COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 109/CENIPA/2014

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PP-PIM**
MODEL:	**525**
DATE:	**13JUN2014**

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 13JUN2014 accident with the 525 aircraft, registration PP-PIM. The accident was classified as “[SCF-NP] System/Component Failure or Malfunction”.

After landing, the crew failed to brake the aircraft and overpassed the end of the runway, colliding with obstacles.

The aircraft had substantial damage.

The pilot suffered a serious injury; the copilot and the five passengers suffered minor injuries.

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

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
CVR	Cockpit Voice Recorder
DIVOP	Operational Disclosure
FOD	Foreign Object Damage
FCU	Fuel Control Unit
IAC	Civil Aviation Instruction
IAM	Annual Maintenance Inspection
IFRA	Instrument Flight Rating - Airplane
INVA	Flight Instructor Rating - Airplane
IS	Supplementary Instruction
KMCO	ICAO Location designator – Orlando International Airport, Florida - USA
MBPV	ICAO Location designator – Providenciales International Airport, Turks and Caicos Islands
MLTE	Airplane Multi Engine Land Rating
NOTAM	Notice to Airmen
PCM	Commercial Pilot License – Airplane
PN	Part Number
PPR	Private Pilot License – Airplane
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
RESA	Runway End Safety Area
SBGO	ICAO Location designator - Santa Genoveva Aerodrome, Goiânia - GO
SBMQ	ICAO Location designator – Macapá Aerodrome - AP
SERIPA	Regional Aeronautical Accident Investigation and Prevention Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SWEF	ICAO Location designator - Europa Farm Aerodrome, Cocalinho - MT
SWNH	ICAO Location designator – Aruanã Aerodrome - GO
TGPY	ICAO Location designator - Point Salines International Airport, Grenada
UTC	Universal Time Coordinated
Vapp	Approach Speed
VFR	Visual Flight Rules
Vref	Minimum Final Approach Speed

1. FACTUAL INFORMATION.

Aircraft	**Model:** 525 **Registration:** PP-PIM **Manufacturer:** Cessna Aircraft	**Operator:** *Planalto Indústria Mecânica* Ltd.
Occurrence	**Date/time:** 13JUN2014 - 1047 UTC **Location:** Aruanã Aerodrome (SWNH) **Lat.** 14º56'22"S **Long.** 051º03'15"W **Municipality – State:** Aruanã – GO	**Type(s):** "[SCF-NP] System/Component Failure or Malfunction" **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Santa Genoveva Aerodrome (SBGO), Goiânia - GO, to the Europa Farm (SWEF), Cocalinho - MT, at 1015 (UTC), with two pilots and five passengers on board.

During the flight, the crew changed their destination and, at 1047 (UTC), the aircraft landed on runway 24 of the Aruanã Aerodrome (SWNH) - GO.

During the run after landing, the pilots failed to brake the aircraft, which overpassed the final boundary of the runway, crashed into the aerodrome fence and into a ravine, stopping near a highway.

The aircraft had substantial damage.

The pilot suffered serious injuries. The copilot and the five passengers suffered minor injuries.

Figure 1 - Left side view of the aircraft after full stop.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	1	-	-
Minor	1	5	-
None	-	-	-

1.3 Damage to the aircraft.

There was substantial damage to the structure of the aircraft.

1.4 Other damage.

The aircraft damaged the metal grid fence with concrete pillars that bordered the aerodrome.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours		
	Pilot	Copilot
Total	17,000:00	1,078:00
Total in the last 30 days	30:00	40:00
Total in the last 24 hours	00:30	00:30
In this type of aircraft	38:40	04:00
In this type in the last 30 days	11:30	04:00
In this type in the last 24 hours	00:30	00:30

N.B.: The data related to the flown hours were obtained through the Pilots' Flight Logbooks (CIV).

1.5.2 Personnel training.

The pilot took the PPR course at the Goiás Aeroclub – GO, in 1967.

The copilot took the PPR course at the Votuporanga Aeroclub – SP, in 2002.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PCM License and valid C525 type aircraft (which included the 525 model – Citation Jet), MLTE, IFRA and INVA Ratings.

The copilot had the PCM License. His MLTE and IFRA Ratings were expired since 2014. He did not have C525 type aircraft Rating.

1.5.4 Qualification and flight experience.

The pilot was qualified and his experience in the operation of jet propulsion aircraft began in January 2014, having a total of 38 hours and 40 minutes, all carried out in the crashed aircraft.

The copilot was not qualified to operate the C525 and did not have prior experience in the operation of jet propulsion aircraft.

1.5.5 Validity of medical certificate.

The pilots had valid CMAs.

1.6 Aircraft information.

The low-wing aircraft, serial number 252-0548, was manufactured by Cessna Aircraft, in 2005 and it was registered in the TPP category.

The aircraft had valid Airworthiness Certificate (CA).

The aircraft was equipped with two Williams FJ44-1A turbofan engines, used for carrying up to six passengers, certified for a single pilot operation.

After the acquisition of the aircraft by the Planalto Indústria Mecânica Ltd., it was submitted to the Initial Technical Inspection by the ANAC, on 23JAN2014, on the grounds of nationalization, confirming its airworthiness in accordance with the applicable RBAC and the RBHA; and also with the applicable Instructions of the IAC and the IS.

The maintenance services were carried out in accordance with the maintenance program of the manufacturer.

The last inspections, the “Inspection Document 2, 9, 10, 11, 12, 21, 33 and 36 type”, according to the Cessna 525 Maintenance Manual, and Enviro Systems 12 Month Inspection were carried out in conjunction with the IAM. These services were completed on 05JUN2014, by the maintenance organization Orlando Citation Service Center (Florida, United States).

In the above citations inspections, in addition to the execution of the cards provided in the maintenance program, the following tasks were performed:

- Special Detail Inspect Left/Right Main Landing Gear Wheel (inspection document 14);

- Special Detail Inspect Nose Landing Gear Wheel Assy (inspection document 14);

- Left Main Landing Gear Brake Assy (Part Number (PN) 2-1559-3/Alternate Part 9912398-8/Serial Number 0214) - comment: "removed due to wear. Installed brake overhauled assembly (Serial Number 1236) by Goodrich Aircraft Wheels & Brakes (Wichita, KS - USA), considered good in operational and leak testing"; and

- Right Main Landing Gear Brake Assy (PN 2-1559-3/Alternate Part 9912398-8/ Serial Number 0096) - comment: "removed due to wear. Installed the overhauled brake assembly (Serial Number 0881) by Goodrich Aircraft Wheels & Brakes (Wichita, KS - USA), considered good in operational and leak testing".

The tires of the main and nose landing gears were also removed, due to wear and new tires were installed.

After the inspections and services mentioned, the aircraft flew 11 hours and 30 minutes until this occurrence. The crash landing was the fifth after the inspections.

After the last inspection, no abnormality related to the operation of the aircraft systems was recorded in the flight logbook.

