

COMANDO DA AERONÁUTICA
CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE
ACIDENTES AERONÁUTICOS



FINAL REPORT
A-160/CENIPA/2020

OCCURRENCE:	ACCIDENT
AIRCRAFT:	PT-KCK
MODEL:	177B
DATE:	29DEZ2020



NOTICE

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

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

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

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

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

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree n  21713, dated 27 August 1946.

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

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

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

SYNOPSIS

This is the Final Report of the 29Dec2020 accident with the 177B aircraft, registration PT-KCK. The accident was typified as “[UIMC] Unintentional IMC and [LOC-I] Loss of control in flight”.

During the en-route phase of the flight, the pilot possibly lost visual references, and inadvertently entered Instrument Flight Conditions (IMC), which probably led him to lose control of the aircraft.

The airplane structure became overloaded. The right-hand wing separated in flight, and the aircraft subsequently crashed into a river located in the municipality of *Mato Rico*, State of *Paraná*.

The aircraft was destroyed in the crash.

All aircraft occupants (the pilot and three passengers) suffered fatal injuries.

Since the USA is the State of aircraft manufacture, an Accredited Representative of the National Transportation Safety Board (NTSB) was designated for participation in the investigation of the accident.



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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ACC-CW	Curitiba Area Control Center
ANAC	Brazil's National Civil Aviation Agency
AOPA	Aircraft Owners and Pilots Association
CA	Airworthiness Certificate
CAVOK	Ceiling and Visibility OK (base of clouds above 5,000 ft., and horizontal visibility more than 10 km)
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIMAer	Aeronautical Meteorology Integrated Center
CINDACTA	Air Defense and Air Traffic Control Integrated Center
CIV	Pilot Individual Logbook
CM	Registration Certificate
CMA	Aeronautical Medical Certificate
COM	Maintenance Organization Certificate
COVID-19	Coronavirus Disease - 2019
CVA	Airworthiness Verification Certificate
DCTA	Department of Science and Aerospace Technology
DECEA	Department of Aerospace Control
FIR	Flight Information Region
GAMET	General Aviation Meteorological Information (FIR Forecast)
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
IAM	Annual Maintenance Inspection
IFR	Instrument Flight Rules
IFRA	IFR Flight Rating
IMC	Instrument Meteorological Conditions
METAR	Meteorological Aerodrome Report
MNTE	Single-Engine Land Aircraft License
NTSB	National Transportation Safety Board (USA)
OM	Maintenance Organization
OS	Service Order
PCM	Commercial Pilot License – Airplane category
PIC	Pilot in Command
PN	Part Number
PPR	Private Pilot License - Airplane category
PRI	Private Aircraft Registration Category - Instruction
RADAR	Radio Detection And Ranging

REDEMET	Command of Aeronautics Meteorology Network
RETA	Air Transporter and Explorer's Responsibility
SBNF	ICAO location designator - <i>Ministro Victor Konder</i> Aerodrome, <i>Navegantes</i> , State of <i>Santa Catarina</i>
SERIPA V	Fifth Regional Service for Aeronautical Accidents Investigation and Prevention
SGSO	Operational Safety Management System
SIGMET	Significant Meteorological Information
SIGWX	Significant Weather
SIPAER	Aeronautical Accidents Investigation and Prevention System
SN	Serial Number
SSGB	ICAO location designator - <i>Guaratuba</i> Municipal Aerodrome, PR
SSGW	ICAO location designator - <i>Manoel Ribas</i> Aerodrome, <i>Goioerê</i> -PR
SSKM	ICAO location designator - <i>Campo Mourão</i> Aerodrome, PR
SSUM	ICAO location designator - <i>Orlando de Carvalho</i> Aerodrome, <i>Umuarama</i> -PR
SPECI	Aviation Selected Special Weather Report
TPP	Private Air Service Aircraft Registration Category
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

1. FACTUAL INFORMATION.

Aircraft	Model: 177B Registration: PT-KCK Manufacturer: Cessna Aircraft.	Operator: Private.
Occurrence	Date/time: 29DEZ2020 - 10:30 UTC Location: Rural area. Lat. 24°39'33"S Long. 052°17'18"W Municipality – State: Mato Rico - PR	Type(s): [UIMC] Unintended flight in IMC [LOC-I] Loss of control - in-flight

1.1. History of the flight.

At approximately 09:30 UTC, the aircraft took off from SSGW (*Manoel Ribas Aerodrome, Goioerê, State of Paraná*) bound for SSGB (*Guaratuba Municipal Aerodrome, State of Paraná*) on a private flight, with one pilot and three passengers on board.

On the en-route phase of the flight, near the municipality of *Roncador, PR*, at a distance of about 49 NM from SSGW, the aircraft probably entered Instrument Meteorological Conditions (IMC), which may have led to loss of control in-flight and structure overload.

Subsequently, the right-hand wing broke up in flight, and the aircraft crashed into a river in the municipality of *Mato Rico, PR*.

The aircraft was destroyed in the crash. The pilot and all three passengers suffered fatal injuries.

1.2. Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	3	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3. Damage to the aircraft.

The aircraft was destroyed in the crash (Figure 1).

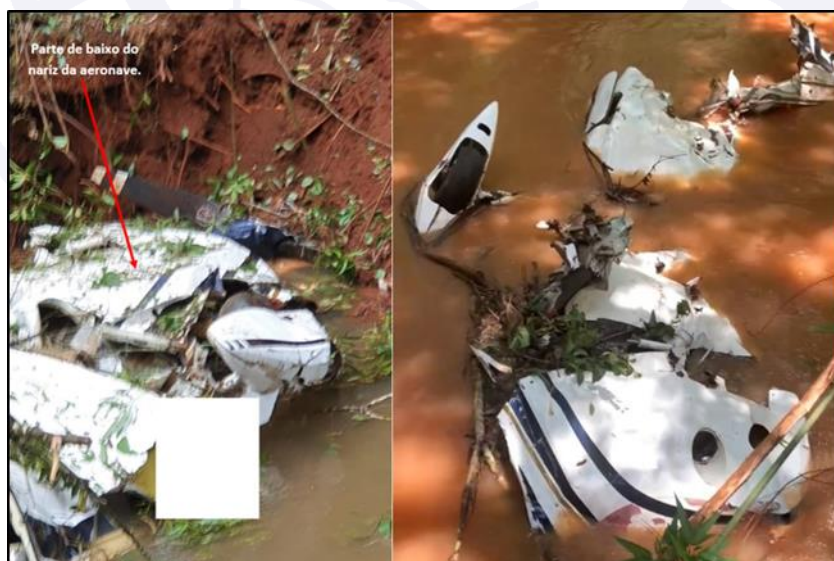


Figure 1 – Upside-down view of the aircraft, and view of the aircraft submerged in the river.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

	PIC
Total	523:30
Total in the last 30 days	01:10
Total in the last 24 hours	00:00
In this type of aircraft	06:15
In this type in the last 30 days	01:10
In this type in the last 24 hours	00:00

N.B.: As per the PIC's (Pilot in Command) Pilot digital Logbook (CIV), the last record was logged on 08Aug2020 relatively to the PR-ORP aircraft, and the flight was registered in the system on 14Sep2020. However, in the aircraft logbook, there were records informing that the PIC also flew on 29Ago2020, 15Sep2020, and 24Sep2020, totaling 4 hours and 40 minutes on those three days.

According to the records of the aircraft logbook, the PIC performed eleven flights on the PT-KCK, the first one on 09Oct2020 between SSKM and SSGW with duration of approximately 30 minutes. In total, 5 hours and 5 minutes of flight on the PT-KCK were recorded before the date of the accident.

The PIC's physical CIV was not found. However, by means of his digital CIV and the logbooks of the PR-ORP and PT-KCK aircraft, it was possible to verify that he flew approximately 7 hours in 2016, 13 hours in 2017, 4 hours in 2019 and 29 hours in 2020. There were no flights logged in 2018.

1.5.2. Personnel training.

The PIC did his Private Pilot - Airplane (PPR) course in 1997 at the *Aeroclub de Londrina*, State of *Paraná*. He performed his last operational check ride on 12Dec2019 at the *Aeroeste Aeroclub do Oeste do Paraná*, State of *Paraná*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a Commercial Pilot license - Airplane (PCM) and a valid Single Engine Land Airplane (MNTE) license. He did not have an IFR Flight - Airplane (IFRA) license.

1.5.4. Qualification and flight experience.

The PIC was qualified to fly under Visual Flight Rules (VFR), and had experience in such type of flight.

1.5.5. Validity of medical certificate.

The PIC held a valid Aeronautical Medical Certificate (CMA).

1.6. Aircraft information.

The aircraft (Serial Number 17702102) was manufactured by Cessna Aircraft in 1974, and registered in the Private Air Services Registration Category (TPP).

The aircraft was purchased through a private sales contract on 03Sep2020. The communication of the aircraft sale was registered at the Notary Public Office (*Tabelionato de Notas e Protesto*) of *Goioerê*, State of *Paraná*, on the same date.

On 22Sep2020, the change of ownership was registered in the Brazilian Aeronautical Registry (RAB). The Aircraft Insurance for Air Operator and Carrier Liability (RETA) was renewed as of 09Sep2020.

