COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-151/CENIPA/2018

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-TLZ**
MODEL:	**HA-420**
DATE:	**24SEPT2018**

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 24SEPT2018 accident with the HA-420 aircraft model, registration PR-TLZ. The accident was classified as "[WSTRW] Windshear / Thunderstorm and [RE] Runway Excursion / Overshooting".

When landing on threshold 32 of the Cataratas Aerodrome (SBFI), Foz do Iguaçu - PR, there was precipitation over the opposite threshold, associated with large variations in wind direction and intensity, consistent with the windshear phenomenon resulting from microburst.

There was aquaplaning of the aircraft and a sudden increase in the Calibrated Airspeed (with a peak of 32 kt), which changed the conditions of the aircraft lift and, consequently, reduced the tire grip on the ground, causing poor braking.

The plane went beyond the limits of the runway, falling into a ravine.

The aircraft had substantial damage.

The two crewmembers and the passenger left unharmed.

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

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AC	Advisory Circular
ADC	Aerodrome Chart
AFM	Aircraft Flight Manual
AGL	Above Ground Level
AIRAC	Aeronautical Information Regulation and Control
AMDT	Amendment (AIP Amendment)
ANAC	Brazil’s National Civil Aviation Agency
APP-FI	Approach Control – Foz do Iguaçu
ASDA	Accelerate-Stop Distance Available
CA	Airworthiness Certificate
CAS	Calibrated Airspeed
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CIV	Pilot’s Flight Logbook
CMA	Aeronautical Medical Certificate
CMF	Central Maintenance Function
CMV-CW	Curitiba Meteorological Surveillance Center
CVFDR	Cockpit Voice and Flight Data Recorder
DA	Airworthiness Directive
DACU	Digital Anti-skid Control Unit
EPBV	Emergency / Park Brake Valve
FAA	Federal Aviation Administration
FIR	Flight Information Region
FL	Flight Level
GAMET	General Aviation Meteorological Information
HACI	Honda Aircraft Company Inc.
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
IMC	Instrument Meteorological Conditions
INFRAERO	Brazilian Airport Infrastructure Company
KCAS	Knots Calibrated Air Speed
KGS	Knots Ground Speed
KHNR	ICAO Location Designator - Harlan Municipal Aerodrome, Iowa - USA
KPDK	ICAO Location Designator - Peachtree DeKalb Aerodrome, Georgia - USA
LABDATA	Flight Data Recorders Read-Out and Analysis Laboratory
LDA	Landing Distance Available

METAR	Aviation Routine Weather Report
MLTE	Airplane Multi Engine Land Rating
NTSB	National Transportation Safety Board (USA)
PBV	Power Brake Valve
PCM	Commercial Pilot License – Airplane
PFD	Primary Flight Display
PLA	Airline Pilot License - Airplane
PMD	Maximum Take-off Weight
PN	Part Number
PPR	Private Pilot License – Airplane
RBAC	Brazilian Civil Aviation Regulation
SBCT	ICAO Location Designator – Afonso Pena Aerodrome, Curitiba - PR
SBCW	Flight Information Region Designator – FIR Curitiba
SBFI	ICAO Location Designator – Cataratas Aerodrome, Foz do Iguaçu - PR
SERIPA V	Fifth Regional Aeronautical Accident Investigation and Prevention Service
SIGWX	Significant Weather
SN	Serial Number
SOV/VC	Shutoff Valve and Volume Compensator
SPECI	Selected Special Aeronautical Weather Report
TDZ	Touchdown Zone
TODA	Take-Off Distance Available
TORA	Take-Off Run Available
TPP	Registration Category of Private Service - aircraft
TSN	Time Since New
TWR-FI	Control Tower of the Cataratas Aerodrome, Foz do Iguaçu - PR
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VREF	Minimum Final Approach Speed
VMC	Visual Meteorological Conditions
VTI	Initial Technical Inspection
WST	Wheel Speed Transducer

1. FACTUAL INFORMATION.

Aircraft	**Model:** HA-420 **Registration:** PR-TLZ **Manufacturer:** Honda Aircraft Company	**Operator:** *Alta-América Latina Tecnologia Agrícola* Ltd.
Occurrence	**Date/time:** 24SEPT2018 - 1642 UTC **Location:** Cataratas Aerodrome (SBFI) **Lat.** 25°35'20"S **Long.** 054°29'46"W **Municipality – State:** Foz do Iguaçu – PR	**Type(s):** [WSTRW] Windshear/Thunderstorm [RE] Runway Excursion **Subtype(s):** Overshooting

1.1 History of the flight.

The aircraft took off from the Afonso Pena Aerodrome (SBCT), Curitiba - PR, to the Cataratas Aerodrome (SBFI), Foz do Iguaçu - PR, at about 1540 UTC, in order to transport personnel, with two pilots and one passenger on board.

After landing on SBFI's threshold 32, the aircraft covered the entire length of the runway, exceeded its limits and fell into a ravine.

The aircraft had substantial damage.

The crewmembers and the passenger left unharmed.

Figure 1 - Aircraft after the occurrence.

1.2 Injuries to persons.

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

1.3 Damage to the aircraft.

The aircraft had substantial damage to the fuselage and landing gear.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours		
	Pilot	Copilot
Total	5.600:00	660:00
Total in the last 30 days	12:40	10:35
Total in the last 24 hours	01:25	01:00
In this type of aircraft	77:00	14:00
In this type in the last 30 days	12:00	10:35
In this type in the last 24 hours	01:00	01:00

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

1.5.2 Personnel training.

The pilot took the PPR course at the Caxias do Sul Aeroclub – RS, in 1996.

The copilot took the PPR course at the Paraná Aeroclub – PR, in 2007.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PLA License since 2007 and had valid HA-420 aircraft type Rating, MLTE and IFRA Ratings.

The copilot had the PCM License since 2011 and had valid HA-420 aircraft type Rating, MLTE and IFRA Ratings.

1.5.4 Qualification and flight experience.

The pilot had previous experience in the aircraft types C750, C560, C56X, BE 19 and BE 30, and had already operated in SBFI before.

The copilot had previous experience in the aircraft types BE 90 and LR45, and had already operated in SBFI before.

Both of them were qualified and had 77 hours and 14 hours in the aircraft model, respectively.

1.5.5 Validity of medical certificate.

The pilots had valid CMAs.

1.6 Aircraft information.

The aircraft, serial number 42000068, was manufactured by Honda Aircraft Company, in 2017, and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The airframe and engines logbook records were updated.

The aircraft underwent Initial Technical Inspection (VTI) on 18APR2018 for nationalization and, at the time, had a Time Since New of 56 hours and 40 minutes.

After the VTI, the aircraft flew 8 hours and 5 minutes until the day of the accident.

The aircraft had not yet undergone inspection or overhaul after the VTI.

<u>Windshear Detection System</u>

The aircraft had a reactive windshear detection system that provided aural alerts and warnings on the PFD, when a windshear was detected.

Aircraft Brake System

Each main landing gear was equipped with a multiple disc brake that used four rotating steel discs and three stationary steel discs.

The brake application was initiated by a force on the top of the rudder pedals, which provided the control pressure on the master cylinders. The amount of braking force was proportional to the force applied to the rudder pedals.

The anti-skid protection was activated when the aircraft wheel speed was above approximately 10kt and below 165kt. The wheel slip, as measured by the speed transducer, was signaled to the control unit, which sent a signal to the anti-skid control valve to release both brake pressures at the same time.

The automatic anti-skid function would resume its standby mode after any wheel slip or brake pedal pressure was reduced below the skid limit level. The normal braking was still available even if the anti-skid system failed.

A touchdown protection prevented the application of the brake until the wheel spin occurred. After three seconds of wheel weight detection, the normal braking was activated, regardless of the existence of a wheel speed indication signal.

A locked-wheel crossover protection was activated if either wheel significantly decreased its speed relative to the other, with the aircraft speed being above 25kt. When the speed of any main landing gear slowed to 30% or less relative to the other wheel, a full release of the brake occurred which removed the locked wheel condition.

The emergency/parking brake system consisted of a mechanically actuated brake valve that directed pressure to both brakes in proportion to the movement of the emergency/parking brake lever. The system had a thermal relief valve to prevent over pressurization of the hydraulic lines and brake assemblies when there was a large thermal variation.

The Master Cylinder was a hydraulic actuator responsible for pressurizing the hydraulic fluid in the brake system based on the brake pedal command.

There were four master cylinders installed on the aircraft, two of which were connected in series between the pilot and the copilot for braking the aircraft (Figure 2). Their operation was redundant between the two pilot seats.

Figure 2 - View of one of the four master cylinders installed on the aircraft.

The Shutoff Valve and Volume Compensator (SOV/VC) had three purposes. The main purpose was to minimize internal fluid leakage from the hydraulic system during flight and thus reduce the cycling rate of the hydraulic pump. During braking, it also served to provide power feedback to the pilot using volume compensation. Finally, it provided hydraulic pressure and flow to the Power Brake Valve.

There was a SOV/VC installed on the aircraft and connected in series between the brake accumulator and the rest of the brake system (Figure 3).

Figure 3 - Shut-off valve and volume compensator.

The Anti-skid Control and the Power Brake Valve (PBV) were electro-hydromechanical devices that supplied pressure to the brakes. The PBV supplied pressure to the brake when a control pressure was applied by the master cylinders. The brake pressure was proportional to the inlet pressure applied in the master cylinders.

The anti-skid control valve in the PBV used a signal from the DACU to actuate a servo valve to relieve brake pressure. The PBV was one of the main components of the aircraft's brake system (Figure 4).

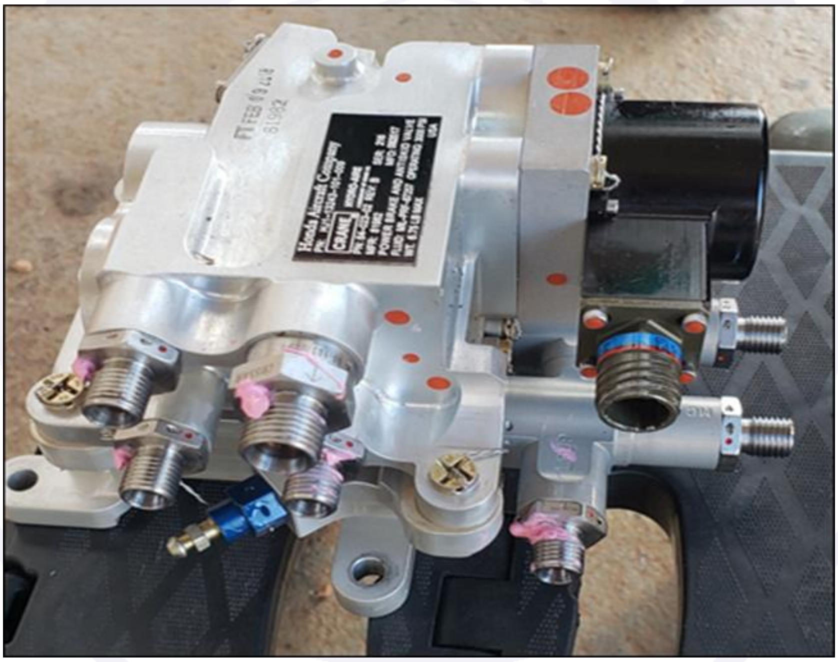

Figure 4 - Power Brake Valve (PBV).

The Brake Assembly consisted of a multiple disc brake that utilized four rotating steel discs and three stationary steel discs.

There were two assemblies installed on the aircraft; one on each main landing gear (Figure 5).