The aircraft had 3,517 airframe hours since new.

1.7 Meteorological information.

At the time of the event, the conditions were favorable for the visual flight, with visibility over 10km, without clouds, temperature around 26° C and wind estimated by the pilot of 230° with 8kt.

1.8 Aids to navigation.

Nil.

1.9 Communications.

There was no coordination with the air traffic control for destination change from SWEF to SWNH.

1.10 Aerodrome information.

The Aerodrome was public, ran by the State of Goiás Government and operated under VFR in daytime and nighttime.

The runway was made of asphalt, with thresholds 06/24, dimensions of 1,300m x 23m, with elevation of 820 feet.

The Field Investigation Team measured the distance from threshold 24 to the end of the runway, measuring 1,550m. At the end of runway 24, there was an extension of the floor, after the markings of threshold 06, with extension of 60m, similar to a RESA.

The runway 24 was used for landing, which, in its final half, had a negative slope.

At the time of the occurrence, there was a NOTAM in force, which prohibited the operation of jet aircraft in SWNH. The text of the NOTAM did not specify the reason, but according to aerodrome officials, the restriction originated because of the significant presence of small stones that could cause a FOD. They also reported that the cleaning had already been done, but that the cancellation of the NOTAM had not yet taken effect.

During the Field Investigation, on the day of the accident, in fact, it could be verified that the runway was clean, without the presence of stones.

1.11 Flight recorders.

The aircraft was equipped with a Cockpit Voice Recorder (CVR) model FA2100, manufactured by L-3 communications, and had no flight data recorder.

The CVR recorded the last 30 minutes of sounds and noises within the cabin.

During the landing roll, when the pilot announced that he was applying the emergency brake, there was the recording of a noise associated with successive actuations of the handle that was activated. The Investigation Team conducted a comparative test with the noise emitted by the emergency brake handle of the aircraft. This test will be detailed in item 1.16 of this Report.

The operational information collected through the CVR will be presented in item 1.18 of this Report.

1.12 Wreckage and impact information.

No braking marks were found on the runway. There were only subtle marks of the tire passing over the last 249m, as depicted in the diagram in Figure 2 below:

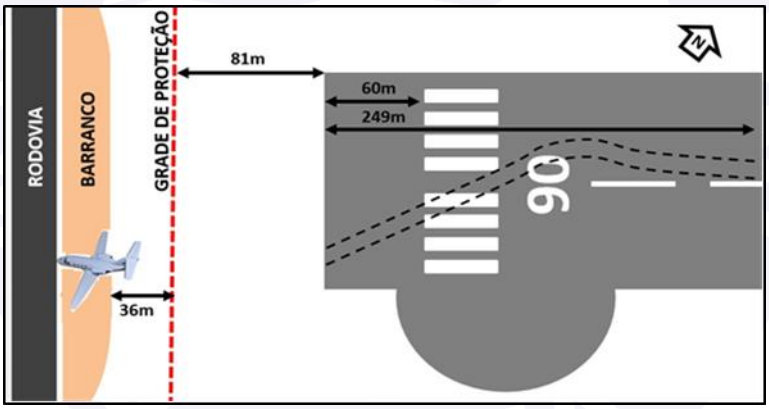


Figure 2 - Trajectory diagram of the aircraft. The black dashes represent subtle markings left by the aircraft tires on the runway in the last 249m.

At the end of the runway, the aircraft traveled 81 meters, on unpaved ground and with ground vegetation until reaching the wire fence, supported by pillars and concrete foundation (Figures 3 and 4). Then, it advanced another 36m until its full stop, after colliding against a ravine near the highway.

Figure 3 - Wire fence with pillars and concrete foundation overturned by the aircraft.

Figure 4 - Wire fence and aircraft in the final position.

The wreckage of the aircraft got concentrated. The front section absorbed the largest amount of energy from the final impact, resulting in the most significant damage (Figure 5).

As a result, the cockpit front panel was deformed, causing serious injury to the pilot's leg and locking the right engine power lever (Figure 6). With the locking of the lever, the crew was unable to perform the right engine shut down normal procedure (thrust lever - OFF).

In an attempt to shut down the right engine, the Aruanã City Fire Brigade team moved some switches in the cockpit.

The impact also resulted in a breakdown of the nose landing gear and some fuselage deformations that prevented the opening of the aircraft door for evacuation.

Figure 5 - Damage to the front section of the aircraft.

Figure 6 - Deformations in the aircraft panel and in the levers console. The right engine lever is already repositioned after the action of the fire brigade.

The anti-skid switch was found in the OFF position (item 1 - Figure 7). The landing gear lever was in the down position and deformed with the impacts (item 2 - Figure 7). The support panel of the emergency brake lever (item 3 - Figure 7) and the auxiliary gear control (item 4 - Figure 7) deformed with the impact.

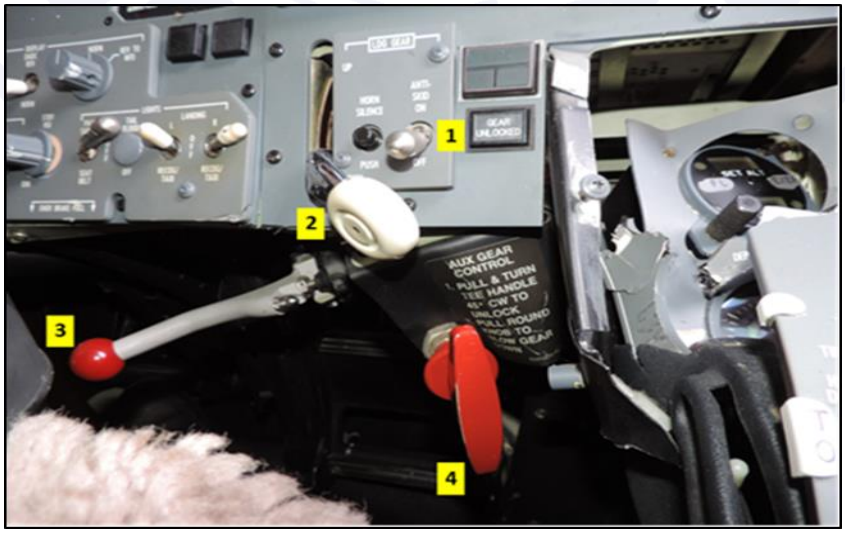


Figure 7 - (1) anti-skid switch in the OFF position; (2) landing gear control lever in the down position; (3) emergency brake lever; and (4) emergency landing gear lowering lever (auxiliary gear control).

On the left circuit breaker panel, the NORM PRESS and FWD EVAP FAN (ENVIRONMENTAL) circuit breakers; R PITOT STATIC (ANTI-ICE); and BRAKE SYSTEM, GEAR CONTROL and SKID CONTROL (SYSTEMS) were found disarmed after the aircraft has stopped (Figures 8 and 9).

Figure 8 - Left circuit breaker panel.

