COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A-005/CENIPA/2021

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-WVW**
MODEL:	**R44 II**
DATE:	**06JAN2021**

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 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 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. 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 is the Final Report pertaining to the accident involving the R44 II aircraft of registration marks PR-WVW on 06 January 2021. The occurrence was classified as “[SCF-PP] Powerplant failure or malfunction” and “[LOC-I] Loss of control in flight”.

During the final approach for landing on runway 05 of SIVU (*João Monteiro* Aerodrome, *Vila Velha*, State of *Espírito Santo*), the aircraft presented an abnormal descent attitude, lost control in flight and collided with the ground in a wooded area near the runway.

The aircraft sustained substantial damage.

Both the pilot and the passenger suffered fatal injuries.

Being the United States of America the State of aircraft manufacture, an Accredited Representative of the USA’s NTSB (National Transportation Safety Board) was appointed for participation in the investigation of the accident.

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GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
APP	Approach Control
AVGAS	Aviation Gasoline
CENIPA	Brazil's Aeronautical Accidents Investigation and Prevention Center
CHT	Pilot/Airman Certificate
CEL	Airframe Rating
CIV	Digital Pilot-Logbook
CMA	Aeronautical Medical Certificate
CVA	Airworthiness-Verification Certificate (CofA)
DECEA	Command of Aeronautics' Department of Airspace Control
GMP	Powerplant Rating
HMNC	Conventional Single-Engine Class Helicopter Rating
IAM	Annual Maintenance Inspection
METAR	Routine Meteorological Aerodrome Report
MMA	Aeronautical Maintenance Mechanic
NTSB	USA's National Transportation Safety Board
OM	Maintenance Organization
P/N	Part Number
PIC	Pilot in Command
POH	Pilot's Operating Handbook
PPH	Private Pilot License - Helicopter
REDEMET	Command of Aeronautics' Meteorology Network
S/N	Serial Number
SB	Service Bulletin
SBVT	ICAO location designator - *Eurico de Aguiar Salles* Aerodrome, *Vitória*, State of *Espírito Santo** *(ES)*
SIPAER	Brazil's Aeronautical Accidents Investigation and Prevention System
SIVU	ICAO location designator - *João Monteiro* Aerodrome, *Vila Velha*, *ES*
SNGA	ICAO location designator - Aerodrome of *Guarapari*, *ES*
TPP	Categoria de Registro de Serviços Aéreos Privados
TSN	Time Since New
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** R44 II **Registration:** PR-WVW **Manufacturer:** Robinson Helicopter.	**Operator:** Private.
Occurrence	**Date/time**: 06JAN2021 - 13:30 (UTC) **Location:** *Riviera da Barra* **Lat.** 20°25'38"S **Long.** 040°20'08"W **Municipality – State:** *Vila Velha – Espírito Santo*	**Type(s):** [SCF-PP] Powerplant failure or malfunction [LOC-I] Loss of control - inflight

1.1. History of the flight.

At approximately 13:15 UTC, the aircraft took off from SNGA (Aerodrome of *Guarapari*, *ES*), bound for SIVU (*João Monteiro* Aerodrome, *Vila Velha*, *ES*) on a private flight, with 02 POB (a pilot and a passenger).

On the final approach for landing, the aircraft presented an abnormal descent attitude, leading to loss of control in flight and collision with the ground in a wooded area near the threshold of runway 05 at SIVU.

Figure 1 - View of PR-WVW helicopter at the accident site.

The aircraft sustained substantial damage. The pilot and passenger suffered fatal injuries.

1.2. Injuries to persons.

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

1.3. Damage to the aircraft.

The aircraft sustained substantial damage to its entire structure, including the rotors and the tail cone, which was severed.

1.4. Other damage.

NIL.

1.5. Personnel information.

1.5.1. Crew's flight experience.

FLIGHT EXPERIENCE	
	PIC
Total	462:00
Total in the last 30 days	03:50
Total in the last 24 hours	00:15
In this type of aircraft	452:15
In this type in the last 30 days	03:50
In this type in the last 24 hours	00:15

RMK: data on the flight hours obtained from records of the pilot's CIV (digital Pilot-Logbook) and from records of the aircraft logbook**.**

1.5.2. Personnel training.

The Pilot in Command (PIC) did the PPH course (Private Pilot – Helicopter) in 2010, at *Aeroclube de Vila Velha*, State of *Espírito Santo*.

1.5.3. Category of licenses and validity of certificates.

The PIC held a PPH License (Private Pilot - Helicopter) and a valid rating for HMNC (Single-Engine Conventional Helicopter). He also held an MMA license (Aircraft Maintenance Mechanic) and valid ratings for GMP (Powerplant) and CEL (Airframe).

1.5.4. Qualification and flight experience.

The electronic CIV records indicated that the PIC had been operating the R44 II aircraft (registration marks PR-WVW) since May 2012, and that SIVU was a frequent destination. These records were out of date, with the latest record dating from May 2019.

As learned by the Investigation Committee, most of the PIC's operational background was limited to private flights departing from SIVU between May 2012 and January 2021.

The records of the PIC's latest HMNC class rating exam showed that the he achieved a satisfactory grade in direct, 90°, and 180° autorotation maneuvers.

The PIC was qualified and experienced in that type of flight in accordance with the requirements established by the ANAC.