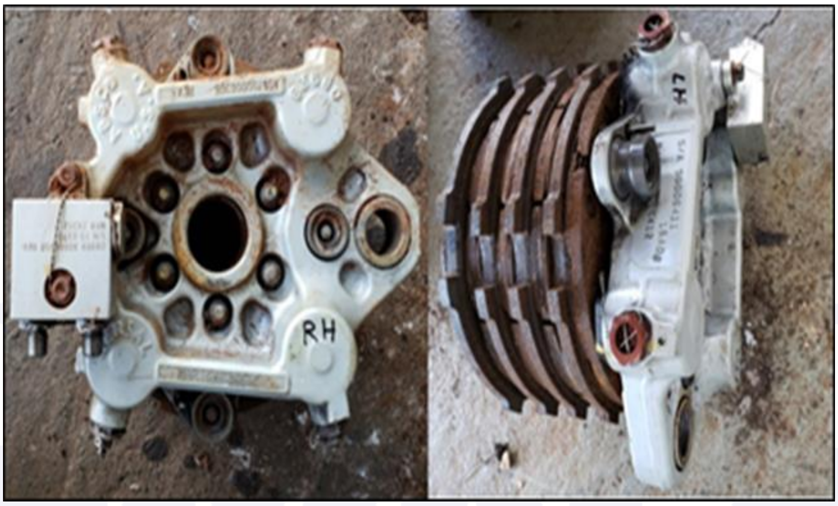

Figure 5 – Aircraft Brake Assembly.

<u>Wheel Speed Tranducer (WST)</u>

The WST was an electromechanical unit that produced a sinusoidal signal at a frequency of 36 cycles per rotation. The speed of the aircraft could be calculated by the Mark IV brake control unit. This speed was used to provide adequate brake control as well as anti-skid protection. There were two WSTs installed on the aircraft; one on each main landing gear (Figure 6).

Figure 6 - View of the Wheel Speed Transducer (WST) from the aircraft's right wheel.

The Emergency/Park Brake Valve (EPBV), was a hydraulic valve that had two main purposes:

- to enable the parking brake function, using hydraulic pressure source to keep the aircraft parked; and

- to activate emergency braking in case of failure of the normal braking system.

The EPBV is shown in Figure 7.

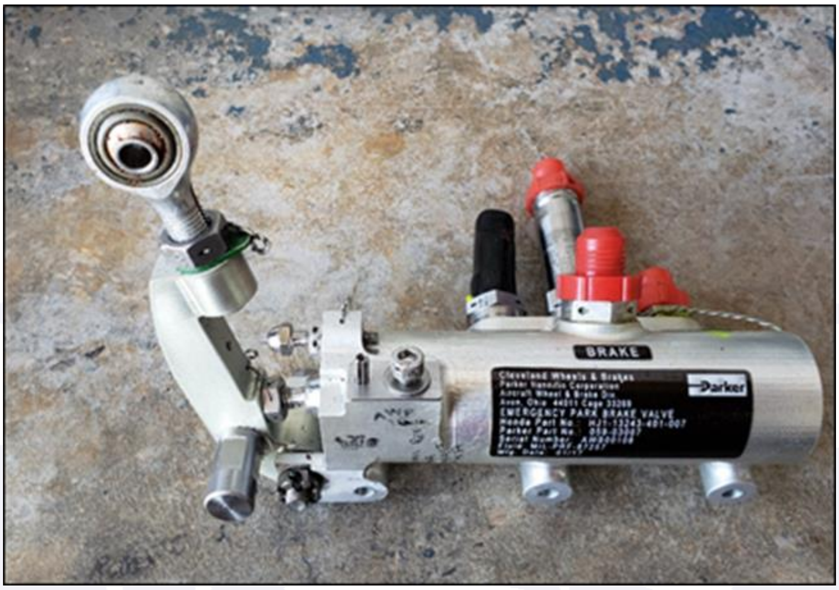

Figure 7 - Emergency/Park Brake Valve (EPBV).

1.7 Meteorological information.

The CMV-CW prepared a weather advisory with the prevailing data for 24SEPT2018, at SBFI, and within 100 nautical miles of the Aerodrome.

According to the SIGWX chart of 1800 (UTC), there was the presence of a semi-stationary frontal system over the state of Rio Grande do Sul (RS) with the forecast of cumulonimbus over the states of Rio Grande do Sul, Santa Catarina, the Western sector of Paraná and West/South of Mato Grosso do Sul (Figure 8).

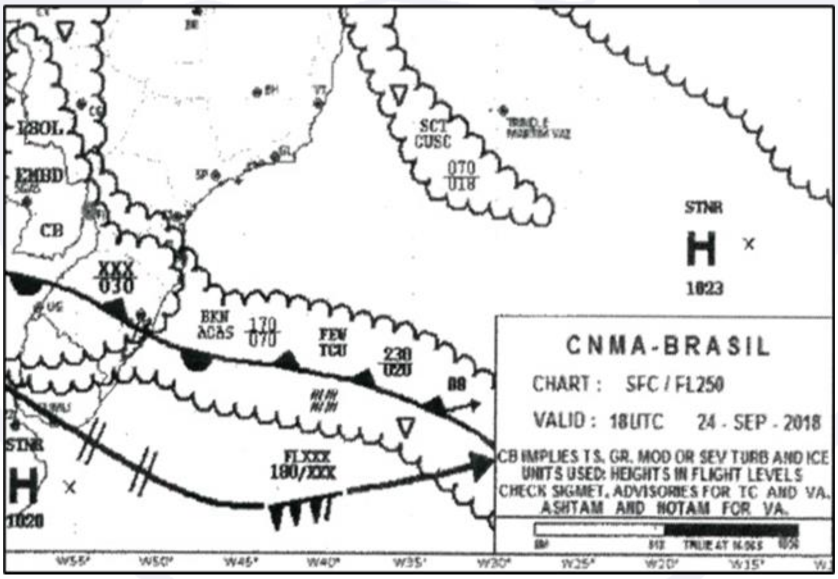

Figure 8 - SIGWX chart (SFC/FL250) from 1800 (UTC) on 24SEPT2018.

According to the GAMET - area forecast message for low-level flights, valid between 1200 (UTC) and 1800 (UTC), on 24SEPT2018, there was a forecast of extensive areas with surface wind speed with intensity of 35 kt in the Curitiba's FIR (SBCW).

SBCW	GAMET	24/09/2018 12:00	SBCW GAMET VALID 241200/241800 SBPA - SBCW CURITIBA FIR/SECTORS 1 TL 4 AND 10 TL 17 BLW FL100 SECN I SFC WSPD: 35KT SFC VIS: 12/15 3000/5000M RA S OF S26 15/18 3000/5000M RA BTN S24 AND S30 15/18 5000M SHRA N OF S24 W OF W053 SIGWX: 12/15 EMBD TS S OF S26 15/18 EMBD TS BTN S24 AND S30 15/18 OCNL TS N OF S24 W OF W053 15/18 ISOL TS S OF S30 MT OBSC: SERRA GERAL AND SERRA DO MAR SIG CLD: 12/15 EMBD TCU/CB 3000/ABV 10000FT AGL S OF S26 12/15 BKN 800/1800FT AGL S OF S26 15/18 EMBD TCU/CB 3000/ABV 10000FT AGL BTN S24 AND S30 15/18 BKN 800/1800FT AGL BTN S24 AND S30 15/18 OCNL TCU/CB 3000/ABV 10000FT AGL N OF S24 W OF W053 15/18 ISOL TCU/CB 3000/ABV 10000FT AGL S OF S30 ICE: 12/15 SEV/MOD ABV FL120 S OF S26 15/18 SEV/MOD ABV FL120 BTN S24 AND S30 TURB: MOD ABV FL025 SECN II PSYS: 12 L 1007 HPA S2600 W06200 STNR NC 12 FRONT S2800 W05700 TO S3600 W03000 MOV E/NE 10KT NC WIND/T: 2000FT: 100/24KT PS18 S OF S30 VRB/22KT PS20 BTN S26 AND S30 360/14KT PS27 N OF S26 5000FT: 110/15KT PS14 S OF S31 270/24KT PS18 BTN S26 AND S31 340/22KT PS23 N OF S26 10000FT: 270/35KT PS07 S OF S26 300/15KT PS10 N OF S26 CLD: 12/15 SCT/BKN CUSC 1800/6000FT AGL S OF S26 12/15 SCT/BKN ACAS 7000/ABV 10000FT AGL S OF S26 15/18 SCT/BKN CUSC 1800/6000FT AGL S OF S24 15/18 SCT/BKN ACAS 7000/ABV 10000FT AGL S OF S24 15/18 SCT CUSC 2500/6000FT AGL N OF S24 W OF W053 FZLVL: ABV 10000FT AMSL MNM QNH: 1010HPA VA: NIL=

Figure 9 - Area forecast for low-level flights - GAMET.

By viewing an infrared spectrum image of the Southern Region of Brazil, it was possible to verify that there was the presence of an atmospheric instability line forming over the Southern/Southeastern region of Paraguay, extending to the Northwestern region of Rio Grande do Sul and the Central/Western region of Santa Catarina (Figure 10).

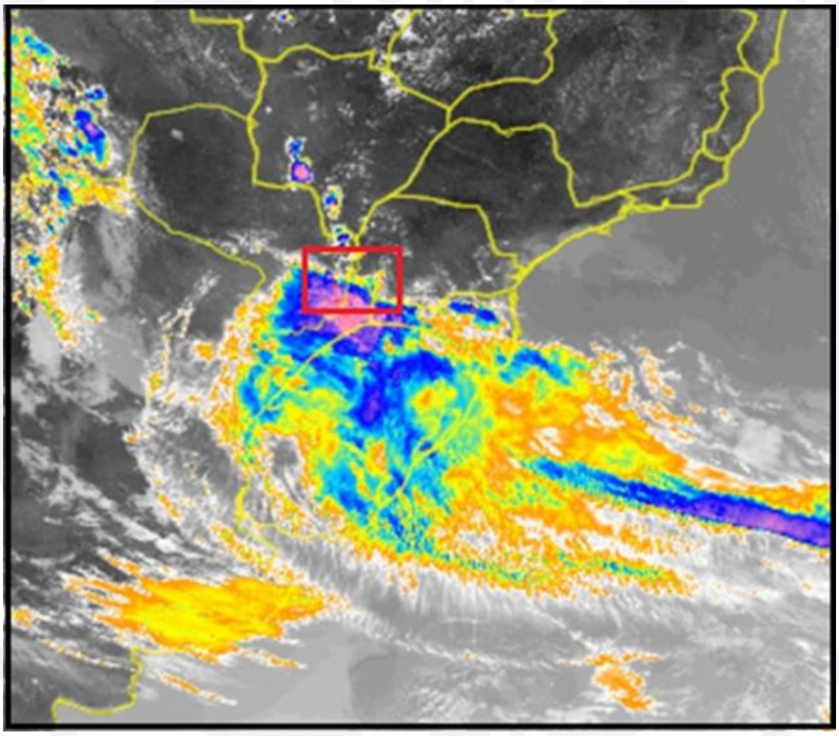

Figure 10 - Infrared spectrum image of 24SEPT2018, at 1630 (UTC). The highlighted area refers to the Cataratas Aerodrome (SBFI).

At 1645 (UTC), a SPECI was prepared reporting the presence of gusty surface winds with the intensity of 44kt, thunderstorms, and hail precipitation (Table 1).

Localidade	Tipo	Data/Hora	Mensagem
SBFI	METAR	24/09/2018 16:00	METAR SBFI 241600Z 36012KT 9999 TS FEW030CB SCT040 BKN100 34/18 Q1010=
SBFI	SPECI	24/09/2018 16:00	**SPECI SBFI 241645Z 03016G44KT 3000 TSGR SCT020 FEW030CB BKN070 24/22 Q1010=**

Table 1 - In detail, the SPECI of SBFI with forecast to 1645 (UTC).

Just prior to touchdown, there was a 40 second time period where the wind intensity decreased from 19kts to 6.5kst.

These variations are represented graphically. The point of wind speed variation comprises the interval 5146 to 5186 on the figure time scale, while the variation in its direction can be observed at the time of landing, on time scale 5203 (Figure 11).

