# COMANDO DA AERONÁUTICA

## CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

# FINAL REPORT
# A - 515/CENIPA/2021

| | |
|---|---|
| **OCCURRENCE:** | **ACCIDENT** |
| **AIRCRAFT:** | **PP-SAM** |
| **MODEL:** | **PC-12/47** |
| **DATE:** | **02MAR2012** |

# 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 Final Report was provided to ANAC and DECEA so that the technical-scientific analyzes of this investigation can be used as a source of data and information, aiming at the identification of hazards and risk assessment, as established in the Brazilian's Program Operational Safety of Civil Aviation (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 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 02MAR2012 accident with the PC 12/47 aircraft model, registration PP-SAM. The accident was classified as “[WSTRW] Windshear/Thunderstorm”.

The aircraft performed a private flight with two pilots and three passengers on board.

After takeoff, there was a significant decrease in speed, causing the aircraft to return to the ground. The impact occurred about 120 meters from the central axis of the runway.

The plane veered to the right, traveling through a small depression to a complete stop.

The aircraft sustained substantial damage.

The two crew and the three passengers were unharmed.

An Accredited Representative of the Swiss Accident Investigation Board (SAIB) - Switzerland, (State where the aircraft was designed) was designated for participation in the investigation.

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## GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

| | |
|---|---|
| AMR | DCTA's Materials Division |
| ANAC | Brazil's National Civil Aviation Agency |
| CA | Airworthiness Certificate |
| CB | Cumulonimbus cloud |
| CCF | Physical Capacity Certificate |
| CENIPA | Aeronautical Accident Investigation and Prevention Center |
| CG | Center of Gravity |
| CIV | Pilot's Flight Logbook |
| CPTEC | Weather Forecast and Climate Studies Center |
| DAESP | São Paulo Airways Department |
| DCTA | Department of Science and Airspace Technology |
| FAA | Federal Aviation Administration |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| INMET | National Institute of Meteorology |
| MAU | Modular Avionics Unit |
| METAR | Meteorological Aerodrome Report |
| MLTE | Airplane Multi Engine Land Rating |
| NTSB | National Transportation Safety Board |
| PCM | Commercial Pilot License – Airplane |
| PIC | Pilot in Command |
| PLA | Airline Pilot License – Airplane |
| PPR | Private Pilot License – Airplane |
| SAIB | Swiss Accident Investigation Board |
| SDAM | ICAO Location Designator - Campos dos Amarais State Aerodrome - Prefeito Francisco Amaral, Campinas - SP |
| SERIPA IV | Fourth Regional Aeronautical Accident Investigation and Prevention Service |
| SIC | Second in Command |
| SIGWX | Significant Weather |
| SWXQ | ICAO Location Designator – Lins Aerodrome - SP |
| TCU | Towering Cumulus clouds |
| TPP | Registration Category of Private Service - Aircraft |
| TSRA | Thunderstorm Rain |
| UTC | Very High Frequency |
| VFR | Visual Flight Rules |
| VMC | Visual Meteorological Conditions |
| WOW | Weight on Wheels |

# 1. FACTUAL INFORMATION.

| | | |
|---|---|---|
| **Aircraft** | **Model:** PC-12/47<br>**Registration:** PP-SAM<br>**Manufacturer:** Pilatus | **Operator:**<br>*Mineração Curimbaba* Ltd. |
| **Occurrence** | **Date/time:** 02MAR2012 – 1735 UTC<br>**Location:** Lins Aerodrome (SWXQ)<br>**Lat.** 21°39'46"S **Long.** 049°43'52"W<br>**Municipality – State:** Lins – SP | **Type(s):**<br>"[WSTRW] Windshear/Thunderstorm"<br>**Subtype(s):**<br>NIL |

## 1.1 History of the flight.

The aircraft took off from the Lins Aerodrome (SWXQ) - SP, to the Campos dos Amarais State Aerodrome - Prefeito Francisco Amaral (SDAM), Campinas - SP, at around 1735 UTC, in order to carry out a private flight, with two pilots and three passengers on board.

After the take-off, there was a significant decrease in speed, causing the aircraft to return to the ground. The impact occurred about 120 meters from the central axis of the runway.

