COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-160/CENIPA/2023

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-MCL**
MODEL:	**510**
DATE:	**15DEZ2023**

NOTICE

According to the Law No. 7565, dated December 19, 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for planning, guiding, coordinating, and executing activities related to the investigation and prevention of aeronautical accidents.

The preparation of this Final Report was conducted considering the contributing factors and hypotheses raised. Therefore, the report is a technical document that reflects the results obtained by SIPAER concerning the circumstances that contributed, or may have contributed, to the occurrence of this event.

The document does not focus on quantifying the degree of contribution of the various factors, including individual, psychosocial, or organizational variables that influenced the human performance and interacted to create conditions conducive to the accident. Instead, it recognizes that the accident resulted from an alignment of these factors, without assigning greater or lesser importance to any particular contributing factor.

The sole objective of this work is to recommend the study and the adoption of preventative measures. The decision regarding their implementation rests with the President, Director, Chief, or the highest-ranking official in the organization to which they are submitted.

This Final Report has been made available to the ANAC and DECEA so that the technical and scientific analysis from this investigation can serve as a source of data and information for identifying hazards and assessing risks, as outlined in the Brazilian Civil Aviation Safety Program (PSO-BR).

This Report does not involve any evidentiary procedures for determining civil or criminal liability and is in accordance with Appendix 2 of Annex 13 to the 1944 Chicago Convention, which was incorporated into Brazilian law by Decree No. 21713, dated August 27, 1946.

Thus, it is important to emphasize the need to protect individuals who provide information regarding an aeronautical accident. Using this report for punitive purposes undermines the principle of "non-self-incrimination", derived from the "right to remain silent" as protected sheltered by the Federal Constitution.

Consequently, using this report for any purpose other than preventing future accidents may lead to erroneous interpretations and conclusions.

N.B.: Note that the English translation of the report was written and published by the CENIPA to make it more accessible to English-speaking individuals. Given the nuances of a foreign language, no matter how precise this translation may be, readers are advised that the original Portuguese document remains the reference.

SYNOPSIS

This Final Report pertains to the December 15, 2023 accident involving the aircraft model 510 of registration marks PR-MCL. The occurrence was typified as “[RE] Runway excursion.”

After landing, the aircraft overran the departure end of the runway at SSIJ (Aerodrome of *Ijuí*, state of *Rio Grande do Sul*).

The aircraft sustained substantial damage.

The pilot was uninjured.

Being Canada the State of manufacture of the aircraft’s engines, the Canadian *Transportation Safety Board* designated an Accredited Representative for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AD WRNG	Aerodrome Warning
AFM	Aircraft Flight Manual
AISWEB	Aeronautical Information Service Website
ANAC	Brazil's National Civil Aviation Agency
CENIPA	Center for the Investigation and Prevention of Aeronautical Accidents
CIMAER	Integrated Center of Aeronautical Meteorology
CIV	Digital Pilot-Logbook
CMA	Aeronautical Medical Certificate
CPTEC	Center for Weather Forecasting and Climate Studies
CVA	Certificate of Airworthiness
DECEA	Department of Airspace Control
GOES	Geostationary Operational Environmental Satellite
IFRA	Instrument Flight Rating - Airplane
INMET	Brazil's National Institute of Meteorology
LABDATA	Cenipa's Flight Recorders Readout and Analysis Laboratory
OM	Maintenance Organization
PIC	Pilot in Command
PLA	Airline Transport Pilot - Airplane
PMD	Maximum Takeoff Weight
PN	Part Number
PPR	Private Pilot License - Airplane
RBAC	Brazilian Civil Aviation Regulation
REDEMET	Command of Aeronautics' Meteorology Network
SACI	Integrated Civil Aviation Information System
SBBI	ICAO location designator – *Bacacheri* Aerodrome, *Curitiba*, PR
SBNM	ICAO location designator – Aerodrome of *Santo Ângelo*, RS
SBPA	ICAO location designator – *Salgado Filho* Airport, *Porto Alegre*, RS
SBPF	ICAO location designator – *Lauro Kurtz* Aerodrome, *Passo Fundo*, RS
SIGWX	Significant Weather Chart
SSIJ	ICAO location designator – *Ijuí* Aerodrome, RS
TAF	Terminal-Aerodrome Forecast
TPP	Private Air Services Registry Category
TSB	Canada's Transportation Safety Board
UTC	Coordinated Universal Time
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** 510 **Registration:** PR-MCL **Manufacturer:** *Cessna Aircraft*	**Operator:** *Roma Participações e Empreendimentos Ltda*.
Occurrence	**Date/time**: 15DEZ2023 - 20:00 (UTC) **Location:** *Ijuí* Aerodrome (SSIJ) **Lat.** 22°22'07"S **Long.** 053°50'47"W **Municipality – State:** *Ijuí - RS*.	**Type(s):** [RE] Runway excursion [

1.1. History of the flight.

At around 1900 UTC, the aircraft took off from SBBI (*Bacacheri* Aerodrome, *Curitiba*, state of *Paraná*), bound for SSIJ (*Aerodrome* of *Ijuí*, state of *Rio Grande do Sul*) for a ferry flight, with one pilot on board.

After landing at SSIJ, the aircraft overran the departure end of the runway, veered to the right, and came to a stop on a sloped area.

Figure 1 – View of the aircraft after coming to a complete stop.

The aircraft sustained substantial damage. The pilot was uninjured.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The aircraft sustained substantial damage to the landing gear assembly and lower fuselage. In addition, minor damage occurred to the wings, flaps, and ailerons.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

HOURS FLOWN	
	PIC
Total	10,000:00
Total in the last 30 days	10:10
Total in the last 24 hours	01:10
In this type of aircraft	800:00
In this type in the last 30 days	10:10
In this type in the last 24 hours	01:10

Note: Data on hours flown obtained from the pilot's CIV (Digital Pilot-Logbook).

1.5.2. Personnel training.

The Pilot-in-Command (PIC) completed his PPR course (Private Pilot – Airplane) in 1998, at *Aeroclube do Paraná*, *Curitiba*, PR. His most recent proficiency check for revalidation of his ratings was conducted on September 30, 2023.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PLA license (Airline Transport Pilot – Airplane) and valid ratings for C510 type aircraft (which includes model 510) and for IFR-A (Instrument Flight – Airplane).

1.5.4. Qualification and flight experience.

The logbook entries indicated that the pilot had been operating the model 510 aircraft, registration marks PR-MCL, since June 2023, and that *Ijuí* Aerodrome (SSIJ) was a frequent destination. Within the thirty days preceding the accident, he had completed three flights to SSIJ.

The pilot had accumulated approximately 800 flight hours on the model. In addition to the Cessna 510, he had experience with the following aircraft models: B-58, SENECA III, SENECA IV, SENECA V, SR-22, C-210, C-208, and C-182.

His experience was primarily based on operations conducted under the requirements of the RBAC-91 (Brazilian Civil Aviation Regulation nº 91) – General Operating and Flight Rules.

The pilot was qualified and experienced in the type of flight.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The serial number 510-0057 airplane was manufactured by Cessna Aircraft in 2008. It was registered in the Private Registry category – Private Air Services (TPP).

The aircraft's CVA (Certificate of Airworthiness) was valid.

The records of the airframe and engine logbooks were up to date.

The most recent inspection ("48-month" type) was conducted according to "Document 20" of the Aircraft Maintenance Manual (AMM), Part Number (PN) 510MM. A certified Maintenance Organization (MO) in *Curitiba*, PR., performed this maintenance activity on December 15, 2023. The aircraft flew approximately 1 hour after the said inspection.

The most recent comprehensive engine inspection, a "12-year (low utilization overhaul)," was performed in accordance with the Pratt & Whitney manual PN 3072691 rev. 26.2 (dated October 11, 2019). A certified MO, located in *Curitiba*, PR, completed this

maintenance activity on June 30, 2020, with the engines having accrued 232 hours and 36 minutes of flight time since the inspection.

The most recent comprehensive inspection of the aircraft followed "Document 16", which had an interval of 1,350 flight hours or 36 months, whichever came first, as per AMM PN 510MM. This maintenance activity was completed on September 5, 2023, by a certified MO in *Curitiba*, PR. The aircraft accumulated 11 hours and 42 minutes of flight time after that inspection.

