COMANDO DA AERONÁUTICA <u>CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE</u> <u>ACIDENTES AERONÁUTICOS</u>



FINAL REPORT IG-010/CENIPA/2022

OCCURRENCE: AIRCRAFT: MODEL: DATE: SERIOUS INCIDENT PT-OSO C90 19JAN2022



NOTICE

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

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

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

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

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

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

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

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

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

SYNOPSIS

This present Final Report pertains to the serious incident involving the King Air C90 aircraft (registration marks PT-OSO). The incident occurred on 19 January 2022 and was classified as "[SCF-NP] System/component failure or malfunction".

The aircraft's landing gear failed to lock in the retracted position after takeoff. The pilots returned to the departure aerodrome and performed the landing gear emergency extension procedure; however, there was no indication that the landing gear was locked in the extended position.

The pilots proceeded with the landing, during which the main landing gear retracted, leading the aircraft to veer off the runway to the right.

The aircraft sustained minor damage, whereas the crewmembers and the passenger were unharmed.

Being the United States of America the State of manufacture of the aircraft in question, the USA's NTSB (National Transportation Safety Board) appointed an accredited representative for participation in the investigation of this serious incident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ADE AFM	Registration Category for Public Aircraft under Direct State- Administration Aircraft Flight Manual
ANAC	Brazil's National Civil Aviation Agency
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CIV	Digital Pilot-Logbook
CMA	Aeronautical Medical Certificate
CRM	Crew Resource Management
CVA	Airworthiness-Verification Certificate
FAA	USA's Federal Aviation Administration
FAP	Pilot-Evaluation Forms
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
INVA	Flight Instructor Rating - Airplane
METAR	Routine Meteorological Aerodrome Report
MLTE	Multi-Engine Land Airplane Rating
ОМ	Maintenance Organization
РСМ	Commercial Pilot License - Airplane
PIC	Pilot In Command
PLA	Airline Transport Pilot - Airplane
SBBH	ICAO location designator - Pampulha - Carlos Drummond de Andrade - Aerodrome, Belo Horizonte, State of Minas Gerais
SBVG	ICAO location designator - Major Brigadeiro Trompowsky Aerodrome,
SIC	Pilot Second In Command
SIPAER	Brazil's Aeronautical Accidents Investigation and Prevention System
UAP	Public Air Unit
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

	Model:	C90	Operator:
Aircraft	Registration:	PT-OSO	Polícia Militar do Estado de Minas
	Manufacturer:	Beechcraft.	Gerais.
	Date/time: 19J/	AN2022 – 19:50 (UTC)	Type(s):
Occurrence	Location: SBB	H (<i>Pampulha - Carlos</i> Andrade – Aerodrome)	[SCF-NP] System/component failure or malfunction (non-powerplant)
	Lat. 19°51'02"S	Long. 043°57'08"W	
	Municipality – State: Belo Horizonte –		
	Minas Gerais.		

1.1. History of the flight.

At approximately 19:20 UTC, the aircraft took off from SBBH (*Pampulha - Carlos Drummond de Andrade -* Aerodrome, *Belo Horizonte*, State of *Minas Gerais*) bound for SBVG (*Major Brigadeiro Trompowsky* Aerodrome, *Varginha*, *Minas Gerais*) with 03 POB (two crew and one passenger) on a flight for the transport of a person in need of medical care.

After takeoff, the landing gear failed to lock in the retracted position, and the aircraft returned to the departure aerodrome. The crew attempted to extend the gear using the emergency system, to no avail.

During the landing roll, the main landing gear retracted, causing the aircraft to veer off the runway via the right side.

The aircraft sustained minor damage.

The pilots and the passenger were unharmed.