1.5.5. Validity of medical certificate.

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

1.6. Aircraft information.

The SN12942 helicopter was a product manufactured by Robinson Helicopter in 2010, and registered in the TPP (Private Air Services) Registration Category.

The CVA (CofA) of the aircraft was valid.

The records of the airframe and engine logbooks were not up to date.

The aircraft's latest inspection ("100-hour" type) took place on 23 September 2020 on the premises of *Aeroclube do Espírito Santo* Maintenance Organization (COM nº 8612-03 ANAC), in *Vila Velha*, *ES*. The helicopter logged 31 hours and 5 minutes of flight time after the referred inspection.

The aircraft's latest Annual Maintenance Inspection – IAM, took place on 23 September 2020 on the premises of *Aeroclube do Espírito Santo* Maintenance Organization, in *Vila Velha*, *ES*. The aircraft flew 31 hours and 5 minutes after the overhaul.

The engine equipping the aircraft was a six-cylinder IO-540-AE-1A5 Lycoming engine (SN L-33867-48E), which ran on Aviation Gasoline (AVGAS). The engine's time since new (TSN) was 685 hours and 24 minutes.

According to the records of the engine logbook, the latest inspection of the magnetos, in compliance with Service Bulletin TCM 643B, was performed during a "100-hour" inspection on 30 May 2019 on the premises of *Aeroclube do Espírito Santo* maintenance organization in *Vila Velha*, *ES*, when the engine had 650 hours and 6 minutes of operation in total.

During this same maintenance intervention, the S6LSC-204T magneto (PN10-600646-201, SN E09CA053) underwent a general overhaul and was approved for return to service. At the time, the item had a total of 650 hours and 6 minutes of operation.

The aircraft's ignition system was equipped with two magnetos at the rear of the engine, one on the right side and one on the left side, types S6LSC-204T and S6LSC-200, respectively. Both magnetos were manufactured by Continental Aerospace Technologies.

The magnetos were designed to provide ignition for the aircraft engines of four and six cylinders.

These magnetos were designed to generate and distribute high voltage for the ignition of the aircraft engine.

Internally, the engine right magneto had two components known as contact points. One of them was responsible for controlling the activation of the spark to the spark plugs and the other for supplying the engine's RPM signal to both the instrument panel tachometer and engine governor.

This system also consisted of spark plugs that served the purpose of converting the magneto's output voltage through the ignition harness, and producing a high-voltage spark to ignite the compressed air-fuel mixture inside each engine cylinder.

1.7. Meteorological information.

The weather information was obtained from the website of the Command of Aeronautics' Meteorology Network (REDEMET).

The aforementioned information was available to the PIC before the flight in which the accident occurred. However, it was not possible to confirm whether he accessed the website before the flight.

The METARs (routine Meteorological Aerodrome Reports) of SBVT (located at a distance of 10 NM from the accident site) contained the following information:

METAR SBVT 061200Z 36010KT CAVOK 29/21 Q1014=

METAR SBVT 061300Z 02011KT 9999 FEW020 30/21 Q1014=

METAR SBVT 061400Z 02012KT 9999 FEW020 31/22 Q1013=

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

Additionally, the Investigation Committee was able to confirm the weather conditions through a video footage with recordings of the moment of the occurrence.

1.8. Aids to navigation.

NIL.

1.9. Communications.

According to the recording of the communications between the PIC and the ATC, it was found that there were no technical issues in the communication equipment during the flight.

1.10. Aerodrome information.

The aerodrome was private, operating under Visual Flight Rules (VFR) during day-time.

It had an asphalt-sealed runway, with thresholds 05/23, measuring 776 m x 18 m, at an elevation of 13 ft.

1.11. Flight recorders.

Neither required nor installed.

1.12. Wreckage and impact information.

The wreckage was located approximately 210 meters from the threshold of runway 05 at SIVU.

According to video recordings from cameras installed at the aerodrome hangars, the aircraft had a heading of 050° when it lost control in flight and crashed into the terrain near the runway.

The crash site was located between the edge of a Brazilian Army wooded area and private residences located in the *Riviera da Barra* neighborhood, in *Vila Velha*, *ES*. The terrain of the site was predominantly flat and situated at sea level.

Members of the Investigation Committee identified the first point of impact in the treetops, at a height of approximately 10 m above the ground. The marks left by the aircraft at hitting the vegetation and subsequently the ground were concentrated, featuring a horizontal dispersion of approximately 5 m (Figure 2).

Figure 2 - View of the damage caused to the vegetation,
from the opposite direction of the aircraft's movement.

Based on the arrangement of the wreckage, on the impact marks on the vegetation, and on the aircraft's resting point, it was possible to conclude that the collision with the terrain occurred with a high sink rate.

Through the security cameras' recordings, it was also possible to observe controls inputs aimed at pitching up the aircraft moments before impact with the ground. In addition, members of the Investigation Committee identified evidence of the separation of the aircraft's tail boom.

During wreckage assessment, investigators observed that the tip of one of the main rotor blades was damaged, and there were matching marks at the location where the tail boom was severed, suggesting that one of the blades struck the tail boom (Figures 3 and 4).

Figure 3 - View of the tips of the main rotor blades with one of them showing damage from the impact against the tail boom.