The aircraft had substantial damage.

The two crewmembers and the three passengers left unharmed.

## 1.2 Injuries to persons.

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | - | - | - |
| Serious | - | - | - |
| Minor | - | - | - |
| None | 2 | 3 | - |

## 1.3 Damage to the aircraft.

The aircraft had substantial damage. One of the propeller blades broke and the other three bent. There was damage to the engine, wings, flaps, fuselage and landing gear.

## 1.4 Other damage.

None.

## 1.5 Personnel information.

### 1.5.1 Crew's flight experience.

| Flight Hours | | |
|---|---|---|
| | PIC | SIC |
| Total | 3.100:00 | 4.200:00 |
| Total in the last 30 days | 11:18 | 11:00 |
| Total in the last 24 hours | 00:00 | 00:00 |
| In this type of aircraft | 357:40 | 210:00 |
| In this type in the last 30 days | 11:18 | 11:00 |
| In this type in the last 24 hours | 00:00 | 00:00 |

**N.B.:** The data related to the flow hours were obtained through the pilots' Digital CIV.

### 1.5.2 Personnel training.

The PIC took the PPR course at the Poços de Caldas Aeroclub - MG, in 1980, obtained the PCM in 1995, and the PLA in 2007.

The SIC took the PPR course at the Poços de Caldas Aeroclub - MG, in 1981, obtained the PCM in 1985, and the PLA in 1992.

### 1.5.3 Category of licenses and validity of certificates.

The PIC had the PLA License and valid PC12 aircraft type Rating (which included the model PC12/47), MLTE and IFRA Ratings.

The SIC had the PLA License and valid PC12 aircraft type Rating (which included the model PC12/47), MLTE and IFRA Ratings.

### 1.5.4 Qualification and flight experience.

The pilots were qualified and had experience in the kind of flight.

### 1.5.5 Validity of medical certificate.

The pilots had valid CCFs.

### 1.6 Aircraft information.

The aircraft, serial number 785, was manufactured by Pilatus, in 2007, and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The airframe, engine and propeller logbook records were updated.

The last inspection of the aircraft, the “100/600 hours” type was carried out on 21JUL2011 by the maintenance organization Oceanair Air Taxi Ltd., in Sorocaba - SP, with the aircraft having flown 646 hours and 54 minutes after the inspection.

### 1.7 Meteorological information.

The Lins Aerodrome did not have an AIS or a meteorological service, having only a windsock for observing the wind.

The METAR of the Marília (SBML), Bauru (SBBU) and São José do Rio Preto (SBSR) Aerodromes, away 33, 56 and 54 NM, respectively, from SWXQ had the following information:

METAR SBML 021800Z 34013KT 9999 FEW040 27/20 Q1017=

METAR SBBU 021800Z 19006KT 6000 TSRA BKN025 FEW040CB 29/24 Q1015=

METAR SBSR 021800Z 03004KT 9999 TS SCT030 BKN035 FEW040CB 29/21 Q1014=

The SIGWX generated at 0949 (UTC), valid until 0000 (UTC), illustrated the presence of few Towering Cumulus (TCU) clouds based at 3,000 ft and top at FL230.

Additionally, the enhanced satellite image generated by the CPTEC at 1730 (UTC), showed the existence of significant meteorological formations in the surroundings of the Aerodrome (Figure 1).