1.2. Injuries to persons.

Crew	Passengers	Others
-	-	-
-	-	
-	-	-
2	1	-
	Crew - - - 2	CrewPassengers21

1.3. Damage to the aircraft.

The aircraft sustained minor damage, limited to the underside of the fuselage.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

Flight Experience					
	PIC	SIC			
Total	4.532:10	356:30			
Total in the last 30 days	11:25	03:25			
Total in the last 24 hours	01:00	01:00			
In this type of aircraft	93:10	100:00			
In this type in the last 30 days	08:15	01:50			
In this type in the last 24 hours	01:00	01:00			

RMK: Flight-hour data obtained from the records of the pilots' CIVs (Digital Pilot-Logbooks).

1.5.2. Personnel training.

The Pilot in Command (PIC) completed the PPR course (Private Pilot - Airplane) at Aeroclube do Estado de Minas Gerais in 1995.

The Second in Command (SIC) completed the PPR course at *Aeroclube de Juiz de Fora*, State of *Minas Gerais* in 2019.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PLA license (Airline Transport Pilot - Airplane) and had valid ratings for MNTE (Single-Engine Land Airplane), MLTE (Multi-Engine Land Airplane), INVA (Flight Instructor - Airplane), and IFRA (Instrument Flight - Airplane).

The SIC held a PCM license (Commercial Pilot - Airplane) and had valid ratings for MNTE, MLTE, and IFRA.

1.5.4. Qualification and flight experience.

The Pilot Evaluation Forms (FAP) provided by the ANAC (Brazil's National Civil Aviation Agency) were reviewed. Upon analyzing these documents, no records were found indicating any difficulties during proficiency check flights.

The pilots were qualified and experienced in the type of flight.

1.5.5. Validity of medical certificate.

The pilots held valid CMAs (Aeronautical Medical Certificates).

1.6. Aircraft information.

The SN LJ-927 aircraft was a product manufactured by Beechcraft in 1981, and registered under the Public Registration Category for aircraft under Direct State-Administration (ADE).

The Airworthiness Verification Certificate (CVA) of the aircraft was valid.

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

The aircraft's latest "400-hour" inspection (phases 1 and 2) took place on 17 August 2021 on the premises of *Claro Aviação* Maintenance Organization in *Belo Horizonte, Minas Gerais*. The aircraft accumulated 166 hours and 40 minutes of flight-time after the inspection.

The latest "400-hour" inspection (phases 3 and 4) took place on 22 February 2021 on the premises of *Claro Aviação* Maintenance Organization in *Belo Horizonte*, Minas Gerais. The aircraft accumulated 387 hours of flight-time after the referred inspection.

The aircraft was used for personnel transport, meeting the travel demands of the Governor of the State of *Minas Gerais*' office. As these travels included transporting dignitaries, the aircraft was given special adornments. Among them was a tapestry installed in the passenger cabin, extending to the pilots' throttle pedestal, as shown in Figure 1.

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Figure 1 - Image of the carpet.

As shown in Figure 2, next to the throttle pedestal was the lever for landing gear emergency extension. In this position, there was also a manufacturer-installed instructional placard describing the procedures. However, the said tapestry covered the placard.



Figure 2 - On the left, a photo of the carpet in the position it was in during the accident and, on the right, the placard appearing after the carpet was manually folded.

The placard showed an excerpt containing a two-step instruction for landing gear emergency extension, as shown in Figure 3.



Figure 3 – Instruction placard covered by the tapestry.

This placard was included in the *Illustrated Parts Catalog* of February 2019, in the *Interior Placards* Section, page 0A, item 100, as depicted in Figure 4.



Figure 4 - Item 100 of the Illustrated Parts Catalog (edited image).

The placard was also listed as a mandatory item, as per the transcription, "On Floor Aft of Pedestal", on page 2-20 of the Aircraft Flight Manual (AFM), Section II, Placards, dated April 1980, illustrated in Figure 5.



Figure 5 - Placards, page 2-20. Source: AFM.

Landing gear system.

The aircraft's landing gear operated in normal mode using a 28V electric motor, which was activated via a conventional lever on the panel with two positions: landing gear extended (down) and landing gear retracted (up).