There were no records of malfunctions and/or discrepancies in the technical documentation.

The accident aircraft was equipped with ground spoilers and speed brakes, both of which were aerodynamic drag-producing systems developed by the manufacturer to, among other functions, assist in deceleration during landing.

1.7. Meteorological information.

SSIJ Aerodrome did not have meteorological information services. Figure 2 shows the location of SSIJ in relation to other aerodromes in the region, as well as to three meteorological stations located in the area.

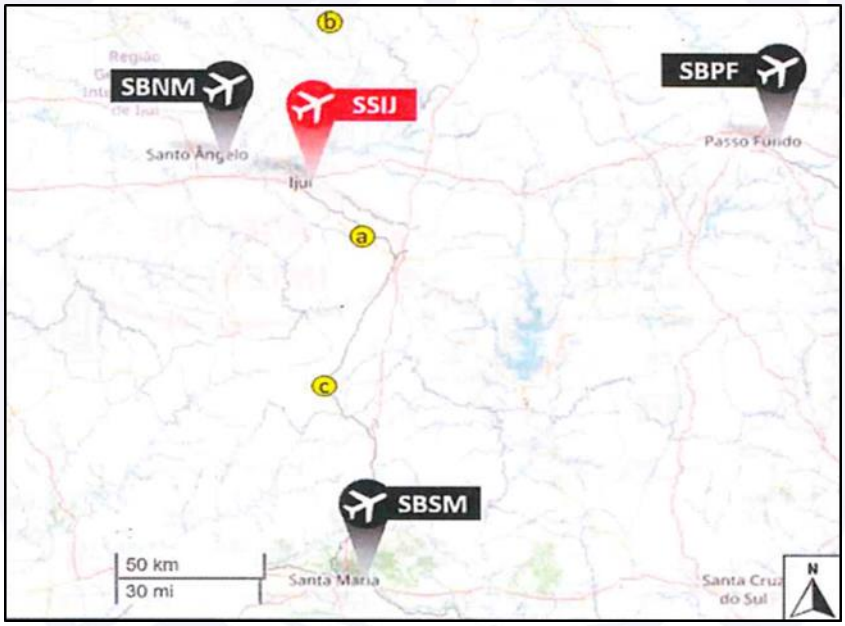


Figure 2 – Map of the region of interest showing the location of the occurrence site, surrounding aerodromes, and automatic weather stations “a,” “b,” and “c.”
Source: adapted from *OpenStreetMap*.

The occurrence site (SSIJ) was located at a distance of approximately 18 NM from *Santo Ângelo* Aerodrome (SBNM); 80 NM from *Lauro Kurtz* Aerodrome (SBPF); and 80 NM from *Santa Maria* Aerodrome (SBSM).

The meteorological data, forecasts, and products used were obtained from REDEMET (Command of Aeronautics’ Meteorology Network), as well as from CPTEC (Center for Weather Forecasting and Climate Studies), AISWEB (Aeronautical Information Services), and INMET (National Institute of Meteorology).

The Significant Weather Chart (SIGWX) for 1800 UTC of December 15, 2023, from the surface to FL250, showed the presence of Tower Cumulus (TCU) clouds with base at 2,500 ft. and tops at 18,000 ft., covering 1 to 2 oktas (FEW); isolated and embedded Cumulonimbus (CB) clouds with base at 3,000 ft. and tops above FL250; medium-level clouds and rain showers and/or continuous rain over the SSIJ region (Figure 3).

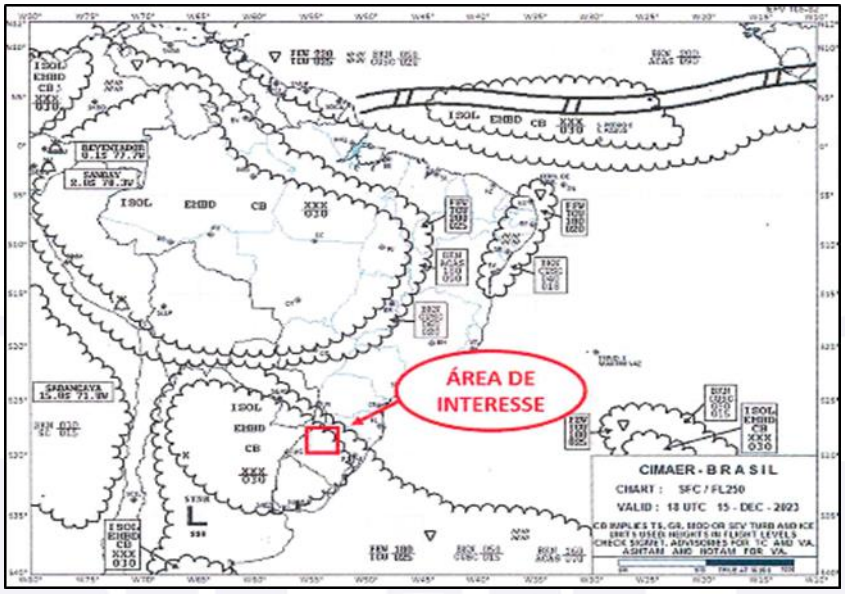


Figure 3 – SIGWX Chart highlighting the region of interest.
Source: adapted from REDEMET.

The Geostationary Operational Environmental Satellite (GOES) 16, channel 13, imagery from 2020 UTC of December 15, 2023, showed a cluster of clouds of varying types and altitudes over the region of interest, resulting from the development of thunderstorms (Figure 4).

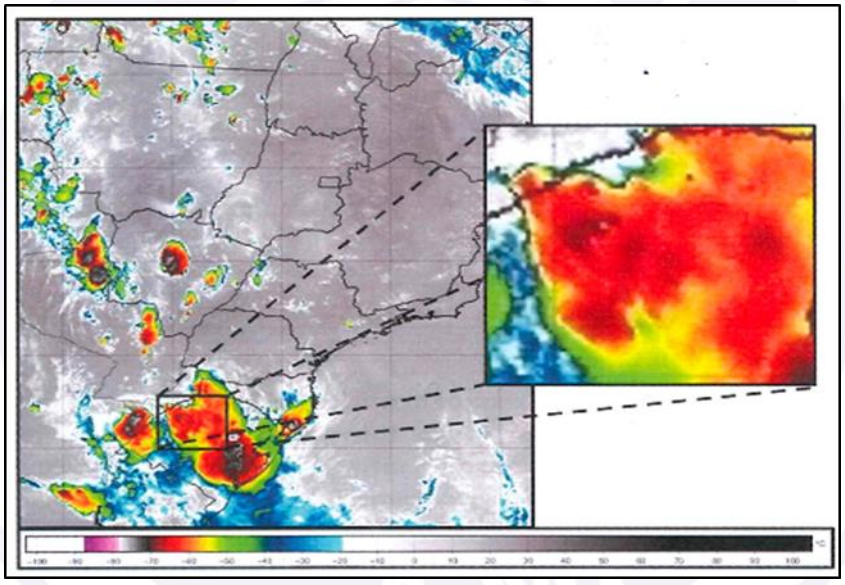


Figure 4 – GOES-16 satellite image, channel 13. Source: adapted from the Center for Weather Forecasting and Climate Studies (CPTEC).

The Terminal Aerodrome Forecast (TAF) is a complete description of the meteorological conditions forecast for a given aerodrome during its validity period, including any significant changes for flight operations.

The TAF issued for SBNM, the nearest aerodrome to SBIJ, valid from 1800 UTC of December 15, 2023, to 1800 (UTC) of December 16, 2023, provided the following information:

> TAF SBNM 151500Z 1518/1606 35013KT 9999 SCT040 TX38/1518Z TN26/1605Z PROB30 TEMPO 1520/1601 16012G26KT 6000 TSRA SCT025 FEW045CB RMK PFR=

According to the TAF, the forecasted weather conditions at SBNM were:

- Surface wind from the north at 13 kt;
- Surface visibility of 10,000 m or more;
- Scattered clouds (SCT) at 4,000 ft, covering 3 to 4 oktas of the sky;
- 30% probability of temporary conditions including:
  - Surface wind from the south at 12 kt, with gusts up to 26 kt;
  - Visibility of 6,000 m;
  - Thunderstorms with moderate rain;
  - Scattered clouds at 2,500 ft., 3 to 4 oktas;
  - Few CB clouds at 4,500 ft., 1 to 2 oktas (FEW).