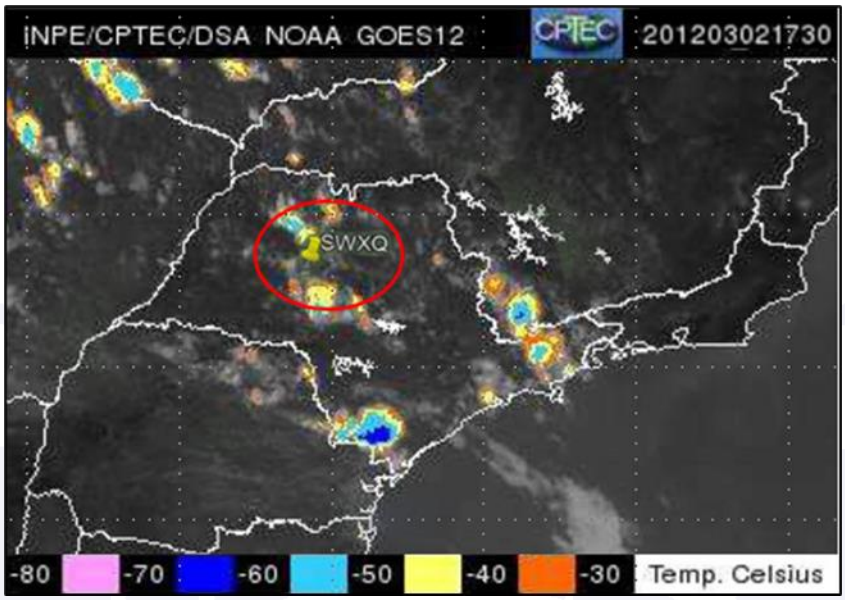


Figure 1 - Satellite image highlighted with the weather condition at a time close to the occurrence. Source: CPTEC.

To complement the meteorological information, data from the meteorological station A727 of the INMET, installed in the city of Lins - SP, were requested.

Relevant information is shown in Table 1, which highlights the directions and gusts of wind recorded at times adjacent to the take-off that preceded the occurrence, with peaks between 32.2 and 22.15 kt.

| HOUR (UTC) | TEMPERATURE | WIND DIRECTION | WIND SPEED | WIND GUSTS |
|---|---|---|---|---|
| 17h00min | 31,4ºC | 266º | 2 kt | 8,3 kt |
| 18h00min | 26,8ºC | 162º | 2 kt | 32,2 kt |
| 19h00min | 26,7ºC | 187º | 5,6 kt | 22,15 kt |

Table 1 - Data from the weather station in Lins - SP.
Source: INMET.

The largest gust recorded in the minutes close to the occurrence, 32.2 kt, breaks down into a tail wind component of 27 kt in relation to the aircraft's take-off direction.

**1.8 Aids to navigation.**

Nil.

**1.9 Communications.**

The SWXQ Aerodrome did not have air traffic control and coordination was carried out bilaterally between the aircraft.

**1.10 Aerodrome information.**

The Aerodrome was public, managed by the DAESP and operated under VFR during the day and night.

The runway was made of asphalt, with thresholds 14/32, dimensions of 1.700 x 35m, with elevation of 1.575 feet.

**1.11 Flight recorders.**

Neither required nor installed.

**1.12 Wreckage and impact information.**

The impact occurred in an irregular grassed area, about 120 meters from the central axis of the runway, in the direction of take-off from the threshold 32, with no evidence of previous impact. The distribution of the debris was of the concentrated type.

After the impact, the aircraft moved about 300 meters, with a yaw to the right, going down a small depression until it came to a complete stop at approximately 90º in relation to the axis of the runway, close to the threshold 14, as shown in Figure 2.


Figure 2 - Final position of the aircraft after the occurrence.

The landing gear, the retractable type, was in the “up” position. The flaps were lowered at 30º.

**1.13 Medical and pathological information.**

**1.13.1 Medical aspects.**

No evidence was found that problems of physiological nature could have affected the flight crew performance.

**1.13.2 Ergonomic information.**

Nil.

**1.13.3 Psychological aspects.**

No evidence was found that problems of physiological nature or incapacitation could have affected the flight crew performance.

**1.14 Fire.**

There was no fire.

**1.15 Survival aspects.**

The crewmembers and passengers left the aircraft using its main door, immediately after it had come to a complete stop.

**1.16 Tests and research.**

Nil.

## 1.17 Organizational and management information.

Nil.

## 1.18 Operational information.

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

The aircraft's normal operation checklist prevised the selection of 15º flaps for take-off, which should take place before the taxi and checked before the take-off.

The crewmembers, however, opted for the take-off with 30º of flaps, foreseen in the manual for a take-off with reduced distance.

According to the performance calculations carried out by the investigation team, the use of flaps in 15º would exceed the acceleration and stopping distance in the conditions in which the take-off was performed.

Among the checks prevised for the normal operation of the aircraft, the stick pusher check was carried out before the take-off.