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In case of failure, the landing gear could also be extended manually. The manufacturer specified the following landing gear emergency extension procedures in Section III, page 3-11, of the AFM, dated April 1980 (Figure 6).

D	ANDING GEAR MANUAL EXTENSION	
1	Airspeed - ESTABLISH 120 KNOTS	
2	2. Landing Gear Relay Circuit Breaker (copilot's subpanel) - PULL	
	3. Landing Gear Switch Handle - DOWN	
4	 Emergency Engage Handle - LIFT AND TURN CLOCKWISE TO THE STOP TO ENGAGE. Extension Lever - PUMP up and down until the 3 green GEAR DOWN lights are illuminated. 	
	CAUTION	
	Stop pumping when the 3 green GEAR DOWN lights illuminate. Further movement of the handle could damage the drive mechanism and prevent subsequent electrical gear retraction.	
	WARNING	
	If for any reason the green GEAR DOWN lights do not illuminate (e.g., in case of an electrical system failure), continue pumping until sufficient resistance is	
	feit to ensure that the gear is down and locked, even though this procedure may damage the drive mechanism.	
	After an emergency landing gear extension has been made, do not stow pump handle, move any landing gear controls, or reset any switches or circuit breakers until the airplane is on jacks, since the failure may have been in the gear-up circuit and the gear might retract on the ground. The landing gear cannot be retracted manually.	
5	Figure 6 - Landing Gear Manual Extension.	

As noted in the "Warning" described above, after the landing gear was extended via the emergency system, the pump handle should not be stowed, nor any landing gear controls moved until maintenance procedures were carried out. However, it is important to emphasize that this procedure applied only in the case of an actual failure.

In the event of manually extending the landing gear during training exercises, the manufacturer outlined the following procedures in Section III, page 3-11, of the AFM:

LAN	IDING GEAR RETRACTION AFTER PRACTICE MANUAL EXTENSION	
Afte	r a practice manual extension of the landing gear, the gear may be retracted electrically as follows:	
1. 2. 3. 4.	Emergency Engage Handle - ROTATE COUNTERCLOCKWISE AND PUSH DOWN Extension Lever - STOW. Landing Gear Control Circuit Breaker (copilot's subpanel) - PUSH IN Landing Gear Switch Handle - UP	
April 1980		3-11

Figure 7 - Landing Gear Retraction After Practice Manual Extension. Source: AFM.

Still on the subject of the landing gear, the Investigation Committee found that there was no significant damage to this system on the occasion of landing, as shown in Figure 8.

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Figure 8 - Image of the landing gear.

1.7. Meteorological information.

The weather conditions were above the minimum required for conducting the operation under the rules of the proposed type of flight.

1.8. Aids to navigation.

NIL.

1.9. Communications.

NIL.

1.10. Aerodrome information.

The aerodrome was public, under INFRAERO administration. It operated under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), during both day- and night-time.

It had an asphalt-sealed runway, with 13/31 thresholds. It measured 2,364 m x 45 m, at an elevation of 2,589 ft.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

Witnesses reported to the Investigation Committee that the aircraft touched down near threshold 13 and, after the beginning of the landing roll, the main landing gear retracted.

The aircraft veered off the runway centerline in a right turn and exceeded the lateral runway boundary. It came to a final stop near taxiway "C", as shown in Figure 9.

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Figure 9 - Final position of the aircraft after stopping. Source: adapted from Google Earth.

In aircraft's final stop location, the main landing gears were in the retracted position, whereas the nose landing gear remained locked down, as shown in Figure 10.



Figure 10 - Main landing gear retracted, with the nose gear down and locked.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

There was no evidence that physiological factors or incapacitation affected the crew's performance.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

There was no evidence that psychological issues affected the crew's performance.

1.14. Fire.

There was no fire.

1.15. Survival aspects.

Both pilots helped the passenger, and everyone evacuated the aircraft through its main door.

1.16. Tests and research.

- Analysis of the Landing Gear System.

Analyses of the aircraft's landing gear system were conducted by SIPAER investigators at an ANAC-certified company.