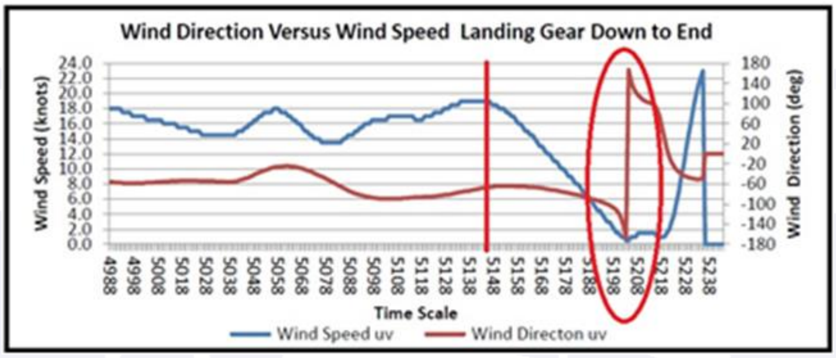

Figure 11 - Wind Direction x Speed during approach.

An anemometer located near pier 14 recorded, at 1642 (UTC), winds with an intensity of 4.86kt and, at 1643 (UTC), winds with an intensity of 42.18kt.

In Figure 12 it is possible to see the weather conditions recorded by a security camera of the Aerodrome in two moments: on the left, with the aircraft on the runway, it is possible to see the precipitation over threshold 14; on the right, 1 minute and 28 seconds after the first recording, it is possible to see a heavy rain over the Aerodrome.

Figure 12 - Comparison of images from threshold 14 at two moments: 13h42min11s (Local Time) (aircraft over the runway) and 13h43min39s (Local Time) (rain over the Aerodrome).

After performing the interpretation of the audio files extracted from the CVFDR, it was possible to identify that during the run after the aircraft landing, in the last 500ft of runway available, there was strong noise caused by rain and hail stones.

Figure 13 represents the conditions of the runway.

Figure 13 - View of SBFI threshold 14 and Stopway, 10 minutes after the accident.

The windshear phenomenon is characterized by a rapid change in wind direction or speed. Severe windshear can represent changes in horizontal wind speed exceeding 15 kt or changes in vertical speed exceeding 500 ft/min.

The windshear can be associated with microbursts. Microbursts can occur anywhere convective weather conditions (thunderstorms, rainstorms, virga) occur. Observations suggest that approximately five percent of all thunderstorms produce microbursts.

The downward currents associated with microburst are typically a few hundreds to 3,000ft in diameter. When the downward current reaches the ground, it spreads horizontally and may form one or more rings of horizontal vortices around it. The outflow region is typically 6,000 to 12,000ft in diameter. The horizontal vortices can extend to over 2,000ft AGL (Figure 14).

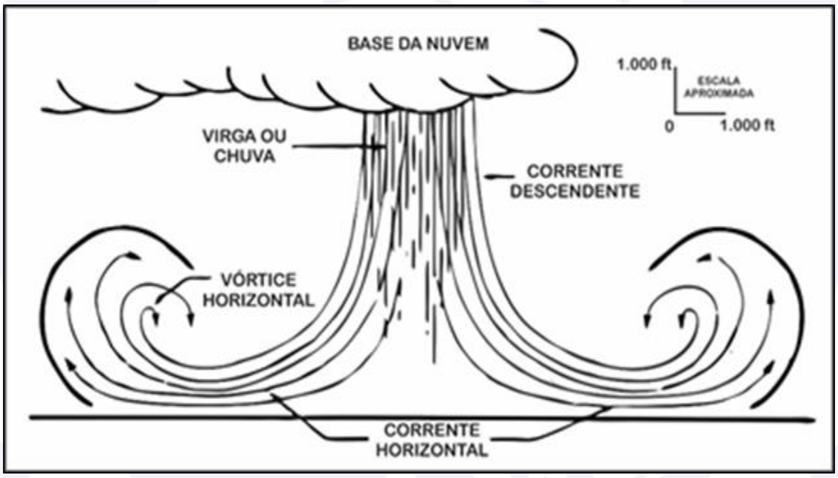

Figure 14 - Illustration of a typical windshear phenomenon.

Microbursts can be associated with both heavy rainfall with thunderstorms and lighter precipitation associated with convective clouds. At their most intense stage, microbursts can cause wind speed variations on the order of 45kt.

1.8 Aids to navigation.

Nil.

1.9 Communications.

According to the transcripts of communications between the PR-TLZ aircraft and the control agencies, it was verified that the crewmembers maintained radio contact with the APP-FI and the TWR-FI, and that there was no technical abnormality of communication equipment during the flight.

At 16h03min20s (UTC), the pilot was informed by the APP-FI that the field (SBFI) was operating under visual conditions, with predominant North wind, intensity of 11kt and that the runway in use was the 32.

At 16h03min36s (UTC), the pilot asked the APP-FI if the weather formations seen were close to the Aerodrome.

At 16h03min42s (UTC), the APP-FI informed the pilot that the formations were around the Aerodrome, that there were aircraft making detours, and that there was a large mass approaching from Paraguay.

At 16h23min47s (UTC), the APP-FI informed the pilot that there was drizzle over the field and that the runway was wet from then on.

At 16h36min14s (UTC), the APP-FI informed the pilot that there was light rain over the Aerodrome (SBFI).

At 16h40min41s (UTC), in the final approach for landing, the TWR-FI cleared the aircraft to land at threshold 32 of SBFI, reporting a wind of 270° direction with 12kt intensity.

At 16h42min06s (UTC), the TWR-FI informed the pilot of the landing time and issued instructions for taxiing the aircraft.

Thereafter, 10 messages were issued from the TWR-FI to the aircraft, with no response.

There was a regular commercial operation aircraft waiting at the SBFI threshold 32 standby point. Thirty seconds after the TWR-FI reported the landing time to the PR-TLZ aircraft, that aircraft reported to the Control Tower that it was receiving a windshear alert.

1.10 Aerodrome information.

The Aerodrome was public, administered by the INFRAERO and operated under VFR and IFR, during day and night.

The runway was made of asphalt, with thresholds 14/32, dimensions 2,195 x 45m, and elevation of 787ft. Threshold 32 had an elevation of 786ft and threshold 14 was at 732ft of altitude. The difference between the thresholds was 54ft, which represented 0.75% negative slope from threshold 32 to 14.

The declared distances of TORA, TODA, ASDA and LDA corresponded to those described in the Aerodrome Chart (ADC), as shown in Table 2.

RWY	TORA(m)	TODA(m)	ASDA(m)	LDA(m)
14	2095	2895	2155	2195
32	2095	2895	2145	2195

Table 2 - Declared distances from the SBFI runway, as per AIRAC AMDT 02/18 01MAR2018.

The runway had two asphalt stopways, located after each of the thresholds. The stopway after threshold14 had dimensions of 50 x 45m. The second stopway, located after threshold 32, had dimensions of 60 x 45m (Figure 15).

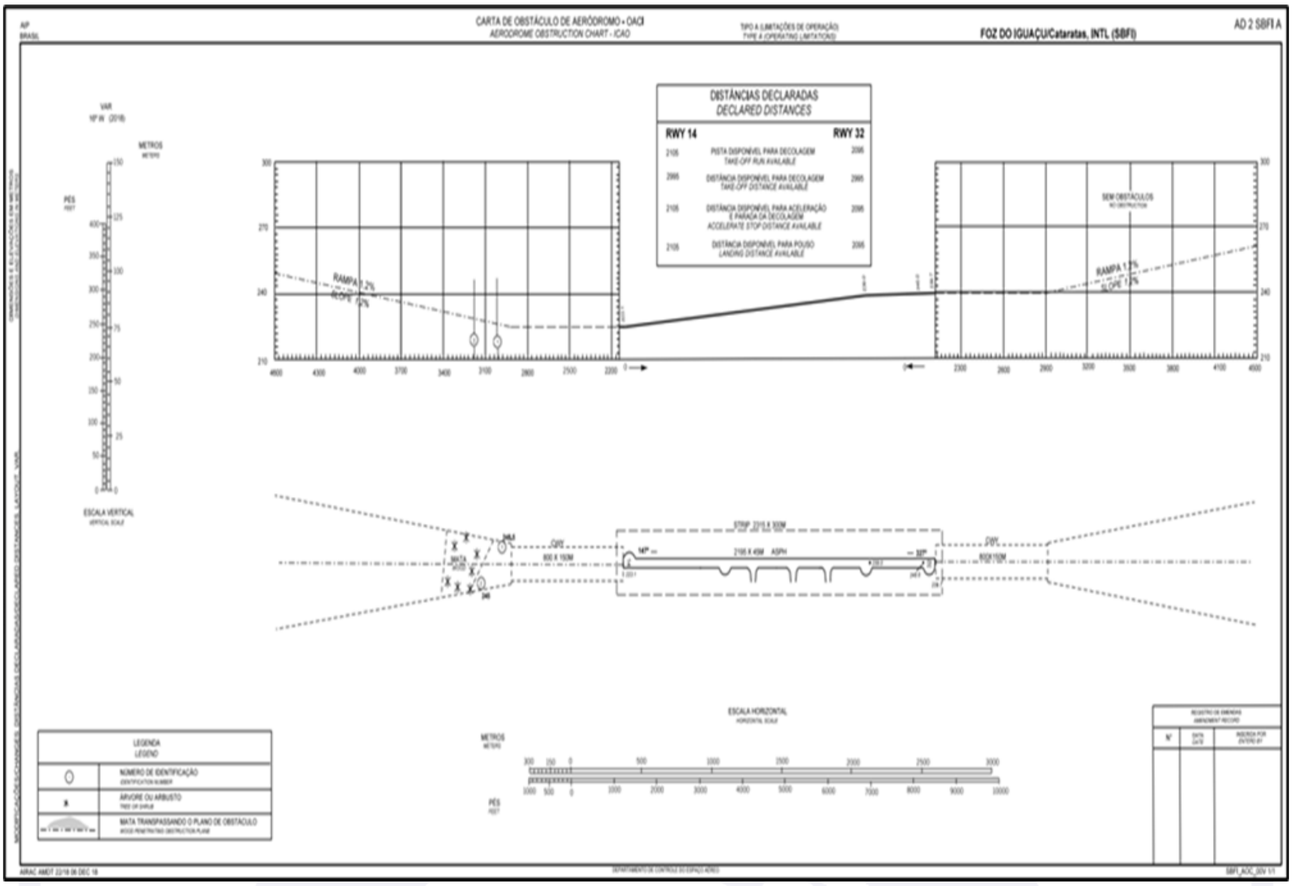

Figure 15 - Obstacle Chart of the SBFI Aerodrome.

The last runway friction coefficient measurement had been performed on 06SEPT2018 and the last macrotexture measurement was performed on 28SEPT2018. The friction and macrotexture measurements were performed in line with the provisions of the RBAC 153 (Amendment 02).

According to the friction measurement report, the SBFI Runway 14/32 was classified as "A > Maintenance Level", which did not require any corrective action. Also, according to the macrotexture measurement report, there were no sections of the SBFI Runway 14/32 with average depths below the regulatory minimums.

1.11 Flight recorders.

The aircraft was equipped with a CVFDR W/RIPS, Part Number 1605-01-00, Serial Number 1465, manufactured by Universal Avionics.

The voice and data recorder was forwarded to the CENIPA's LABDATA, where the data was successfully downloaded.

The equipment functioned normally and contained data relating to the flight of the occurrence.

1.12 Wreckage and impact information.

The aircraft exceeded the limit of runway 32, crossing the opposite threshold (14) and the stopway.

When realizing he was about to leave the runway, the pilot commanded a right turn, stopping at 90° in relation to the runway (Figure 16).

Figure 16 - Aircraft trajectory.

After exceeding the limits of the stopway, the plane crashed into a ravine that was 7 meters deep. There were no parts detached from the aircraft (Figure 17).

Figure 17 - View of the ravine and the aircraft, after full stop.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

During data collection with the crewmembers involved in the occurrence, no health problems were identified that could have interfered with the flying activity, either physical or mental. The crewmembers denied smoking or regular consumption of alcoholic beverages. They had no prescription for continuous use medication, nor any history of drug abuse.

Regarding the regular health inspection required by the ANAC, their CMAs were valid, with no significant diagnoses indicated.

In reference to the crewmembers' workload, it was verified that the flight in question had been the longest in the 48 hours prior to the accident and that the resting period was considered adequate.