The Airworthiness Verification Certificate (CVA) was issued on 08Oct2020. The Airworthiness Certificate (CA) and the Registration Certificate (CM) were valid, and were

issued on 18Nov2020 in the name of the persons who owned the PT-KCK on the date of the occurrence.

According to the aircraft logbook, the PT-KCK performed a flight on 30Mar2019, when it still belonged to the former owner. The aircraft remained without other flight records until 09Oct2020, when a flight was logged by the same operator who later died in the occurrence flight.

It was observed that, after being purchased, the aircraft underwent maintenance checks, aiming at confirming its airworthiness and regularizing the necessary documentation, as the PT-KCK had not flown for a period of a few months. It was also observed that, after provision of the pertinent maintenance services, the PIC performed eleven flights in the aircraft, totaling 5 hours and 5 minutes of flight until the accident.

The airframe, engine, and propeller logbooks were out of date for missing their respective Part-I entries.

The last inspection of the aircraft (type "100 hours+CVA"), was carried out on 08Oct2020 by the *Aerocampo Importação de Aeronaves Ltda* Maintenance Organization (OM) in *Campo Mourão*, State of *Paraná*. The aircraft flew 6 hours and 10 minutes after the inspection.

The last comprehensive inspection of the aircraft (type "200 hours") was carried out by the abovementioned Maintenance Organization on 31Jan2018. The aircraft flew 30 hours and 25 minutes after the inspection.

The PT-KCK aircraft did not have certification for IMC operations.

1.7. Meteorological information.

The Aeronautical Meteorology Integrated Center (CIMAer) issued a meteorological report and forecast messages with en-route weather information between the municipalities of *Goioerê* and *Mato Rico*, State of *Paraná*, on 29Dec2020, valid for the period between 09:00 UTC and 12:00 UTC. The information was available on the Command of Aeronautics Meteorology Network (REDEMET) page. The information indicated that the meteorological conditions were not favorable for VFR flights.

The Significant Weather chart for the State of *Paraná* contained forecast of cloudy skies with isolated showers and rain, base of clouds at 1,000 ft., in addition to convective cloudiness with base at 3,000 ft. (Figure 2).

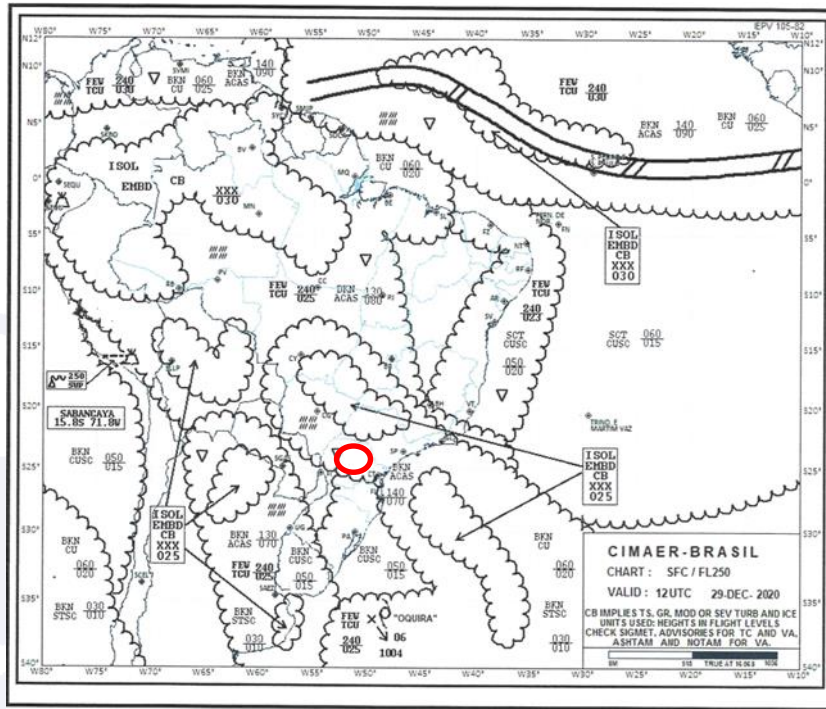


Figure 2 - SIGWX chart, valid until 12:00 (UTC) of 29Dec2020 (area of the accident highlighted by a circle in red).

Satellite images from the Geostationary Operational Environmental Satellite (GOES) indicated good weather over SSGW (aerodrome of origin). However, along the route of the PT-KCK, approximately 15 NM from the starting point, there was degradation of the weather conditions.

The meteorological analysis indicated a significant increase in cloud cover, occurrence of isolated atmospheric electrical discharges, rain in the form of showers, and possibility of turbulence at low levels due to the sudden variation in the wind direction/intensity caused by convective cloudiness (Figures 3 and 4).

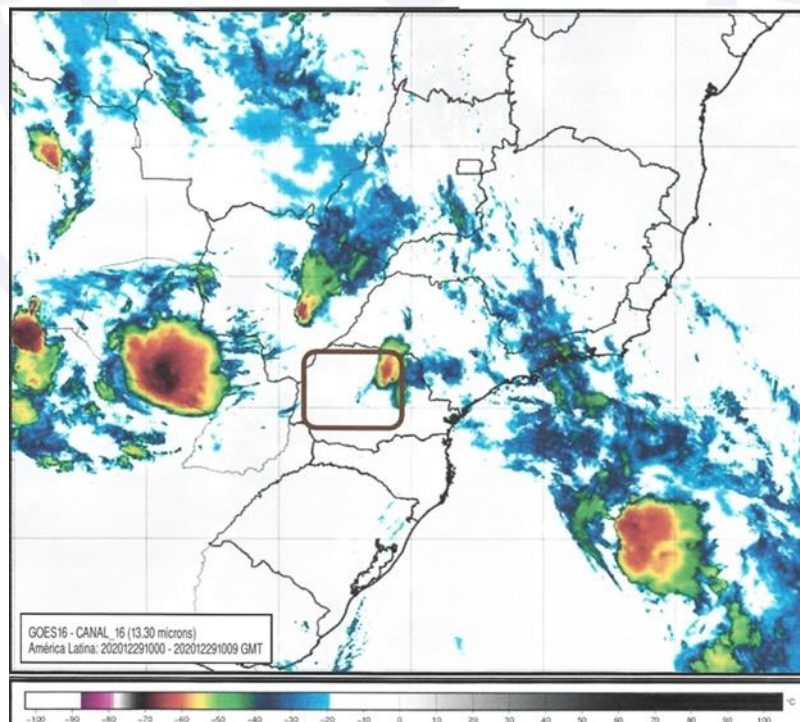


Figure 3 - GOES 16 satellite (infrared) image at 10:00 UTC of 29Dec2020.

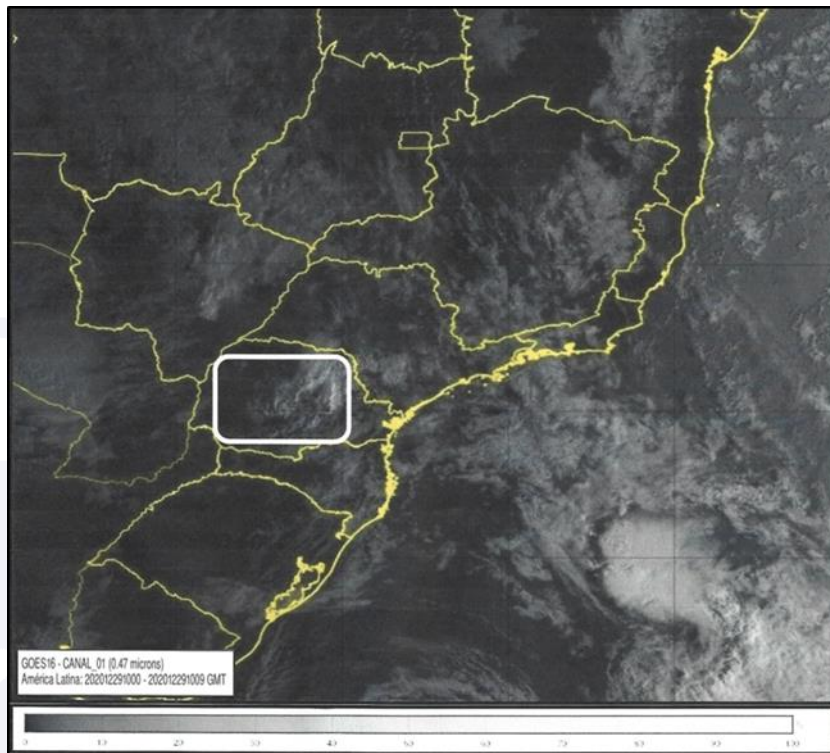


Figure 4 - GOES 16 satellite image (visual) at 10:00 UTC of 29Dec2020.

There was precipitation of up to 15 millimeters next to the place of the occurrence (Figure 5).