Initially, a comprehensive visual inspection of the entire landing gear system was carried out. This analysis did not reveal any evidence that the landing took place with excessive "G" forces.

It is important to note that the landing gear extension was performed through the normal system, which consisted of an electric motor activated by a switch in the cockpit. This electric motor transmitted rotation to the system, moving the landing gear for extension or retraction.

The landing gear emergency (manual) extension method involved disconnecting the electric motor from the shaft and manually operating a lever in the cockpit. When activated, this lever transmitted movement through a chain connected to the shaft, allowing the landing gear to be extended manually. In the image below, it is possible to observe, on the right, the position of the electric motor that moved the landing gear shaft (normal method) and, on the left, the chain that moved the shaft via the emergency method (Figure 11).



Figure 11 - Image of the landing gear drive shaft.

Regarding the manual (emergency) extension system, no faults were found that could explain its malfunction. The procedure was performed with the aircraft supported on stands, and the system operated normally.

In the primary (normal) extension system, nonconformities were detected in relation to the standards established by the manufacturer for the Gearbox and Clutch Hub Assembly.

For the analysis of this assembly, the "Retract Gear box and Retract Clutch hub assembly" process was performed, as outlined in the King Air 90 Series maintenance manual, chapter 32-30-00, page 4. This procedure enabled the removal of this item and allow for a bench analysis in accordance with the manufacturer's standards, thereby eliminating the possibility that the faults observed during bench testing were due to improper removal of the assembly.

It was observed that the screw fastening the Tension Nut was not properly secured, resulting in a "loose" condition. The safety-wiring mechanism, intended to keep the screw in its designated position, was installed in a way that might have allowed the screw to rotate within its cavity (Figure 12). The maintenance records did not provide information on the most recent action concerning to the adjustment and securing of this screw.

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Figure 12 - Screw secured on the Tension Nut.

According to the *Component Maintenance Manual* of May 1984, revised in April 2018, Chapter 32 - *Landing Gear*, page 7, this screw was listed as item 40 (*Set Screw*) and was positioned to secure the *Tension Nut* to the rest of the assembly (Figure 13).



Figure 13 – Landing Gear Actuation Shaft components.

During the bench test, it was observed that within this assembly, only the Tension Nut moved, meaning the Clutch Housing remained stationary, as the set screw did not secure the Tension Nut. Consequently, this item was unable to transmit the electric motor's movement to the landing gear shaft.



Figure 14 - Tension Nut and Clutch Housing.

After completion of this test, the components were reassembled by certified technicians under the supervision of the Investigation Committee, following the standards established by the manufacturer. After this procedure, the assembly operated correctly, and it is important to highlight that no repairs were needed on any of the components.

Regarding the maintenance history, the aircraft's airframe logbook, Part II (Primary records of maintenance, inspection, overhaul, minor modifications, and minor repairs), contained a record of the inspection of the "Retract Gearbox and Clutch Landing" item. The record indicated the 6Y/8000C inspection (six years or eight thousand cycles as per Maintenance Manual 32-30-00) was performed between 10 September 2019 and 21 January 2020, as shown in Figure 15.