Figure 9 - Disarmed circuit breakers - BRAKE SYSTEM, GEAR CONTROL and SKID CONTROL (SYSTEMS).

On the right circuit breaker panel, the DME 1, MKR BCN, RFGC, LFGC, AHRS 2, RADAR, ADC 2, PFD2 HTR circuit breakers were found disarmed after the aircraft stopped.

The flaps were in the position 60° and the speed brakes panels were open.

Figure 10 - Flaps configuration in 60° and open speed brake - left wing.

Figure 11 - Flaps configuration in 60° and open speed brake - right wing.

The hydraulic and pneumatic power lines of the normal and emergency brake systems and their connections to the right and left brake sets did not show signs of leakage (brake shuttle valve and nitrogen vent line - Figure 12). There was fluid leakage from the brakes only inside the hydraulic components compartment, located in the front section of the aircraft, that is, at the direct impact site against the ravine. The impact caused the rupture of the hydraulic reservoir.

The nitrogen accumulator of the emergency brake system (Figure 13) was under pressure in the normal range and its pneumatic power lines from the reservoir to the right and left brake sets remained undamaged.

Figure 12 - Hydraulic power line and nitrogen vent line of the brake system.

Figure 13 - Nitrogen accumulator of the emergency brake system (green band from 1,800 to 2,050psi)

1.13 Medical and pathological information.

1.13.1 Medical aspects.

The pilot and copilot, according to the results of their last health inspection, had no physiological restrictions that would prevent them from flying. Both reported that they did not perform work on the previous day and that they slept more than 7 hours the night before the accident.

1.13.2 Ergonomic information.

In Figure 14, it is possible to check the emergency brake and emergency landing gear handles, as well as their descriptions in English. It should be noted that the description of the emergency brake is concealed for the pilot positioned on the left seat, since the stick column obstructs the view.

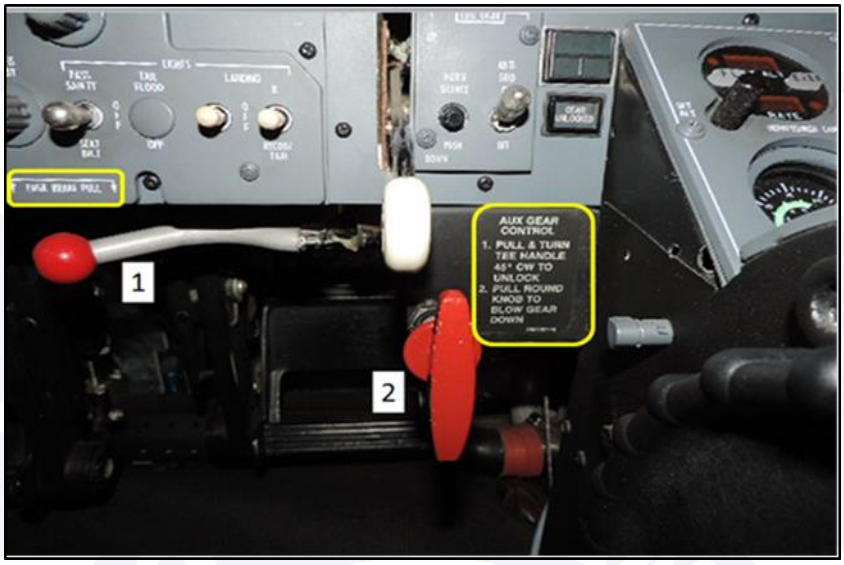


Figure 14 - Panel of the 525. (1) - emergency brake actuator handle, with the description EMERG BREAK PULL, highlighted in the yellow photo; (2) - auxiliary gear control, with the description AUX GEAR CONTROL.

The pilot, positioned on the left seat of the Cessna 525, has the view of the emergency brake system handle obstructed by the stick column (Figure 15).

Figure 15 – View of the panel for the pilot positioned on the left seat of the Cessna 525. The stick column obstructs the view of the emergency brake handle.

The auxiliary gear control lever is easily visible, in front of the pilot's right leg (Figure 16).

Figure 16 - Visualization of the emergency landing gear lever by the pilot positioned on the left seat.

When the emergency brake is activated, the pilot cannot see the handle, since it is out of sight (Figure 17).

Figure 17 - Simulation of the emergency brake lever drive.

1.13.3 Psychological aspects.

The pilot reported having a long professional career in aviation, including experiences in mining aviation.

He described himself as a careful and methodical professional, reporting having had a normal routine the day before the accident.

According to the results of the last pilots' health inspections, they had no psychological restrictions for the flights performances.

On the flight that caused the accident, the pilot and copilot reported not having noticed any abnormalities regarding the aircraft brakes until the moment they touched the runway.

During the landing roll, after several unsuccessful attempts at using the brake pedals, the pilot reported that he had taken his right hand to a lever on the aircraft panel, located around the height of his right knee, which he believed was the emergency brake lever. According to him, his action on this lever also had no effect for braking the plane.

Yet, according to the commander, he had familiarity and felt safe for the operation at SWNH. For more than two years he had operated on that aerodrome in another aircraft model, and with the Cessna 525, it would be his fourth time.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

After the full stop of the aircraft, the pilot had difficulty leaving the cabin, due to the serious injury he had suffered in the leg. The copilot found that the passengers had the initiative to evacuate the aircraft, so he focused his attention on assisting the pilot in his abandonment.

The passengers evacuation was fast. They, initially, tried to open the door of the aircraft and found that it was stuck. Then one of them opened the emergency exit.

The first passenger to leave the aircraft had long hair. As she passed next to the right engine, which remained on, her hair was sucked toward the engine air intake. The passenger behind her pushed her away, preventing her hair from getting into the engine.

The crewmembers were the last to leave the aircraft. The copilot estimated that his exit occurred about three minutes after the aircraft stopped.

The right engine stayed on, even after the evacuation of all occupants.

Figure 18 - View of the emergency exit and air intake of the right engine.

1.16 Tests and research.

The hydraulic fluid reservoir of the normal brake system had some fractures because of the impact, resulting in leakage of large amounts of fluid. The other components of the normal and emergency brake systems were removed from the aircraft to perform bench tests.

The hydraulic and pneumatic power lines of the right and left brakes, normal and emergency ones were in good condition and there were no signs of leaks.

Figure 19 - Left brake assembly and hydraulic and pneumatic power lines.

Figure 20 - Right brake assembly and hydraulic and pneumatic power lines.

The tires installed were new and, at the last inspection, they were in good condition and showed no wear marks due to intense braking.

Figure 21 – Left tire.

Figure 22 – Right tire.

Brake sets and shuttle valves Tests

The right brake assembly (PN 2-1559-3 and SN 0881), the right shuttle valve (PN 195-191-2 and SN 908), the left brake assembly (PN 2-1559-3 and SN 1236) and the left shuttle valve (PN 195-191-2 and SN 1264) underwent functional bench tests at the UTC Aerospace Systems in Troy (Ohio - United States) facilities, with the follow-up of the Investigator-In charge, the Maintenance Investigator (member of the investigation team), an operator representative, the Accredited Representative of the United States and his Adviser (representative of Cessna Aircraft).