The Aerodrome Warning (AD WRNG) is a notice concerning adverse weather conditions that may affect the safety of aircraft on the ground, as well as aerodrome infrastructure and services. There was an AD WRNG valid from 1930 (UTC) to 2330 (UTC) for SBNM reporting the following:

> SBPA SBPK/SBBG/SBUG/SBSM/SBNM AD WRNG 8 VALID 151930/152330 TS SFC WSPD 15KT MAX 30 FCST NC=

The AD WRNG indicated a forecast of thunderstorms and surface wind with intensity from 15 kt to a maximum of 30 kt.

Security camera footage from the aerodrome showed it was raining and the runway was wet at the time of the landing that culminated in the accident. The footage also showed a layer of low clouds and limited horizontal and vertical visibility. Figure 5 shows the overcast and rainy conditions at *Ijuí* Aerodrome during the landing of PR-MCL that resulted in the accident.

Figure 5 – Weather conditions at *Ijuí* Aerodrome at the time of landing.
Source: security camera footage from the aerodrome.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The aerodrome was public, managed by the *Ijuí* Municipal Government, and operated under Visual Flight Rules (VFR), during both daytime and nighttime periods.

The runway (thresholds 18/36) was asphalt-sealed, measuring 1,280 m × 23 m, and an elevation of 1,197 ft.

The aerodrome featured a windsock, which was operating normally at the time of landing. However, the security camera footage made available to the Investigation Committee did not capture the windsock, making it impossible to analyze the prevailing wind direction at the time of landing using that device.

1.11. Flight recorders.

Not required and not installed.

Although not equipped with flight data recorders or cockpit voice recorders, the aircraft was fitted with a Garmin G1000 Avionics System for the Cessna Citation MUSTANG, 190-00600-01, Rev B, dated April 2007.

This system featured LOG memory cards capable of storing data recorded during flights. However, in order for the recording to take place, the system needed to be kept up to date with the equipment manufacturer, which involved costs for the operator.

Failure to update the system did not violate any regulation, nor did it impose any operational restriction on the aircraft operating under RBAC-91 requirements. The operator chose not to keep the system updated.

The Garmin G1000 cards were sent to the Cenipa's LABDATA (Flight Recorder Data Readout and Analysis Laboratory) for data download.

The data were successfully extracted. However, they did not correspond to the flight that resulted in this accident.

1.12. Wreckage and impact information.

The landing took place in the direction of runway 36. The aircraft's touchdown point was approximately 340 m after the 36 threshold, which was also consistent with the tire marks found on the runway.

Figure 6 illustrates an overview of the aerodrome, including the estimated point of the aircraft's touchdown on the runway.

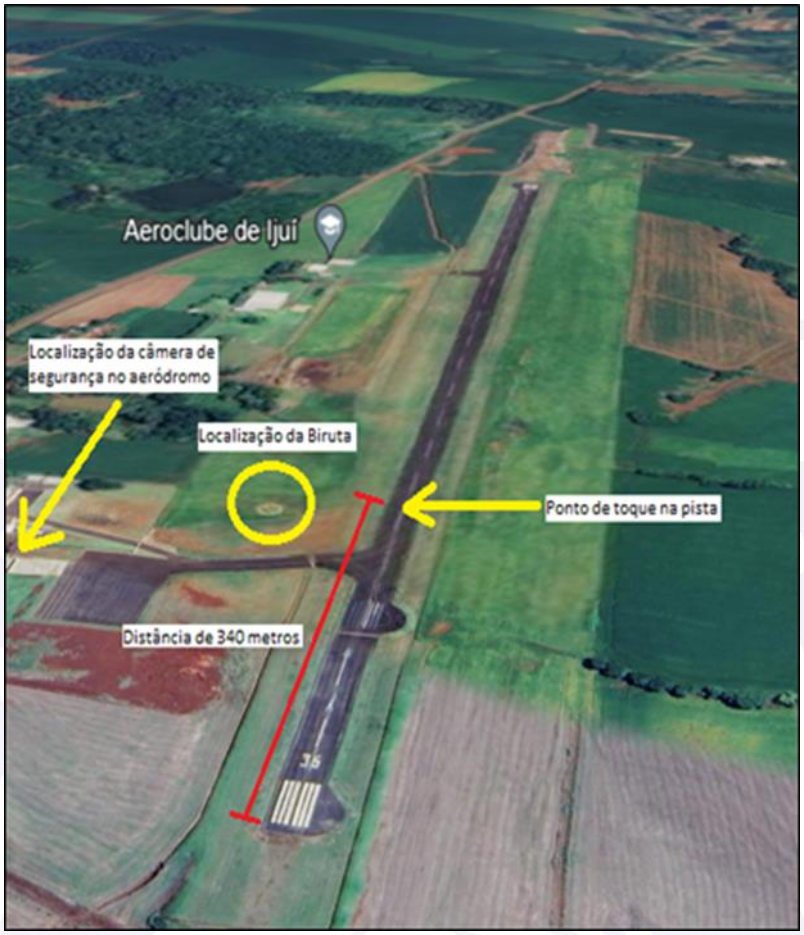


Figure 6 - General view of *Ijuí* Aerodrome.
Source: adapted from GoogleEarth.

After the runway excursion through the departure end of runway 36, the aircraft traveled 90 m across open land and about 20 m on sloped terrain until coming to a complete stop. The aircraft's final stop occurred in a nose-down attitude (approximately 35°) after its front impacted stones on the ground.

Figure 7 - Aircraft trajectory after runway excursion
past the departure end of SSIJ RWY 36.

There was damage to the hydraulic system, main landing gear, as well as the collapse of the auxiliary landing gear. The lower fuselage suffered dents in its structure.

The central and rear sections of the fuselage remained intact, as did the tail cone and its components.

Figure 8 - View of the aircraft damage after its full stop.

The landing gear legs were down and locked. The internal and external surfaces of the flaps on both wings were deflected to the 15º (TO/APR) position.

The flap lever in the cockpit was set to the TO/APR position.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

NIL.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

NIL.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

The pilot was rescued by a ground support team that was at the hangar awaiting the aircraft's landing, and later transported by the Mobile Emergency Care Service (SAMU).

1.16. Tests and research.

The cockpit instruments showed no visible markings that could indicate the aircraft's speed at the moment of impact.

1.17. Organizational and management information.

The PIC did not have an employment relationship with the aircraft owner and performed on-demand flights. The flights were private and planned according to the owner's schedule of appointments.

Law No. 13,475/2017, which regulates the exercise of the aircraft crew profession, established the following:

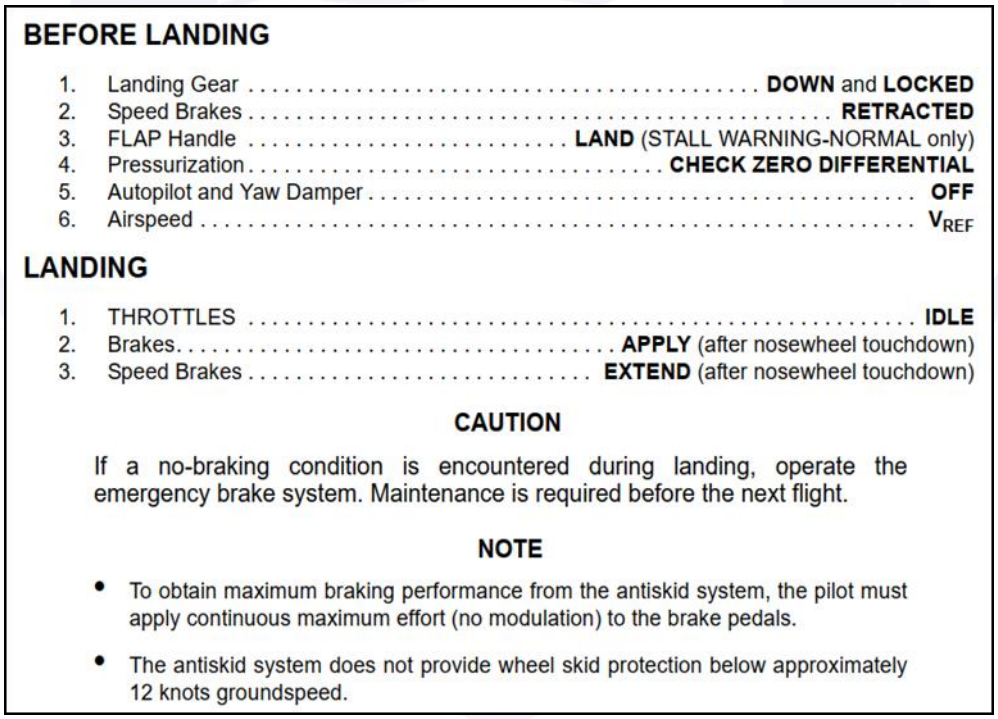
> Article 20. The remunerated function of crewmembers on board an aircraft must be formalized by means of an employment contract signed directly with the aircraft operator.
>
> §1. A flight or cabin crewmember may only perform a remunerated function on board an aircraft of an operator with whom they are not directly employed when the air service does not constitute a core activity, and provided that it does not exceed 30 (thirty) consecutive days from the start date of the service provision.