CADERNETA DE CE	LULA Nº 09	1 PT-0501	Te	Nº SÉRIE	927	0039/132
PARTE II - REGISTRO	PRIMÁRIOS DE I			O PEQUENAS MOI	DIFICACÓES E	PEQUENOS REPAROS
PARTE IN TRACTOTION	Prefixo: PT-OSO	Modelo: C90	S/N1.1.927	TSN 8 177.9 CSN	9.158	
	Motor LH:	Modelo: PT6A-135A	S/N.PCE-PZ0939	TSN 1.762,9 CSN	2.078 TSO: NEW	CSO: NEW
	Motor RH:	Modelo: PT6A-135A	S/N:PCE-PZ0938	TSN: 1.762,9 CSN:	2.078 TSO: NEW	CSO: NEW
1	Hélice LH:	Modelo: HC-D4N-3C	S/N:FY-2048	TSN: 3.278,0 TSO:	331,0	
No periodo de 10/SET Etetuada Nose gea	7/2019 a 21/JAN/2020 r actuator overhaul	foram efetuados segui P/N: 50820208-5 S/N:	ntes serviços na cé C797-525 serviço e	lula: executado por AV Aero	máutica COM: 95	07-02/ANAC Segvoo 003
Efetuada Retract g Efetuada Landing 003 N*: AGV-00000	earbox and clutch la pear motor overhau 09/2020 de 08/JAN/20	nding gear - 6Y / 800 P(N: 40, 1 (91, 380002 (20)	C inspection cont SAL 1447, service	forme MMC 32-30-00	conáutica COM: 9	507-02/ANAC Segvoo
 Efetuado Oxygen 0 01/ANAC Segvoo 0 	Cylinder Hydrostatic 03 N°: AES3805/19 d	test, P/N: 101-384140- e 22/NOV/2019;	1/176023-22 S/N: 4	465193306, serviço ex	ecutado por Aero	safety COM: 0606-
 Efetuado Regulato 003 Nº: AES3805/1 	r valve oxygen cylin 9 de 22/NOV/2019;	der overhaul, P/N: 172	010-03 S/N: 5733,	serviço executado por	Aerosafety COM	0606-01/ANAC Segvoo
Efetuada Detailed	Aileron Inspection					
Efetuada Calibraçã 2011S10-13	io do regularo de pr	essão de oxigênio por	UnitecHospitalar ce	ertificado de qualidade	Nº: 34370 confor	me solicitado pelo CST



Every 200 flight hours, the maintenance manual required a check of the landing gear extension and retraction, although this specific component was not included in the analysis.

Safety-wiring methods.

The Federal Aviation Administration (FAA) issued the Advisory Circular - Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, No. 43.13-1B, dated 08 September 1998, which, in Section 7, item 7-124 - Safety-Wiring Procedures, outlined the following recommended procedures for handling safety wires:

Advisory Circular - Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, n° 43.13-1B, dated 08 September 1998, Section 7, 7-124 -SAFETY-WIRING PROCEDURES.

[...]

c. To prevent failure due to rubbing or vibration, safety wire must be tight after installation.

[...]

h. Install safety wire where practicable with the wire positioned around the head of the bolt, screw, or nut, and twisted in such a manner that the loop of the wire fits closely to the contour of the unit being safety wired.

1.17. Organizational and management information.

The operation of the Public Air Unit (UAP) of the State of *Minas Gerais*' Military Police was under the requirements established in the Brazilian Civil Aviation Regulation n^o 90 (RBAC-90). The operator implemented a training program for its crewmembers, prioritizing instruction conducted in its own aircraft, rather than using flight simulators.

The training of landing gear manual (emergency) extension was not carried out on aircraft because various sectors within the operator's structure believed that, following such training, maintenance procedures on the aircraft would be required. Interviews with key personnel and pilots revealed that this unfounded belief had been reported on several occasions.

This situation led to the decision not to include the aforementioned training in the pilots' training programs.

As stated in item 1.6 of this report, the manufacturer had established procedures for the landing gear to be retracted in flight after manual extension training without requiring maintenance.

The operator had an aircraft fleet composed of a variety of aircraft models. At the time of the incident, there were five distinct fixed-wing models in the fleet, with a team of approximately fifteen pilots. Many of the pilots were qualified to operate all five models composing the fleet.

The variety of aircraft types compared to the low number of pilots posed an additional challenge for the operator in terms of personnel training. According to information gathered by the Investigation Committee, the pilots regularly underwent three types of training: theoretical instruction, crew resource management (CRM) - which included Line Oriented Flight Training (LOFT) - and actual training flights.

As previously mentioned in this report, training for lowering the landing gear through the emergency system was not conducted by the pilots.