The tests indicated that:

- the internal parts were clean;
- the rotor parts could be easily rotated manually;
- the pistons extended and retracted with pressure application, making five cycles from zero to 800psi;
- no leakage was observed with maintenance of 800psi pressure;
- at 10psi, the brake components were less than 0,020 inches apart, but rotated freely and easily when moved manually;
- on the right brake assembly, the wear pins were measured and were adequate, between 0,389 and 0,408 inches (the new wear pin measures 0,410 inches);
- on the left brake assembly, the wear pins were measured and were adequate, between 0,409 and 0,404 inches; and
- in both brake sets, when the pressure application test was performed by the emergency system, on the corresponding side of the shuttle valve, the poppet shuttle could be heard and the fluid was sprayed out by the other access (hydraulic feed line supply).

The results confirmed that both brake sets and their respective shuttle valves functioned normally.

Transducers, skid control braking system - control box and valve assembly power brake relay Test

These components undergone functional tests on Crane Aerospace & Electronics facilities in Burbank (California - United States), with follow-up of the Investigator-In Charge, Maintenance Investigator (member of the Investigation Team), an Accredited Representative of the United States and his Adviser (representative of Cessna Aircraft).

The two transducers (PN 40-955; SN 6979 and SN 6958) showed normal performance in the bench tests.

The skid control breaking system - control box (PN 42-707-1 and SN 302) was subjected to the following tests: voltage, skid response, PBM, locked wheel crossover, spinup override, squat delay time, fault detection and dynamic. The results showed normal control box conditions.

In relation to the valve assembly power brake relay (PN 38-747 and SN 681), initially, the hydraulic fluid (MIL-H-83282) inside was removed for laboratory analysis. These confirmed that the fluid was within expected specifications without contamination. The tests also indicated normal operation of the valve assembly power brake relay.

Hydraulic pack assy Test

The hydraulic pack assy (PN 6517102-11 and SN 2885) removed from the PP-PIM aircraft in good condition was installed on another aircraft of the same model, at TAM

Aviação Executiva e Táxi Aéreo SA (Jundiaí - SP), with monitoring of the Investigator-In charge and of the Maintenance Investigator (member of the investigation team), in order to evaluate its functionality.

The tests indicated that the hydraulic pack assy operated maintaining the normal pressure parameters, which ensured the correct operation of the brake system.

Emergency brake system Test

A part of the investigation team, composed of two Maintenance Investigators, accompanied by a mechanic specialized in the aircraft model, performed the test of the emergency brake system.

During the execution of the test, it was verified that the nitrogen accumulator of the emergency brake system (shown in Figure 13) was in the operating green band, indicating between 1,800 and 2,050psi. The pneumatic lines from the accumulator to the right and left shuttle valve remained intact after impact. In the successive applications of the emergency brake handle, it was found that the nitrogen was being discharged with pressure in the connection of the right and left shuttle valve.

Comparative examination of noises recorded in the CVR during the landing roll

The noise emitted during the activation of the emergency brake lever and the emergency landing gear control of the PP-PIM aircraft were recorded by the investigation team, in order to carry out a comparative examination with the noises registered in the CVR during the landing roll, at the moment when the pilot mentioned that he was applying the emergency brake.

This examination indicated that the sound recorded in the CVR had a greater similarity with the driving noise of the emergency landing gear control. This led the investigation team to conduct further interviews with the pilots on board another aircraft of the same model.

1.17 Organizational and management information.

The aircraft was acquired by its owner in January 2014. He hired a company to handle the operational and administrative costs of the aircraft. This company was run by the pilot of the aircraft.

According to the pilot, who was responsible for the administration of the aircraft, the copilot participated in the flight only as a way to accumulate experience, since the aircraft fit in the regulation of single pilot operation.

1.18 Operational information.

The aircraft was above the maximum landing weight limit but within the balance limit.

After the completion of the maintenance services at the Orlando Citation Service Center (Florida - United States), the aircraft took off from the Orlando International Airport (KMCO) on 11JUN2014 to Santa Genoveva Aerodrome (SBGO), Goiânia – GO, performing technical landings at the Providenciales International Aerodrome (MBPV), Turks and Caicos Islands at the International Point Salines Aerodrome (TGPY) - Grenada, and at Alberto Alcolumbre International Aerodrome (SBMQ), Macapá - AP.

The runway lengths involved in the landing operations of 11JUN2014 were as follows:

- MBPV: 2.316m;
- TGPY: 2.744m;
- SBMQ: 2.100m; and
- SBGO: 2.500m.

The pilot who was involved in the accident participated in the flights from KMCO to SBGO, acting as copilot. He reported that at the first more intense application of the brakes, during the taxi, after maintenance and before the take-off from KMCO, the left brake responded sharply ("it was a bump", according to his words). The operation then showed to be uniform and normal for both the left and right brakes.

During the climb, after the KMCO take-off, the pilot reported that the "POWER BRAKE LOW PRESS AND ANTISKID INOP" lights came on in the alarm panel. The crew performed the checklist items, and moments after they were completed, the lights went out.

The landing in MBPV was normal. The brakes were checked and the performance was adequate.

In the final approach to landing on TGPY, the "POWER BRAKE LOW PRESS AND ANTISKID INOP" lights momentarily lit up and went out without performing procedures. The landing on TGPY was normal.

In the flight stages for SBMQ and SBGO, the light did not turn on at the alarm panel and the behavior of the brakes was normal.

During the landing at SBGO, the aircraft used only 1,400m of extension in runway 14, leaving it by taxiway "C".

In preparation for the flight on 13JUN2014, the crew did not identify abnormalities in the operation of the aircraft systems prior to landing in SWNH.

The crew issued two flight plans. The first one from SBGO to SWEF (Europe Farm Aerodrome, Cocalinho - MT), alternating SWNV (National Aerodrome of Aviation - Goiânia, GO); the second from SWEF to SBGO, alternating SWNV.

The SWEF runway, with 800m of extension and 18m wide, did not have compatible dimensions for operation of this aircraft at its maximum landing weight (9,700 pounds).

The purpose of the flight was to carry five passengers to take part in an event in Aruanã - GO.

The crew proceeded to landing at SWNH, without coordinating changes to the flight plan with the air traffic control.

According to the CVR, during the en-route flight, all preparation of the aircraft was made for landing at SWNH. The copilot calculated the landing speeds for the weight of 10,150 pounds. The Minimum Final Approach Speed (Vref) was 109kt and the Approach Speed (Vapp) was 116kt.

According to the flight manual of the aircraft, the maximum landing weight was limited to 9,700 pounds, which may be due to the brake energy or the rate of climb.