According to the previous medical history, it was found that the pilots did not have any diseases that could impair their piloting performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

The pilot was 39 years old, had been with the company for three years, and was responsible for the maintenance control of the aircraft. The copilot was 44 years old and had worked for the company for three years.

The flights were scheduled by demand of the owner or by the needs of the company's managers. The pilots worked an average of 170 hours a year. Eventually, they were on call, waiting in a company room at the airport or at their homes.

The flight that led to the accident was scheduled for September 25, but due to weather conditions, it was brought forward to September 24. On the day of the accident, the pilot, the copilot, and one passenger were on board and, according to the crew, there were no problems until the moment of landing.

When evaluating the individual and psychosocial variables related to the accident, no psychological issues that could have affected the crewmembers' performance on the flight in question were evident.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

The pilot reported that after the aircraft stopped, the engine shutdown and evacuation procedures were performed.

The abandonment of the aircraft took place through the main door and there were no additional difficulties.

1.16 Tests and research.

According to the pilot's report, the aircraft brakes would have shown little effectiveness during the run after landing. Therefore, research was conducted in coordination with Honda Aircraft Company (HACI) to verify the hypotheses of brake system failure and the occurrence of hydroplaning of the aircraft.

<u>Tests related to the operation of the brake system</u>

As for the operation of the hydraulic system, according to data obtained from the CVFDR and the CMF recordings, the hydraulic pressure of the system remained within normal operating parameters and no signs of malfunction were found during the flight.

The brake system components were removed and sent for testing at HACI's headquarters in Greensboro, NC (USA). The technical procedures were performed by HACI professionals and accompanied by representatives from the NTSB and the SERIPA V.

The list of components removed from the aircraft for the tests and their respective SN can be seen in Table 3.

ID	Nomenclature	Serial Number	Notes
01	MASTER CYLINDER	AWB00246	LH Pilot
02	MASTER CYLINDER	AWB00245	RH Pilot
03	MASTER CYLINDER	AWB00244	LH Copilot
04	MASTER CYLINDER	AWB00243	RH Copilot
05	VOLUME COMPENSATOR AND SHUTOFF VALVE	AWB00166	
06	ANTISKID CONTROL AND POWER BRAKE VALVE	0216	
07	BRAKE ASSEMBLY	MAR16/0215	LH MLG
08	BRAKE ASSEMBLY	MAR16/0216	RH MLG
09	WHEEL SPEED TRANSDUCER	0270	LH MLG
10	WHEEL SPEED TRANSDUCER	0271	RH MLG
11	EMERGENCY/PARK BRAKE VALVE	AWB00108	

Table 3 - List of components removed from the aircraft.

The components of the aircraft brake system were tested according to the aircraft manufacturer's protocols. The methodology used to perform the tests consisted of two stages:

- In a first step, visual inspections were carried out on all components and some components were also subjected to basic individual tests. No evidence of any kind of discrepancy or abnormality of the components in relation to the parameters stipulated by the manufacturer was detected. As such, all were considered "approved" in the tests; and

- In a second step, the components were installed on a bench in order to simulate the operation of the aircraft brake system and measure the results obtained. It should be noted that it was not possible to perform the tests directly on the aircraft, due to the damage suffered as a result of the impact.

Since the bench did not allow the simultaneous installation of all four master cylinders at the pilot and copilot stations, the tests were performed with one cylinder installed at a time.

Four tests were performed, alternating the installation of the master cylinders. In all of them, the parameters achieved were in accordance with those stipulated by the aircraft manufacturer.

Figure 18 illustrates the results obtained during "test 01", with the pilot master cylinder installed. Note that, throughout the period, the nominal pressure of the hydraulic system remained stable at 3,000 PSI and, when simulating the application of the aircraft brakes through the master cylinder, the system reached the value of 3,000 PSI, as recommended by the manufacturer.

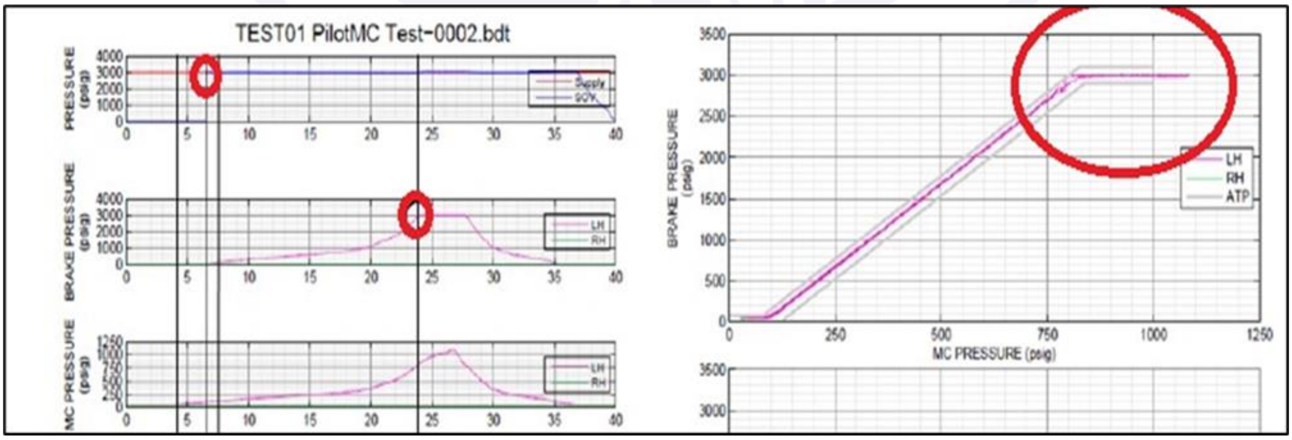

Figure 18 - Result of pressure test 01, performed on the bench.

After the procedures were completed at the HACI, the PBV was sent for further testing and disassembly at its manufacturer, Crane Aerospace & Electronics. The procedure was accompanied by a representative of the NTSB and technicians from the HACI and Crane.

The PBV had 64 hours and 48 minutes of operation and 64 cycles from its installation on the aircraft to the time of the accident.

The valve was inspected and no visual damage was observed. An oil sample was taken from inside the valve and checked for cleanliness and possible impurities.

No impurities were found in the oil and the unit passed all the technical requirements of its manufacturer.

From Figure 19 it can be seen that during pressure tests performed with both brakes (left and right) the system reached a pressure of 3,000 PSI.

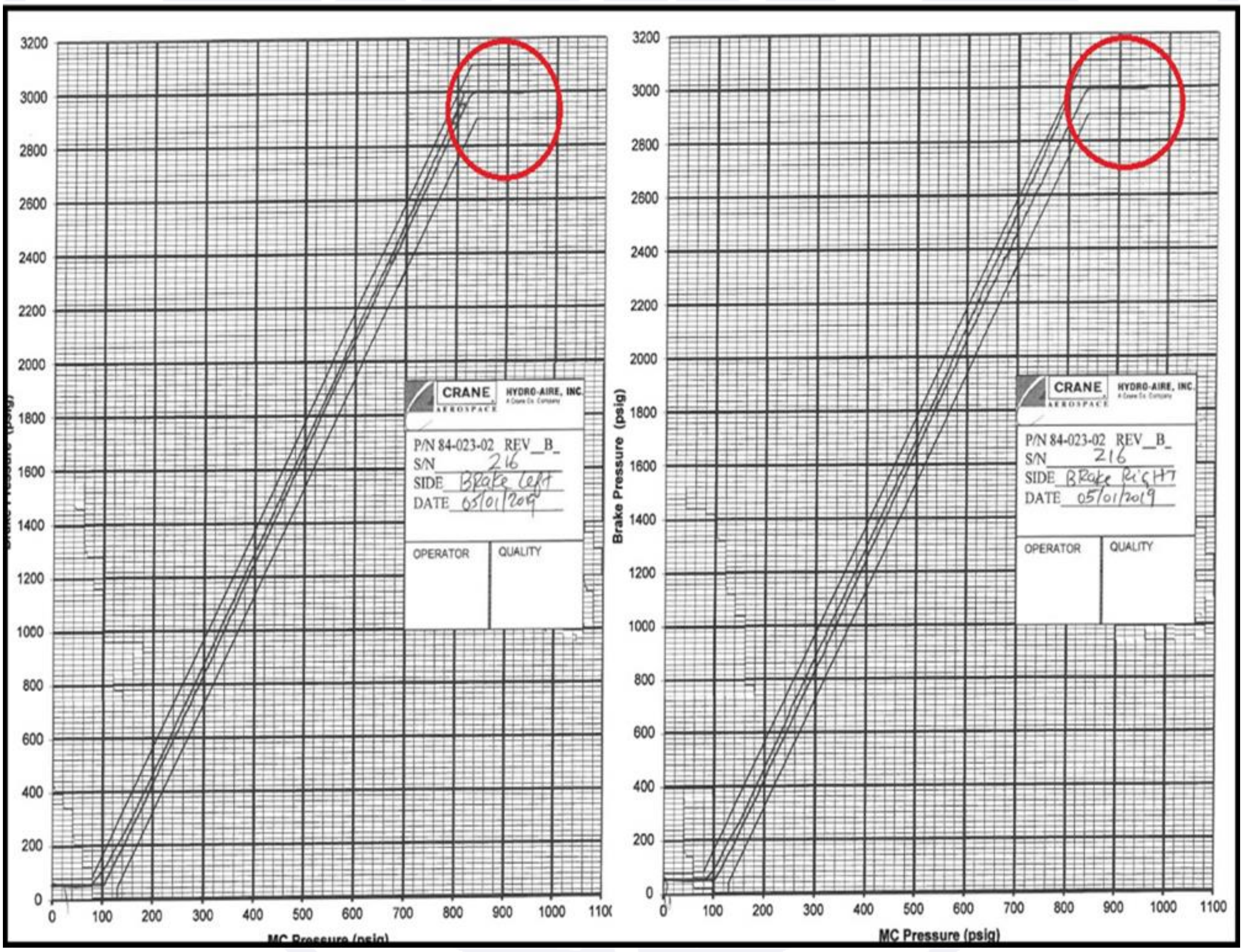

Figure 19 - Results of pressure measurement tests performed at the PBV.

<u>Research related to hydroplaning.</u>

A surveillance camera of the Aerodrome recorded images of the moment of landing, in which it was possible to verify a spray formed on the back of the aircraft, denoting the existence of a significant amount of water on the runway (Figure 20).

Figure 20 - Detail of the landing run, highlighting the spray formed on the back of the aircraft.

The Honda Aircraft Company Flight Science Department developed the 7.5 √p curve to model the predicted hydroplaning for the HA-420 aircraft with the normal main tire pressure of 215 PSI. The result of this curve corresponded to an estimated hydroplaning speed of 110 kt (Figure 21).

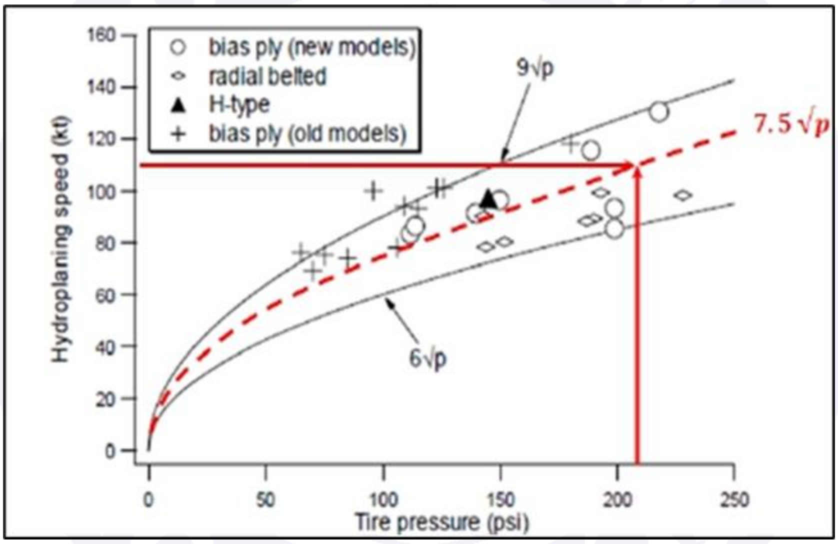

Figure 21 - Experimental hydroplaning speeds as a function of tire pressure for the HA-420 aircraft.