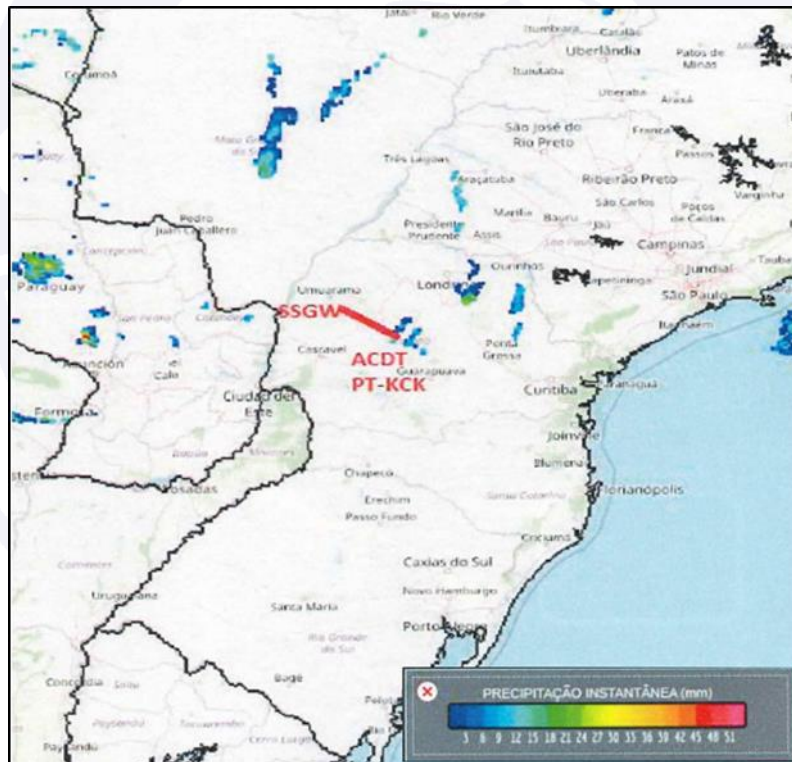


Figure 5 - Satellite Image of Instantaneous Precipitation at 10:00 UTC of 29Dec2020.

The 09:00 UTC and 10:00 UTC Meteorological Aerodrome Reports (METAR) of SSUM (*Orlando de Carvalho Aerodrome, Umuarama-PR*), located at a distance of about 30 NM from the municipality of *Goioerê-PR*) contained the expression CAVOK (Ceiling and Visibility OK), which ratified that the PT-KCK aircraft had taken off in good weather.

However, the regions located further north of the state of *Paraná* had more degraded meteorological conditions, and atmospheric electrical discharges could be identified north

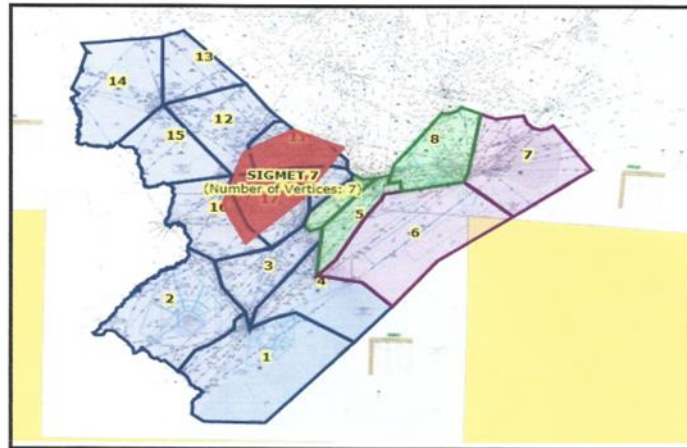
of *Maringá-PR*, as well as the presence of light rain, with a restricted ceiling of 600 ft. in *Londrina-PR*. (Figure 6).

<p>1) METAR – SBCA (CASCAVEL/PR)</p> <p>-METAR SBCA 290900Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SBCA 291000Z 03012KT 9999 FEW040 23/20 Q1014= -METAR SBCA 291100Z 02011KT 9999 FEW040 24/18 Q1014= -METAR SBCA 291200Z 36015KT 9999 FEW010 FEW040TCU 27/21 Q1015=</p> <p>2) METAR – SBLO (LONDRINA/PR)</p> <p>-METAR SBLO 290900Z 04007KT 9999 -RA BKN006 22/22 Q1014= -METAR SBLO 291000Z 04003KT 8000 BKN006 22/22 Q1015= -METAR SBLO 291100Z 07005KT 6000 BKN003 BKN005 22/22 Q1015= -METAR SBLO 291200Z 08005KT 6000 SCT003 BKN006 22/22 Q1016=</p> <p>3) METAR – SBMG (MARINGÁ/PR)</p> <p>-METAR SBMG 290900Z 36009KT 9999 VCTS FEW020 FEW040CB SCT090 22/20 Q1012= -METAR SBMG 291000Z 02010KT 9999 FEW020 SCT090 23/21 Q1012= -METAR SBMG 291100Z 01011KT 9999 FEW020 SCT090 25/22 Q1012= -METAR SBMG 291200Z 36012KT 9999 SCT010 SCT020 26/22 Q1013=</p> <p>4) METAR – SSGG (GUARAPUAVA/PR)</p> <p>-METAR SSGG 290900Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SSGG 291000Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SSGG 291100Z 07007KT 9999 SCT007 FEW030TCU BKN070 20/18 Q1017= -METAR SSGG 291200Z 01003KT 9999 BKN012 FEW030TCU SCT080 22/19 Q1017=</p> <p>5) METAR – SSUM (UMUARAMA/PR)</p> <p>-METAR SSUM 290900Z AUTO 34003KT CAVOK 22/21 Q1012= -METAR SSUM 291000Z AUTO 36007KT CAVOK 24/21 Q1013= -METAR SSUM 291100Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SSUM 291200Z - AUSENTE - não localizada na base de dados da REDEMET</p> <p>6) METAR – SBTB (TOLEDO/PR)</p> <p>-METAR SBTB 290900Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SBTB 291000Z - AUSENTE - não localizada na base de dados da REDEMET -METAR SBTB 291100Z 03012KT 9999 FEW040 23/20 Q1014= -METAR SBTB 291200Z 02010KT 9999 FEW040 26/22 Q1014= -SPECI SBTB 291220Z 01010KT 9999 TS VCSH FEW010 SCT030 FEW035CB 25/21 Q1014=</p>
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Figure 6 - METAR/SPECI summary of aerodromes near the take-off location.

The SIGMET (Significant Meteorological Information) showed built-in thunderstorms in the State of *Paraná* (Figure 7), and the GAMET (General Aviation Meteorological Information, FIR Area/Sub-area Forecast) predicted ceiling layers at 300 ft. and 1,000 ft. (Figure 8).

SBCW SIGMET 7 VALID 290630/291030 SBCW - SBCW CURITIBA FIR EMBD TS FCST WI S2130 W04942 - S2231 W05133 - S2444 W05220 - S2619 W05125 - S2422 W04916 - S2211 W04749 - S2130 W04942 TOP FL400 STNR NC=



SBCW SIGMET 10 VALID 291030/291345 SBCW - SBCW CURITIBA FIR EMBD TS FCST WI S2211 W05022 - S2449 W04801 - S2642 W05053 - S2327 W05253 - S2211 W05022 TOP FL400 STNR NC=

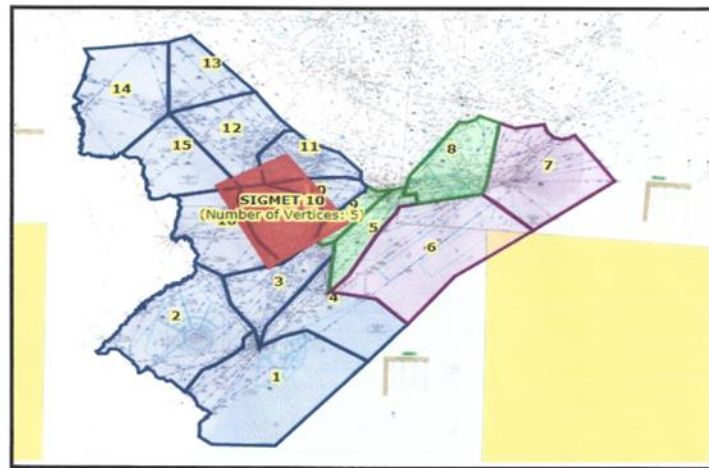


Figure 7 - 29Dec2020 SIGMET between 06:30 and 13:45 UTC.

SBCW GAMET VALID 290600/291200 SBGL - SBCW CURITIBA FIR BLW FL100

SECN I

SFC VIS: N OF S22 AND W OF W045 2000 RA BR

SIGWX: N OF S22 AND W OF W045 ISOL TS

SIG CLD: N OF S22 AND W OF W045 ISOL EMBD TCU/CB 2500/ABV 10000FT AGL/AMSL

N OF S22 AND W OF W045 BKN 0300/2000FT AGL/AMSL

SECN II

PSYS: NIL

WIND/T: 2000FT: 060/09KT PS21 5000FT: 330/05KT PS17 10000FT: 270/09KT PS07

CLD: E OF W053 BKN STSC 1000/3000FT AGL/AMSL E OF W053 SCT/BKN ACAS 9000/ABV 10000FT AGL/AMSL AGL

FZLVL: ABV 10000FT AGL MNM

QNH: 1010 HPA

SEA: T24 HGT 2M

VA: NIL=

Figure 8 – 29Dec2020 GAMET between 06:00 and 12:00 UTC.