At the maximum landing weight (9,700 lbs.), at the SWNH (820ft) altitude, temperature of 26° C, with head wind component of about 8kt, the landing distance required was 823m, according to the flight manual of the aircraft.

According to the CVR record, the crew listed all the items in the descent, approach, before landing and landing checklist. At the landing approach, the copilot mentioned the speeds of the aircraft, speaking "122, 119, 116 ... 109kt", before the aircraft touched the ground.

Regarding the anti-skid switch found in the "OFF" position, crewmembers stated that this was checked in the "ON" position during the execution of the approach checklist, and there was no indicative light of the inoperative anti-skid condition on the alarms panel. In the CVR, it was registered the copilot stating the accomplishment of this inspection.

Based on the CVR, from the touch of the aircraft on the ground to the impact against the fence, 34 seconds elapsed and it took two seconds more until the final impact against the ravine.

According to the crewmembers, the touch down occurred at the beginning of the runway, at a distance of less than 300m from the threshold. Both said that the approach was made in a stabilized way and that the aircraft was configured for landing when crossing 1,000ft above the altitude of the field.

Shortly after touching the ground, the copilot said "ground flap". Then he questioned whether the commander was braking. He answered: - yes.

The commander said that he had tried braking through the normal system up to the beam of the taxiway that gives access to the apron, but the brakes were null. This distance corresponded to 910m of runway. From this position on, the commander said that he tried to use the emergency brake system. In parallel, the copilot applied pressure on the pedals in an attempt to brake by the normal system. There were also no brakes.

The aircraft exceeded the end of the runway without brake action, stopping only after the collisions against the fence and the ravine, as shown in Figure 2.

The pilot reported that after the full stop, he pulled some circuit breakers, but said he did not remember how many or which they were.

In the case of the "POWER BRAKE LOW PRESS AND ANTISKID INOP" alarm light, the checklist established the actions shown in Figure 23 below.

■ **POWER BRAKE SYSTEM FAILURE (PWR BRK LOW PRESS AND ANTISKID INOP CAUTION LIGHTS ON AND MASTER CAUTION)**

1. SKID CONTROL and BRAKE SYSTEM Circuit Breakers (LH Panel) - RESET.

● **IF LIGHTS REMAIN ILLUMINATED**

2. Plan to use the emergency brake system for landing.
3. Multiply landing distance by 1.4
4. Brake Pedals - REMOVE FEET FROM BRAKE PEDALS.
5. Emergency Brake Handle - PULL AS REQUIRED.

CAUTION

- ANTISKID SYSTEM DOES NOT FUNCTION DURING EMERGENCY BRAKING. EXCESSIVE PRESSURE ON EMERGENCY BRAKE HANDLE CAN CAUSE BOTH WHEEL BRAKES TO LOCK, RESULTING IN BLOWOUT OF BOTH TIRES.
- AFTER LANDING, CLEAR THE RUNWAY AND STOP. DO NOT ATTEMPT TO TAXI ONTO RAMP USING EMERGENCY BRAKES.

NOTE

Best performance can be obtained using a smooth, steady, continuous pull of handle to obtain the desired deceleration rate. Multiple pulls and releases of the handle will deplete the nitrogen charge.

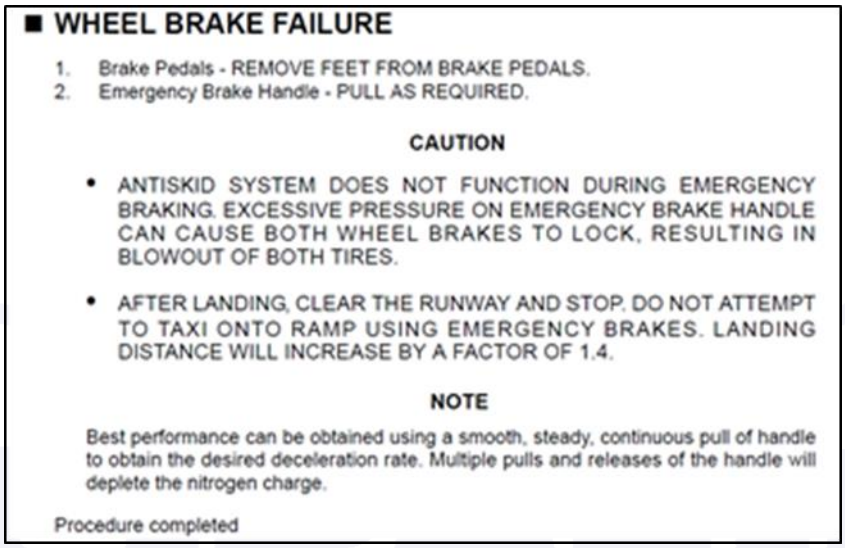
Procedure completed

● **IF LIGHT EXTINGUISHES**

Procedure completed

Figure 23 - Emergency Checklist - Power Brake System Failure.

Emergency procedures in case of brake system failure are described in the checklist, as shown in Figure 24 below.



■ WHEEL BRAKE FAILURE

1. Brake Pedals - REMOVE FEET FROM BRAKE PEDALS.
2. Emergency Brake Handle - PULL AS REQUIRED.

CAUTION

- ANTISKID SYSTEM DOES NOT FUNCTION DURING EMERGENCY BRAKING. EXCESSIVE PRESSURE ON EMERGENCY BRAKE HANDLE CAN CAUSE BOTH WHEEL BRAKES TO LOCK, RESULTING IN BLOWOUT OF BOTH TIRES.
- AFTER LANDING, CLEAR THE RUNWAY AND STOP. DO NOT ATTEMPT TO TAXI ONTO RAMP USING EMERGENCY BRAKES. LANDING DISTANCE WILL INCREASE BY A FACTOR OF 1.4.

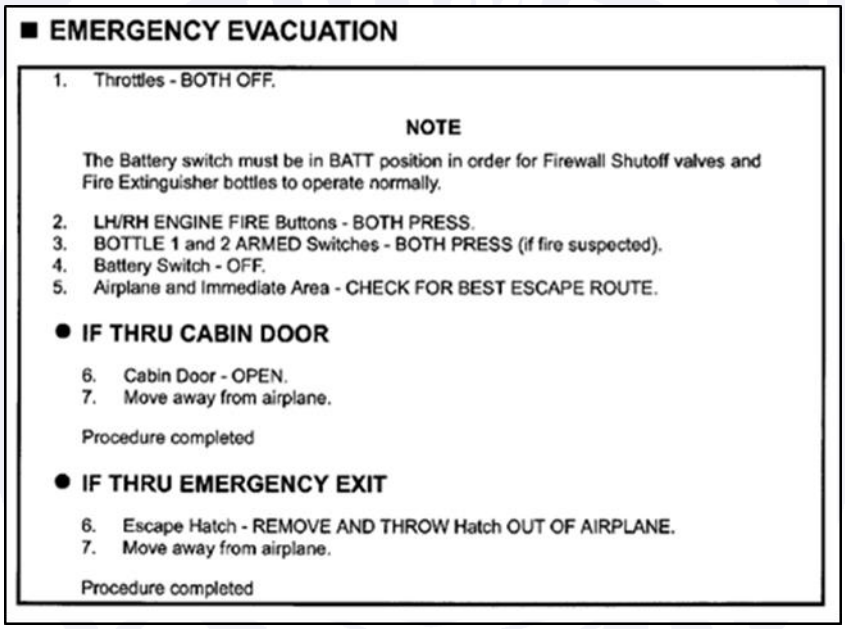
NOTE

Best performance can be obtained using a smooth, steady, continuous pull of handle to obtain the desired deceleration rate. Multiple pulls and releases of the handle will deplete the nitrogen charge.