1.18. Operational information.

The flight between SBBI (*Bacacheri* Aerodrome) and SSIJ (*Ijuí* Aerodrome) was conducted under the requirements established by the RBAC-91.

During an interview, the pilot reported having used the *ForeFlight* application to carry out flight planning, including the meteorological analysis for the route and the SSIJ area. As a reference, the PIC stated he used the weather forecasts available for SBNM, SBPA, and SBPF aerodromes in his flight planning.

Regarding the final approach, the pilot reported that he performed all aircraft landing preparation procedures, completing the items from the Before-Landing and Landing checklists of the Aircraft Flight Manual (AFM), including extending the flaps to the LAND position.



BEFORE LANDING

1. Landing Gear ..... **DOWN** and **LOCKED**
2. Speed Brakes ..... **RETRACTED**
3. FLAP Handle ..... **LAND** (STALL WARNING-NORMAL only)
4. Pressurization ..... **CHECK ZERO DIFFERENTIAL**
5. Autopilot and Yaw Damper ..... **OFF**
6. Airspeed ..... V_{REF}

LANDING

1. THROTTLES ..... **IDLE**
2. Brakes ..... **APPLY** (after nosewheel touchdown)
3. Speed Brakes ..... **EXTEND** (after nosewheel touchdown)

CAUTION

If a no-braking condition is encountered during landing, operate the emergency brake system. Maintenance is required before the next flight.

NOTE

- To obtain maximum braking performance from the antiskid system, the pilot must apply continuous maximum effort (no modulation) to the brake pedals.
- The antiskid system does not provide wheel skid protection below approximately 12 knots groundspeed.

Figure 9 – Before-Landing and Landing procedures. Source: Section III – Operating Procedures of the AFM, page 3-149.

He also reported that the aircraft's speed at the time of crossing the threshold of runway 36 at SSIJ was approximately 93 kt, and that, according to his perception, there was a tailwind component.

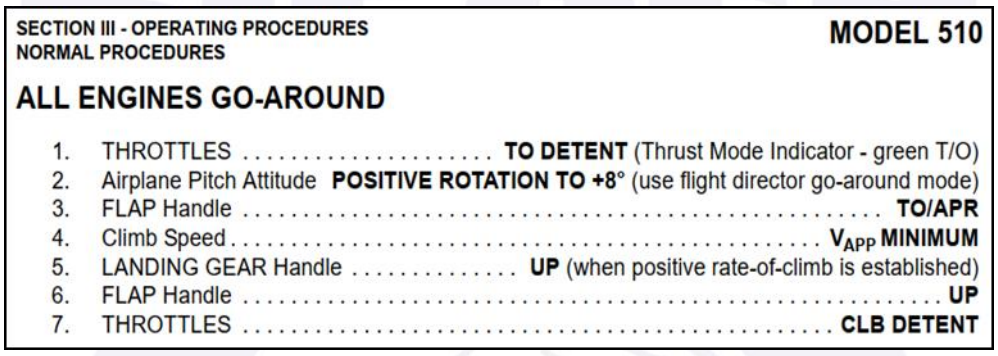
The PIC stated that he had the impression the aircraft was not decelerating as expected after touchdown at SSIJ.

Additionally, he mentioned that, after the nose landing gear touched the ground, the aircraft veered slightly to the right of the centerline, requiring corrective control inputs to return to the runway center.

He further stated that he selected the flaps to the TO/APR position during the landing roll, as he was considering executing a go-around after touchdown. However, he reported that he did not advance the engine power levers and, ultimately, did not carry out the go-around procedure.

The emergency brake was not used during the landing.

The AFM provided sequential steps for executing a go-around with all engines operating. In that procedure, flap retraction was to be the third action performed by the pilot, after advancing the throttles and adjusting the aircraft's pitch, as shown in Figure 10.



SECTION III - OPERATING PROCEDURES
NORMAL PROCEDURES

MODEL 510

ALL ENGINES GO-AROUND

1. THROTTLES ..... **TO DETENT** (Thrust Mode Indicator - green T/O)
2. Airplane Pitch Attitude **POSITIVE ROTATION TO +8°** (use flight director go-around mode)
3. FLAP Handle ..... **TO/APR**
4. Climb Speed ..... V_{APP} **MINIMUM**
5. LANDING GEAR Handle ..... **UP** (when positive rate-of-climb is established)
6. FLAP Handle ..... **UP**
7. THROTTLES ..... **CLB DETENT**

Figure 10 – Go-around procedures. Source: Section III – Operating Procedures of the AFM, page 3-150.

The landing procedures did not include flap retraction, which should only occur from the LAND position after the completion of the landing.

Considering the meteorological conditions present on the day of the accident, the Investigation Committee consulted the manuals provided by the manufacturer in order to identify the parameters for a safe operation under those circumstances.

The AFM, in its Section IV, established the unfactored landing distances for the aircraft. These distances were calculated based on landing weight, wind direction and intensity, ambient temperature, flap position, and field elevation.

The aircraft's basic operating weight was 5,150 lb. The PR-MCL airplane was fueled to full tank capacity, totaling 2,580 lb. of Jet A-1 fuel. Considering the pilot's weight and baggage, the resulting takeoff weight was approximately 8,200 lb.

The Maximum Takeoff Weight (MTOW) specified by the manufacturer was 8,645 lb.

The route between SBBI and SSIJ was 304.4 NM long. The Flight Planning Guide, Revision FM-03, OM-00, published by the manufacturer in 2007, included a mission planning table with various operational parameters, located in the section *Mission Planning Table*, pages 25, 26, 27, and 28.

This section of the manual established typical cruise altitudes between 33,000 ft and 37,000 ft for flight segments ranging from 300 NM to 499 NM (Figure 11).

Typical cruise altitudes for various distances are:

Distance (nm)	Typical Cruise Altitude (ft)
0 - 99	6,000 - 15,000
100 - 199	14,000 - 28,000
200 - 299	27,000 - 35,000
300 - 499	33,000 - 37,000
500 - 999	35,000 - 39,000
1000 +	39,000 - 41,000

Figure 11 – Typical cruise altitudes. Source: adapted from Flight Planning Guide, Revision FM-03, OM-00.

However, the flight that culminated in the accident was planned and conducted at an altitude of 32,000 ft., under Instrument Flight Rules (IFR).

The Flight Planning Guide included fuel consumption tables according to the distance between two points and the altitude at which the flight was conducted. The tables considered only odd flight levels. For this reason, the fuel consumption calculations used 31,000 ft. as a reference altitude.

Thus, one considered that the aircraft would take 58 minutes to cover a distance of 300 NM, with a fuel consumption of 733 lb. (Figure 12).