In critical emergencies of the aircraft, it included the “inadvertent operation of the pusher”, which included “holding” the stick against the action of the pusher, pressing and holding the system button and then disarming its respective circuit breaker.

According to reports collected, the pilots believed that the conditions at the Aerodrome were favorable for the visual flight, with visibility above 10 km and few clouds at 3,000 ft.

The aircraft had the ability to measure and report the direction and intensity of the wind present.

In this device, according to the report of the crew, it was read 150° of direction with 4kt of intensity before the taxi.

On the taxiway, they reported having noticed a sudden change in wind direction and opted to takeoff from threshold 32.

One of the passengers, who was trained as a pilot and occupied the third seat on the left side of the aircraft, said he watched the taxi up to the threshold as well as the take-off run.

He reported that, after the landing gear retracted, he felt a strong turbulence. He also said it was raining from halfway down the runway. In his perception, after the turbulence, the aircraft continued to climb and, after a few seconds, returned to the ground.

As reported by the crewmembers, after the take-off, with the speed close to 95 kt, still on the runway and with the landing gear retracted, the PIC noticed a significant decrease in speed.

This condition led to the activation of the stall alarm and the stick shaker/pusher causing the aircraft to lose height and touch the ground.

After touching the ground, the aircraft veered sharply to the right, having its stop position at approximately 90º in relation to the runway, near threshold 14 (Figure 3).

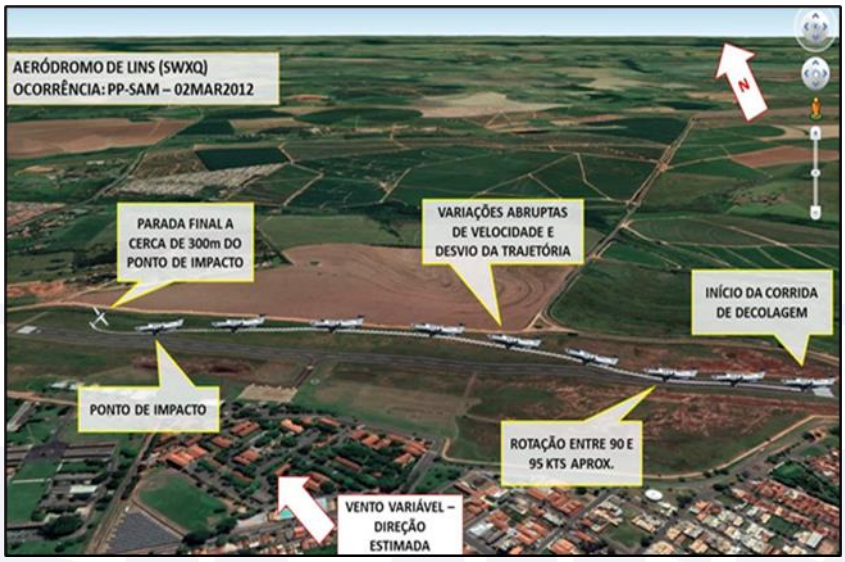


Figure 3 - Sketch of the occurrence, from the take-off to the final stop (out of scale).

Through data extracted from the MAU, the graph was obtained in which the speed and time information were combined with the information on WOW, as seen in Figure 4:

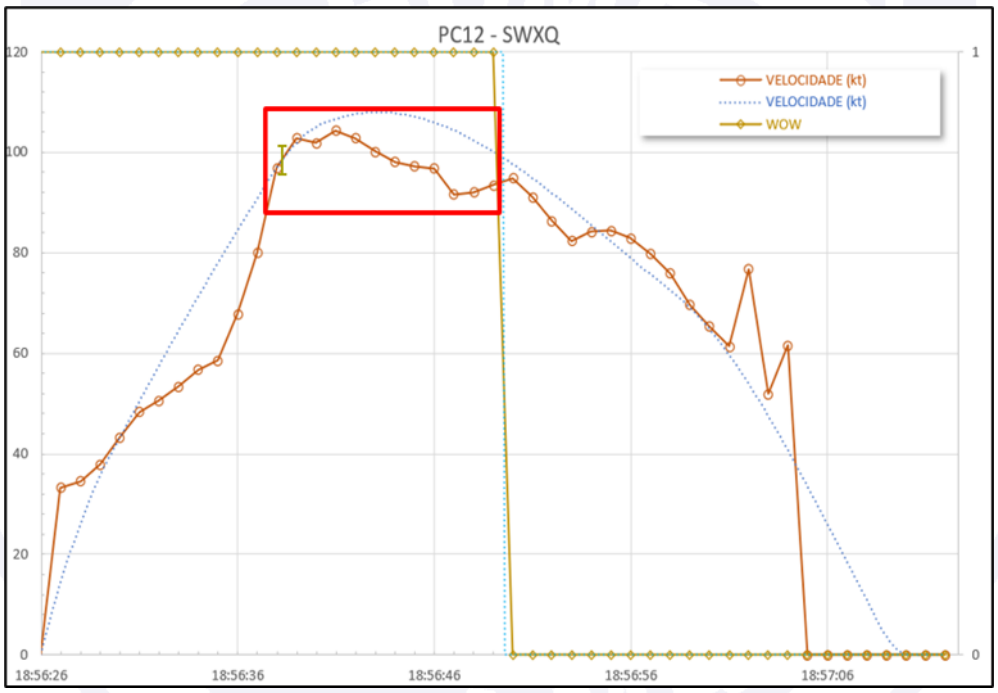


Figure 4 - Speeds recorded by the MAU from the take-off (WOW = 0) to the aircraft impact.

## 1.19 Additional information.

The aircraft did not have an onboard windshear detection system.

As defined in the FAA Flight Safety Manual (P8740-40; AFS-8, 2008), which dealt with windshear, this phenomenon occurs when there is a rapid change in wind direction and/or speed.

The Manual also mentioned that the four most common origins of low height windshears are: frontal activity (related to cold fronts), storms, temperature inversions and surface obstacles.

The same manual indicated that the two worst problems related to storms are: the first gust and the downburst gust.

The first happens in the instants that precede the arrival of rainwater on the ground, in which there is a rapid change in direction and an increase in the wind intensity. The second, the downburst, is the descending air current that is “pushed” by the water that breaks out of the clouds at the beginning of precipitation.

The strength of this air stream is enhanced by the pressure difference between the warm surface air and the cool air near the cloud base. The effects of the descending gust on an aircraft taking off can be seen in Figure 5.

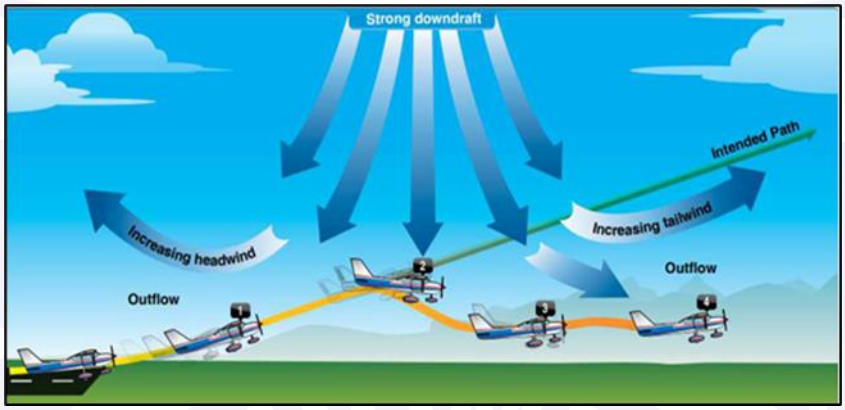


Figure 5 - Effects of the descending gust on an aircraft's take-off.
Source: FAA AC 00-6B/2016.

According to the "Manual on Low-level Windshear" of the ICAO, regarding the effects of a windshear on the speed of the aircraft:

> Under windshear conditions, the horizontal wind is neither stable nor varies gradually, but tends to vary rapidly over relatively short distances. If an aircraft encounters such rapid tail or headwind variations due to inertia, it will not be able to instantly accelerate or decelerate to recover the originally set speed, which causes the instantaneous speed to vary according to the variations of the wind. This “transient” variation in speed alters lift, drag and affects the balance of forces acting on the aircraft. (Doc 9817 NA/449, 2005).