Procedure completed

Figure 24 - Emergency Checklist - Wheel Brake Failure.

Emergency procedures in case of emergency evacuation are described in the checklist, as shown in Figure 25 below.



■ EMERGENCY EVACUATION

1. Throttles - BOTH OFF.

NOTE

The Battery switch must be in BATT position in order for Firewall Shutoff valves and Fire Extinguisher bottles to operate normally.

2. LH/RH ENGINE FIRE Buttons - BOTH PRESS.
3. BOTTLE 1 and 2 ARMED Switches - BOTH PRESS (if fire suspected).
4. Battery Switch - OFF.
5. Airplane and Immediate Area - CHECK FOR BEST ESCAPE ROUTE.

● IF THRU CABIN DOOR

6. Cabin Door - OPEN.
7. Move away from airplane.

Procedure completed

● IF THRU EMERGENCY EXIT

6. Escape Hatch - REMOVE AND THROW Hatch OUT OF AIRPLANE.
7. Move away from airplane.

Procedure completed

Figure 25 - Emergency Checklist - Emergency Evacuation.

The commander took the 525 theoretical course at the EWM Aviation Ground School in São Paulo-SP, in 2012 and his training was done on the aircraft itself. The copilot was not certified on the aircraft.

Neither the pilot nor the copilot had performed flight simulator training on this aircraft model; nor simulation on the aircraft using the emergency brake. This was the first time they needed to make use of the emergency brake system.

In order to fly the Cessna, model 525, according to the RBAC 61 in force at the time, it was not required to carry out training in flight simulator.

Approximately four months after the accident, when the braking system components were examined, the investigation team performed a reconstitution of the landing and evacuation procedures of the aircraft, with the participation of both pilots. It was verified that the handle activated during the landing roll was the auxiliary gear control, which serves to

lower the landing gear in an emergency situation. The handle of the emergency brake system has not been actuated.

The pilot said that during the completion of the Cessna 525's "Ground School" there were no warnings highlighting the location of the emergency brake system drive handle.

During the reconstitution of the procedures, the crew did not identify how to shut down the engine in case of power lever locking.

1.19 Additional information.

As a result of an accident with the aircraft PT-LPZ, model C-500, on 18MAY2013, during the landing at Campo de Marte Aerodrome, a DIVOP n° 002/SERIPA IV/2013, was issued, alerting for improper use of the emergency landing gear control handle, instead of the emergency brake drive handle. The DIVOP reported that the occurrence had at least two antecedents, one in Brazil and one in England.

For C-500 aircraft, Cessna Aircraft issued the Service Bulletin No. 32-11 of a non-mandatory nature, repositioning the emergency brake drive handle, so as to be less concealed by the panel. However, for the pilot positioned on the left seat, the view of the handle remained obstructed by the stick column.

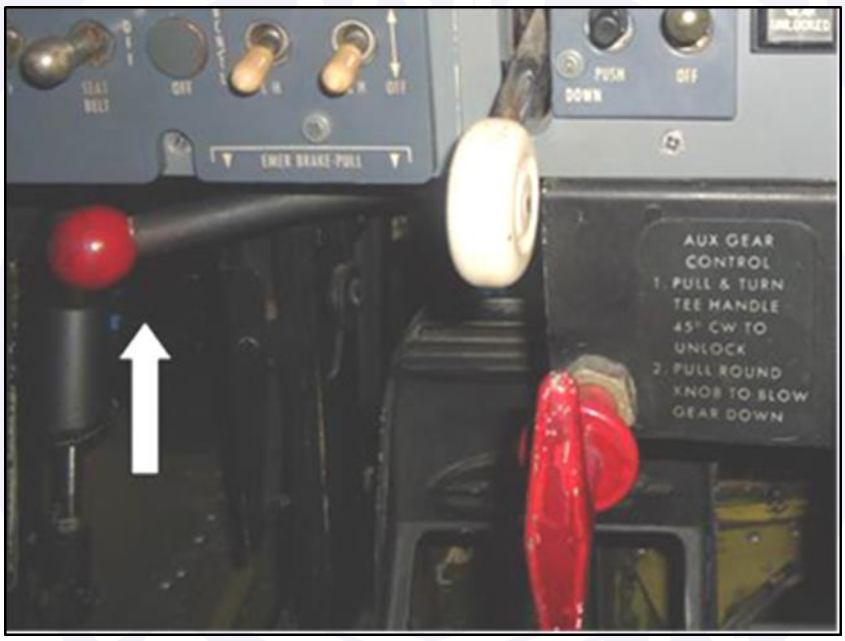


Figure 26 - Citation I aircraft panel with bulletin application.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

In the analysis of the factors involved in this accident, the aspects related to the lack of performance of the normal brake system and the emergency brake system, associated to the possible correlations of the operational factor, the human factor and the material factor were verified.

Initially, it was found that the copilot was not qualified to operate the Cessna 525. However, a single pilot could operate the aircraft, according to regulatory criteria.

In this case, there was only one aspect that raised doubts about the occupation of the right seat, in the cabin, by an unqualified pilot. The wheel brake failure checklist procedure

(Figure 24) determined, in item # 1, that the feet were removed from the pedals, while the emergency brakes were applied.

According to the information collected, during the pilot's emergency braking attempts on the left seat, the copilot attempted to apply normal braking on the pedals.

Although the checklist did not recommend this procedure, the investigation found that this was not the cause of the emergency brake not to work, as will be discussed below.

There was an inconsistency at the flight plan destination aerodrome (SWEF) as it did not have sufficient runway length for landing the aircraft at its maximum landing weight (9,700 pounds).

During the en-route flight, according to the CVR, all preparation of the aircraft was made for the landing at an aerodrome that was not on the flight plan, SWNH (Aruanã - GO), weighing 10,150 pounds. In the meantime, two inconsistencies were verified, one related to the excess of 450 pounds of the maximum landing weight and another allusive to the operation in closed aerodrome for jet aircraft, according to the NOTAM in force.

The limitation of 9,700 pounds of maximum landing weight was due to the braking energy or the rate of climb. In this case, the landing performance could require runway extension greater than that provided in the manual, 823m, for the maximum landing weight. The SWNH runway had the extension of 1,300m. However, overweight would not justify the total failure of the normal and the emergency brake systems.