CITATION MUSTANG

MISSION PLANNING

FLIGHT TIME & FUEL BURN

	Cruise Altitude (ft)									
	15,000		25,000		27,000		29,000		31,000	
Dist (nm)	Time (min)	Fuel (lb)	Time (min)	Fuel (lb)	Time (min)	Fuel (lb)	Time (min)	Fuel (lb)	Time (min)	Fuel (lb)
100	0:22	375	0:21	336	0:22	329				
150	0:31	528	0:30	460	0:31	446	0:32	435	0:31	426
200	0:41	682	0:39	584	0:40	562	0:40	544	0:40	528
250	0:51	836	0:48	708	0:49	678	0:49	654	0:49	630
300	1:00	990	0:57	832	0:57	795	0:58	763	0:58	733
350	1:10	1,144	1:06	957	1:06	912	1:07	873	1:06	836

Figure 12 – Planning factors for 31,000 ft. altitude.
Source: adapted from *Flight Planning Guide*, *Revision* FM-03, OM-00.

Based on the planning parameters defined in the Flight Planning Guide, one calculated that the landing weight corresponded to the takeoff weight minus the fuel consumed during the flight.

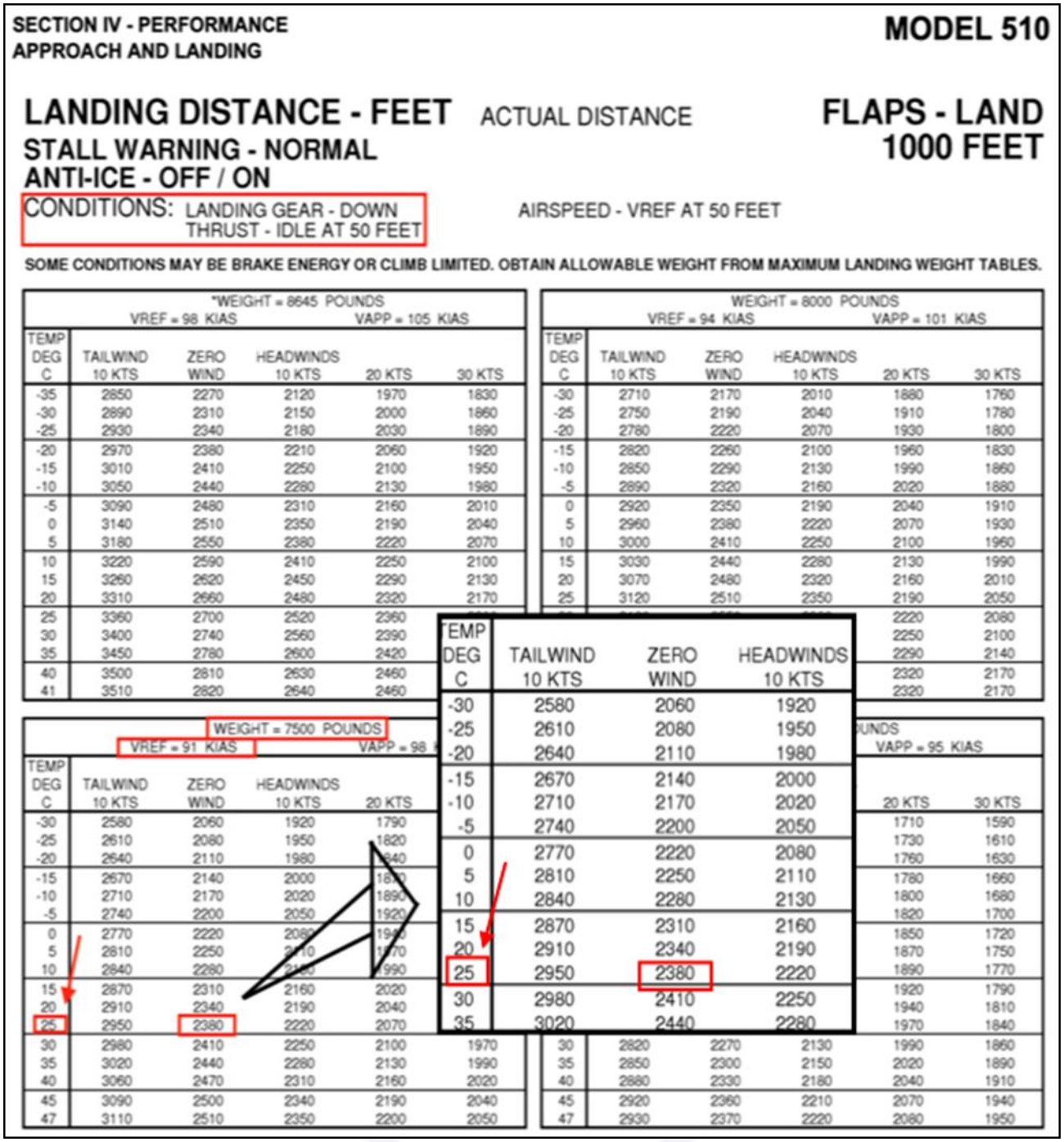
As a result, the estimated landing weight was approximately 7,467 lb. The manufacturer established 8,000 lb. as the maximum landing weight for the model.

The aircraft's center of gravity (CG) calculation indicated that the aircraft was within the limits specified by the manufacturer.

To calculate the landing distance required at SSIJ, the table found in Section IV of the AFM was used.

The calculations were made using the table corresponding to a field elevation of 1,000 ft.; a landing weight of 7,500 lb.; a Reference Speed (VREF) of 91 kt; a temperature of 25°C; and zero wind.

Accordingly, the required landing distance under the reference conditions was calculated to be 2,380 ft. (approximately 726 m), as shown in Figure 13.



SECTION IV - PERFORMANCE
APPROACH AND LANDING

MODEL 510

LANDING DISTANCE - FEET ACTUAL DISTANCE

FLAPS - LAND
1000 FEET

STALL WARNING - NORMAL
ANTI-ICE - OFF / ON

CONDITIONS: LANDING GEAR - DOWN
THRUST - IDLE AT 50 FEET

AIRSPEED - VREF AT 50 FEET

SOME CONDITIONS MAY BE BRAKE ENERGY OR CLIMB LIMITED. OBTAIN ALLOWABLE WEIGHT FROM MAXIMUM LANDING WEIGHT TABLES.

*WEIGHT = 8645 POUNDS
VREF = 98 KIAS VAPP = 105 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 KTS
-35	2850	2270	2120	1970	1830
-30	2890	2310	2150	2000	1860
-25	2930	2340	2180	2030	1890
-20	2970	2380	2210	2060	1920
-15	3010	2410	2250	2100	1950
-10	3050	2440	2280	2130	1980
-5	3090	2480	2310	2160	2010
0	3140	2510	2350	2190	2040
5	3180	2550	2380	2220	2070
10	3220	2590	2410	2250	2100
15	3260	2620	2450	2290	2130
20	3310	2660	2480	2320	2170
25	3360	2700	2520	2360	
30	3400	2740	2560	2390	
35	3450	2780	2600	2420	
40	3500	2810	2630	2460	
41	3510	2820	2640	2460	

WEIGHT = 8000 POUNDS
VREF = 94 KIAS VAPP = 101 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 KTS
-30	2710	2170	2010	1880	1760
-25	2750	2190	2040	1910	1780
-20	2780	2220	2070	1930	1800
-15	2820	2260	2100	1960	1830
-10	2850	2290	2130	1990	1860
-5	2890	2320	2160	2020	1880
0	2920	2350	2190	2040	1910
5	2960	2380	2220	2070	1930
10	3000	2410	2250	2100	1960
15	3030	2440	2280	2130	1990
20	3070	2480	2320	2160	2010
25	3120	2510	2350	2190	2050
				2220	2080
				2250	2100
				2290	2140
				2320	2170
				2320	2170

WEIGHT = 7500 POUNDS
VREF = 91 KIAS VAPP = 98

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 KTS
-30	2580	2060	1920	1790	
-25	2610	2080	1950	1820	
-20	2640	2110	1980	1840	
-15	2670	2140	2000	1870	
-10	2710	2170	2020	1890	
-5	2740	2200	2050	1920	
0	2770	2220	2080	1940	
5	2810	2250	2110	1970	
10	2840	2280	2130	1990	
15	2870	2310	2160	2020	
20	2910	2340	2190	2040	
25	2950	2380	2220	2070	
30	2980	2410	2250	2100	1970
35	3020	2440	2280	2130	1990
40	3060	2470	2310	2160	2020
45	3090	2500	2340	2190	2040
47	3110	2510	2350	2200	2050

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS
-30	2580	2060	1920
-25	2610	2080	1950
-20	2640	2110	1980
-15	2670	2140	2000
-10	2710	2170	2020
-5	2740	2200	2050
0	2770	2220	2080
5	2810	2250	2110
10	2840	2280	2130
15	2870	2310	2160
20	2910	2340	2190
25	2950	2380	2220
30	2980	2410	2250
35	3020	2440	2280

UNDS
VAPP = 95 KIAS

20 KTS	30 KTS
1710	1590
1730	1610
1760	1630
1780	1660
1800	1680
1820	1700
1850	1720
1870	1750
1890	1770
1920	1790
1940	1810
1970	1840
2130	1990
2150	2020
2180	2040
2210	2070
2220	2080

Figure 13 – Table for landing distance calculation, zero wind. Source: *Section IV – Performance Approach and Landing* of the AFM, page 4-242.