1.8. Aids to navigation.

NIL.

1.9. Communications.

From the transcript of the audios containing communication between the PT-KCK and the ATC agencies, the investigation committee verified that the pilot had already made contact during the cruise phase.

The flight level was confirmed to be FL075, and the estimates of landing and entry into sector 17 of the *Curitiba* Flight Information Region (FIR) were relayed to the *Curitiba* Area Control Center (ACC-CW). There were no technical abnormalities in the communication equipment during the flight, and everything was normal between 10:18:50 UTC and 10:20:01 UTC.

The investigation committee accessed some RADAR images of the aircraft, from the first contact at 09:59:26 UTC until 10:23:00 UTC, when the ACC-CW lost RADAR contact with the aircraft, as shown in Figure 9.

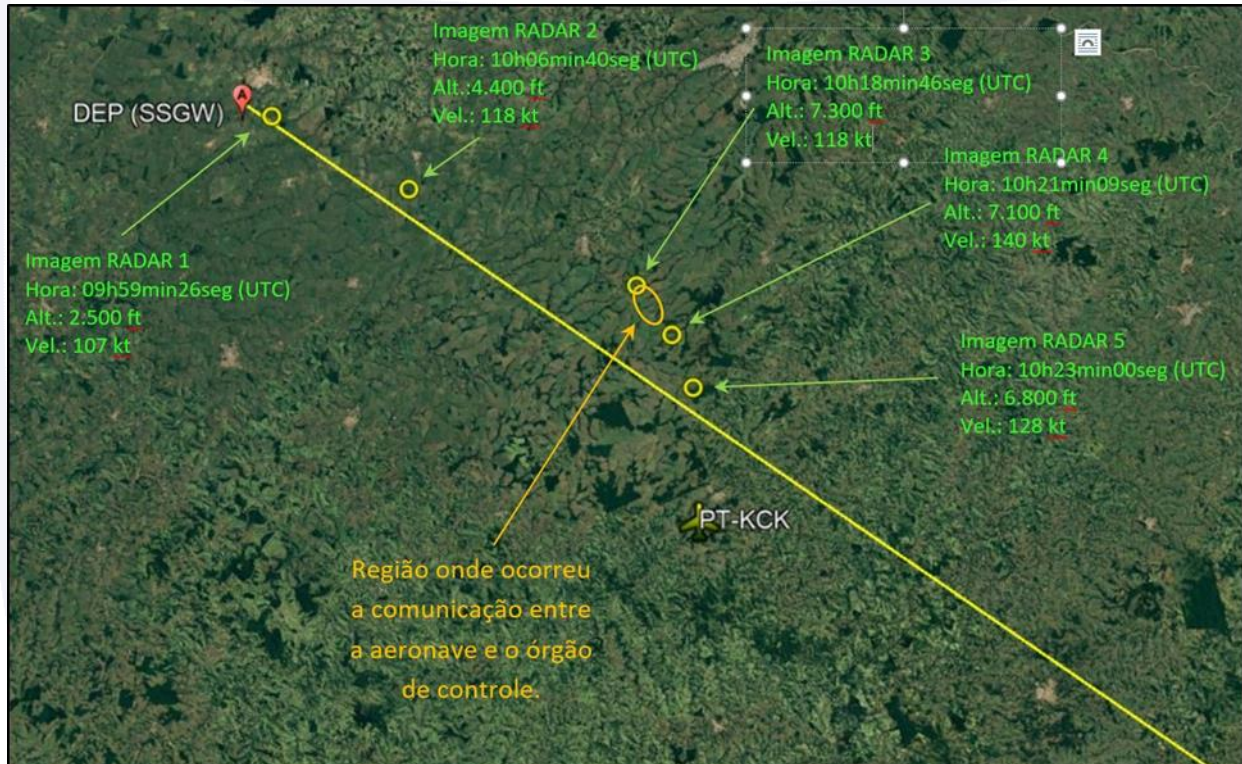


Figure 9 - Points where RADAR contact was recovered, and moment radio communication exchange between the aircraft and the ATC agency.

1.10. Aerodrome information.

The occurrence was outside of aerodrome area.

1.11. Flight recorders.

A *Garmin Aera 500 Global Positioning System* (GPS) piece of equipment was recovered from the aircraft wreckage (Figure 10).

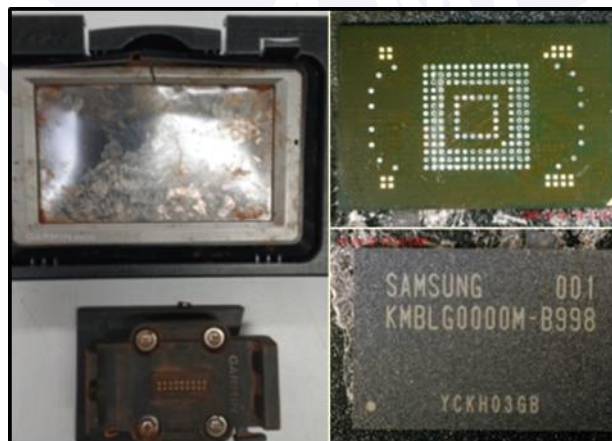


Figure 10 - Garmin Aera 500 (left) and respective memory chip (right).

The aforementioned GPS was sent to the USA for analysis by the Vehicle-Recorders Division of the National Transportation Safety Board (NTSB), which concluded that it did not contain any significant data.

Technicians removed the Samsung KMBLG0000M-B998 chip from the circuit board, and created a binary image, about 3.8GB in size. Initially, attempts were made to convert the data into engineering units, to no avail.

Further investigations into the binary file, by means of laboratory equipment, revealed lack of historical data in the referred chip. Thus, it was not possible to obtain information concerning the day of the accident capable of contributing to the investigation.

1.12. Wreckage and impact information.

A dweller of a farm close to the accident site reported having seen the PT-KCK still in flight at low altitude. After the aircraft disappeared among the treetops, a very loud noise was heard. The dweller, for not being familiar with aviation, was not able to specify whether the aircraft was under the pilot's control or falling uncontrollably (Figures 11, 12, 13 and 14).

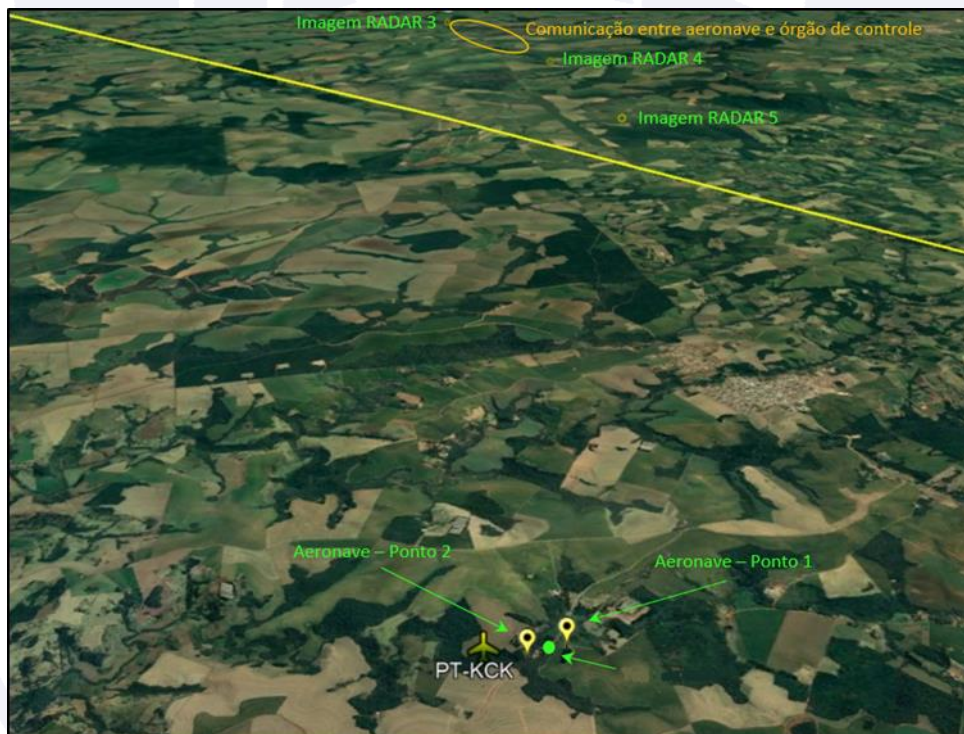


Figure 11 - Possible travel of the aircraft, according to the RADAR and the observer.

From the observer's report, it was possible to infer that the aircraft entered a valley, about 85 m below the highest point of the relief.



Figure 12 - Top view of the possible aircraft travel segments in the valley.