Figure 22 shows the Calibrated Airspeed (CAS), and ground speed of the aircraft over time, with Time 0 (start time) set as the estimated touchdown point. The speed reference lines are included values for Nominal VREF, Nominal Touchdown Speed, estimated hydroplaning speed (tire pressure 7.5 X SQRT) and 85% of hydroplaning speed.

The first graph shows that the ground speed was greater than the CAS during the first 26 seconds of the landing, indicating a tailwind. The CAS becomes greater than ground speed during the rapid increase in the CAS starting 30 seconds after the touchdown (Figure 22). The graph also shows that at 50ft AGL, the CAS was approximately 117kt.

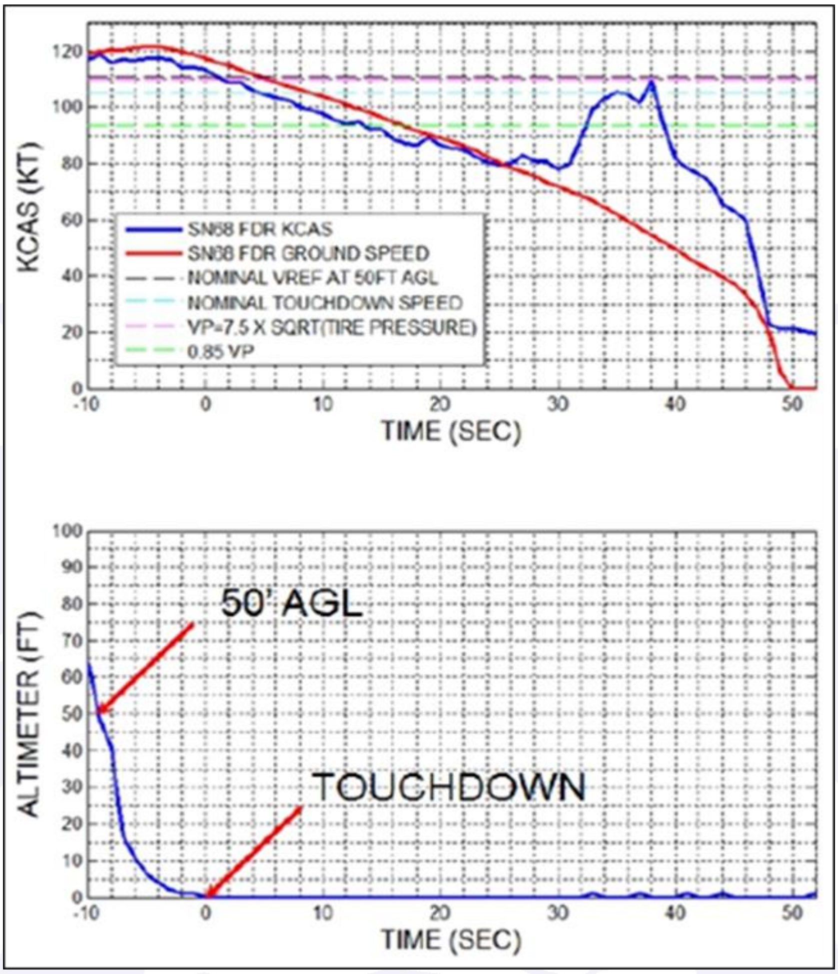

Figure 22 - Velocity and height (AGL) vs Time, Touchdown at T=0.

Figure 23 shows the aircraft deceleration recorded after the touchdown (red line) compared to a Honda Aircraft aerodynamic model curve showing the predicted aerodynamic drag deceleration (black line, no aircraft brakes applied). It is evident from the figure that forces, other than aerodynamic drag, acted to decelerate the aircraft after the touchdown.

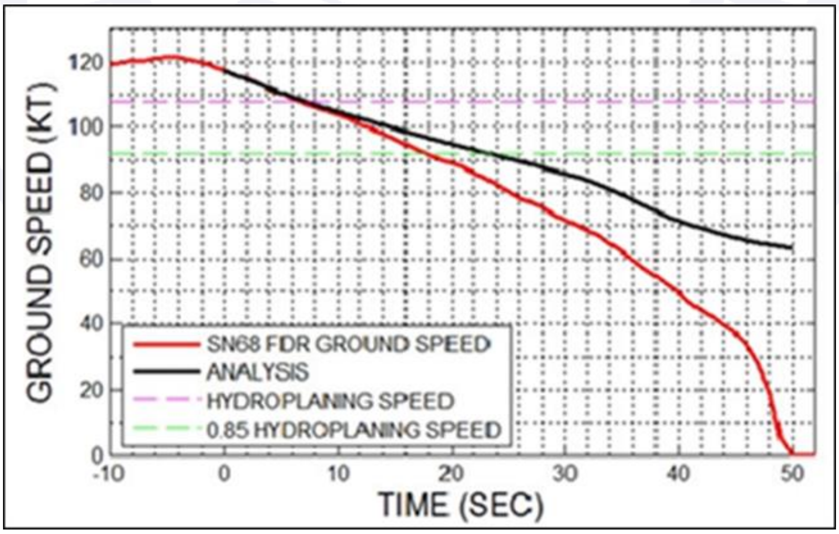

Figure 23 - Aerodynamic drag model (black line) and deceleration curve relative to the ground (red line).

The Federal Aviation Administration (FAA) Advisory Circular AC 25-31 provided standardized data for calculating operations on contaminated runways and specifically provided estimated wheel braking coefficients as a function of runway surface condition.

Figure 24 is derived from braking coefficient data from the AC 25-31 and graphs of the wet runway braking coefficients against ground speed for various levels of water contamination on the runway.

The solid horizontal lines depict conditions of a wet runway (FAA WET RWY BRK MU - DEPTH<3mm), a very wet runway (FAA WET RWY BRK MU - DEPTH>3mm), and a very wet runway with hydroplaning (FAA WET RWY BRK MU - DEPTH>3mm&HYDROPLANING). Any data point below the red line indicates a potential for hydroplaning.

The simulated braking coefficient for the PR-TLZ, assuming a value of "0" for all speeds, is mapped in Figure 24 (black circles). This equates to no braking and that the expected deceleration would correspond to the black line shown in Figure 23 (aerodynamic braking only).

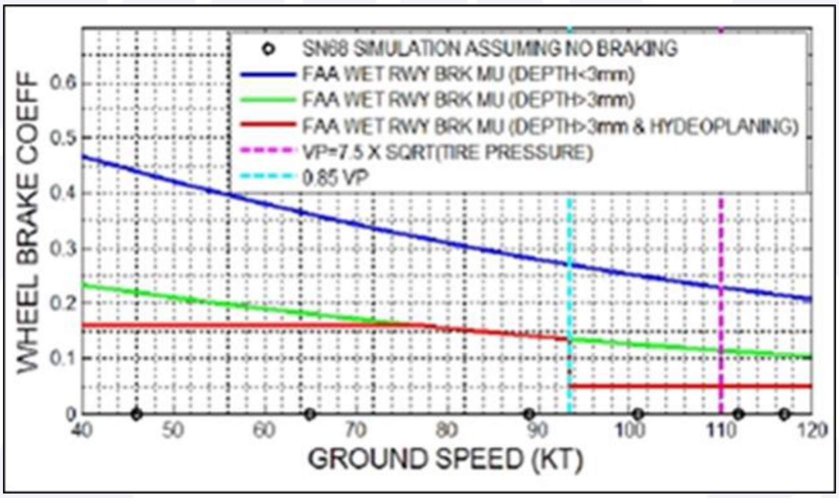

Figure 24 - Aerodynamic drag only (black circles, brake coefficient = 0 for all speeds) data points compared to the FAA model braking curves for a wet runway with various water depths.

If the aircraft braking coefficients (black circles) are progressively adjusted until the black model curve is represented and if Figure 23 matches the actual aircraft deceleration curve in the same figure, the curve fitting will produce the braking coefficient values represented at the speeds listed in Table 4.

Figures 25 to 29 depict how the curve fitting progresses as the braking coefficient values are adjusted to match the analysis curve with the ground speed curve (SN68). The braking coefficient values are progressively applied until the analysis curve matches the SN68 ground speed curve, resulting in the values in Table 4.

For better understanding, the braking coefficients are represented by the symbol CF subscripted by the aircraft ground run time parameter, where T represents the instant of touchdown plus the ground run time.

Each step of the curve fitting is shown as follows:

- Figure 25 - Braking Coefficients: CFT = 0; CFT+4 = 0.04, constant after T+4;

- Figure 26 - Braking Coefficients: CFT = 0; CFT+4 = 0.04; CT+12 = 0.08, constant after T+12;

- Figure 27 - Braking Coefficients: CFT = 0; CFT+4 = 0.04; CT+12 = 0.08; CFT+18 = 0.10, constant after T+18;

- Figure 28 - Braking Coefficients: CFT = 0; CFT+4 = 0.04; CT+12 = 0.08; CFT+18 = 0.10; CT+34 = 0.19, constant after T+34;

- Figure 29 - Braking Coefficients: CFT = 0; CFT+4 = 0.04; CT+12 = 0.08; CFT+18 = 0.10; CT+34 = 0.19; CFT+46 = 0.65.

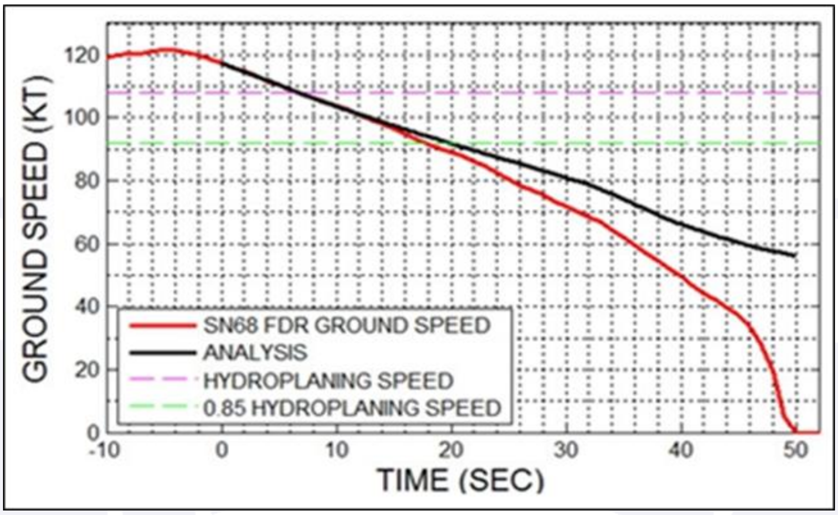

Figure 25 - Analysis of the curve of the braking coefficient adjusted for Touchdown, T+4.

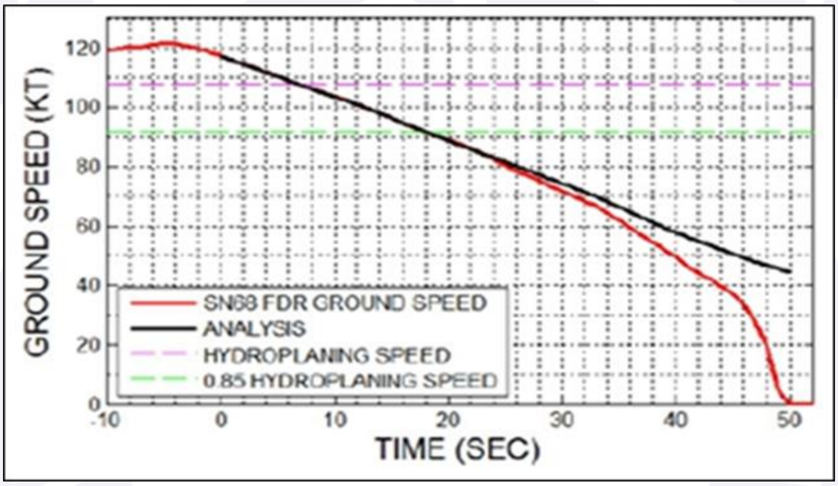

Figure 26 - Analysis of the curve of the braking coefficient adjusted for Touchdown, T+4, T+12.