After this occurrence, other events took place involving the windshear phenomenon, such as the accident with the PT-MCM aircraft, on 21APR2016, which the CENIPA sent to the ANAC the Safety Recommendation (RS) No. A-073/CENIPA/2016 - 01, reinforcing the need to provide pilots with informative material on the phenomenon known as windshear, containing a recommendation on how to act in this condition.

In response to the RS, the ANAC informed that it complied with the RS in an alternative way, publishing Flight Alert on the website of that Regulatory Agency, more specifically in the option “Promotion of Operational Safety”.

Analyzing the Flight Alert No. 02/2017, of 23JUN2017, it was observed that there was no reference to the possibility of the phenomenon occurring during the take-off, as well as some links contained in the Alert were not available.

Another Flight Alert verified on the same topic, AV No. 06/2018, dated 29MAR2018, also presented the same comments mentioned above.

### 1.20 Useful or effective investigation techniques.

Nil.

## 2. ANALYSIS.

It was a private passenger transport flight.

As described in the operational information, the aircraft's normal operation checklist prevised the selection of 15º flaps for take-off, but the crew opted for a 30º take-off, prevised in the manual for take-off with reduced distance.

According to the performance calculations performed by the investigation team, the decision proved to be correct, since the use of flaps in 15º would exceed the acceleration and stopping distance in the conditions in which the take-off was carried out.

Regarding the activation of the stick shaker/pusher system, it was found that this equipment received input signals consistent with the current configuration of the aircraft, so that the system activation speeds were automatically calibrated according to each situation.

The wind information provided by the aircraft, of 150° direction with 4 kt of intensity, presupposed the selection of the threshold 14 for take-off, so that this would occur with head wind.

The pilots, however, decided to switch to threshold 32 after noticing a sudden change in wind direction when they were in the taxiway. This information, when combined with the meteorological data surveyed and the testimony of the mentioned passenger, evidenced potential opportunities for perception by the pilots that there were relevant variations in the direction and intensity of the wind.

Analyzing the graph shown in Figure 4, it was evident that the variations in speed, in the moments prior to the rotation, occurred in an abrupt and inconsistent manner, with registers ranging between 104 and 93 kt, as seen in the table highlighted in red on the graph. After the rotation itself, the records indicated that the speed decreased from 94 to 61 kt, the last record before the impact.

The relevance of analyzing these data is due to the fact that, in a normal take-off, there would be a progressive increase in speed, without the reductions and variations shown.

Thus, as no variations or failures in the powertrain had been verified or reported, these variations had typical characteristics of events related to meteorological phenomena such as windshear.

Referring to this accident, the reports showed that there was rain from a certain point on the runway, which could be estimated through meteorological surveys performed at adjacent Aerodromes and the meteorological products analyzed.

Considering the characteristics of the speed variation observed in the graph of Figure 4 and the wind parameters elucidated in Table 1, as well as the accident dynamics, it is inferred that the aircraft was subjected to a strong influence of wind currents variables and of great intensity that affected its performance during the take-off.

These conditions were consistent with an event typically related to what has been described as a windshear.

Furthermore, what is described in Figure 5, when contrasted with the information displayed in the graph in Figure 4, allows visualizing typical windshear velocity gradients.

The rapid increase in speed, greater than that which would occur by the simple action of the engine, followed by abrupt reductions, could not materialize, except through the interference of external factors.

According to the ICAO’s Manual on Low-level Windshear, the description of this phenomenon, added to what has already been analyzed about the expressive gusts of wind present in the Aerodrome at the time of the occurrence, can explain the variations of speed recorded on the aircraft.

In fact, the largest gust recorded in the minutes close to the occurrence, 32.2 kt, decomposes into a tail wind component of 27 kt.

The resulting decrease in speed and the changes in the forces acting on the aircraft made it approach the stall condition and trigger the stall warning/stick pusher system.

In critical emergencies of the aircraft, the "inadvertent operation of the pusher" was included, which was not the case in this occurrence, as the activation occurred due to the reduction of speed itself (and not inadvertently), with no time or height enough to perform the actions listed in the checklist.