Therefore, it was understood that the aircraft was above the maximum landing weight limit, but within the balance limit.

Regarding the NOTAM that prohibited the operation of jet propulsion aircraft in SWNH, the origin of the problem was the existence of small rocks on the runway that could cause a FOD. This problem was already solved and no correlation was established with the failure of the normal and the emergency brake systems, configuring at most a flight indiscipline that would not have contributed to the occurrence.

An analysis has therefore been made to verify if overpassing the end of the runway limit could be associated with a destabilized approach or long landing.

According to the CVR, the pilots listed all the items in the descent, approach, before landing and landing checklist. They confirmed that the aircraft configuration for the landing was done correctly. Likewise, the configuration of the aircraft after the impacts corroborates this information.

The CVR also registered the copilot to announce the Vref of 109kt just before the touchdown. Therefore, with the aircraft in the correct configuration and with adequate speed, it remained to know if the touchdown point would not have been far from the threshold in use (long landing).

Using the event times (touchdown point, fence impacts and ravine) recorded in the CVR and the distances reported in the diagram of the occurrence, it was found that the aircraft touched the runway within the 1,000-foot range, as declared by the crew.

Regarding the meteorological conditions estimated by the pilot, wind of 230° with intensity of 8kt, as well as slope of the runway, negative in its final part, there would be no such significant changes in landing distance that would prevent the aircraft from stopping within the limits of the runway.

At the last inspection of the aircraft, completed on 05JUN2014, two brake sets were installed that had been overhauled, tested and inspected for leaks and considered good for application.

In the five landings, carried out between the last inspection and the accident, the normal brake system presented adequate performance. Although these landings were made in runways longer than 2,000m, on the landing made in SBGO the aircraft used 1,400m and the braking occurred properly.

During this period, however, the "POWER BRAKE LOW PRESS AND ANTISKID INOP" lights went on in two occasions. The first occurrence was during the climb phase, after the take-off from KMCO, on 11JUN2014, that is, the first flight after the last inspection and exchange service of the brake sets. In this event, the crew performed the emergency checklist for that part, which included in its first item the reset of the skid control and brake system circuit breakers. Then the lights went off, indicating that the problem was solved.

On the second event, the "POWER BRAKE LOW PRESS AND ANTISKID INOP" lights momentarily went on during approach to the landing on TGPY. However, the lights went off without any action being taken.

Having in mind the normal performance of the brakes in the five previous landings to the accident, as well as the fact that there was no light indicating the fault in the alarm panel on the flight when the accident occurred, no correlation between the two previous events of illumination of the "POWER BRAKE LOW PRESS AND ANTISKID INOP" lights with this accident was found.

After the accident, there was no evidence of leakage of hydraulic fluid in the feed lines of the brake sets. Functional tests were performed on components of the normal brake system. The two brake sets and their shuttle valves, the two transducers, the skid control breaking system - control box and the power brake relay valve assembly were bench tested and showed adequate performance. The hydraulic pack assy was installed on another aircraft and worked normally.

The hydraulic fluid (MIL-H-83282) inside the hydraulic pack assy was removed for laboratory analysis. These ones confirmed that the fluid was within expected specifications without contamination.

The reservoir of hydraulic fluid in the front section of the aircraft had leaks, but the evidence was that these occurred as a consequence of the fractures that happened due to the impact of the aircraft against the ravine with high energy level.

The improper activation of the pedals acting on the brakes proved to be unlikely to have happened, pointing out that successive attempts were made by the pilot occupying the left seat, as well as by the copilot.

Regarding the circuit breakers found to be unarmed, the pilot mentioned that he had pulled some of these, without however remembering how many and which ones they were. In any case, if these circuit breakers were disarmed before landing, the aircraft would have indicated that the system was inoperative by turning on the light on the alarm panel, a fact that was not reported.

In the same way, the anti-skid switch found in the "OFF" position would not be consistent with the situation before and during the landing. The crew said they had checked the procedures before landing, a fact that was recorded in the CVR.

Through these assessments, the investigation was inconclusive as to why it was not possible to brake the aircraft after landing using the normal brake system.

The nitrogen accumulator of the emergency brake system, after the accident, had an indication of pressure within its operating range. The right and left shuttle valve and the pneumatic power lines from the accumulator to the brake assemblies were intact.

The investigation team performed tests of the emergency brake system. The results indicated that the emergency brake system discharged nitrogen under pressure to the brake

sets. Therefore, the expected result was that the emergency system would provide the braking of the aircraft.

After the tests of the emergency brake system, the investigation team carried out a reconstitution with the pilots, aboard another aircraft of the same model, concluding that the crew did not act in command of the emergency brake system. In this reconstitution, the pilot, when trying to brake the aircraft in emergency, incorrectly activated the lever of activation of the emergency landing gear (auxiliary gear control), believing to be activating the emergency brake.

When researching the factors that motivated the inadequate procedures of the crew, regarding the use of the emergency brake system, two topics stood out: ergonomics and training.

In terms of ergonomics, for the pilot occupying the left seat, the display of the emergency brake system lever and the sign indicating its position (Figure 27) are obstructed by the stick column (Figure 28), both of which remain outside the pilot's sight field.

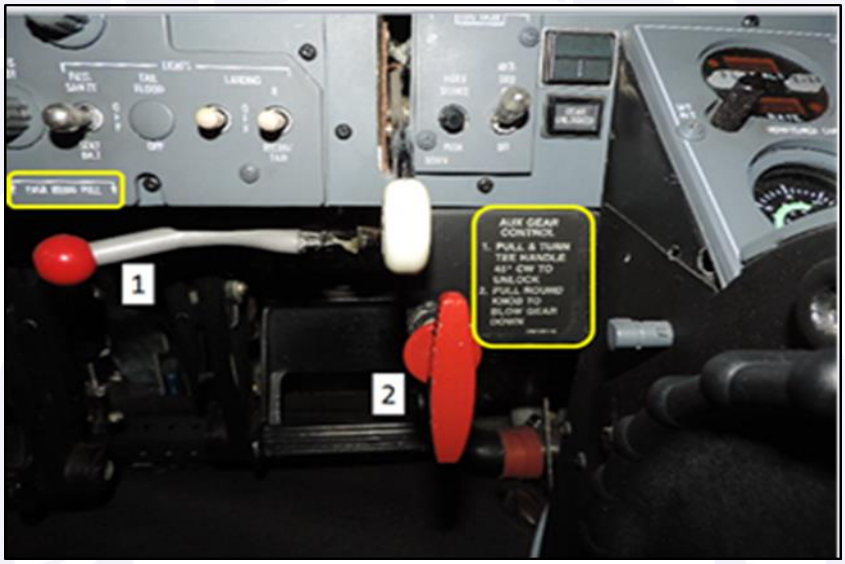


Figure 27 - Panel of the 525. (1) - emergency brake actuator handle, with the description EMERG BREAK PULL, highlighted in yellow in the photo; (2) - auxiliary gear control, with the description AUX GEAR CONTROL.