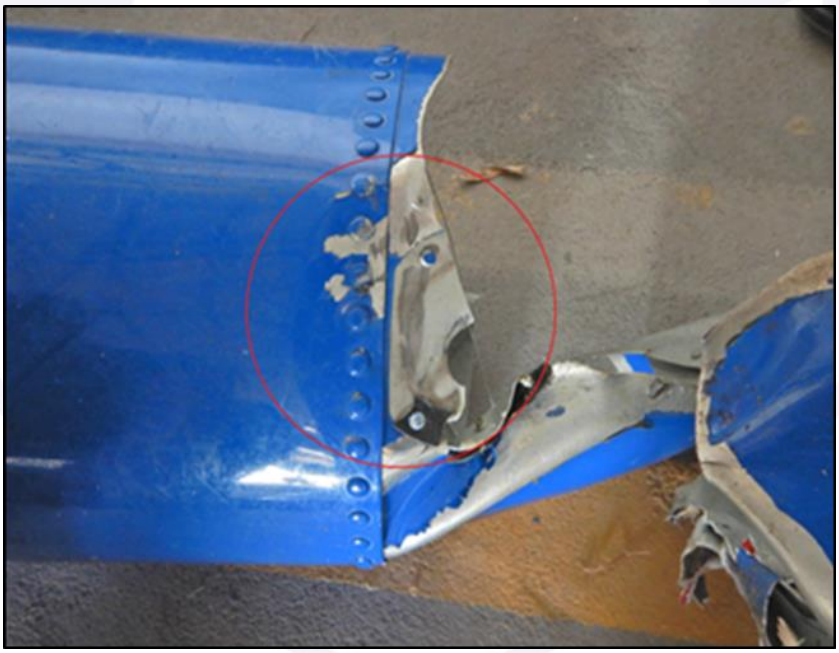

Figure 4 - Detail of the mark on the tail boom due to contact with one of the blades.

Given this, parts of the aircraft's tail cone and the rear drive shaft were sent to a specialized laboratory for analysis to determine the nature of the failures in these components.

Visual examinations and stereoscopic analysis were conducted, and it was possible to identify that the material exhibited typical characteristics of failure due to overload, as shown in Figures 5, 6 and 7, below.

Figure 5 - Tail cone and rear drive shaft of the aircraft PR-WVW.

Figure 6 - Detail of the surface with a fracture typical of failure due to overload.

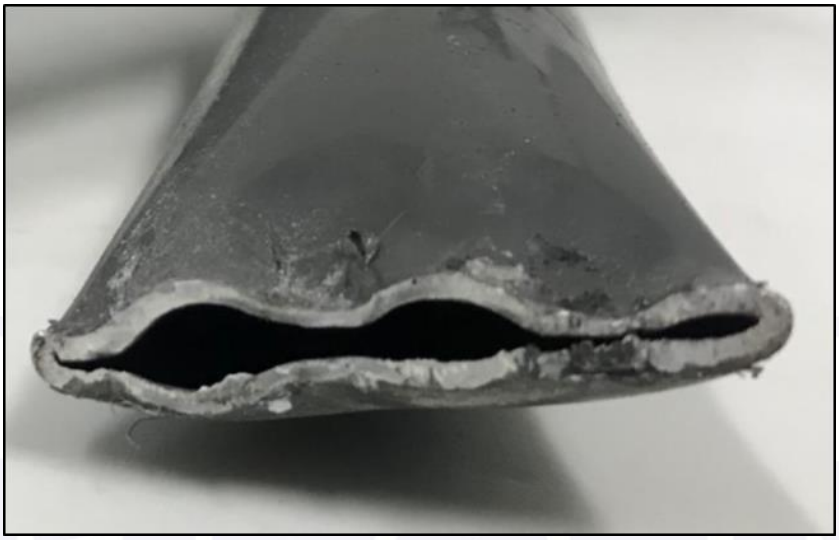

Figure 7 - Drive shaft with a “fish mouth” fracture, typical of failure due to overload.

The analyzed material exhibited fractures consistent with overload caused by the aircraft’s impact with the ground. Furthermore, no evidence of corrosion or fatigue was identified in the analyzed material.

It was not possible to accurately determine the position of the controls, switches, and circuit breakers due to the efforts to rescue the accident victims.

To minimize the risk of explosion, the fuel supply was cut off by the rescue team.

1.13. Medical and pathological information.

1.13.1. Medical aspects.

The forensic examination concluded that the cause of death for the PIC and the passenger was polytrauma.

A toxicological examination was conducted on the PIC, and the result was negative for amphetamines, tricyclic antidepressants, barbiturates, benzodiazepines, cannabinoids, cocaine, ethyl alcohol, and other substances that otherwise might have affected his performance.

The PIC's CMA was valid, with a note for corrective lenses. It was not possible to confirm whether he was wearing corrective lenses on the day of the accident in question.

According to reports from close acquaintances, the PIC had hearing difficulties that hindered day-to-day communication with him. However, there was no evidence to substantiate this information.

1.13.2. Ergonomic information.

NIL.

1.13.3. Psychological aspects.

The PIC was seen by his family as a person passionate about aviation. According to reports, when he began his career as a pilot, his goal was to acquire an R44 model aircraft, which he purchased in 2009 in the United States. At the time of the purchase, he flew the aircraft back to Brazil.

The initial training on the aircraft was conducted directly with the manufacturer, Robinson Helicopter, when the aircraft was purchased. The training provided by the manufacturer included six hours of ground training and ten hours of flight training.