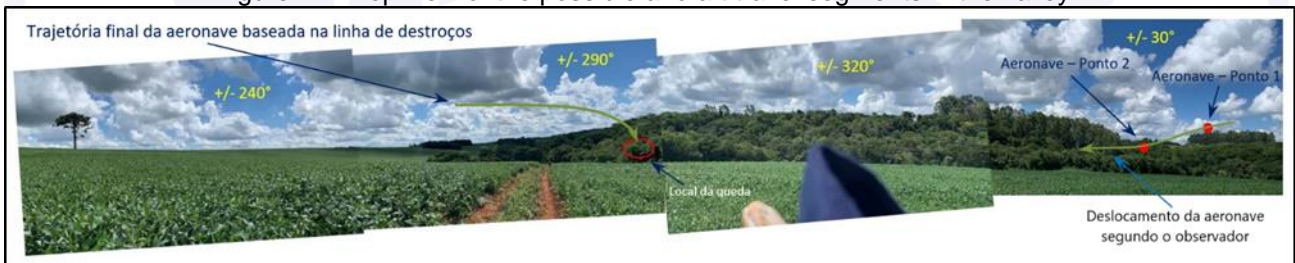


Figure 13 - Panoramic image of the accident site with the possible aircraft travel segments.



Figure 14 - Image of the probable downward travel (fall) of the aircraft.

At the initial investigation, no impact marks were found other than those observed in the crash site. Members of the Military Police reported that dozens of people were at the scene before the crash site could be isolated. Therefore, it is possible that parts of the aircraft were moved by third parties.

Most of the aircraft was found submerged in a river of the region, and only a few tree branches along the vertical path traveled by the aircraft were broken. Several other components lay scattered between the riparian forest and a nearby crop, as shown in Figure 14.

It was also observed that the right-hand wing had detached in flight, and that the right-hand wing-tip fairing, in turn, detached from its attachment site, but was found close to the right-hand wing.

The left-hand wing remained connected to the fuselage even after the impact with the ground. The tip of left-hand wing was subjected to an intense “G load”, which ripped out several rivets, but the component did not separate from the left-hand wing.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

The investigators gathered data related to the PIC, and did not identify any health issues, either physical or mental, capable of interfering with his air activity. The PIC had a valid health certificate and a favorable opinion for a 1st Class Aeronautical Medical Certificate, without any relevant diagnoses.

In consonance with his previous medical history, the PIC did not have any illnesses capable of impairing his performance in piloting a private aircraft. An alcohol concentration test was also carried out, with a negative result.

The PIC's cause of death derived from the injuries suffered by him at the moment of the impact.

As for his workload in the days closely anteceding the accident, there was no overload in the last 48 hours prior to the occurrence.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC was described as a calm, quiet, dedicated, responsible person, possessing good character and competence, who valued being with his family and friends. According to reports, he was also regarded as a cautious, careful, experienced pilot, who would always seek to fly during daytime.

He started his pilot training in the city of *Londrina-PR*, and concluded his training in *São Paulo-SP*. When starting his career as a pilot, he opened a company for provision of aero-agricultural services in partnership with friends. At that time, he had been operating agricultural aircraft for approximately five years.

While working in agricultural aviation, the PIC suffered an accident in which he collided with electric wires and had to make a forced landing. After that episode, he quit his activities as an agricultural pilot, and left the company. At that time, he already had other businesses to which he started dedicating full-time attention.

According to his relatives and friends in interviews, the PIC was enjoying a positive moment in his personal life and, apparently, was not enduring any affective, professional or financial conflicts. In the days preceding the accident, he was very motivated for the trip between *Goioerê* and *Guaratuba*, expressing his great desire to spend the end-of-year festivities with his family and friends on the *Paraná* coast.

Nation-wise, it was a complicated moment, as the COVID-19 pandemic had ravaged the country for ten months. According to reports, that New Year's Eve would be an opportunity to rest, relax and relieve the tensions imposed by social isolation. There was considerable self-imposed pressure on the PIC, as the other people who would participate in the festivities were already on their way toward the selected venue.

There were reports that the PIC had initially planned the flight for 28Dec2020, but due to unfavorable weather on that day, the flight was postponed to the following day.

1.14. Fire.

There was neither in-flight fire nor post-impact fire.

1.15. Survival aspects.

As the aircraft was falling, the passengers were thrown out away from the aircraft, except for the PIC, who remained in the cabin even after the collision with the ground. The aircraft was found by local dwellers, who called the police authorities. There were no survivors.

1.16. Tests and research.

The O-360-A1F6D aircraft engine (Serial Number L-18791-36A) manufactured by *Lycoming Engines*, was disassembled and inspected by engineers of the Department of Science and Aerospace Technology (DCTA).

It was verified that all mechanical components of the engine were intact, indicating normal operation (in opposition to being inoperative) at the moment of accident. Production of power by the engine was characterized by the slight forward bending observed in one of the propeller blades.

In the initial analysis, investigators verified that the damage sustained by the engine resulted from the PT-KCK accident. In addition, they found a large amount of clay inside the engine, due to the fact that the aircraft was found submerged in a river. Some components, such as magnetos, main oil filters, and the fuel pump, were ripped off their housing at the moment of impact with the ground, as shown in Figure 15.



Figure 15 - Rear view of the engine.

As for the fuel system, one was not able to perform functional tests of either the carburetor or the fuel pump. In the carburetor, a large amount of earth, mud and water was found inside the vat. In the fuel pump, one observed that the pump body had broken as a result of the impact. After the pump was disassembled, corrosion was observed on account of the presence of water in its interior.



Figure 16 - View of engine components.

In the ignition system, only the spark plugs were examined, since the magnets were not found. The spark plugs analyzed had an aspect and color indicative of normal operation.



Figure 17 – General view of the spark plugs.

The lubricating-oil pump was not disassembled, but upon being turned manually, it was observed that it was stuck, probably due to the amount of clay found in the rear cover.

No abnormal wear was found on the cams capable of compromising the production of engine power.

Regarding the cylinders and pistons of the engine, an attempt was made to identify aspects such as marks, pre-ignition, lubrication, and detonation. However, no abnormality was found, except for the existence of oxidation of the components due to the presence of water inside the cylinders, as shown in Figure 18.

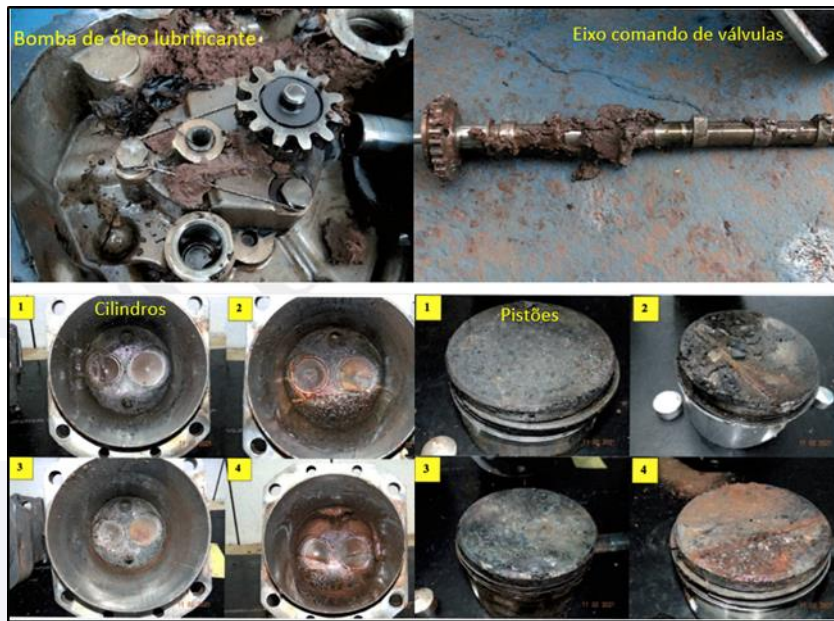


Figure 18 - View of engine components.

The propeller was the component showing evidence of normal engine operation at the moment of the accident: a slight forward bend, observed at the tip of one of the blades, indicated by the arrow and highlighted by the circle (Figure 19).

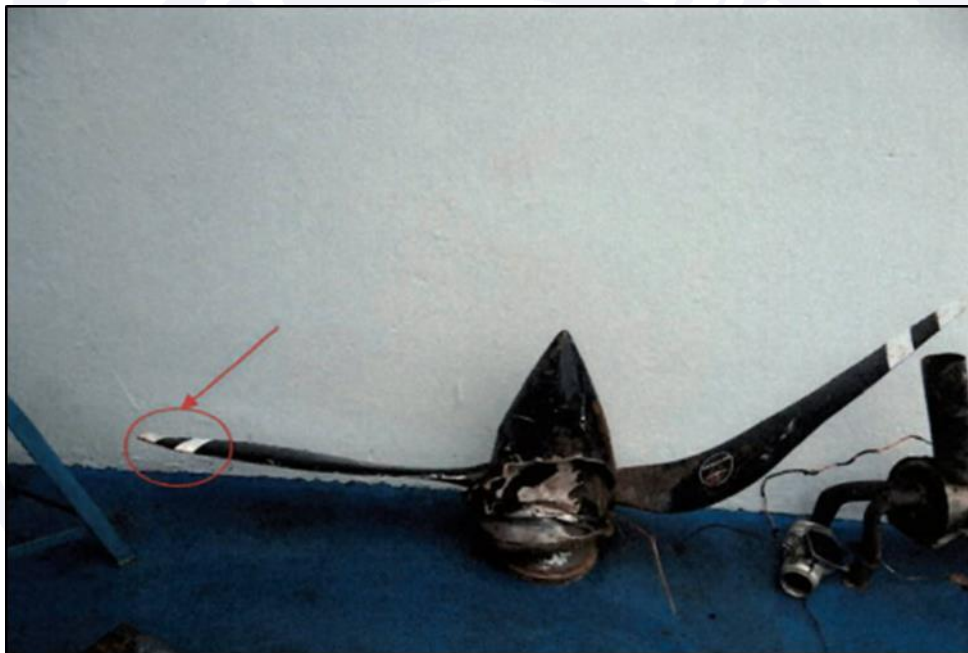


Figure 19 - General view of the propeller, with one blade showing a slight forward bend (left), while the other blade had a more accentuated forward bend close to its root.