1.18. Operational information.

The purpose of the flight was to transport a passenger in need of medical care from SBBH to SBVG. The takeoff occurred at 19:20 UTC, and the estimated flight time was 40 minutes.

After takeoff, the red lights indicating that the landing gear had not locked in the retracted position remained illuminated.

Because of this, the crew decided to extend the landing gear manually and return to the departure aerodrome. It is worth noting that the pilots on board the aircraft had not trained for this type of emergency before the incident.

The Landing Gear Manual Extension procedures, outlined in Section III, page 3-11 of the AFM, were performed with the checklist being read. However, based on the interviews

conducted, it was inferred that the procedures were not executed properly, and the red lights remained illuminated.

Failing to successfully lower the gear manually, the crew proceeded with the landing, during which the main landing gear ended up retracting. Eyewitnesses reported that the aircraft touched down smoothly and then suffered a runway excursion (veer-off) via the right side.

For evaluation of the maximum landing weight, one considered the following values:

	WEIGHT	REMARKS
Basic operating weight	2, 913.38 kg	Aircraft weight measured in accordance with the O.S. 0614/13 of 02 September 2013.
Fuel remaining	1,400 pounds (635.05 kg)	Verified on the aircraft by the investigation team.
Crew + Passenger weight	240 kg	2 pilots and 1 passenger.
Total	3, 788.43 kg	

In consonance with the AFM, page 2-9, Section II – *Limitations*, the aircraft's maximum landing weight was 9,168 pounds (4,158.53 kg).

1.19. Additional information.

NIL.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

The airplane was operated by the Military Police of *Minas Gerais* in accordance with the requirements established in RBAC-90. In addition to its routine operations, it was also used to transport high officials of the organization and state authorities. The aircraft had undergone modifications, including the installation of a tapestry component.

Regarding the referred modifications, it is important to note that a portion of the tapestry wound up covering a placard. The referred placard was a mandatory item in the aircraft manual, meant to remain visible to the pilots as an aid for the proper execution of procedures. It served as the final line of defense against improper execution of the landing gear extension procedures.

After takeoff, the pilots activated the retraction of the landing gear; however, the red lights indicating that the landing gear was not locked in the up position remained illuminated. In view of this, they chose to use the manual (emergency) system to extend the landing gear and return to the departure aerodrome. Nevertheless, after executing the prescribed procedures, the red lights did not go out, signaling that the landing gear was not locked in the down position.

During the landing roll, the aircraft's main landing gear retracted, leading to loss of control and subsequent runway excursion.

With regard to the landing procedure, eyewitnesses reported that the aircraft touched down smoothly. This assessment was later confirmed during the investigation, as no signs of damage resulting from significant overload during landing were found. Additionally, it is worth mentioning that the landing weight was considerably below the limit specified by the manufacturer.

During the investigation process, it was found that a set screw securing the Tension Nut was not properly safety-wired, remaining in a "loose" position within its cavity. Consequently, only the Tension Nut rotated while the Clutch Housing remained stationary, preventing the landing gear from moving.

In aviation, the safety wiring of components is a critical step of maintenance procedures. The FAA had issued Advisory Circular - Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, nº 43.13-1B, dated 08 September 1998, which, in Section 7, item 7-124 - Safety-Wiring Procedures, outlined the recommended procedures for using safety wires.

This afore mentioned Advisory Circular established technical procedures for the proper use of safety wires, particularly in items C and H, where the FAA advised that the safety wires should be tightened after installation to prevent vibrations and friction between components, and provided specific instructions on how these adjustments should be executed.

After analyzing all components of the landing gear system, reassembly was performed with appropriate safety wiring, restoring the full functionality of the system without the need for repairs. It is important to note that no element of this system required intervention, confirming that the landing gear failed to lock due to the identified issue.

Regarding the manual extension procedures, the Investigation Committee did not detect any mechanical failure that could have caused the unsuccessful attempt. Even with the identified issue, it would have been possible to lower and lock the landing gear using the manual system.

