodrome led the Investigation Team to believe that this could be the presence of fog or mist at the site.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The communications between the PT-JSM and the Approach Control Campo Grande (APP-CG) were as follows:

HORA	ÓRGÃO/AERONAVE	MENSAGEM
10h08min29seg	PT-JSM	"[...], Coordenar com o tráfego em Santa Maria, para coordenação em Santa Maria o Papa Tango Juliett Sierra Mike. Está descendo para a cabeceira dois quatro."
10h08min44seg	APP-CG	"Juliett Sierra Mike, coordene em uno dois três decimal quatro cinco."
10h08min46seg	PT-JSM	"[...], Santa Maria."
10h08min54seg	APP-CG	"Ciente, coordene frequência local, com os tráfegos no circuito, não na frequência do controle. Chame o controle após a decolagem."
10h14min52seg	PT-JSM	"Controle Grande, é o Papa Tango Juliett Sierra Mike."
10h15min02seg	APP-CG	"Papa Tango Juliett Sierra Mike, acione zero uno três uno no transponder."
10h15min04seg	PT-JSM	"Zero uno três uno."
10h15min42seg	APP-CG	"Juliett Sierra Mike, contato radar vertical do Santa Maria, confirme a proa ideal para o destino."
10h15min43seg	PT-JSM	"Três zero cinco."
10h15min53s	APP-CG	"Ciente. Prossiga inicialmente nos corredores mantendo a altitude prevista, o ajuste em Campo Grande uno zero uno três."
10h15min55seg	PT-JSM	"Uno zero uno três."
10h21min33seg	APP-CG	"Juliett Sierra Mike, controle."
10h21min39seg	APP-CG	"Papa Tango Juliett Sierra Mike, controle."
10h21min50seg até 10h32min04seg	APP-CG	Repetição da chamada do controle Campo Grande ao Papa Tango Juliett Sierra Mike.

Figure 5 - Communications between PT-JSM and APP-CG.

1.10 Aerodrome information.

The occurrence took place outside the Aerodrome.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

The accident occurred approximately 12 nautical miles from the Campo Grande International Airport (SBCG) and 10 nautical miles from the take-off airport.



Figure 6 - Aerial image of the crashed aircraft with highlight to the tree in which the aircraft collided before reaching the ground, and the spot formed by the contact of the fuel with the vegetation.



Figure 7 - The crashed aircraft with its front part completely buried.

The first impact of the aircraft occurred against a dry tree approximately 3 meters away from the full stopping place.

Many dry branches were found lying around the tree and even in the wreckage of the aircraft, notably a piece of branch in the leading edge of the right wing, which opened at the impact.

There was the torsion of the back, especially of the tail cone, counterclockwise, probably because the aircraft was turning to that side at the time of impact against the ground.

When the previous part entered the ground, the rest of the aircraft twisted to that side because of the inertia.

Some parts of the aircraft were loose like the wing tip, pulley, an antenna, the left landing gear wheel and other small pieces. All parts of the aircraft were concentrated at the fall site.

The aircraft had fixed landing gear and flap deflection, without being able to measure precisely how many degrees.

The aircraft's levers appeared to be consistent with a flight situation, especially the power lever, which was in the reduced power position and deformed in the accident.

Regarding the instruments' indication, the tachometer showed an indication of 2,550 RPM and a speed of 80 knots, emphasizing that the instrument indications did not necessarily reflect the flight parameters at the moment of impact.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

At the time of the accident, the pilot worked as a freelancer on flights in the Campo Grande region, operating different aircraft models, depending on demand.

In relation to previous experiences of the pilot, it was reported that he had already flown in mining regions and indigenous villages, as well as had been acting during a period of his life carrying flights of valuables.

According to the information obtained, the pilot had a lot of appreciation for the activity he carried out, but at the time, he complained about the region's labor market, which was very restricted.

He had also acted as a flight inspector and instructor, and his qualification at the time of the occurrence was valid. As an instructor, it was reported that he used to be demanding and rigorous. According to reports, he always sought to help train new pilots by taking them on flights so they could gain experience.

He was regarded by colleagues as a great instructor and a good friend. Other aviation professionals, who got in contact with him, described him as an experienced and very confident pilot.

According to reports, he was accustomed to flying in adverse weather conditions, performing procedures described by other pilots as "drilling the layer" on his flights.

Such a practice consists of entering into meteorological conditions by instruments to rise above the cloud layer or descend below it to obtain visual conditions and to continue flight under these conditions.