The left blade was probably the first to collide with the obstacle, and then the spinner impact occurred, leaving the mark shown in Figure 20. There was also a rupture of the crankshaft next to the coupling flange with the propeller.



Figure 20 - Mark on the spinner.

The bend of the other blade (right) close to its root may be explained by the inertia of the aircraft, which, while still in motion, may have moved over the propeller with the blade caught in some obstacle.

At the analysis of the aircraft wreckage, it was verified that the right-hand wing had separated in flight, and that its leading edge was inflated from the inside out, as shown in Figure 21.



Figure 21 - View of the aircraft, reassembled after the initial action, with details on the leading edge of the right wing, which showed characteristics of inflation.

Later, parts of the wing were sent to Department of Science and Aerospace Technology (DCTA) for analysis.

They verified that all the material analyzed presented failure characteristics typical of overload. The right-hand wing featured overload on the lower spar, in the riveted region of the trailing edge, and breakage of the wing-tip fairing also due to overload.

In the second semester of 2020, the right-wing tip (TIP ASSEMBLY-WING RH) was replaced with a new one, as the original part had signs of wear and tear, as well as minor damage due to the long time of usage.

In the initial investigation, the two wingtips equipping the aircraft at the time of the accident were collected.

Investigators also had access to the right-wing tip that had been replaced. Those three items were sent to the DCTA for analysis. The invoice describing the new part that was installed in the PT-KCK was also found and examined.

The Cessna 177 Parts Catalog contained information that the right wingtip of this aircraft could have two different Part Numbers: PN 1723000-200 or PN 1723005-202.

However, the invoice in question had a PN 1723005-200 for the item described as "*Ponta Asa Cessna177 Cardinal Dir*". Thus, one found out that the part purchased by the operator had a PN incompatible with the Tip Assembly-Wing RH of the Cessna 177.

The right- and left-hand wing-tip fairings equipping the aircraft at the time of the accident had an average thickness of 1.5 mm.

The fairing of the former right wing-tip, which had equipped the PT-KCK months before, had an average thickness of 3.5 mm.

In the analysis of the support structures of the right-hand wing, as shown in Figure 22, in the fragments of the lower right-hand spar, it was possible to observe details of surfaces with fracture characteristics consistent with overload.

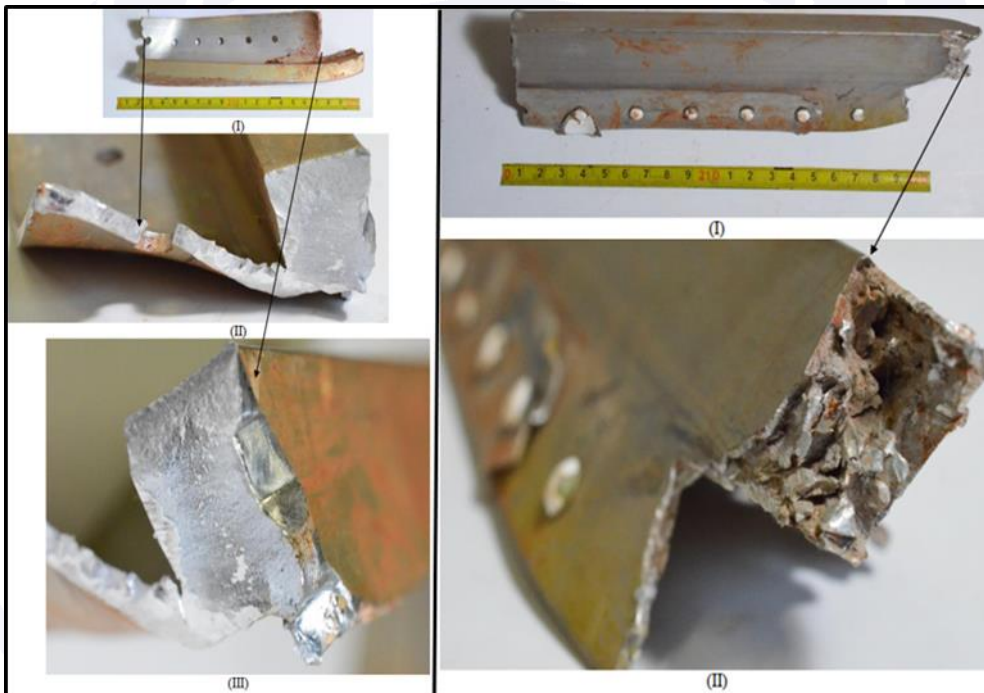


Figure 22 - Fragments of the lower right-hand spar. In (I) an overview, in (II, III) detail of surfaces with fracture characteristics compatible with overload.

From a schematic view of the wing, presented by the original drawing extracted from the aircraft manual, a mock-up of the right wing along with its fractures was built (Figure 23).

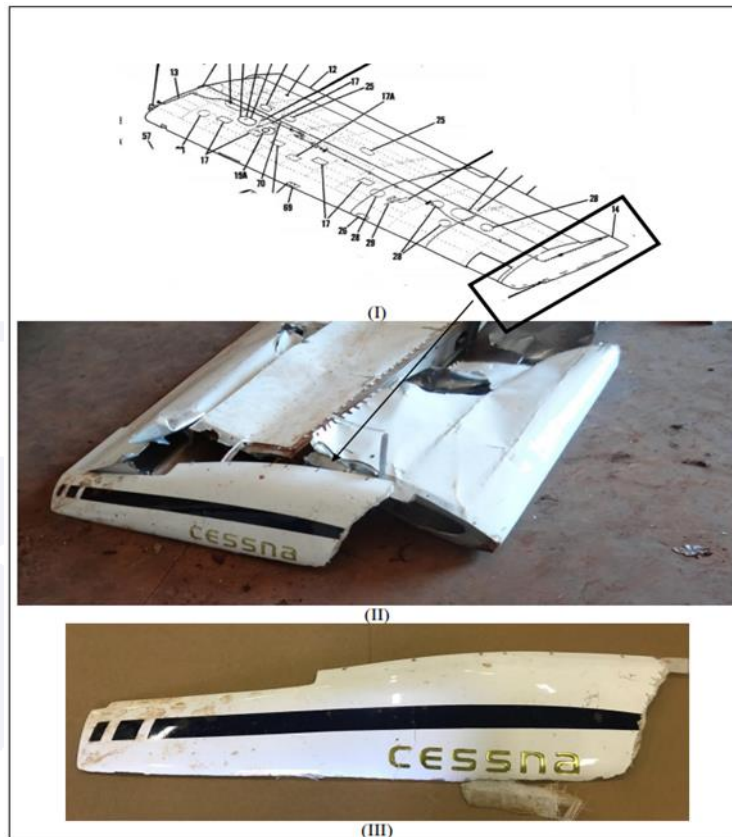


Figure 23 - Schematic view of the wing (I), mockup of the right wing (II), and detail of the fractured fairing (III).

The right and left wingtips equipping the PT-KCK at the time of the occurrence were identified, compared, and analyzed, as well as another right wingtip which had formerly equipped the aircraft prior to the accident (Figure 24).



Figure 24 - Fairing of the left-wing tip (I); fractured fairing of the right-wing tip (II); and original fairing that had equipped the PT-KCK prior to the accident (III).

Upon analysis of the fairings of the left- and right-wing tips, it was found that both had overload-related tears in the riveted region, and that the average thickness of the material (measured by means of a caliper) was 1.50 mm (Figures 25 and 26).

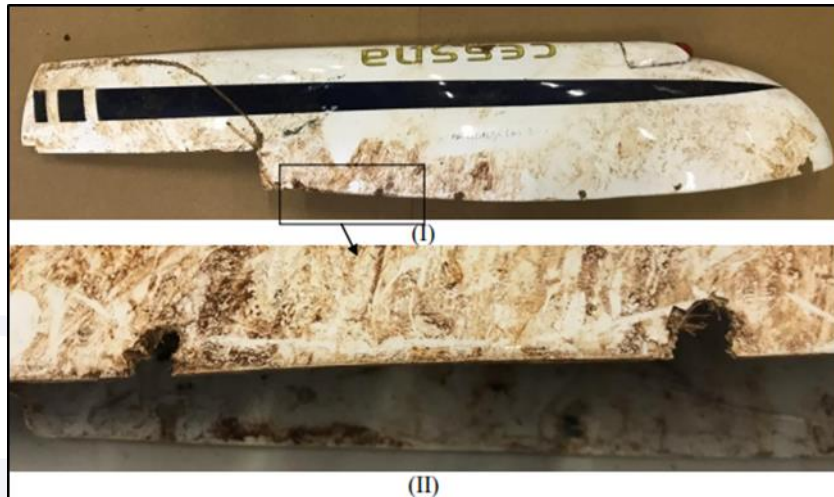


Figure 25 - Details of the left-wing tip fairing, emphasizing the overload tears in the riveted region.