Additionally, based on the interviews conducted, it was inferred that the landing gear manual extension procedures were not properly executed, preventing the landing gear from locking in the extended position. The difficulties in performing the procedures properly revealed an inefficiency of the systematic processes designed to enhance knowledge and skills, resulting in inadequate performance on the part of the pilots.

There was a widespread misconception among the operator's personnel that training for landing gear manual extension would necessitate maintenance on the aircraft after the flight. This belief led the operator to exclude this procedure from the pilots' training program, resulting in a gap in their skills development.

Owing to this situation, the pilots were confronted with the landing gear emergency extension procedure in a real occurrence without prior training.

3. CONCLUSIONS.

3.1. Findings.

- a) the pilots held valid Aeronautical Medical Certificates (CMA);
- b) the PIC held valid ratings for MNTE (Single-Engine Land Airplane), MLTE (Multi-Engine Land Airplane), INVA (Flight Instructor - Airplane), and IFRA (Instrument Flight - Airplane);
- c) the SIC held valid ratings for MNTE, MLTE, and IFRA;
- d) the pilots were qualified and experienced in this type of flight;
- e) the aircraft had a valid CVA (Airworthiness-Verification Certificate);
- f) the aircraft was within the weight and balance limits;
- g) the records of the airframe, engine, and propeller logbooks were up to date;
- h) weather conditions were above the minimum required for the flight;

- i) after the aircraft took off from SBBH, the landing gear failed to lock in the retracted position, prompting the crew to return to the aerodrome;
- j) the landing gear was lowered using the emergency system;
- k) the landing gear red lights remained illuminated;
- I) during the landing rollout, the main landing gear retracted;
- m) the aircraft veered off the runway via the right side;
- n) the instructional placard number 100, as described in the Illustrated Parts Catalog of February 2019, was hidden beneath a tapestry component;
- o) the Tension Nut fastening screw was not properly secured, remaining "loose" within its cavity;
- p) the aircraft suffered minor damage; and
- q) the pilots and passenger were uninjured.

3.2. Contributing factors.

- Training – a contributor.

The difficulties in executing the landing gear manual extension procedures in an appropriate manner highlighted inefficiencies in the systematic processes intended to enhance knowledge and skills, resulting in inadequate performance on the part of the pilots.

The pilots were confronted with the landing gear emergency extension procedure during an actual occurrence, without prior training for such a situation.

Organizational culture – a contributor.

There was a widespread misconception among the operator's personnel that training landing gear manual extension would necessitate maintenance on the aircraft after the flight. This belief led the operator to exclude this procedure from the pilots' training program, creating a gap in their skills development process.

- Aircraft maintenance – undetermined.

A screw that was not properly safety wired may have allowed vibrations and movement of the Tension Nut, resulting in an action not anticipated by the manufacturer, which may have interfered with the proper functioning of the landing gear retraction and extension system.

Additionally, regarding this contributing factor, an instructional placard was covered by the aircraft's interior tapestry. This placard specifically contained the landing gear emergency extension procedures. Its placement was mandated by the manufacturer and was intended to serve as a final warning to the pilots.

4. SAFETY RECOMMENDATIONS

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 consonance with the Law n°7565/1986, recommendations are made solely for the benefit of 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".

To Brazil's National Civil Aviation Agency (ANAC):

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Disseminate the lessons learned from this investigation to the Public Air Unit (UAP) of the Military Police of the State of *Minas Gerais*, so that the referred UAP may address the importance of crew training during internal events aimed at promoting aviation safety.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Following the incident, the operator acknowledged a deficiency in its Training Programme and conducted a comprehensive review of its training processes, incorporating various activities.

Initially, simulator training was provided to all crew members to address gaps, covering not only landing gear manual extension procedures but also others that could not be adequately conducted without the use of a simulator.

Furthermore, immediately after the incident, instructions on landing gear manual extension were provided to all crew members.

It is worth noting that this process review was perceived as an opportunity to improve the training process related to the entire fleet.

On April 25th, 2025.