The PIC was described by close acquaintances as a daring, fearless, and competent individual. He was interested in all matters related to the aircraft's operation. He had the habit of taking acquaintances to fly with him in the aircraft PR-WVW and made a point of explaining all the procedures.

According to the collected data, the PIC held a degree in mechanical engineering and possessed a technical qualification certificate (CHT) as an aircraft maintenance mechanic, issued by the ANAC. His initial training as a private pilot was conducted at the CIAC (Civil Aviation Training Center) of *Vila Velha Aeroclube* in the State of *Espírito Santo*.

According to the information provided to the Investigation Committee, the PIC had undergone a proficiency check flight in the same aircraft and had failed. Reports indicated that the poor performance leading to the failure was related to the autorotation maneuver.

According to reports from local CIAC operators, it was common for pilots of that type of aircraft to perform the autorotation maneuver for training purposes when approaching to land at SIVU.

The PIC worked at the CIAC of the *Vila Velha Aeroclube*, *Espírito Santo*, without an employment contract, and his aircraft had been included in the CIAC's operational specifications, authorized by the ANAC. He used the CIAC's hangar in exchange for his services in the workshop and served as the technical manager, chief inspector, quality manager, mechanical engineer, and maintenance technician.

According to data gathered in interviews, since he was qualified as an MMA, the PIC carried out maintenance interventions on his own aircraft. It was noted that such records were not always made in accordance with current regulations. These interventions were carried out at the maintenance organization of the *Aeroclube* OM and were not always reported to the secretariat.

According to reports from close acquaintances, the PIC focused on cost-saving, and during the course of the investigation, indications of the use of uncertified products were observed, as well as the adaptation of repairs to keep the aircraft available for flight. He performed these repairs himself based on his technical knowledge.

In addition to the PIC's personal profile, reports were collected indicating that he had been involved in other incidents which were not reported to the competent authority.

During interviews, it was reported to the members of the Investigation Committee that the PIC used to provide freelance services informally during election campaigns, launching parachutists, transporting people to Christmas events, among other services.

The PIC maintained a good relationship with other pilots in the community. He even lent his aircraft for others to carry out proficiency check flights.

According to feedback from colleagues, he exhibit a tendency to reject opinions and criticism, believing he had extensive technical knowledge. This often led to conflicts, he often clashed with those who disagreed with his point of view.

According to witnesses present on the day of the accident in question, the PIC had gone on a private flight with a passenger on board and, upon returning to SIVU, initiated an autorotation maneuver before colliding with the ground.

In the days leading up to the accident, no information was found indicating that the PIC had exhibited any behavior out of the ordinary that might have compromised his piloting.

1.14. Fire.

There was neither evidence of fire in flight, nor evidence of post-impact fire.

1.15. Survival aspects.

According to information gathered from a local military police officer, the Operations Center requested support from firefighters and rescue teams via radio after the accident of the aircraft PR-WVW. During this radio contact, it was reported that both occupants were seriously injured.

With the help of civilians, police officers removed the helicopter's windshield and cut the passenger's seat belt to rescue him. They later performed the same operation to free the PIC from the aircraft.

To mitigate the risk of explosion, one of the military personnel, guided by an employee from the *Aeroclube*, shut off the fuel flow. The victims were positioned appropriately to prevent aspiration of fluids due to the severity of their injuries.

Finally, advanced support units from the Mobile Emergency Care Service (SAMU) and several fire department vehicles arrived at the scene. Resuscitation procedures were initiated, lasting approximately 50 minutes. Despite the efforts, both victims were declared dead at the scene of the accident.

1.16. Tests and research.

Due to the condition of the aircraft after the accident, it was not possible to collect samples of engine lubricating oil and avgas to verify whether these materials met their technical specifications or showed signs of contamination.

The Lycoming engine (model IO-540-AE-1A5, S/N L-33867-48E, which powered the aircraft) was analyzed by the Investigation Committee, initially being inspected and disassembled at the *Aeroclube do Espírito Santo*, *Vila Velha*, State of *Espírito Santo*. In addition to the engine analysis, the magnetos were removed and later bench-tested.

During the initial observations, it was noted that the engine had all its components and accessories intact. However, due to the damage resulting from the impact with the ground, the engine's dry sump was damaged, preventing functional testing on another aircraft, as well as bench-testing (Figure 8).

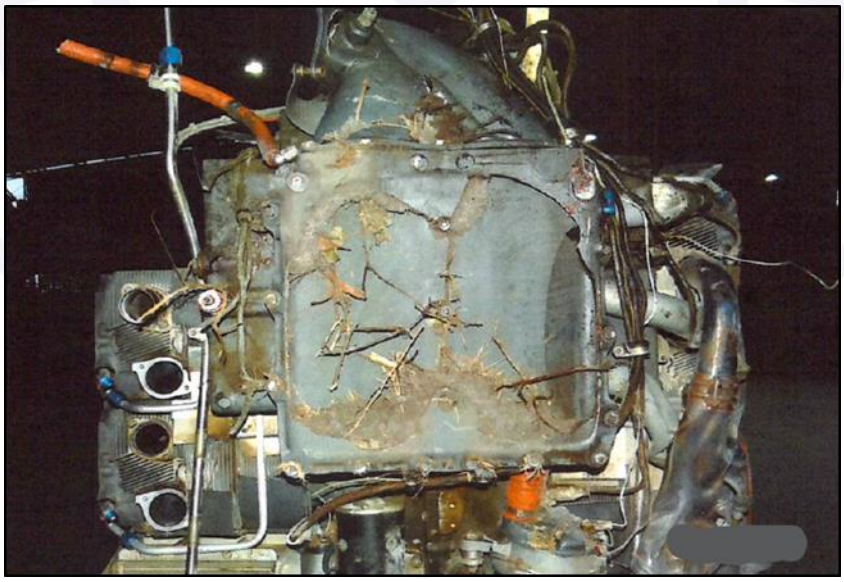

Figure 8 - View of the dry sump of the damaged engine.