Section IV of the AFM did not establish landing distance factoring conditions for wet runways; this information was provided in Section VII – Advisory Information.

In Table 7-11 of the referenced section, it was possible to apply a factor to landing distances originally calculated for dry runways in order to account for wet runway conditions.

To use the conversion table for wet runways, the value of 2,400 ft. was selected as the closest to the previously calculated 2,380 ft for dry conditions.

One observed that, under wet runway conditions, the landing distance increased to 3,350 ft. (1,021 m), which is 970 ft. (296 m) longer than the original dry runway distance.

LANDING DISTANCE - FEET **FLAPS - LAND**
ANTI-ICE OFF / ON **AIRSPEED - V_{REF}**
STALL WARNING - NORMAL

DRY RUNWAY	ADVERSE RUNWAY CONDITIONS (WITHOUT TAILWINDS, 50 FT SCREEN HEIGHT)														
	WET RUNWAY	WATER COVERED RUNWAY - INCHES *					SLUSH OR WET SNOW COVERED RUNWAY - INCHES *					DRY SNOW INCHES *		COMPACT SNOW	WET ICE **
		0.125	0.2	0.3	0.4	0.5	0.125	0.2	0.3	0.4	0.5	1.0	2.0		
1200	1550	1650	1600	1550	1500	1450	1650	1550	1600	1550	1500	1700	1550	1850	4900
1400	1800	1950	1900	1800	1750	1700	1950	1900	1850	1800	1750	2100	1850	2250	5700
1600	2100	2350	2200	2100	2000	1950	2350	2250	2150	2050	2000	2500	2200	2650	7450
1800	2450	2750	2600	2450	2300	2200	2800	2650	2600	2450	2250	2950	2500	3100	10500
2000	2750	3150	2950	2800	2650	2550	3200	3000	2900	2750	2550	3350	2850	3500	13550
2200	3050	3600	3300	3150	3000	2850	3600	3400	3250	3050	2800	3800	3200	4000	16600
2400	3350	4050	3650	3500	3350	3150	4000	3750	3600	3400	3050	4200	3500	4450	
2600	3650	4400	4000	3850	3650	3450	4350	4100	3950	3700	3300	4600	3800	4900	
2800	3950	4850	4400	4250	4050	3800	4800	4500	4300	4050	3550	4850	4100	5100	
3000	4250	5300	4800	4600	4400	4150	5250	4950	4750	4450	3850	5100	4350	5300	
3200	4550	5750	5200	5000	4800	4500	5700	5350	5150	4850	4100	5350	4600	5500	
3400	4850	6150	5550	4950	4500	4150	6350	5750	5150	4700	4350	5550	4800	5700	
3600	5200	6550	5900	5250	4800	4400	6750	6150	5500	5000	4650	5750	5000	5900	
3800	5500	6950	6250	5550	5050	4650	7150	6550	5850	5300	4900	5950	5200	6100	
4000	5800	7350	6600	5850	5350	4900	7550	6950	6200	5600	5150	6150	5400	6300	
4200	6100	7750	6950	6150	5650	5150	7950	7350	6550	5900	5400	6350	5600	6500	
4400	6400	8150	7300	6450	5950	5400	8350	7750	6900	6200	5650	6550	5800	6650	
4600	6700	8550	7650	6750	6250	5650	8750	8150	7250	6500	5900	6750	6000	6850	
4800	7000	8950	8000	7050	6550	5900	9150	8550	7600	6800	6150	6950	6200	7050	
5000	7300	9350	8350	7350	6850	6150	9550	8950	7950	7100	6400	7150	6400	7250	
5200	7600	9750	8700	7650	7150	6400	9950	9350	8300	7400	6650	7350	6600	7450	
5400	7900	10150	9050	7950	7450	6650	10350	9750	8650	7700	6900	7550	6800	7650	
5600	8200		9400	8250	7750	6900		10150	9000	8000	7150	7750	7000	7850	
5800	8500		9750	8550	8050	7150			9350	8300	7400	7950	7200	8050	
6000	8800		10100	8850	8350	7400			9700	8600	7650	8150	7400	8250	
6200	9100			9150	8650	7650			10050	8900	7900	8350	7600	8450	
6400	9400			9450	8950	7900				9200	8150	8550	7800	8650	
6600	9700			9750	9250	8150				9500	8400	8750	8000	8850	
6800	10000			10050	9550	8400				9800	8650	8950	8200	9050	
7000					9850	8650				10100	8900	9150	8400	9250	
7200					10150	8900					9150	9350	8600	9450	
7400						9150					9400	9550	8800	9650	
7600						9400					9650	9750	9000	9850	
7800						9650					9900	9950	9200	10050	
8000						9900					10150	10150	9400		
8500						10550							9900		
9000													10400		
9500															
10000															

Figure 14 – Table for landing distance calculation, zero wind and wet runway.
Source: *Section VII – Advisory Information* of the AFM, page S4-82.

Since the pilot reported having perceived a tailwind component during the landing approach, calculations were performed to determine the influence of that factor on the landing distance.

For these calculations, the same reference parameters used for the zero-wind condition were adopted (1,000-ft. field elevation; 7,500 lb. weight; VREF of 91 kt.; temperature of 25°C).

However, a 10 kt. tailwind component was considered, which is the minimum value established by the tables in the aircraft manual.

Under these conditions, the resulting landing distance was 2,950 ft. (899 m), as shown in Figure 15.

SECTION IV - PERFORMANCE
APPROACH AND LANDING

MODEL 510

LANDING DISTANCE - FEET ACTUAL DISTANCE

FLAPS - LAND
1000 FEET

STALL WARNING - NORMAL
ANTI-ICE - OFF / ON

CONDITIONS: LANDING GEAR - DOWN
THRUST - IDLE AT 50 FEET

AIRSPEED - VREF AT 50 FEET

SOME CONDITIONS MAY BE BRAKE ENERGY OR CLIMB LIMITED. OBTAIN ALLOWABLE WEIGHT FROM MAXIMUM LANDING WEIGHT TABLES.

*WEIGHT = 8645 POUNDS
VREF = 98 KIAS VAPP = 105 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 KTS
-35	2850	2270	2120	1970	1830
-30	2890	2310	2150	2000	1860
-25	2930	2340	2180	2030	1890
-20	2970	2380	2210	2060	1920
-15	3010	2410	2250	2100	1950
-10	3050	2440	2280	2130	1980
-5	3090	2480	2310	2160	2010
0	3140	2510	2350	2190	2040
5	3180	2550	2380	2220	2070
10	3220	2590	2410	2250	2100
15	3260	2620	2450	2290	2130
20	3310	2660	2480	2320	2170
25	3360	2700	2520	2360	22
30	3400	2740	2560	2390	22
35	3450	2780	2600	2420	22
40	3500	2810	2630	2460	23
41	3510	2820	2640	2460	23

WEIGHT = 8000 POUNDS
VREF = 94 KIAS VAPP = 101 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 KTS
-30	2710	2170	2010	1880	1760
-25	2750	2190	2040	1910	1780
-20	2780	2220	2070	1930	1800
-15	2820	2260	2100	1960	1830
-10	2850	2290	2130	1990	1860
-5	2890	2320	2160	2020	1880
0	2920	2350	2190	2040	1910
5	2960	2380	2220	2070	1930
10	3000	2410	2250	2100	1960
15	3030	2440	2280	2130	1990
20	3070	2480	2320	2160	2010
25	3120	2510	2350	2190	2050
30	2820	2270	2130	1990	1860
35	2850	2300	2150	2020	1890
40	2880	2330	2180	2040	1910
45	2920	2360	2210	2070	1940
47	2930	2370	2220	2080	1950