Figure 26 - Details of the right-wing tip fairing, emphasizing the overload tears in the riveted region.

For comparison purposes, measurements were taken of the original right-wing tip fairing, which had equipped aircraft prior to the accident.

By means of a digital caliper, it was verified that the average thickness of the original part was 3.50 mm (Figure 27).



Figure 27 – Right-wing tip that ha equipped the aircraft prior to the accident (I); detail of the holes for fairing attachment (II).

It was also observed that the wing surfaces in contact with wingtip fairings showed fractures with overload characteristics (Figure 28).

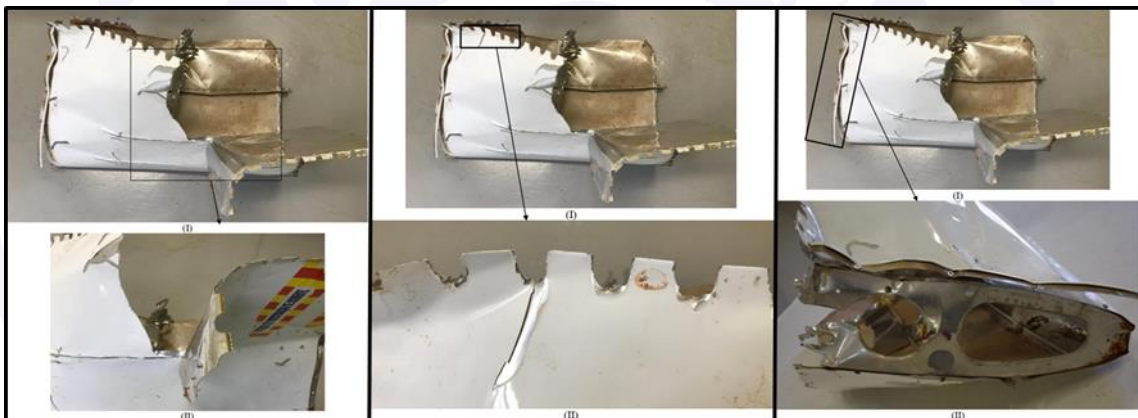


Figure 28 - Overview of a fractured surface (I), and details of the fractured surfaces with overload characteristics (II).

1.17. Organizational and management information.

NIL.

1.18. Operational information.

According to verification, the PIC had presented a flight plan on 28Dec2020 at 13:43 UTC, containing information related to takeoff from SSGW on the following day (ETD: 09:30 UTC of 29Dec2020).

The flight plan included the intention to maintain a VFR flight after takeoff, climbing to flight level 075 (FL 075), maintaining a cruise speed of approximately 110 kt, and proceeding directly to the destination aerodrome (SSGB) , as shown in Figure 29.



Figure 29 – Illustration the planned flight, and distance traveled up to the crash site.

The flight plan also listed the following pieces of information: the aircraft was equipped with a mode C transponder; the total flight time was estimated at 2 hours and 20 minutes; and the selected alternate aerodrome was SBNF (*Ministro Victor Konder Aerodrome, Navegantes, SC*). Additionally, the aircraft would have a fuel endurance of 5 hours and 30 minutes, with 04 persons on board.

Observers related that, on the day before the accident, the PIC had refueled and prepared the aircraft for the flight. It was also reported that the luggage of the pilot and passengers was transported overland by family members. On board the aircraft, the occupants had only their small hand-luggage.

According to data available, it is estimated that the aircraft was within the weight and balance limits specified by the manufacturer. The data only corroborated with the impression of the observers, without necessarily expressing the actual situation of the aircraft at the time of the accident.

The Pilot's Manual of the Cessna Model 177 Cardinal Aircraft contained some guidelines for crew members who, inadvertently, entered IMC, such as executing a 180°-turn within clouds, emergency descent through clouds, and recovering from a spiral dive. However, it was not possible to confirm whether the PIC followed any of those guidelines during the flight.

1.19. Additional information.

After verifying that the thickness of the wing-tips equipping the aircraft (1.50 mm) was not the same as the thickness of the replaced right-wing tip (3.50 mm) that once equipped the aircraft prior to the accident, the investigation committee identified that the thinner right-wing tip had been purchased from a company named *Aeroservice Comércio de Peças e Importação Ltda.*, according to the Electronic Invoice (NF-e) no. 6084, series 1, issued on 03Sep2020, as described below:

- Wing tip CESSNA 177 Cardinal right 1723005-200.

Thus, on 15Oct2021, the investigation committee issued a letter to the aforementioned company, questioning whether the material mentioned in the electronic invoice was an Approved Aeronautical Product. However, no response was received.

In consequence, a letter was sent to Brazil's National Civil Aviation Agency (ANAC), dated 19Apr 2022, containing the same questions. In its response, the ANAC informed that

the *Aeroservice Ltda.* Maintenance Organization (OM Certificate nº 0102-02/ANAC) had its certificate revoked on 10Sep2014.

Besides, the Agency informed that companies that resell aeronautical parts were not under the ANAC's supervision and surveillance, and that, in accordance with the current legislation, both the operator and the maintainer were responsible for verifying the applicability and traceability of the materials and parts employed in aircraft and components. Therefore, it was suggested that the query be directed to the person responsible for installing the wing tip on the PT-KCK aircraft.

Based on the ANAC's response, on 17May2022, an official letter was issued to *Aerocampo Importação de Aeronaves Ltda.*, an OM contracted by the operator to carry out the "100 hours+CVA" inspection, as well as the verification of the aircraft airworthiness conditions.

In response, the OM stated that, on 14Aug2020, they had opened the Service Order (OS) 083/20, with the purpose of surveying the costs for the new owner to make the PT-KCK airworthy.

The OS remained open until 08Oct2020, as it was agreed between the parties that the new owner would have the services performed in that OM. The services were finished on 08Oct2020 (closing date of the OS, and date of issuance of the CVA).

On 09Oct2020, the aircraft was ferried from SSKM to SSGW. The company also informed that, when the PT-KCK entered the OM for the planned services and inspections, the new right-wing tip was already equipping the aircraft.

According to the Maintenance Organization, the installation of the component had been carried out by the very operator, who was not an aircraft maintenance mechanic, while the aircraft was in the hangar, as the service for installing the component was of low complexity. No records were found regarding the installation of the said wingtip after its acquisition. Regarding the component, the *Aerocampo* OM was responsible for the removal, painting, and reinstallation services.

The fact that a small and low-performance aircraft lost the fairing of one of the wing-tips would not, in historical terms, generate any further serious problems, nor the disruption of essential components of the aircraft structure.

As an example, one might refer to the accident involving a Cessna 172, registration N254RA, registered and operated by Reynolds Aviation, which hit a tower cable on 21Dec2018, while performing a low-altitude flight for verification of oil pipelines located south of the city of Abilene, Texas.

The aircraft lost 1.3 m of its left-hand wing, including its whole aileron, but managed to continue flying for another 10 NM until landing safely at the airport of that locality.

In terms of spatial disorientation, about 80% of human orientation is achieved through the sense of sight (external visual references). The other 20% are shared between the inner ear and the proprioceptive system (sensory system, which allows the individual to perceive the location, position and orientation of the body in space).

When flying, a pilot is operating in an unnatural environment that may be under the influence of different forces. Normally, it is easy to orient oneself during a VFR flight, as there are visual references on the horizon outside the aircraft and, in a normal flight, there is only the 1G force acting on the crew. Even a sharp turn with a 2G force is usually not a problem as long as the horizon is still visible.

But when a pilot flying under VMC enters cloud formations, the horizon disappears, and the external sight is lost, i.e. 80% of the spatial orientation capability is also lost. If the

flight attitude changes, or if any maneuvers are made that result in forces greater than 1G, the sense of balance will also change.

In 1954, at the request of the AOPA (Aircraft Owners and Pilots Association), the American University of Illinois carried out a study entitled "180-Degree Turn Experiment". The aim of the work was to enable pilots not qualified to fly under Instrument Flight Rules to safely perform a 180°-turn in order to evade an IMC situation.

In the initial test, before any previous instruction, 20 pilots not qualified for IFR flights, aged 19 through 60 years old, with experience ranging from 31 to 1,625 hours of flight, underwent instrument flight in a simulator.

None of them managed to land safely. On average, the flight time lasted 178 seconds before collision with the ground. Despite being an old study, it demonstrates that a pilot not qualified to fly IMC, and without specific preparation, would hardly survive an inadvertent entry into Instrument Flight Conditions.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

The aircraft was engaged on a private passenger transport flight.

The former owner of the aircraft performed his last local flight at SSKM on 03Mar2019. From that day onwards, no other flight was recorded in the aircraft logbook until the date of 09Oct2020, when a flight was performed by the PIC between SSKM and SSGW, with duration of about 30 minutes.