Thus, the initial step was to check if the engine’s cylinders had compression. To do this, a spark plug was removed from each cylinder to facilitate turning the engine. The result of the check showed that there was compression in all cylinders, indicating that the engine was not seized.

Continuing with the fuel supply system, the engine's fuel injectors were checked and all were found unobstructed. The fuel distributor was disassembled for diaphragm inspection, and was found to be in normal condition, without discrepancies or abnormalities that could compromise the fuel supply to the engine (Figure 9).

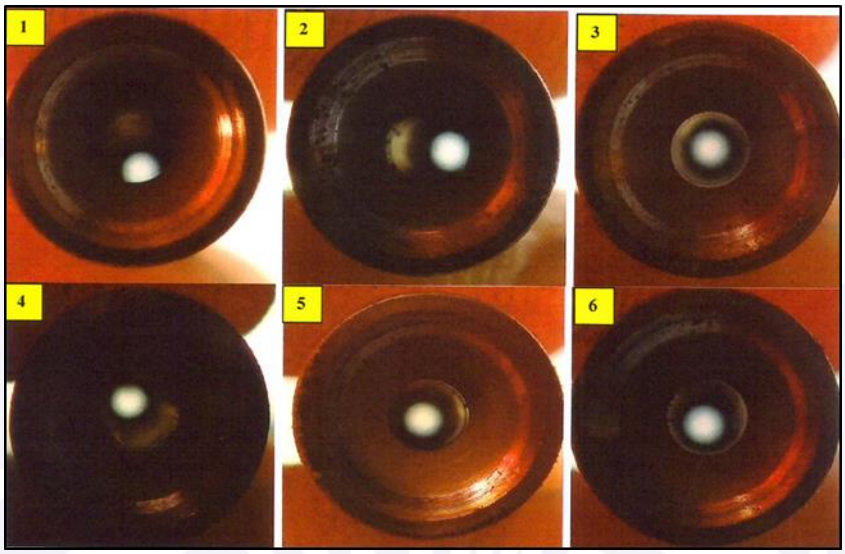

Figure 9 - View of the engine's injector nozzles.

Also within the engine's fuel supply system, the servo-injector and its internal components were examined. All the items examined appeared to be in normal working condition.

The fuel pump was not bench-tested nor operated manually by means of the rod, because the lower chamber was perforated, preventing fuel transfer to the upper chamber and hindering the test. It was disassembled, and the check valves were found to be normal and functioning correctly. No contamination was found inside the fuel chambers.

Figure 10 - Internal and external views of the engine's fuel pump.

Next, the engine's lubrication system was checked. The primary oil filter was free of any type of contamination. Additionally, no contamination from abnormal wear of the engine's internal components was found in the primary oil filter element. Finally, no abnormalities or metal shavings were found inside the crankcase that could indicate engine malfunction.

The spark plugs were examined, and signs of oxidation were observed. However, upon inspecting the central electrodes, they were found to have a normal coloration, indicating proper functioning (Figure 11).

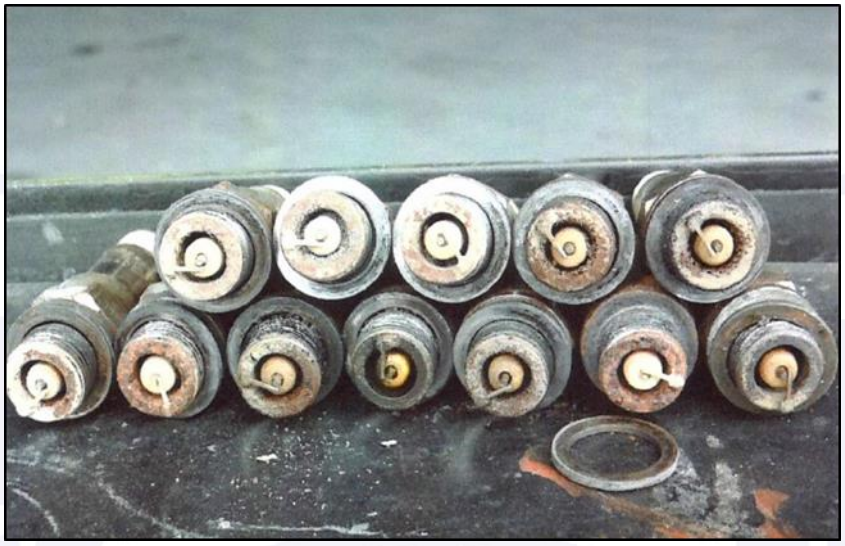

Figure 11 - General view of the engine's spark plugs.