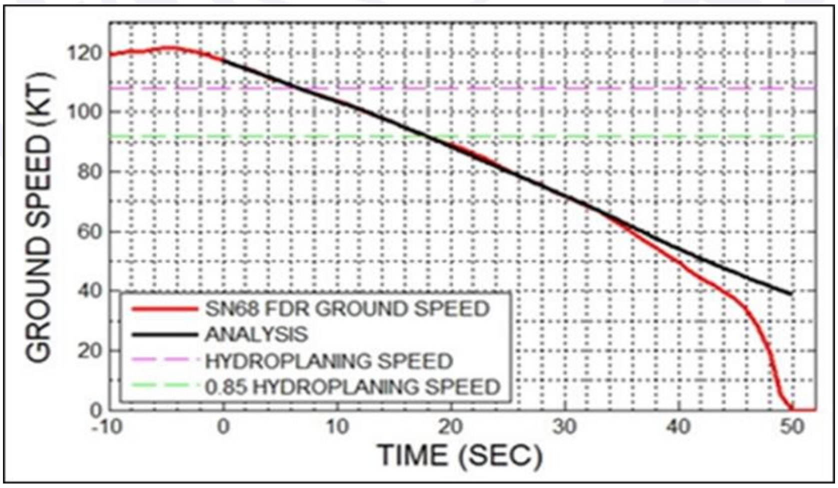

Figure 27 - Analysis of the curve of the braking coefficient adjusted for Touchdown, T+4, T+12, T+18.

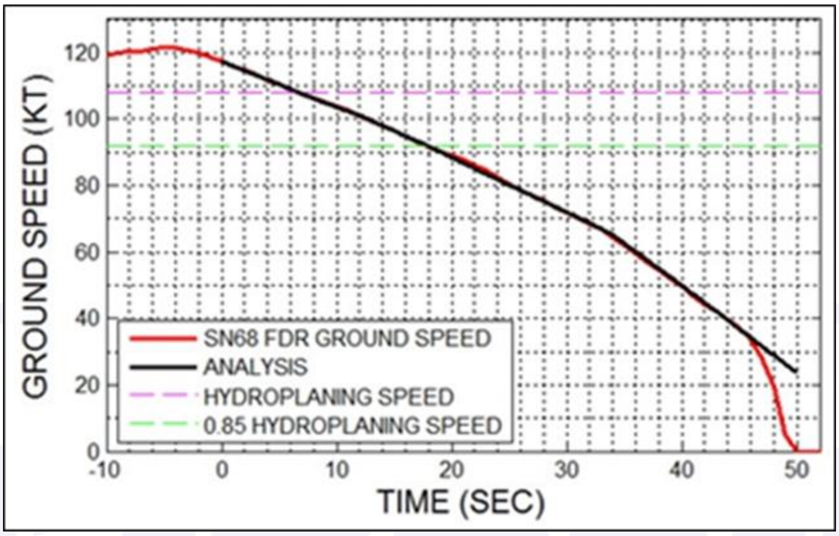

Figure 28 - Analysis of the curve of the braking coefficient adjusted for Touchdown, T+4, T+12, T+18, T+34.

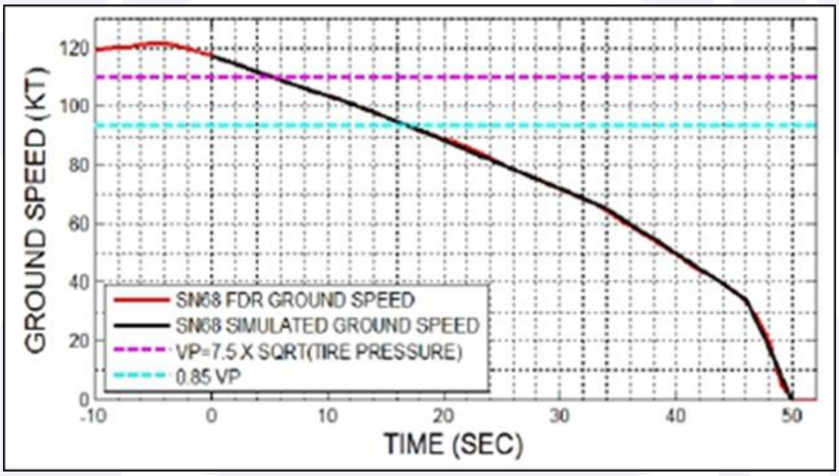

Figure 29 - Analysis of the curve of the braking coefficient adjusted for Touchdown, T+4, T+12, T+18, T+34, T+46.

TIME AFTER TOUCHDOWN (SEC)	GROUND SPEED (KNOTS)	WHEEL BRAKING COEFFICIENT
0 (T)	117	0
T+4	112	0.04
T+12	101	0.08
T+18	89	0.10
T+34	65	0.19
T+46	46	0.65

Table 4 - Ground Speed and estimated wheel braking coefficient during the landing run.

Figure 30 shows the six values from the curve in Table 4 corresponding to the SN68 braking coefficients (black circles) for various water depths on the runway.

Three of the higher speed braking coefficient values (Touchdown, T+4, and T+18) are below the hydroplaning curve of the aircraft experimentally tested by the FAA. At these points, the estimated aircraft deceleration corresponds to what would be expected from a hydroplaning aircraft. Two data points (T+12 and T+34) are above the FAA hydroplaning curve.

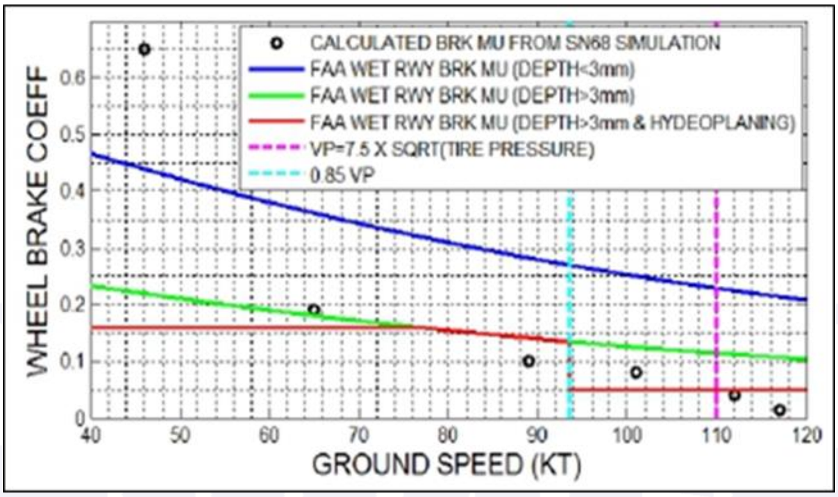

Figure 30 - Braking coefficient data points (black circles) compared to the FAA model braking curves for a wet runway with various water depths.

Having derived estimated braking coefficient values at different speeds by matching the modeled aircraft deceleration to the actual speed recorded by the CVFDR and then comparing the braking coefficients to the FAA model curves for wet runways, the analysis shows that the estimated aircraft deceleration corresponded to what would be expected on a very wet runway (> 3mm of water) with tire hydroplaning at the highest speeds.

1.17 Organizational and management information.

According to reports, the crewmembers hired to operate this aircraft were submitted to a formal recruitment and selection process by a company psychologist. In addition, they were submitted to technical evaluation in an aviation company that operated the same model aircraft, and their previous professional references were checked.

1.18 Operational information.

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

The next flight would carry four passengers from the city of Foz do Iguaçu - PR, to the city of Goiânia - GO.

Due to the fact that the aircraft and crew were based in Curitiba - PR, it was necessary to move from SBCT to SBFI in order to start the planned flights.

It was decided that the flight from SBCT to SBFI would take place on 24SEPT2018, before 1700 (UTC), as there was a forecast of deteriorating weather conditions at the destination Aerodrome (SBFI). The takeoff occurred at 1540 (UTC) and the flight proceeded without en-route abnormalities.

The basic operating weight of the aircraft was 7,239.8 lb. and it was fueled with 2,680 lb. (QAV-1). Added to the weight of the crewmembers, passenger, baggage and stewarding supplies, a takeoff weight of 10,580 lb. was obtained. The aircraft's maximum takeoff weight (PMD) stipulated by its manufacturer was 10,600 lb.

Through the aircraft's flight data recording, it was found that the leg lasted 62 minutes and that it consumed 900 lb. of fuel.

The estimated landing weight at SBFI was approximately 9,600 lb. The manufacturer's maximum landing weight was 9,860 lb. and the center of gravity (CG) calculation indicated that the aircraft was within the expected parameters.

In order to calculate the parameters for the SBFI landing, the Aircraft Flight Manual (AFM) table, page 236, section 5, was used to obtain the required runway length. It should be noted that the values applied in this table referred to dry runway, zero-slope and zero-wind conditions. No interpolation was used, the considered aircraft weight was 9,600 lb. and the field altitude was 786ft. Therefore, the required landing distance for these conditions was calculated as 3,631ft. (1,107m), as shown in Table 5.

Uncorrected Landing Field Length [feet]
Dry Runway, Zero Slope, No Wind
Flaps LDG, Ice Protection Off

ALT [ft]	TEMP [°C]	Landing Weight [lb]						
		7600	8000	8500	9000	9500	9860	10600
		VREF [KIAS]						
		100	102	105	108	111	113	117
-1000	-40	2539	2602	2703	2802	2900	2970	3112
	15	2906	2981	3101	3219	3335	3418	3587
	25	2973	3051	3173	3294	3414	3500	3674
	35	3041	3120	3246	3371	3494	3581	3760
	45	3108	3190	3319	3446	3573	3663	3846
	50	3141	3224	3355	3484	3612	3703	3889
	55	3174	3258	3390	3521	3651	3743	3931
Sea Level	-40	2596	2662	2765	2867	2968	3040	3186
	15	2976	3054	3177	3298	3418	3504	3678
	25	3046	3126	3252	3377	3500	3588	3767
	35	3116	3198	3327	3455	3582	3672	3856
	45	3185	3269	3402	3534	3663	3756	3945
	50	3219	3305	3439	3572	3704	3797	3989
	55	3253	3340	3476	3611	3744	3839	4032
1000	-40	2657	2724	2830	2935	3039	3113	3264
	10	3014	3093	3218	3341	3462	3549	3726
	20	3085	3167	3295	3422	3547	3636	3818
	30	3157	3241	3373	3503	3631	3723	3910
	40	3229	3315	3450	3583	3715	3810	4001
	45	3265	3352	3488	3624	3757	3853	4047
	50	3300	3388	3526	3663	3799	3895	4092
2000	-40	2721	2791	2900	3008	3115	3191	3346
	10	3090	3172	3300	3427	3552	3642	3823
	20	3165	3249	3381	3511	3640	3731	3919
	30	3239	3325	3461	3594	3727	3821	4013
	40	3313	3402	3540	3678	3813	3910	4108
	45	3349	3439	3580	3719	3856	3955	4155
	50	3386	3477	3619	3760	3899	3998	4201

Table 5 - Unfactored landing distance (AFM, p. 236, section 5).

According to the data obtained through the CVFDR transcription, it was possible to verify that, at the time of the aircraft landing (time scale 5203), the speed in relation to the ground was 3.5kt higher than the calibrated speed. Therefore, it was assumed that there was a tailwind component, with intensity of 3.5kt (Figure 31).

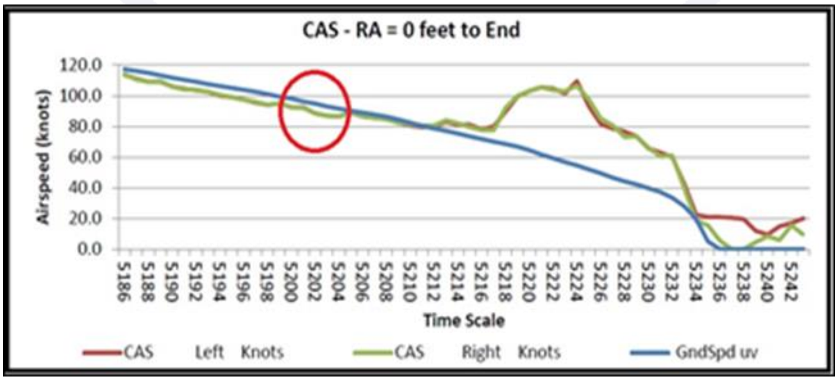

Figure 31 - Calibrated speed x ground speed.