WEIGHT = 7500 POUNDS
VREF = 91 KIAS VAPP = 98 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 KTS	30 K
-30	2580	2060	1920	1790	16
-25	2610	2080	1950	1820	17
-20	2640	2110	1980	1840	17
-15	2670	2140	2000	1870	17
-10	2710	2170	2020	1890	17
-5	2740	2200	2050	1920	17
0	2770	2220	2080	1940	18
5	2810	2250	2110	1970	18
10	2840	2280	2130	1990	18
15	2870	2310	2160	2020	18
20	2910	2340	2190	2040	19
25	2950	2380	2220	2070	19
30	2980	2410	2250	2090	1970
35	3020	2440	2280	2130	1990
40	3060	2470	2310	2160	2020
45	3090	2500	2340	2190	2040
47	3110	2510	2350	2200	2050

WEIGHT = 7500 POUNDS
VREF = 91 KIAS VAPP

TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	20 K
2580	2060	1920	17
2610	2080	1950	18
2640	2110	1980	18
2670	2140	2000	18
2710	2170	2020	18
2740	2200	2050	19
2770	2220	2080	19
2810	2250	2110	19
2840	2280	2130	19
2870	2310	2160	20
2910	2340	2190	20
2950	2380	2220	20

P = 95 KIAS

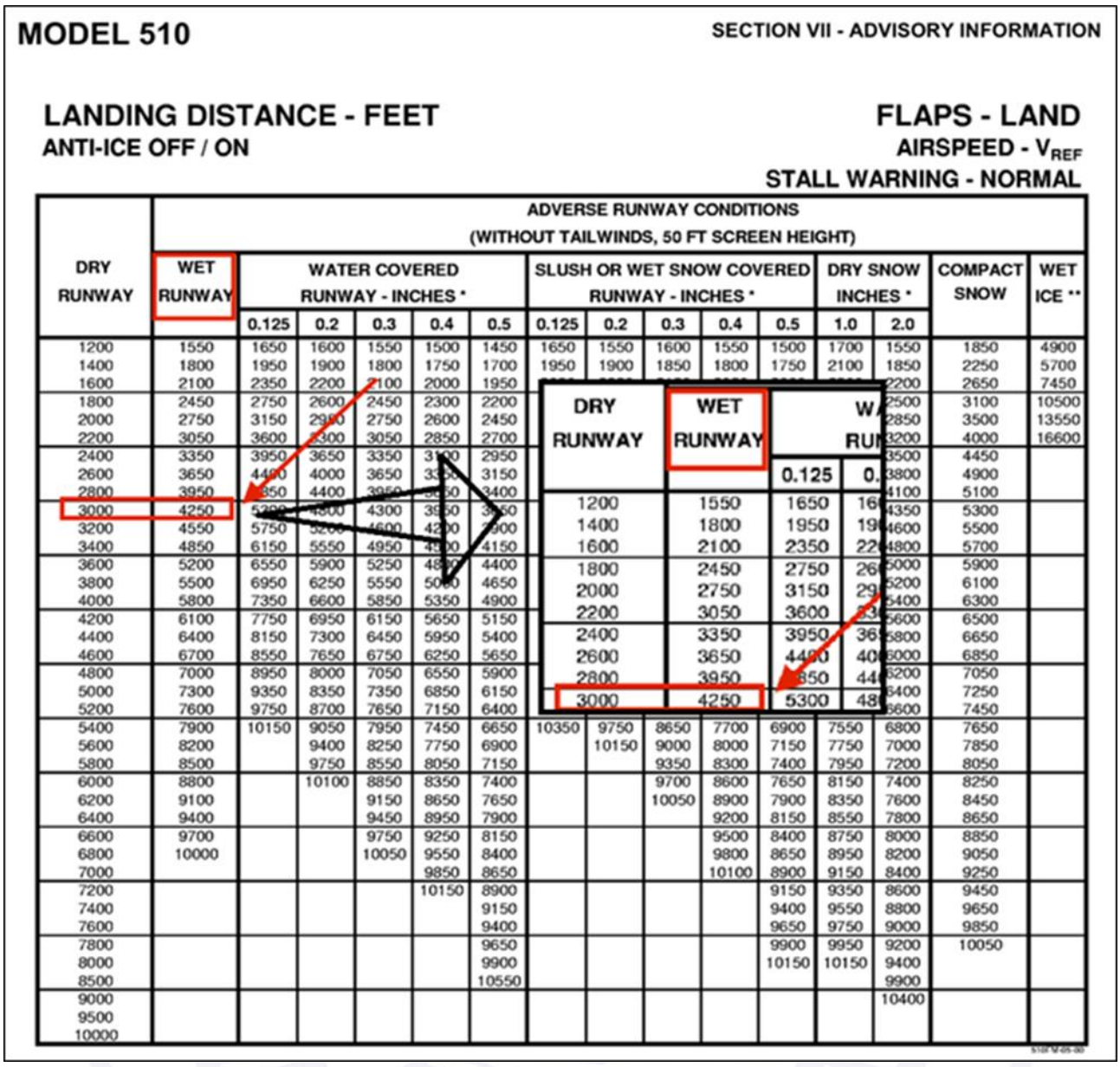
KTS	30 KTS
710	1590
730	1610
760	1630
780	1660
800	1680
820	1700
850	1720
870	1750
890	1770
920	1790
940	1810
970	1840

Figure 15 – Table for landing distance calculation with tailwind.
Source: *Section IV – Performance Approach and Landing* of the AFM, page 4-242.

The value obtained was valid for a dry runway condition. To convert the values to a wet runway condition, the aircraft manual's conversion table was used.

The value of 3,000 ft. was selected as the closest to the 2,950 ft. calculated for a dry runway.

One verified that, under wet runway conditions, the landing distance increased to 4,250 ft. (1,295 m), which is 1,300 ft. (396 m) longer than the distance originally calculated for dry conditions (Figure 16).



MODEL 510

SECTION VII - ADVISORY INFORMATION

LANDING DISTANCE - FEET
ANTI-ICE OFF / ON

FLAPS - LAND
AIRSPEED - V_{REF}
STALL WARNING - NORMAL

DRY RUNWAY	ADVERSE RUNWAY CONDITIONS (WITHOUT TAILWINDS, 50 FT SCREEN HEIGHT)														
	WET RUNWAY	WATER COVERED RUNWAY - INCHES *					SLUSH OR WET SNOW COVERED RUNWAY - INCHES *					DRY SNOW INCHES *		COMPACT SNOW	WET ICE **
		0.125	0.2	0.3	0.4	0.5	0.125	0.2	0.3	0.4	0.5	1.0	2.0		
1200	1550	1650	1600	1550	1500	1450	1650	1550	1600	1550	1500	1700	1550	1850	4900
1400	1800	1950	1900	1800	1750	1700	1950	1900	1850	1800	1750	2100	1850	2250	5700
1600	2100	2350	2200	2100	2000	1950							2200	2650	7450
1800	2450	2750	2600	2450	2300	2200							2500	3100	10500
2000	2750	3150	2950	2750	2600	2450							2850	3500	13550
2200	3050	3600	3300	3050	2850	2700							3200	4000	16600
2400	3350	3950	3650	3350	3100	2950							3500	4450	
2600	3650	4450	4000	3650	3350	3150							3800	4900	
2800	3950	4850	4400	3950	3650	3400							4100	5100	
3000	4250	5300	4800	4300	3950	3650							4350	5300	
3200	4550	5750	5200	4600	4200	3900							4600	5500	
3400	4850	6150	5550	4950	4500	4150							4800	5700	
3600	5200	6550	5900	5250	4800	4400							5000	5900	
3800	5500	6950	6250	5550	5050	4650							5200	6100	
4000	5800	7350	6600	5850	5350	4900							5400	6300	
4200	6100	7750	6950	6150	5650	5150							5600	6500	
4400	6400	8150	7300	6450	5950	5400							5800	6650	
4600	6700	8550	7650	6750	6250	5650							6000	6850	
4800	7000	8950	8000	7050	6550	5900							6200	7050	
5000	7300	9350	8350	7350	6850	6150							6400	7250	
5200	7600	9750	8700	7650	7150	6400							6600	7450	
5400	7900	10150	9050	7950	7450	6650	10350	9750	8650	7700	6900	7550	6800	7650	
5600	8200		9400	8250	7750	6900		10150	9000	8000	7150	7750	7000	7850	
5800	8500		9750	8550	8050	7150			9350	8300	7400	7950	7200	8050	
6000	8800		10100	8850	8350	7400			9700	8600	7650	8150	7400	8250	
6200	9100			9150	8650	7650			10050	8900	7900	8350	7600	8450	
6400	9400			9450	8950	7900				9200	8150	8550	7800	8650	
6600	9700			9750	9250	8150				9500	8400	8750	8000	8850	
6800	10000			10050	9550	8400				9800	8650	8950	8200	9050	
7000					9850	8650				10100	8900	9150	8400	9250	
7200					10150	8900					9150	9350	8600	9450	
7400						9150					9400	9550	8800	9650	
7600						9400					9650	9750	9000	9850	
7800						9650					9900	9950	9200	10050	
8000						9900					10150	10150	9400		
8500						10550							9900		
9000													10400		
9500															
10000															