Then, the initial ignition timing (dwell) was checked by setting the engine to the 20-degree mark of top dead center (TDC). At that moment, both lights on the timing light corresponding to the magnetos illuminated, indicating that they were correctly installed and synchronized.

The magnetos were removed and bench-tested individually. During the test of the engine left magneto, it was observed that it did not operate normally, as the sparks produced were intermittent and random across all cylinders, even with variations in engine speed. Upon disassembly, it was found that the breaker points (contacts) were charred (Figure 12).

Figure 12 – Charring observed on the breaker points of the engine left magneto.

The engine right magneto, in way similar to the left one, also exhibited an abnormality in its operation. The absence of the contact spring at the magneto outlet for the ignition cables of cylinders 02 and 06 was observed. The springs were loose inside and, when the magneto was handled, they came out of their housing. During this same test, the presence of verdigris at the outlet for the cable of cylinder 02 was also observed, indicating the malfunction of the spark plug corresponding to that cable.

Continuing with the tests, the top part of the magneto was disassembled, and a discrepancy was observed in the breaker point responsible for generating the signal for the tachometer and governor controller. This breaker point worked completely insulated from the magneto housing (Celeron insulators were used for the insulation). However, the presence of a non-standard washer was noted, which was touching the screw that fastened the electrical terminals (Figure 13).

Figure 13 - Comparison between the assembly of the screw securing the electrical terminals of the engine right magneto (non-standard washer) and another similar magneto (correct washer).

The non-standard washer used in the assembly broke the insulation of the breaker point in question, potentially causing a degraded signal to the governor controller. Another discrepancy was observed in the breaker point contacts (pads), which were charred. This might also have contributed to the degradation of the electrical signal to the governor controller, indicating main rotor's low RPM.

The combination of discrepancies observed in the engine right magneto and the intermittent sparking seen in the engine left magneto may have contributed to a failure, resulting in the loss of engine power.

1.17. Organizational and management information.

NIL.

1.18. Operational information.

At approximately 13:15 UTC, the aircraft PR-WVW took off from SNGA (*Guarapari* Aerodrome). Upon contacting APP-*Vitória* (*Vitória* Approach Control), the pilot informed that he was maintaining an altitude of 1,000 ft. AGL, with 02 POB and an endurance of 2 hours and 30 minutes.

According to the evidence observed, the aircraft was within weight and balance limits and had an estimated weight of 910 kg at the time of the accident.

In the radio communication, the PIC informed APP-*Vitória* that they were flying towards *Ponta da Fruta* position (20°31'S/040°22'W) and that they would then proceed to SIVU (*João Monteiro* Aerodrome) for a final landing.

During this communication, APP-*Vitória* asked if the aircraft PR-WVW would maintain 1,000 ft. The PIC reported that he intended to descend to 500 ft. This procedure was authorized by APP-*Vitória*, requesting that the PIC report passing *Ponta da Fruta* position at the altitude of 500 ft., an instruction that was acknowledged by the pilot.

Approximately five minutes after the initial contact with the aircraft PR-WVW, APP-*Vitória* informed that the wind conditions at SBVT were 060 degrees at 8 kt, and authorized

a frequency change to the free coordination frequency (123.45 MHz). The PIC acknowledged the message and reported passing *Ponta da Fruta* position. This was the last known contact made by the aircraft PR-WVW.

According to witness reports, confirmed by security camera footage, the aircraft was entering the traffic pattern to make an approach for landing in the direction of the runway 05 at SIVU. At the time, the aircraft was maintaining an estimated altitude of 500 ft. when it began a steep descent.

According to the POH (*Pilot's Operating Handbook*) - *Section 3 - Emergency Procedures*, an engine failure could be indicated by a change in noise level, a yaw to the left, the illumination of the oil pressure light, and/or a decrease in engine RPM. The manual further advised that in the event of engine failure, the collective should be lowered immediately to enter autorotation (Figure 14).

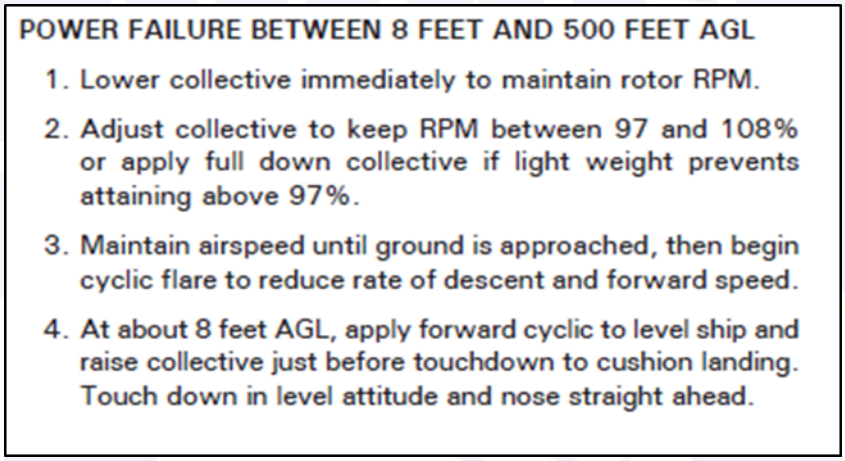

Figure 14 - R44 POH - Section 3 - Emergency –
Power Failure between 8 ft. and 500 ft. AGL.