According to reports, when other pilots accompanied the commander on these occasions, he passed the practice related to these teachings, as if it were a technique demonstrating the skill of the pilot in command.

At the time of the accident, the pilot resided alone in Campo Grande, aiming to facilitate his displacement in case he being called to make some flight.

The pilot only had contact with his family on weekends. Relatives reported that he was accustomed to the work routine, had a lot of vitality and was in a very quiet moment of life.

The day before the accident, a friend of the pilot, who was also in that position, had consulted his availability to make that flight the next day in the morning.

This contact occurred around 22:50 local time. As reported, the fact that the pilot already has experience in that model of aircraft motivated his choice for that flight.

According to the report of people of his conviviality, the pilot had a habit of sleeping and waking up early, between 04:30 and 05:00 (local time).

It was not possible to determine how his rest before the accident was, since no one near him was present during the night. However, according to the information obtained, the flight plan was passed to the air traffic control, by telephone, at around 00:00 local time.

It was also reported that the pilot had left his home to make the flight around 05:30 local time. At 06:39 local time, he sent a message to his friend, informing him that he was already boarding the aircraft.

The purpose of the flight was to transport personnel. The trip would be a trip to the passenger's farm, in which he would accompany the vaccination of his cattle.

According to the information obtained from the passenger's relatives who had contracted the pilot's services, there was no urgency for the flight. It was reported that the passenger was cautious and always accepted the opinion of the pilots on the conditions to make a flight or not.

1.14 Fire.

No signs of either inflight or post-impact fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

The engine analysis indicated that it was operational before the accident.

It was found by manual actuation that both magnets sparked normally and the spark plugs had appearance and coloring corresponding to normal operation.

The fuel pump was not jammed and the distributors were found without damage or evidence of failure that could have compromised the power to the engine. Nozzles were found without obstruction.

No abnormality was found for engine lubrication.

The crankshaft had no evidence of lack of lubrication or malfunction.

No cracks, evidence of leakage or incorrect assembly were found in the engine semi-housing, and the bearings also had normal appearance and coloration.

In the crankshaft-coupling flange, superficial cracks at 45° were found due to the stress, evidencing normal operation of the engine at the moment of impact.

In the propeller assembly, two loose pitch change pins were verified, this fact being damage due to the impact in the accident.

In addition, the propeller pitch change links were also fractured, indicating that the engine was operational at the time of impact.

Regarding the structure of the aircraft, were found fractures caused by overload and deformations on the wing surface compatible with impact against the ground.

Fatigue fractures were not found in the material and all parts of the aircraft were concentrated at the fall site.

However, repairs were found in the wing structure, whose material differed from the standard of the rest of the aircraft.

The survey revealed that there was a previous aeronautical occurrence with this airplane, on 26FEB2005, classified as an accident, where it was recorded in the Final Report the following sentences:

... the left wing broken after the flap, folded down. The tip of the right wing with small kneaded due to the first impact with the tree. Right elevator with little dent ...
".

It should be noted that between the day of the occurrence and the date on which the technicians who were making the structural report had access to the wreckage, there was an interval of about 03 months. During that time, the wreckage was moved to a hangar and not all parts of the aircraft were available for analysis.

During the First Action, investigators were not given maintenance records or aircraft recovery records in the period between the date of the accident on 26FEB2005 and their return to flight on 29JUL2008.

Subsequently, it arrived in the hands of the investigators, material confirming that post-accident repair was requested, however, the material was incomplete, lacking information, and others were incoherent.

Information on this recovery was not in the aircraft logbooks.

At that time, legislation dealing with post-accident recovery was IAC 3127 and RBHA 43.

1.17 Organizational and management information.

The aircraft belonged to a private operator. There was no employment relationship between the pilot and the aircraft operator.

In addition to the operator flights, at the time of the accident, the pilot worked as a freelancer for other business operators, a common practice to other pilots in the Campo Grande region.

Regarding the management of the aerial activities performed with the PT-JSM aircraft, it was reported that each flight was performed by the contracted pilot who was willing to perform the task.

This practice had an impact on the control of the flights performed, and the pilot's and aircraft's logbooks were found outdated.

According to the data obtained, the preparation of the pilot for the flight that originated the accident had started the day before the accident. The take-off occurred approximately seven hours after the flight plan was transmitted.

It was not possible to determine if, on the day of the occurrence, there was any action of the pilot focused on the re-evaluation of his flight planning.