Figure 16 – Table for landing distance calculation under wet runway conditions.
Source: *Section VII – Advisory Information* of the AFM, page S4-82.

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

This was a ferry flight between SBBI and SSIJ Aerodromes, with only the pilot on board. The aircraft landed in the direction of runway 36 and overran its departure end, coming to a stop on sloped terrain beyond the runway limits.

According to the maintenance records, the airframe and engine logbooks were up to date. Furthermore, the pilot did not report any anomalies with the aircraft, and no system malfunctions were recorded in the aircraft's technical documentation.

Given this scenario, it was concluded that no aircraft or system failures contributed to the accident.

During flight preparation, the aircraft was fully refueled. Considering the basic aircraft weight, the amount of fuel on board, the pilot's weight, and the load carried, the calculated takeoff weight was approximately 8,200 lb., which was below the Maximum Takeoff Weight (MTOW) established by the manufacturer (8,645 lb.).

The flight lasted one hour and was conducted under IFR at an altitude of 32,000 ft. Under these conditions, according to data from the *Flight Planning Guide*, fuel consumption was 733 lb., resulting in an estimated landing weight of approximately 7,467 lb., which was below the maximum landing weight established by the manufacturer (8,000 lb.).

Based on this information, it was concluded that the aircraft was operating within the weight limits defined by the manufacturer.

Meteorological data obtained from satellite imagery, weather radar, SIGWX chart, TAF message, and AD WRNG indicated the forecast of clouds with significant vertical development—types TCU and CB—near the vicinity of SSIJ. Additionally, thunderstorms with moderate rain were present, which could consequently result in horizontal and/or vertical visibility restrictions in the region. In addition to weather forecasts, security camera footage from the aerodrome showed that it was raining at the time of the landing that resulted in the accident.

Thus, it was concluded that there was an unstable atmospheric scenario in the region surrounding the destination aerodrome, and that the runway at SSIJ was wet at the time of the PR-MCL airplane's landing at that location.

According to the pilot's accounts, for flight planning purposes, a mobile application called *ForeFlight* was used. By means of this application, an analysis of the operating conditions at SSIJ was performed, and one considered that the operation was feasible, despite weather forecasts indicating an unstable meteorological condition. The flight proceeded without anomalies until the approach phase for landing.

The pilot reported that all landing preparation items were completed, including the Before-Landing checklist, during which the flaps were extended to the LAND position.

Security camera footage from the aerodrome recorded the landing. The images showed that the touchdown occurred approximately 340 m after the aircraft had crossed the threshold of runway 36.

In order to determine the landing distance required by the PR-MCL airplane at SSIJ, performance charts provided by the manufacturer in the AFM were consulted. The AFM performance charts for landing distance calculation considered dry runway conditions. Since the SSIJ runway was wet at the time of landing, it was necessary to use the AFM conversion table to adjust the values obtained from the dry runway charts to landing distances under wet runway conditions.

Ijuí Aerodrome featured a wind direction indicator (windsock). However, the security camera footage made available to the Investigation Committee did not capture the windsock, making it impossible to analyze the prevailing wind direction at the time of landing using that device. Nevertheless, the pilot reported perceiving a tailwind component during landing. Given this scenario, the landing distances for both zero-wind and tailwind conditions were calculated.

For a wet runway and zero wind condition, the aircraft would have a calculated landing distance of 1,021 m, which is shorter than the length of the runway at SSIJ, which measured 1,280 m.

For a wet runway and a 10-kt. tailwind component (the lowest tailwind value listed in the AFM tables), the aircraft would have a calculated landing distance of 1,295 m, which exceeds the runway length at SSIJ (1,280 m).

Based on these results, it is possible to affirm that the landing of the PR-MCL airplane at SSIJ, under the existing operational conditions—especially with a wet runway—was acceptable, although near the limit, in the case of zero wind. However, for a landing under a tailwind condition, one concluded that the operation was incompatible, as the calculated landing-distance exceeded the total runway length.

The pilot reported that, during the landing roll, he considered the possibility of executing a go-around. Accordingly, he selected the flaps to the TO/APR position but did not advance the throttles nor follow the other steps of the go-around procedure described in the AFM.

It is noteworthy that flap retraction by the pilot during a go-around maneuver was the third item in the procedure specified in the AFM. This means that, after making the decision and initiating the go-around procedure, the pilot should have first advanced the throttles to accelerate the engines and established a pitch attitude of 8° nose-up before selecting the flaps to the TO/APR position.

The landing procedures did not include flap retraction, which should only occur from the LAND position after the landing was completed. The fact that the flaps were retracted to the TO/APR position during the landing roll may have contributed to an increased landing distance, since retracting these aerodynamic surfaces results in a reduction of drag on the aircraft.

The pilot reported that he had the impression the aircraft was not decelerating as expected during the landing. It is likely that this behavior was a consequence of the flap retraction and the resulting decrease in aerodynamic drag during the landing roll.

Therefore, it could not be ruled out that flap retraction contributed to the aircraft overrunning the limits of the runway length.

3. CONCLUSIONS.

3.1. Findings.

a) the pilot held a valid CMA (Aeronautical Medical Certificate);

b) the pilot held valid ratings for C510 type aircraft and IFR-A;

c) the PIC was qualified and experienced in the type of flight;

d) the aircraft had a valid CVA (Certificate of Airworthiness);

e) the aircraft was within weight and balance limits;

f) the records of the airframe and engine logbooks were up to date;

g) the prevailing meteorological conditions near SSIJ were unstable, with rain, thunderstorms, clouds with significant vertical development, and wind gusts;

h) It was raining at the time of landing, and the runway at SSIJ was wet;

i) touchdown occurred approximately 340 m beyond the threshold of runway 36;

j) during landing, the aircraft traveled the full length of the runway and overran its limits at the departure end;

k) the aircraft sustained substantial damage; and

l) The PIC was uninjured.

3.2. Contributing factors.

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

The prevailing meteorological conditions near SSIJ were unstable, with rain, thunderstorms, clouds with significant vertical development, and wind gusts. Under such

conditions, aircraft operation was critical, particularly regarding the runway length and the landing distance required for a wet runway with a tailwind component.

- **Pilot judgment – a contributor.**

The decision to proceed with the aircraft operation under the existing operational and meteorological conditions revealed shortcomings in the pilot's judgment, since in a scenario involving a wet runway and a tailwind component, the calculated landing distance exceeded the available runway length at SSIJ at the time of the accident.

- **Flight planning – a contributor.**

The decision to proceed with the flight despite the scenario of instability indicated in the available weather forecasts and the wet runway condition revealed deficiencies in the flight preparation, especially regarding the determination of surface wind direction and intensity at the aerodrome—an essential factor in the context of the accident**.**

4. SAFETY RECOMMENDATIONS

None.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

NIL.

On June 23th, 2025.