Considering the final moments before impact with the ground, according to the security camera images and witness reports, a deviation to the left in the PR-WVW aircraft's trajectory was observed, along with an attempt to perform the autorotation procedure.

According to the FAA-H-8083-21 Helicopter Handbook, the autorotation maneuver in helicopters is a controlled descent maneuver where the engine is disengaged from the main rotor system, and the rotor blades are driven only by the upward flow of air through the rotor.

During the final phase of the autorotation, at an altitude of approximately 40 to 100 ft. above the ground, a flare is initiated (an increase in the angle of attack) by pulling the cyclic control backwards, reducing horizontal speed and rate of descent. The timing and intensity of the flare are crucial to ensure a smooth and controlled landing.

According to images captured by the security camera, at 10:27:48 a.m. (local time), the aircraft began its descent. After approximately six seconds, at 10:27:54 a.m. (local time), the aircraft initiated a movement similar to a flare, counteracting the high rate of descent at that moment (Figure 15).

Figure 15 - Aircraft PR-WVW moments before the impact with the ground.

1.19. Additional information.

The Safety Notice SN-24 from *Robinson Helicopter Company*, issued in September 1986 and revised in June 1994, addressed a safety alert regarding helicopter rotor stall due to low RPM - a significant cause of both fatal and non-fatal helicopter accidents. Rotor stall occurs when the rotor fails to produce sufficient lift to keep the helicopter airborne, resulting in the aircraft descending uncontrollably and crashing.

The alert explained that rotor stall is similar to the stall of an airplane wing at low speeds, where a greater angle of attack is required to produce lift. In helicopters, the stall occurs due to low rotor RPM, not low airspeed. As rotor RPM decreases, a greater angle of attack of the rotor blades is required to generate the necessary lift.

Furthermore, the notice detailed that when rotor stall occurs, it does not happen symmetrically due to the forward speed of the helicopter, causing the stall of the retreating blade to begin first. This can lead to a phenomenon known as rotor blowback, where the rotor disc rapidly tilts backward.

As the helicopter begins to fall, the upward airflow under the tail surfaces tends to pitch the aircraft downward. These effects, combined with the pilot's backward cyclic input to prevent the nose from dropping, often result in contact between the main rotor blade and the tail cone.

1.20. Useful or effective investigation techniques.

NIL.

2. ANALYSIS.

The aircraft departed from SNGA, bound for SIVU for a private flight.

The weather conditions were favorable, with clear skies and visibility above 10 km, not being a contributing factor to the accident.

The PIC held a PPH license and was qualified to operate the aircraft. Additionally, he held an Aircraft Maintenance Mechanic license, with certifications to work on powerplants and airframes, suggesting possession of a deep technical understanding of the aircraft.

He was also the owner of the aircraft, which introduces an unusual dynamic regarding the maintenance and operation of the helicopter. His experience, qualifications, and even maintenance choices may have played a distinct role in his conduct in managing the equipment.

According to the toxicology exam, no substances were found that could impair his ability to fly, confirming that the PIC was not under the influence of elements that could affect his judgment or performance.

He was described as a person passionate about aviation, with a tendency to be daring and fearless. These characteristics can have both positive and negative influences. On one hand, they demonstrate confidence and enthusiasm for aviation. On the other, they can lead to risky decision-making or a disregard for safety protocols.

According to reports, the PIC himself performed maintenance work on the aircraft, which indicated a high level of involvement and technical understanding. However, this also suggests a potential reluctance to seek external assistance or adhere to standardized procedures, which could increase the risk of critical errors or omissions.

The PIC's history suggested a conduct marked by self-confidence and perhaps a tendency to rely excessively on his individual abilities. This may have influenced how he responded to the emergency, potentially favoring quick and decisive actions but also potentially leading to hasty judgment or a lack of seeking alternatives.

The accounts collected about the PIC indicated the possibility that his approach to piloting and maintenance may not have always been prudent or in line with best practices, potentially contributing to the sequence of events that led to the accident.

As for the aircraft, it was found to be certified and registered in the private air service category, indicating its compliance with applicable airworthiness regulations. Maintenance inspections, including the "100-hour" inspection and the annual maintenance inspection, were carried out on 23 September 2020 according to the records reviewed by members of the Investigation Committee.

The components of the aircraft engine's fuel system, such as the injector nozzles and servo-injector, were inspected and showed no blockages or significant discrepancies that could compromise the fuel delivery to the engine. Similarly, the analysis of the lubrication system did not reveal contamination or signs of abnormal wear, suggesting that the system was operating within expected standards.

During magneto testing, discrepancies were found, such as the presence of an unapproved washer and charring on the contact points, indicating possible flaws in the ignition system that could lead to irregular operation or engine power loss. Furthermore, there are indications that the PIC assumed maintenance responsibilities and made decisions that may have compromised the aircraft's integrity, such as using non-certified parts and making adaptations during repairs. Certain actions, aimed at cost-saving, may have introduced uncalculated risks to the aircraft's operationality.

In the final approach phase for landing, the aircraft entered an "abnormal descent attitude", indicating a significant deviation from the standard landing procedure. This suggests a loss of control during a critical phase of the flight, where the margin for correction and recovery was minimal.

Since the accident occurred near the runway, the failure condition may have arisen suddenly, limiting the PIC's options for an effective response.