Thus, using the wind correction table (AFM, page 239, section 5), it was found that 278ft had to be added to the distance of 3,631ft, totaling 3,909ft (1,191m).

Next, a correction was made for the negative gradient of Runway 32, which was 0.75% (see Item 1.10 - Aerodrome Information). After the correction, 730ft was added to the distance of 3,909ft for a total of 4,639ft (1,414m).

Because the runway was wet, there was also a 30% increase in landing distance, totaling 6,031ft (1,838m).

The analysis of the aircraft flight parameters, obtained through the CVFDR recording, indicated that during the final approach there were no significant variations in the ramp angle.

The AFM predicted reference speed (VREF) at 50ft AGL was 111 KCAS, but the flight data recorder registered a speed of 118 KCAS. The prevised ground speed at touchdown was 105 KGS, however, the speed registered in the recorder was 117.3 KGS (Table 6).

ALTITUDE	NOMINAL	SN68 FDR
50 FT AGL	111 KCAS (V_{ref})	118 KCAS
Touchdown	105 KGS	117.3 KGS

Table 6 - Predicted velocities x velocities registered in the aircraft's FDR.

According to the aerodynamic modeling by Honda's Flight Science Department for a dry, flat, windless runway, landing with a speed 8.5kt beyond the prevised rated speed would imply a 400ft increase in landing distance over the table published in the AFM.

Adding 400ft to the value of 6,031ft previously found, gives a landing distance of 6,431ft (1,960m).

The representation of the data obtained from the CVFDR transcription indicated that the touchdown on the runway occurred in the Touchdown Zone (TDZ), about 70m before the 1,000ft mark, as illustrated in Figure 32.

Figure 32 - Touching point on the runway in relation to threshold 32.

Data extracted from the CMF showed that, during the run after landing, some kind of indicated speed anomaly occurred, which caused a sudden increase in the calibrated speed of the aircraft.

As shown in Figure 33, it can be seen that from 16:42:21, the calibrated airspeed suddenly starts to increase by approximately 32kt, decreasing again at 16:42:34. Point "A" shows the moment when the aircraft touches the runway (16:41:52). Point "B" represents the moment when the aircraft exceeds the runway limits (16:42:36). The circled area, in red, indicates the range of occurrence of variation in the calibrated speed of the aircraft starting 30 seconds after the touchdown on the runway.

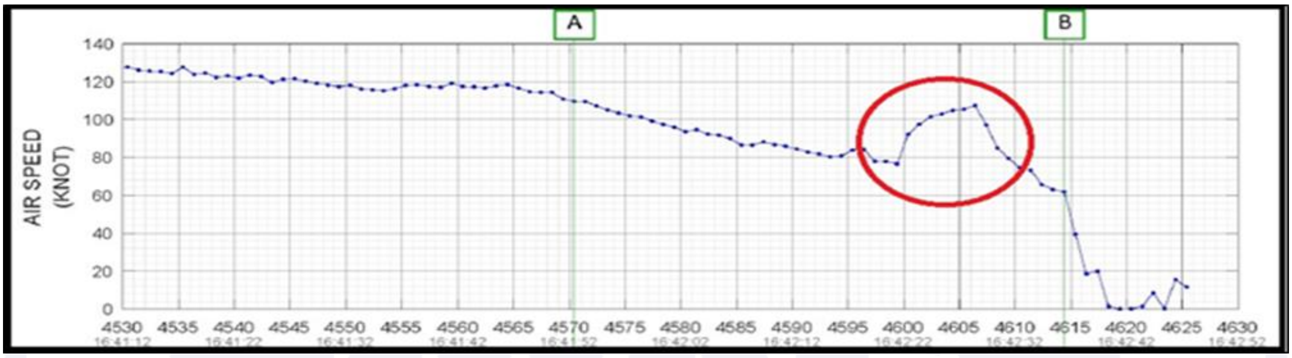

Figure 33 - Variation in the calibrated speed of the aircraft.

As observed in Figure 34, during this event, there was no increase in the power developed by the aircraft engines. The area circled in red indicates the moment of the aircraft touchdown on the runway (16:41:52). Also, there was no change in the engine speed (% N1) during the run after landing.

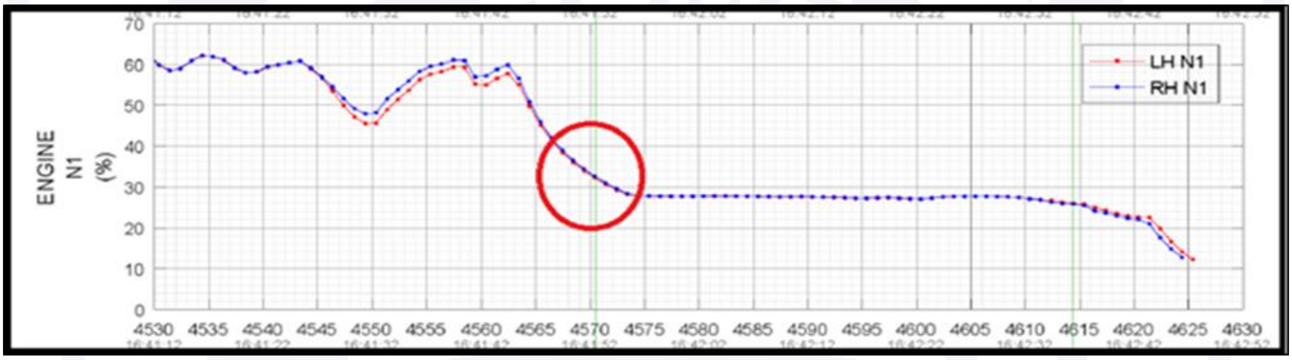

Figure 34 - Variation of N1 of the aircraft engines.

Through flight data obtained from the CVFDR transcription, it was possible to illustrate the deceleration of the aircraft from 100kt to 60kt (Figure 35).

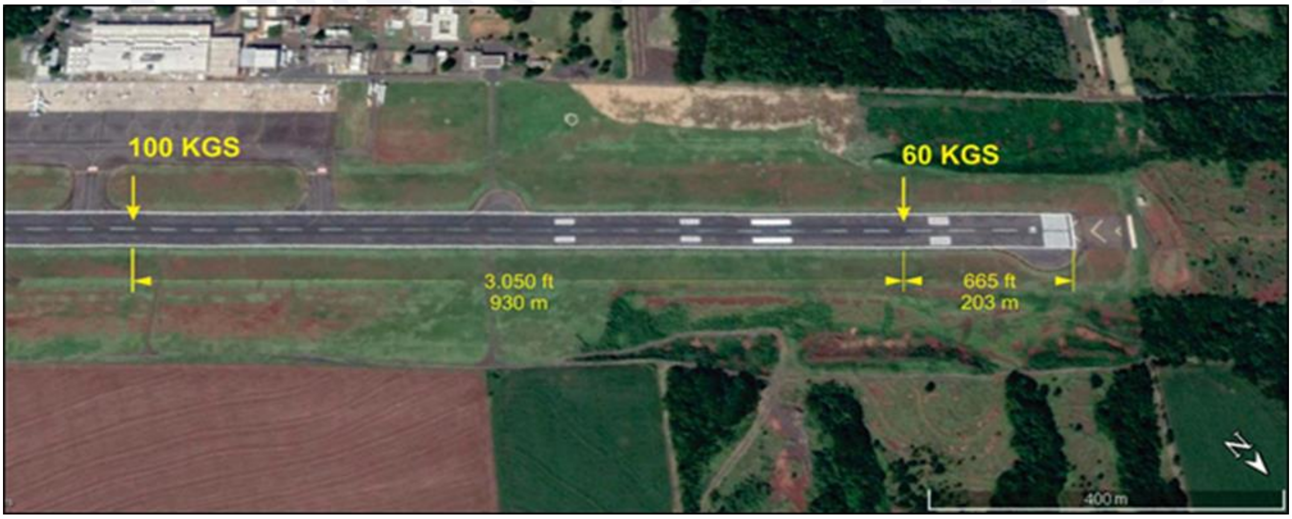

Figure 35 - Representation of the distance traveled by the aircraft from the point of 100 KGS to 60 KGS.

The aircraft's flight data recorders indicated that the emergency brake was applied when there was 500ft left to the end of the runway.

The emergency brake was intended to be applied when the normal brake failed. The procedure was prevised in the AFM (section 3, p. 28) for such cases. However, it warned that the anti-skid was inoperative and that the distance traveled on a wet runway would be increased by 100% (Figure 36).

NORMAL BRAKES FAIL

Normal wheel brakes have failed

CAUTION *Anti-skid will not operate. Avoid cycling the brake handle. Approximately ten applications are available with a fully charged system.*

NOTE Gradually pull emergency brake handle until desired braking action is achieved.

NOTE Landing distance will increase by 50% on a dry runway and 100% on a wet runway.

1. EMERGENCY BRAKE .... Apply gradually

Figure 36 - AFM note (section 3, page 28) for the Normal Brakes Fail procedure.

Although this was optional equipment, the aircraft was equipped with speedbrakes. According to the pilot's report and through flight data recorder registers, it was found that this feature was not used during the run after landing.

The AFM (p. 28, section 4) stated that speedbrakes, if installed in the aircraft, should be extended after the touchdown (Figure 37).

LANDING

1. Thrust Levers.. IDLE
2. Brakes..Apply (after touchdown)

NOTE Establish directional control using rudder and then apply brakes symmetrically during the initial part of the landing rollout.

3. SPEEDBRAKE (if installed).. EXT

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Figure 37 - Aircraft landing checklist (AFM, page 28, section 4).

No data quantifying the effectiveness of the use of speedbrakes was found in the aircraft operation manuals. In consultation with the aircraft manufacturer, it was informed that their use could reduce the landing distance by approximately 50ft.

1.19 Additional information.

At the end of March 2018, the FAA issued an Airworthiness Directive (AD - 2018-06-10) that required a temporary revision of the flight manual for the HA-420 Honda Jet aircraft.

According to the AD, certain checks were to be performed on the aircraft's brakes by pilots. In addition, any defective PBVs were to be replaced.

The demand arose due to the history of reports of asymmetric braking, during ground operations and landing deceleration, which involved some aircraft of that model.

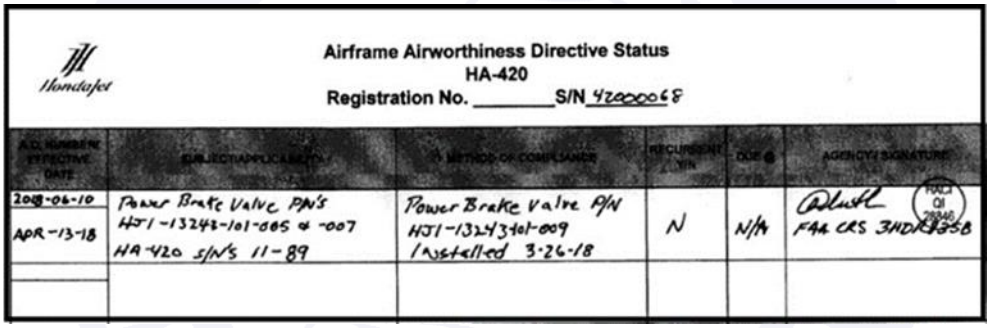
On 15APR2018, the Honda Jet, registration N10XN, went off the runway and hit the grass while landing at Peachtree DeKalb Airport (KPDK). Two days later, on 17APR2018, the Honda Jet N166HJ went off the runway while landing at Harlan Municipal Airport in Iowa (KHNR). On 04MAY2018, during landing at Lebanon-Springfield Airport (FAA LID: 6I2), the aircraft registration N144FF also went off the runway.