It was verified that, on 14Aug2020, in accordance with the OS no. 083/20, the aircraft entered a maintenance organization for a survey of the parts to be replaced, and possible services to be performed in view of confirming the aircraft airworthiness condition, since the PT-KCK was going through a purchase and selling process.

Both the aircraft airworthiness and registration certificates were valid. The airframe, engine, and propeller logbooks, on the other hand, were out of date due to absence of pertinent Part-I records.

The aircraft inspections were up to date, and the latest one ("100 hours+CVA" type) was performed on 08Oct2020. A comprehensive inspection ("200 hours" type) was carried out on 31Jan2018 by the same maintenance organization. The aircraft had flown 30 hours and 25 minutes after that major inspection.

It was not possible to locate the PIC's physical Pilot Logbook. However, his digital CIV and aircraft logbook showed that he performed private flights in August and September of 2020 on another aircraft, prior to purchasing the occurrence Cessna 177. Piloting the PT-KCK aircraft, the PIC conducted three flights in the month of October, six in November, and two in December. Thus, it was observed that he maintained a certain frequency of flights, keeping in touch with the air activity.

On 28Dec2020, the PIC filed a flight plan for a flight on 29Dec2020 between SSGW and SSGB (cruise level FL075, speed approximately 110 kt).

The first RADAR contact was obtained by the air traffic control at 09:59 UTC shortly after the aircraft took off. It had already reached an altitude of around 2,200 ft., at a speed of approximately 107 kt.

Radio contact was established between the pilot and the air traffic control unit. The transcripts of the recordings revealed neither any technical abnormalities of the communication equipment during the flight, nor any alterations in the PIC's communication indicating that the aircraft might be experiencing an abnormal situation.

The last RADAR contact occurred at 10:23 UTC, when the aircraft was seen making a slight turn to the right, losing altitude and increasing speed. The last time the aircraft was spotted by an observer, it was flying close to the crash site at low altitude.

Forecast and en-route weather messages were available on the REDEMETS page, and the meteorological conditions between the municipalities of *Goioerê* and *Mato Rico*, State of *Paraná*, were not consistent with VFR flights.

The SIGWX chart forecast cloudy skies with isolated showers, rain and convective clouds over the State of *Paraná*, especially in the eastern region.

Satellite images indicated good weather in the region where the flight of PT-KCK had started. However, further to the east, the weather conditions were not appropriate for visual flights.

It was verified that, approximately 15 NM from the aerodrome of origin, there was degradation of the meteorological conditions, with a significant increase of the cloud cover, occurrence of isolated lightning, rain in the form of showers, precipitation of up to 15 mm, and possibility of turbulence at low levels due to sudden variation of the wind direction and speed, caused by convective cloudiness.

Also, despite the good weather conditions at SSGW, there were certain meteorological phenomena, such as horizontal visibility (mainly), amount of clouds, thunderstorms, precipitation and turbulence, which created a scenario unfavorable for VFR flights.

An observer close to the place of occurrence said he saw the aircraft at low altitude, flying near the tree-tops. Shortly afterwards, it disappeared. A little later, a very loud noise was heard. From the observer's report, it was possible to infer that the aircraft entered a valley, about 85 meters below the highest point of the local relief.

The analysis of the wreckage revealed that the right-hand wing and other smaller parts detached from the aircraft in flight. The fuselage was found in a local river, but several other components were scattered between a riparian forest and a nearby plantation area.

The PIC remained in the cabin until the impact with the ground, but the passengers were thrown out of the aircraft during flight. These facts indicate that the aircraft and its occupants were subjected to a high load-factor, which is typical in a situation of loss of control in flight after an inadvertent entry into IMC.

There was no excessive workload in the 48 hours prior to the occurrence, and a medical expert examination concluded that the PIC's *causa mortis* was a direct consequence of the injuries received at the impact, with no health problems being identified prior to the accident. A blood alcohol-concentration test was also carried out, with a negative result.

After the initial investigative action, the wreckage was removed from the occurrence area, and examined anew by the investigation committee, which verified the need for technical analysis of some of the aircraft components.

It was found that the PT-KCK's engine was operating (and not stopped) at the time of impact. Production of power by the engine was characterized by the slight, forward bend observed in one of the propeller blades.

Parts of the right-hand wing, which separated in flight, were also sent for analysis by DCTA engineers. They observed that, at several points, the material showed failure characteristics that were typical of overload.

The right-hand wing had ruptures due to overload, mainly in the lower spar, in the riveted region of the trailing edge, and in the fairing of the wingtip. The right-hand wing was found separated from the fuselage, however close to it. The right-wing tip, in turn, had all its rivets ruptured, and separated from the wing, but was also found a few meters from the rest

of the aircraft. The collapse of the right wing and its components occurred with the PT-KCK still in flight.

The left-hand wing was found still connected to the fuselage. The left-wing tip, despite having several rivets broken, was also attached to the corresponding wing.

During the climb, on the occasion of the radio contacts made between the PT-KCK and the control agencies, no abnormality was reported. However, upon reaching its cruise level, the aircraft entered a region of bad weather.

The PIC was not qualified to fly IFR, and the PT-KCK was not certified for such type of operation. The aircraft manual provided for some actions in case of inadvertent entry into clouds; however, it was not possible to confirm whether the pilot was aware of those actions or whether he performed any of them.

Possibly, after the unintentional entry into IMC, the PIC suffered spatial disorientation due to the loss of visual references and, consequently, may have lost control of the aircraft. Thus, it is very likely that the PIC, when encountering bad weather, experienced spatial disorientation, which resulted in loss of control of the aircraft in flight.

The possibility that the PT-KCK was out of control, in addition to the probable abrupt inputs in the flight controls performed by the pilot in an attempt to regain control of the flight, resulted in passing beyond the structural limits of the aircraft. The high load-factor applied to this Cessna 177B caused the rupture of crucial components of the airframe structure close to the ground, but with the aircraft still in flight.

When a pilot not qualified for IFR flights encounters adverse weather conditions, it is extremely important that the visual references with the terrain be not lost.

In many cases, deviations can prevent an aircraft from entering IMC, but sometimes the safest action to be taken is to discontinue the flight, returning to the aerodrome of origin, or performing a precautionary landing in a safe place. However, such decision was not adopted in the case in question.

According to reports from family members and colleagues close to the PIC, there was considerable self-imposed pressure, as there would be a year-end party, and the PIC's family, as well as his friends, were waiting for him on the coast of *Paraná*. Some of those people had already arrived at the venue, and others were on the way.

It was very important for the PIC to accomplish the flight between the two locations on that day. There were reports that he had initially planned the flight for the 28th of December 2020, but on account of the existing unfavorable weather, the flight had been postponed to the following day. Such fact may have contributed even more to increasing his expectations for the success of the trip.

3. CONCLUSIONS.

3.1. Findings.

- a) the PIC held a valid Aeronautical Medical Certificate (CMA);
- b) the PIC had a valid MNTE license, but did not have an IFR flight rating;
- c) the PIC had qualification for, and was experienced in, VFR flights;
- d) the aircraft had a valid Airworthiness Certificate (CA);
- e) the aircraft was within its weight and balance limits;
- f) the airframe, engine, and propeller logbooks were out of date, and the aircraft was not certified for IMC flights;
- g) the weather conditions were not consistent with visual flights;

- h) the PIC contacted the ATC agencies but did not report any abnormalities;
- i) analysis of the engine showed evidence of normal operation at the time of the accident;
- j) analysis of the right-hand wing structure identified rupture due to overload;
- k) most of the aircraft was found submerged in a river;
- l) the aircraft sustained substantial damage; and
- m) the PIC and the three passengers suffered fatal injuries

3.2. Contributing factors.

- **Attitude – a contributor.**

Flying along a route in adverse weather conditions indicated a careless attitude, which may have been influenced by excessive motivation for the flight.

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

The meteorological analysis indicated good weather conditions at takeoff, but degraded conditions along the flight route.

- **Disorientation – undetermined.**

Being aware of the possibility of inadvertent entry into IMC by pilots flying VFR, the investigation committee considered the hypothesis of spatial disorientation. In the case in question, the loss of visual references possibly caused spatial disorientation and loss of control in flight.

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

It is possible that there was an attempt to regain control of the aircraft after the inadvertent entry into bad weather, with inappropriate actuation on the flight controls, thus contributing to exceeding the PT-KCK aircraft structural limits.

- **Motivation – undetermined.**

The historical moment of social isolation resulting from the COVID-19 pandemic, in addition to the opportunity of being able to celebrate New Year's Eve with family and friends on the coastline of Paraná, may have increased the motivation for making the trip that precise day, to the point of jeopardizing a more thorough judicious evaluation regarding the weather conditions along the route.

- **Flight planning – a contributor.**

The fact that the aircraft passed through a region of bad weather demonstrates that there was inappropriateness in the work of preparation for the flight, which contributed to the aircraft entry into IMC.

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

When encountering meteorological conditions unfavorable for a VFR flight, no decision was made for an effective route deviation or discontinuance of the flight. Conversely, there was an attempt to reach the planned destination, leading the aircraft to enter IMC.

4. SAFETY RECOMMENDATIONS

None.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On August 15th, 2023.