Figure 15 – View of the panel for the pilot positioned on the left seat of the Cessna 525. The stick column obstructs the view of the emergency brake actuator handle.

In the human factor engineering perspective, the interaction between the equipment technology and human capacities and limitations must be dynamic and adjusted, and this interaction should happen in the most natural way possible. In this case, it would be reasonable to envisage that a device intended for use in emergencies would be in a position of easy reach and user view, given the scenario of greater cognitive, motor and emotional requirement that an emergency context naturally produces, generally allied to a short response time.

In this accident, realizing that the brake pedals did not work, as the pilot himself mentioned, he quickly, as in an automatic response movement, took his right hand to the lever that most visually stood out on the panel, which he believed to be related to the emergency brake. That is, in the midst of a demanding prompt response scenario, the pilot sought the lever more adjusted to his control capability at that time - the emergency landing gear drive lever.

This ergonomic factor was negatively potentiated by the lack of adequate training, especially for pilots operating this aircraft under the aegis of RBAC 61, where there was no requirement for flight simulator training.

Training is the tool that enables professionals to perform their work with expertise, whose objective is to explore the learning potential and productive capacity of people. Therefore, the inadequate performance of the training, or lack of it, compromises the effective execution of the work, especially in an emergency situation, in which the individual needs to access the more massive contents in the memory.

In this case, in addition to not having performed the flight simulator, the pilot mentioned that during the realization of the Cessna 525 "Ground School", there was no warning for the correct positioning of the emergency brake lever, this turning to be an unknown element to the pilot.

Therefore, the adequate management by the pilot of the abnormal condition presented was improbable, due to his ignorance about the correct lever to be activated for the emergency braking. His insufficient qualification for the emergency management experienced, added to the positioning of the aircraft brake handle, because it remained hidden from the pilot's vision, did not favor the memorization of its function and its proper use.

Despite the great experience of the pilot in aviation, about 17,000 flight hours, and the confidence he had in his operational capability on the Cessna 525, he was little experienced in this model, having only 38 hours and 40 minutes, which was his first model of jet propulsion aircraft.

Inadequate training also affected emergency evacuation procedures. During the evacuation, the pilots attempted to shut down the right engine according to normal procedures, but did not do so because the corresponding lever was stuck, unable to be retarded to the "OFF" position.

As a result, one of the passengers had her hair sucked into the engine air intake, but she was saved from injuries because the passenger, who followed her, pushed her away after realizing the situation.

In this case, the appropriate procedure was "emergency evacuation", which would lead to the shutdown of both engines, through item 2 that determined the activation of the engine fire buttons.

It should also be noted that this was the first time that the pilot had to use the emergency brake system. In addition, this is an emergency situation characterized by the lack of time for opening and reading the emergency checklist and its alerts, that is, it requires a prompt response from the pilots.

During the investigation, it was found that this ergonomic issue associated with inadequate training is a latent condition that triggered other accidents, such as the Cessna model C-500, aircraft PT-LPZ, occurred in Campo de Marte - SP, on 18MAY2013. In addition, DIVOP No. 002/SERIPA IV/2013 mentions two other cases, one in Brazil and another in England.

From what has been presented, it can be said, in summary, that there was no confirmation of the origin of the normal brake system failure. The emergency brake system was operational and ready for use. However, it was not activated by the crew for lack of knowledge of its location. The lack of knowledge showed a correlation with the inadequate training of pilots flying this aircraft model, under the aegis of RBAC 61, and with aspects of the project ergonomics.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid Aeronautical Medical Certificates (CMA);

b) the commander had valid C525 type aircraft (which included the 525 model), MLTE, IFRA and INVA Ratings.

c) the commander was qualified and had about 39 hours of flight in that aircraft model;

d) the copilot was not certified in the C525 type aircraft;

e) the aircraft had valid Airworthiness Certificate (CA);

f) the aircraft was above the maximum landing weight limit, but within the balance limit;

g) the aircraft maintenance services were being performed at appropriate intervals to the manufacturer's maintenance program;

h) the aircraft completed the last inspection and the installation services of brake sets, from overhaul, and of new tires on 05JUN2014;

i) on the five landings, carried out between the last inspection and the accident, the normal brake system presented adequate performance;

j) on 13JUN2014, there was a NOTAM in force, informing the prohibition of jet aircraft operation in SWNH;

k) the aircraft took off from SBGO to SWEF, with two pilots and five passengers;

l) the meteorological conditions were conducive to the accomplishment of the flight;

m) the aircraft landed on runway 24 of SWNH;

n) during the landing roll, the aircraft passed the final limit of the runway, struck a fence and collided with a ravine;

o) the aircraft had substantial damage; and

p) the commander suffered a serious injury; the copilot and the five passengers suffered minor injuries.

3.2 Contributing factors.

- **Control skills – a contributor.**

The pilot acted incorrectly on the handle of the auxiliary gear control, thinking that he was applying the emergency brake, making the braking of the aircraft impossible.

- **Training – a contributor.**

The activation of the incorrect lever for the emergency braking of the aircraft was due to insufficient training received by the pilot for the use of the system in question, thus compromising the proper management of the abnormal condition.

- **Ergonomics Equipment (ergonomic characteristics) – a contributor.**

The emergency brake actuator handle of the aircraft was located outside the pilot's sight field, which, together with the lack of knowledge about the correct lever to be activated for emergency braking, favored the pilot's automatic response in triggering the lever that was most adjusted and visually available on the panel - the emergency landing gear drive lever.

- **Instruction – a contributor.**

The instruction that the pilot received to operate the Cessna aircraft, model 525 did not emphasize in the theoretical phase the proper use of the emergency brake, nor contemplated training for the use of this system.

- **Insufficient pilot's experience – a contributor.**

Despite having a lot of experience in aviation, the pilot was little experienced in the aircraft and still did not know basic functionalities like the use of the emergency brake and the engine shutdown through the evacuation checklist procedure.

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-109/CENIPA/2014 - 01 **Issued on 06/28/2019**

Disseminate the lessons learned in the present investigation, in order to alert the Brazilian civil aviation pilots and operators about the ergonomic characteristics of the Cessna 525 aircraft, in which the stick column blocks the visualization of the emergency brake handle and the plate with the inscription "EMERG BREAK PULL".

A-109/CENIPA/2014 - 02 **Issued on 06/28/2019**

Reevaluate the training requirements for Cessna 525 and similar aircraft, in order to provide the knowledge necessary for its safe operation.

A-109/CENIPA/2014 - 03 **Issued on 06/28/2019**

Act in conjunction with the Aviation Schools and Training Centers certified for the Cessna 525, in order to increase the knowledge of the students on the use of the emergency brake.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On June 28th, 2019.