The analysis of the wreckage indicated that the aircraft sustained substantial structural damage upon impact, including damage to the rotors and tail cone. This damage was consistent with a high-energy impact. Notably, evidence of one of the rotor blades striking the tail cone was observed, suggesting an operational anomaly.

The collision with the ground occurred in a wooded area near the runway threshold, indicating that the PIC was attempting to reach the aerodrome but faced difficulties that prevented the safe completion of the approach and landing. The crash site, to the left of

threshold 05 at SIVU, provided insight into the final trajectory and the recovery attempts made by the PIC.

Based on observations and the final trajectory of the flight, there are indications that the PIC attempted an autorotation maneuver.

This maneuver is critical and performed in response to an engine failure. It suggests that the PIC identified an emergency which required an immediate response to a possible left yaw resulting from engine failure, as outlined in *Section 3* - *Emergency Procedures* - of the aircraft's POH.

The information contained in *Safety Alert* SN-24 highlighted the possibility of rotor stall due to low RPM, a dangerous condition in which the rotor does not generate sufficient lift. This scenario aligns with the suspected engine failure or ignition system issues, which could lead to a reduction of the main rotor's RPM.

Integrating this information, the main hypothesis was that the PIC was operating the aircraft within normal parameters until encountering an adverse situation, possibly related to engine performance.

The decision to execute an autorotation suggests an awareness of the emergency, possibly due to a loss of power or indications of low rotor RPM.

The possibility of rotor stall, as indicated by the information in Safety Alert SN-24 and corroborated by the findings of the magneto examinations, provides a plausible explanation for the loss of control of the aircraft.

While autorotation is the correct response to an engine failure, the effectiveness of the maneuver depends on several factors, including altitude, speed, and the pilot's ability to execute the maneuver under pressure.

Although the records of the pilot's latest class rating exam showed satisfactory performance in the autorotation maneuver, members of the Investigation Committee raised concerns about a history of poor performance related to this maneuver.

Considering the outcome of the occurrence, it is possible that the PIC lacked the necessary knowledge and technical skills to effectively perform the procedure.

According to the images captured by the security camera, the aircraft began its descent and, after approximately six seconds, initiated a movement resembling a flare, counteracting the high sink rate at that moment.

In this context, the timing and intensity of the flare are crucial, and it is possible that the PIC misjudged the altitude at which to perform the flare to ensure a smooth and controlled landing.

Therefore, the analysis suggests that a chain of events, beginning with potential issues in the ignition system, may have led to a reduction in engine power, necessitating an autorotation maneuver in a critical scenario that ultimately proved unsuccessful.

3. CONCLUSIONS.

3.1. Findings.

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

b) the PIC had a valid HMNC rating;

c) the PIC held an MMA license (Aircraft Maintenance Mechanic) and valid ratings concerning GMP (Powerplant Group) and CEL (Airframe);

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

e) the aircraft had a valid CVA (Airworthiness Certificate);

f) the aircraft was within weight and balance limits;

g) the records of the airframe and engine logbooks were not up to date;

h) the weather conditions were above the minima required for the flight;

i) the aircraft's collision with the terrain occurred at a high sink rate;

j) the toxicological exam did not identify any substances that could have affected the PIC's performance;

k) a non-standard washer was found in contact with the engine right magneto's electric terminal screw;

l) the report indicated discrepancies in the engine right magneto and intermittent sparking in the engine left magneto;

m) during the final approach, there was a deviation to the left in the PR-WVW aircraft's trajectory with a high rate of descent;

n) the aircraft sustained substantial damage; and

o) the PIC and passenger suffered fatal injuries.

3.2. Contributing factors.

- **Attitude – undetermined.**

There were indications that the PIC took on maintenance responsibilities and made decisions that may have compromised the aircraft's integrity, such as using uncertified parts and making adaptations in repairs. These actions, in an attempt to reduce costs, may have introduced uncalculated risks to the aircraft's operationality.

- **Handling of aircraft flight controls – undetermined.**

The high rate of descent at which the aircraft impacted the ground, along with the left deviation in the final trajectory indicated improper use of the flight controls during a possible attempt to perform the autorotation procedure.

- **Piloting judgment – undetermined.**

According to images captured by the security camera, the aircraft began its descent, and after about six seconds, it initiated a movement similar to a flare, counteracting the high rate of descent at that moment.

In this context, the timing and intensity of the flare are crucial, and it is possible that the PIC did not correctly judge the altitude for performing the flare to ensure a smooth and controlled landing.

- **Aircraft maintenance – undetermined.**

During the course of the investigation, one observed the use of a non-standard washer that was in contact with the engine right magneto's electric terminal screw. This fact indicated inadequate maintenance performed on the aircraft, which may have contributed to a possible engine malfunction.

- **Managerial oversight – a contributor.**

It was possible to observe inadequate supervision by the maintenance organization where the PR-WVW aircraft underwent inspections, as the PIC himself was the technical manager, chief inspector, quality manager, and maintenance engineer for the services performed on the aircraft.

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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Act together with the Maintenance Organization of *Aeroclube do Espírito Santo* to ensure that both the execution and supervision of the maintenance work performed are appropriate and sufficient to meet the airworthiness requirements of the aircraft under the referred OM's responsibility.

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Disseminate the lessons learned from this investigation with the aim of alerting operators of R44 helicopters about the risks associated with the proper technical application of the autorotation maneuver, especially with regard to the content of Service Alert SN-24.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On April 25th, 2025.