1.18 Operational information.

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

According to information searched on the page of the National Civil Aviation Agency (ANAC), the aircraft was only certified to perform VFR flights in the daytime.

It was a transfer flight, transporting a passenger to Capão Verde Farm - MS.

After the take-off, the aircraft established contact with the APP-CG and started the exit of the Campo Grande Terminal by the Special Aircraft Route (REA) ARAU in the North direction.

Approximately 05 minutes after take-off, a left turn was made, just before the point predicted on the route specified in the flight plan. The aircraft was crossing 3,400 ft. rising and with 142 knots of speed.

Subsequently, upon reaching 3,600 ft., a right reversal was verified. The aircraft changed altitude from 2,800 ft., then 3,100 ft., again 3,600 ft., and the speed ranged from 142 knots (the first time it reached 3,600 ft.) and 107 knots (when it went through 2,800 ft.).

Approximately 07 minutes after takeoff, the last view of the aircraft was received by the radar, in a geographic position consistent with the location of the wreckage.

Those present at the time of take-off reported that, shortly after departure, the aircraft disappeared through the clouds, which were low.

1.19 Additional information.

Cessna U206F Manual Speed Limitations:

The Never Exceed Speed (VNE), is defined as the speed limit that can never be exceeded, under penalty of structural disintegration of the aircraft in flight.

SECTION 2 OPERATING LIMITATIONS		CESSNA MODEL T206H NAV III GFC 700 AFCS		
AIRSPEED LIMITATIONS				
Airspeed limitations and their operational significance are shown in Figure 2-1.				
AIRSPEED LIMITATIONS				
SYMBOL	SPEED	KCAS	KIAS	REMARKS
V _{NE}	Never Exceed Speed	179	182	Do not exceed this speed in any operation.
V _{NO}	Maximum Structural Cruising Speed	147	149	Do not exceed this speed except in smooth air, and then only with caution.
V _A	Maneuvering Speed:			Do not make full or abrupt control movements above this speed.
	3600 Pounds	123	125	
	2950 Pounds	118	120	
V _{FE}	Maximum Flap Extended Speed:			Do not exceed this speed with flaps down.
	FLAPS UP to 10°	139	140	
	FLAPS 10° to 20°	119	120	
	FLAPS 20° to FULL°	100	100	
-----	Maximum Window Open Speed	179	182	Do not exceed this speed with windows open.

Figure 2-1

Figure 8 – Speed Limits.

The investigators had many difficulties during the investigation, since several documents were not made available during the First Action, while others were incomplete or incoherent.

Spatial Orientation

Under normal conditions, the human being is able to determine, with precision, its spatial orientation. To do so, it uses information provided by three specialized sensory systems:

- the visual system, which provides 80% of orientation information;
- the vestibular system, related to the inner ear (semicircular canals, responsible for angular acceleration information, and otolithic organs responsible for linear acceleration and gravity information), which contributes 10% of the information; and
- the proprioceptive system (receptors located in the skin, muscles, tendons, ligaments and joints), which contributes another 10%.

Through specialized sensory receptors, these three systems constantly collect information that is transmitted to the central nervous system, where they are integrated and processed, creating a spatial orientation model that, under normal conditions, is highly reliable. This model determines the position of the body in relation to a fixed system of coordinates that has as reference the Earth (horizontal) and the gravity (vertical).

These systems, so complex and important, were not "designed" to operate in the three-dimensional environment of flight. Flight movements dramatically increase the risk of Spatial Disorientation (DE), given the physiological limitations of human orientation systems. Under these circumstances, guidance can be maintained with the aid of instruments.

In situations where visual references are poor or absent, such as in bad weather or at night, up to 80% of normal orientation information can be lost, with the 20% remaining being in charge of the vestibular and proprioceptive systems. Under these conditions, each of these two systems contribute with 50% of the orientation information. However, they are less accurate and more prone to illusions and misinterpretations. This becomes especially relevant in the three-dimensional environment of flight, and explains the various types of illusion a pilot can experience.

In this way, it is noted that the lack of good visual references deprives the human being of most of the information about his orientation. Therefore, most disorientation events are associated with a lack of visual references, such as instrument meteorological conditions (IMC) and night flight.

On the Earth's surface, orientation is generally limited to two axes of motion (forward or backward and left or right). In aviation, it is added the altitude dimension, which significantly changes the experiences perceived by the visual and vestibular systems. For this reason, the complex movements of the flight environment increase the probability of occurrence of spatial disorientation by exposing the human being's physiological limitations of the normal systems of orientation.