The AD (2018-06-10) was published on March 29 and became effective on 13APR2018.

According to this Directive, it was observed that inside the PBV there was an oversizing of the O-ring. This could lead to a possible hydraulic pressure leak in the valve. This leakage tended to increase over time, causing the PBV to malfunction. As a consequence, there could be degradation in the braking performance and reduction of the aircraft's directional control.

Therefore, the AD contemplated the HA-420 aircraft with SN numbers from 42000011 to 42000089 and with installed PBVs with PN HJ1-13243-101-005 or HJ1-13243-101-007. These PBVs were to be replaced by more improved ones (PN HJ1-13243-101-009).

At the time of the accident, it was verified that the PR-TLZ aircraft already had the improved PBV, PN HJ1-13243-101-009, installed (Figure 38).


HondaJet

Airframe Airworthiness Directive Status
HA-420
Registration No. ________ S/N 42000068

A.D. NUMBER/ EFFECTIVE DATE	SUBJECT/APPLICABILITY	METHOD OF COMPLIANCE	RECURRENT Y/N	DUE @	AGENCY/ SIGNATURE
2018-06-10 APR-13-18	Power Brake Valve PN's HJ1-13243-101-005 & -007 HA-420 S/N's 11-89	Power Brake Valve P/N HJ1-13243-101-009 Installed 3-26-18	N	N/A	FAA CRS 3HDR[illegible]

Figure 38 - Record of installation of the latest version of the PBV on the aircraft (PN HJ1-13243-101-009).

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a staff transport flight from Curitiba - PR, to the Cataratas Aerodrome (SBFI), Foz do Iguaçu - PR, in order to carry passengers from SBFI to the city of Goiânia - GO, later.

After landing on threshold 32, in SBFI, the aircraft went all the way down the runway, overpassed its limits and crashed into a ravine.

According to the pilot’s report, the aircraft brakes were not very effective during the run after landing, which prevented the aircraft from stopping within the runway limits.

The aircraft model HA-420, PR-TLZ, was manufactured by Honda Aircraft Company in 2017. The VTI had been conducted on 18APR2018 and the aircraft had not yet undergone subsequent inspection or overhaul. The CA was valid and the airframe and engine logbook records were updated.

Due to the history of asymmetric braking reports involving some HA-420 model aircraft, an AD (2018-06-10) had been issued in March 2018, which mandated the replacement of PBVs that were defective.

The investigation found that this AD had been complied with prior to the accident and that the latest version of the PBV (PN HJ1-13243-101-009) was properly installed on the aircraft.

Thus, tests and research were conducted in coordination with Honda Aircraft Company (HACI) to verify the hypothesis of failure of the aircraft's brake system.

The data obtained through the transcription of the aircraft's CVFDR and CMF indicated that the hydraulic pressure generated by the system remained within normal operating parameters throughout the flight.

The brake system components were tested and showed no evidence of any kind of discrepancy or abnormality in relation to the parameters stipulated by the manufacturer.

Also, bench tests were performed that resulted in normal operation of the system at the expected pressure of 3,000 PSI.

Additionally, specific tests of the PBV were performed at the component manufacturer's headquarters, where the hydraulic pressure was measured and the results found were in accordance with the recommended for normal operation of the aircraft.

With these results, no evidence of malfunction of the aircraft brake system that could have caused the runway excursion was found.

The pilot took his PPR License in 1996 and his PLA License in 2007. His HA-420, MLTE and IFRA Type Rating were valid. He had been working for that operator for three years and, besides being a crewmember of the two aircraft belonging to the group (King Air C90GTI and Honda HA-420), he also controlled maintenance. He had 5,600 total flight hours, of which 77 hours in the HA-420 aircraft. His CMA was valid.

The copilot took his PPR license in 2007 and his PCM license in 2011. His HA-420, MLTE and IFRA Type Ratings were valid. He had been working for the operator for three years. He had 660 total flight hours, of which 14 hours in the HA-420 aircraft. His CMA was valid.

Thus, the technical qualifications and flight experience of the crewmembers, although relatively low on the HA-420 type, were considered adequate for the proposed operation.

Regarding medical and psychological interactions, there was no evidence that physiological, incapacitation, individual, psychosocial or organizational considerations affected the crew's flight performance.

The flight from SBCT was normal and in accordance with the planning parameters established by the aircraft manufacturer.

The landing performance calculations for SBFI Aerodrome, considering a weight of 9,600 lb, resulted in a VREF of 111 KCAS at 50ft AGL, and the predicted runway touchdown was 105 KGS.

Analysis of the CVFDR data indicated that at 50 ft AGL, the aircraft was at 118 KCAS and that the landing was performed with a tailwind component corresponding to 3.5 kt intensity, which resulted in a runway touchdown at 117.3 KGS.

Although the parameters recorded in the CVFDR indicated a tailwind component, the ground wind reported by the TWR-FI was 270º with 12 kt, which corresponded to a left crosswind component of 9 kt and a headwind component of 8 kt.

The analysis of the aircraft flight parameters, obtained by means of the CVFDR transcription indicated that, although the speed was 7 KCAS above the VREF during the final approach, there were no significant variations in the ramp angle and that the approach could be considered stabilized. Additionally, it was found that the touchdown on the runway occurred at the TDZ, about 70m before the 1,000ft mark.

Considering these parameters presented by the aircraft before landing, and also that the runway was wet, it was calculated that 6,431ft (1,960m) was required for landing. Thus, it was found that despite the aircraft's excessive ground speed, the required distance of 6,431ft (1,960m) was compatible for the operation, given the LDA of runway 32 at SBFI which was 7,201ft (2,195m).

Thus, the possibility of operational failure related to flight planning or pilot judgment related to approach and landing procedures was also ruled out.

At the time of landing, the runway was wet with a significant amount of water on the pavement. Analysis of the aircraft's aerodynamic drag and braking data revealed that the estimated deceleration corresponded to what would be expected on a very wet runway (> 3mm of water) with tire hydroplaning at higher speeds.

According to the friction measurement report, the SBFI runway was classified as "A > Maintenance Level", which did not require any corrective action. Also, according to the macrotexture measurement report, there were no sections of runway 14/32 at SBFI with average depths below the regulatory minimums, and therefore it was considered that these parameters did not contribute to the aircraft's poor deceleration.

Additionally, the meteorological data recorded at the time of the aircraft landing denoted that there was a rapid change in wind and precipitation conditions over the Aerodrome.

An anemometer located near threshold 14 recorded, at 1642 (UTC), winds of 4.86 kt and, at 1643 (UTC), winds of 42.18 kt. Images from a security camera revealed the onset of heavy rain over the Aerodrome, with precipitation starting from threshold 14 as the aircraft was racing over the runway.

In addition, the 1645 (UTC) SPECI reported the presence of gusty surface winds with an intensity of 44 kt, thunderstorms, and hail precipitation. Analysis of the audio from the CVFDR, allowed confirming that during the run after the aircraft landing, in the last 500ft of the runway available, there was strong noise caused by rain and hail stones.

The characteristics of the precipitation, coupled with large variations in wind direction and intensity, were consistent with the windshear phenomenon, resulting from a microburst. This finding is corroborated by the windshear alert issued about 30 seconds after the landing of the PR-TLZ by an aircraft that was at the threshold 32, as well as by the characteristics of the precipitation observed over the threshold 14.

Despite being equipped with a reactive windshear detection system, there was no alarm issued to the PR-TLZ crewmembers. The hypothesis considered for the absence of such an alarm is that the microburst started in the vicinity of the threshold 14 (opposite to the threshold in use) and would have intensified when the aircraft was running over the runway.

In addition, it was found that the variations in wind direction and intensity detected by the on-board sensors during the approach for landing were relatively subtle, so they may have remained below the detection parameters of the equipment.

The large variation in wind intensity was recorded by the CMF as a sudden increase in calibrated speed that peaked at 32 kt when the aircraft was running over the runway (about 30 seconds after the touchdown). This variation lasted 13 seconds and raised the indicated airspeed from 76 kt to 108 kt.

Thus, considering that the speed of 108 kt was very close to the VREF (111 KCAS), it can be said that this phenomenon changed the conditions of lift of the aircraft and, consequently, reduced the adhesion of the tires on the ground, resulting in poor braking on the parts where the aircraft was already at a lower ground speed and out of the aquaplaning effect.

Additionally, it was found that the emergency brake was activated when there was 500ft left to the end of the runway. Considering that the use of this feature implied that the anti-skid was inoperative, and that the distance traveled on a wet runway would be increased by 100% under these conditions, it was concluded that this fact also contributed to the reduction of braking efficiency on that final part of the runway.

Finally, it should be considered that the speedbrakes were not extended during the run after landing, as provided in the AFM. This device was optional on the aircraft and, according to the manufacturer, its use could reduce the stopping distance by approximately 50ft. Despite their low contribution to landing distance reduction, speedbrakes represent a deceleration feature through aerodynamic drag that should not be neglected, especially during landing on wet runways.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid CMAs;

b) the pilots had valid HA-420 aircraft type Rating, MLTE and IFRA Ratings;

c) the pilot and the copilot were qualified and had 77 hours and 14 hours in the aircraft model, respectively;

d) there was no evidence that physiological, incapacitation, individual, psychosocial, or organizational considerations affected the crewmembers' performance in flight;

e) the aircraft had valid CA;

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

g) the airframe and engines logbook records were updated;

h) the aircraft had the latest version of the Power Brake Valve (PBV) installed (PN HJ1-13243-101-009);

i) the weather conditions were favorable for the flight;

j) the aircraft took off from SBCT with two crewmembers and one passenger on board, in order to transfer to SBFI;

k) the flight proceeded normally, during the route;

l) there were no significant variations in the ramp angle during the final approach;

m) the approach was considered stabilized;

n) the required landing distance of 6,431t (1,960m) was compatible for the operation, since the LDA of runway 32 at SBFI was 7,201ft (2,195m);

o) there was no evidence of malfunction of the aircraft brake system that could have caused the runway excursion;

p) at the time of landing, the runway was wet with a significant amount of water on the pavement;

q) the estimated deceleration corresponded to what would be expected on a very wet runway (> 3mm of water) with hydroplaning of the tires at higher speeds;

r) the friction and macrotexture measurements had normal parameters and did not contribute to the aircraft's poor deceleration;

s) the characteristics of the precipitation over threshold 14 associated with the large variations in wind direction and intensity were consistent with the windshear phenomenon, resulting from a microburst;

t) the PR-TLZ sensors did not detect the occurrence of windshear during the landing approach;

u) a sudden increase in the calibrated speed that peaked at 32kt altered the aircraft's lift and, consequently, reduced the tires' grip on the ground, resulting in poor braking in the parts where the ground speed was lower;

v) the speedbrakes were not extended during the run after landing, contrary to what was prevised in the AFM;

w) the aircraft ran the full length of the runway, overpassed its limits and crashed into a ravine;

x) there was a windshear alert issued about 30 seconds after the landing of the PR-TLZ by an aircraft that was at the threshold 32;

y) the aircraft had substantial damage; and

z) the crewmembers and the passenger left unharmed.

3.2 Contributing factors.

- **Control skills – undetermined.**

Despite the low contribution of the speedbrakes to the reduction of the landing distance, this device represents a deceleration resource through aerodynamic drag that should not be neglected, especially during landing on wet runways, and could have contributed to avoiding runway excursion.

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

The large variation in wind intensity peaked at 32 kt. This variation lasted 13 seconds and raised the indicated speed from 76 kt to 108 kt.

Considering that the speed of 108 kt was very close to the VREF (111 KCAS), it can be stated that this phenomenon altered the aircraft's lift and, consequently, reduced the tires' grip on the ground, leading to poor braking.

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-151/CENIPA/2018 - 01 **Issued on 11/16/2021**

Disseminate the lessons learned from this investigation, in order to alert pilots and operators of the Brazilian civil aviation, about the risks of performing landing procedures when weather conditions conducive to the formation of windshear (thunderstorms, rainstorms, virga) are occurring in the vicinity of the aerodrome.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On November 16th, 2021.