Also, despite the wind information initially provided by the aircraft, the pilots decided on a take-off where the wind was predominantly tailwind.

The very sudden change in wind direction, identified by them during the taxi, was an indication of windshear.

This information, if combined with accurate planning, where the weather conditions of nearby Aerodromes were checked, could have supported a decision to abort the take-off before it started.

Furthermore, considering the fact that Lins Aerodrome only allowed visual operations, the deterioration of meteorological conditions at nearby Aerodromes could have supported the decision not to continue the flight while still in the planning phase.

Once the take-off run started, the abort could have been commanded by the crew still on the ground, based on the perception that the speed varied abnormally.

However, the time window for this judgment and decision was just over 10 seconds.

Therefore, it is not considered reasonable for the crew to be able to identify and react in this short space of time, even with the experience of both pilots.

It should be noted that the aircraft did not have an onboard windshear detection system, which could have subsidized an eventual abortive decision by the pilots.

Once in flight, given the aircraft's lateral displacement and the rapid decrease in speed that followed, the accident was irreversible.

Having reached speeds close to the stall speed, the stick pusher system was activated, which quickly took the aircraft back to the ground.

## 3. CONCLUSIONS.

### 3.1 Facts.

a) the pilots had valid CCFs;

b) the pilots had valid PC12 aircraft type Ratings (which included the model PC12/47), MLTE and IFRA Ratings.

c) the pilots were qualified and had experience in the kind of flight;

d) the aircraft had valid CA;

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

f) the airframe, engine and propeller logbook records were updated;

g) meteorological conditions at nearby Aerodromes indicated the presence of storms and cumulonimbus clouds (CB) in the region close to SWXQ;

h) during the taxi, the crewmembers verified the variation in the wind direction, choosing to take-off from runway 32;

i) the crew opted for take-off with 30º flaps, foreseen in the manual for take-off with reduced distances;

j) the meteorological station in Lins - SP, recorded wind gusts between 32.2 and 22.15kt, with a direction varying between 162º and 187º at times close to take-off;

k) during the take-off, the aircraft registered abrupt speed variations in the moments before and immediately after rotation;

l) the aircraft stall warning/stick pusher system was activated;

m) after the impact with the ground, the aircraft stopped about 120 meters from the threshold 14, in its abeam;

n) the aircraft had substantial damage; and

o) the two crewmembers and the three passengers left unharmed.

**3.2 Contributing factors.**

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

The INMET weather station in Lins recorded wind gusts with variable direction from 22.15 to 32.2 kt at times close to the take-off.

The presence of important meteorological formations around the Aerodrome, especially cumulonimbus clouds, as well as the pilots' perception that the wind direction changed during the taxi, evidenced the conditions for the formation of windshear.

The drastic reductions in speed caused by the windshear during the take-off led to the activation of the stick shaker/pusher system of the aircraft, which made it abruptly return to the ground.

- **Piloting judgment – undetermined.**

It was evident that, during the taxi and in the take-off segments prior to the rotation, there were signs of weather conditions proper to the formation of windshear.

The high-speed gradient in the run on the runway, as well as the abrupt variations perceived, could have motivated an abortive on the ground.

- **Flight planning – undetermined.**

A careful verification of the meteorological conditions of nearby Aerodromes, since there was no such service at the take-off Aerodrome, as well as the possible consultation of available meteorological products, such as the SIGWX chart, could have contributed to the pilots noticing the deterioration of the meteorological conditions.

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

The decision to carry out the flight proved to be inadequate, both because of the rain that started to fall from a certain point in the take-off run and because of the abrupt variations in speed presented in the instruments. Therefore, there were opportunities to decide to abort the take-off.

The external and internal signs to the aircraft indicated a strong possibility of windshear and degradation of the necessary conditions for take-off, which should occur under visual conditions.

## 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-515/CENIPA/2021 - 01** **Issued on 02/09/2022**

Establish procedures to ensure the updating of publications referring to recurring themes in aeronautical accidents or incidents, in particular the phenomenon of windshear, especially concerning the need for a flight planning which takes into account the meteorological conditions that may affect the air operations.

## 5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On February 09th, 2022.