Spatial Disorientation

In general, Spatial Disorientation is the misperception of the position and movement of the body in space.

Relating to aeronautical accidents, Space Disorientation is defined as: "occurrence in which the pilot in command enters into a process of confusion in the interpretation of the attitude of the aircraft, entering or not into an abnormal attitude".

Changes in linear acceleration, angular acceleration, and gravity are detected by receptors in the vestibular and proprioceptive systems and are compared in the brain with visual information. Any difference or discrepancy between the sensorial stimuli coming

from the visual, vestibular and proprioceptive systems can cause a sensorial incompatibility, being able to produce illusions and lead to Spatial Disorientation.

Therefore, illusion is a false impression of reality, or misperception of something that exists objectively. The illusions are divided into two major groups:

- vestibular illusions, and
- visual illusions.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The flight was intended to transport a passenger from the Santa Maria Estancia Aerodrome, near the city of Campo Grande - MS, to a rural property in the countryside, for professional appointments.

There was no formal link between the operator and the pilot, who acted as a freelancer for other businesspersons on flights in the region. Due to this condition, he performed flights with different aircraft models.

A friend had contacted the pilot the night before to take the flight that caused the accident. It was identified that the transmission of the flight plan occurred approximately seven hours before the take-off of the aircraft, evidencing that his flight plan was carried out still at night, after being called.

Based on the interval between the transmission of the flight plan and the time of presentation at the place of take-off, it was found that there was little time available for the pilot to make the necessary preparations and to have adequate rest, approximately four hours of sleep the night before the flight.

Since the pilot's CIV were not found, it was difficult to compute his hours, and it was not possible to determine the frequency of instrument flights that the pilot performed, although it was reported that he eventually operated under adverse weather conditions.

In addition, the pilot had his IFRA Rating overdue since April 2014. This fact denoted that he did not maintain regularity in the necessary checks to prove the maintenance of his proficiency in instrument flights.

These findings indicated that, at the time of the occurrence, there were vulnerabilities related to the pilot's management of his technical skills, which may have affected his proficiency for instrument flight operations.

According to reports, the aircraft would have taken off from Santa Maria Estancia in visual conditions, but soon after, it would have entered adverse weather conditions with compromised visual references.

In addition, according to the survey, this aircraft was not certified for flights under the IFR rules.

According to the data collected, there were other situations in which the pilot did not consider such conditions impeding the operation, including using the "drilling the layer" artifice. This procedure, when performed correctly, that is, with a properly qualified pilot, using an aircraft approved to fly by instruments and following air traffic regulations, it does not pose any major problems and does not expose the aircraft and its occupants to unacceptable risks.

In this occurrence, such events (aircraft not approved for IFR flight and pilot with the IFR Rating expired) would indicate a possible complacent attitude that would have favored

an inadequate piloting judgment regarding the parameters related to the operation of the aircraft.

It was not possible, however, to determine precisely how long the pilot would have flown without the necessary visual references. However, if the weather conditions were degraded, the decision to takeoff would show an inadequate assessment, which could have led to the aircraft entering critical flight conditions, especially considering that the pilot did not have a valid IFRA Rating.

According to the information obtained by the radar, the aircraft varied in altitude and also in the direction of displacement, indicating that it did not perform navigation in a usual way, which led the Investigation team to consider the possibility of loss of visual references with the ground.

Difficulties in performing that flight without visual references may have been worsened by the pilot's lack of proficiency in instrument flight conditions as his IFRA Rating was overdue and no information about his recent flight experience could be obtained.

Such circumstances may have provided a context favorable to the occurrence of the pilot's perception errors in relation to his position, movement or attitude of his aircraft.

Thus, the hypothesis that there was a spatial disorientation, with the entry of the aircraft into an abnormal attitude was considered quite probable, since all the characteristics for this fact were present. This hypothesis was reinforced by the rather erratic navigation verified by the APP-CG radar.

This hypothesis also took into account that the pilot had the habitual practice to disregard such conditions as impeditive to the flight, due to the fact that his IFRA Rating had expired and also that the aircraft was not certified for IFR flight.

On the equipment, through examinations and research elaborated by necessity of the investigation, there was no abnormality in the aircraft's engine operation nor in its systems.

Also, according to the tests performed, no evidence of fatigue was found in the material of the aircraft structure to which the technician team had access, although structural repairs, different from the standards stipulated by the manufacturer, were verified.

Considering that the aircraft had been involved in an accident before and that the logbooks' records of the structural repairs were incomplete, there were no technical parameters, which would allow an opinion on a possible structural failure.

The arrangement of the wreckage, with the engine completely buried in the ground, and the marks at the scene, denoted that the aircraft had a high angle of downward rate at the time of impact, ruling out the possibility of an attempted landing.

The lack of record of the aircraft repair due to the accident on 26FEB2005 in the aircraft's logbooks, the outdating of these books, added to the untimely activation for the flight, indicated that there were flaws in the processes of monitoring the activities developed with the aircraft PT -JSM.

The proper monitoring of processes related to air activities constitutes a defense against the risks present in aviation. When this management is flawed or absent, it can promote vulnerabilities to operational safety.

Such management failure was present as a latent factor, but it was not possible to prove its direct contribution to the occurrence.

3. CONCLUSIONS.

3.1 Facts.

- a) the pilot had valid Aeronautical Medical Certificate (CMA);
- b) the pilot had valid MLTE and MNTE Ratings;
- c) the pilot's IFRA Rating was overdue since April 2014;
- d) the pilot had experience in that type of flight, but it was not possible to verify his recent experience;
- e) the aircraft had valid Airworthiness Certificate (CA);
- f) the aircraft was not approved for the performance of IFR flights;
- g) the aircraft was within the weight and balance parameters specified by the manufacturer;
- h) the airframe, engine and propeller logbook records were outdated;
- i) the aircraft maintenance / retrieval records after the accident (2005) provided by current legislation were incomplete and were not available to the investigators until 4 years after the accident;
- j) the aircraft took off from the Santa Maria Estancia Aerodrome (SSKG) with two occupants and went to the REA ARAU of the TMA-CG;
- k) according to reports, soon after the take-off the aircraft entered in adverse weather conditions;
- l) the aircraft failed to respond to APP-CG calls seven minutes after take-off;
- m) the wreckage of the aircraft was found 10 nautical miles North of SSKG;
- n) the aircraft was destroyed; and
- o) the occupants suffered fatal injuries.

3.2 Contributing factors.

- **Control skills – undetermined.**

There may have been an inadequate use of the aircraft's flight commands, which led to loss of control.

- **Attitude – undetermined.**

It is possible that the risks involved in the operation have been unduly analyzed, since the meteorological conditions were reported as adverse.

This attitude would denote complacency when flying under critical conditions and may have contributed to the accident.

- **Adverse meteorological conditions – undetermined.**

The take-off of the aircraft followed by the entry into fog or damp fog would indicate that the pilot would have missed the visual flight references by one or more times.

This total or partial loss of flying conditions under visual conditions may have contributed to the loss of control in flight.

- **Disorientation – undetermined.**

It is possible that the pilot has suffered spatial disorientation when entering adverse weather conditions after take-off, which would have led to loss of control of the aircraft and abnormal attitude.

- **Piloting judgment – undetermined.**

The evaluation of whether it would be possible to conduct the flight, even with the presence of an adverse event at the departure Aerodrome, with an aircraft without approval, and the presumption that there would be no adverse meteorology en route, may have contributed to the entering in instrument flight situation without the conditions for it to be carried out safely.

- **Aircraft maintenance – undetermined.**

Failures were observed in the follow up of the maintenance, present as latent factor, however, it was not possible to prove its direct contribution in the occurrence.

- **Perception – undetermined.**

Possible weather restrictions may have provided a context favorable to the occurrence of the pilot's perception errors in relation to his position, movement or attitude of his aircraft.

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

The decision to takeoff, if weather conditions were degraded, would demonstrate an improper decision making process, especially considering that the pilot had not valid IFRA.

- **Other – undetermined.**

The lack of record of the aircraft repair due to the accident on 26FEB2005 in the pilot's logbooks, the outdating of these books, added to the untimely activation for the flight, indicated that there were flaws in the processes of monitoring the activities developed with the aircraft PT -JSM.

These management failures were present as latent factors; however, it was not possible to prove their contributions in the occurrence.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

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 Brazil's National Civil Aviation Agency (ANAC):

A-194/CENIPA/2014 - 01

Issued on 29/01/2019

Act together with the Hora - Hangar, *Oficina and Recuperação de Aviões* LTD. (COM No 6804-03 / ANAC), in order to demonstrate that it possesses and applies all the necessary resources for the proper provision of maintenance services on U206F aircraft, manufactured by Cessna Aircraft. This aims to increase levels of competence required for the performance of the activities for which such organization is certified.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On January 29th, 2019.

