COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 049/CENIPA/2016

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-ZRA**
MODEL:	**CA-9**
DATE:	**19MAR2016**

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 19MAR2016 accident with the CA-9 aircraft, registration PR-ZRA. The accident was classified as “[LOC-I] Loss of Control In-Flight”.

After takeoff, the aircraft described a curve trajectory to the right and collided against a building in an urban area.

The aircraft was destroyed.

All occupants suffered lethal injuries.

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

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS 5

1. FACTUAL INFORMATION. 7
1.1 History of the flight. 7
1.2 Injuries to persons. 7
1.3 Damage to the aircraft. 7
1.4 Other damage. 7
1.5 Personnel information. 7
1.5.1 Crew's flight experience. 7
1.5.2 Personnel training. 8
1.5.3 Category of licenses and validity of certificates. 8
1.5.4 Qualification and flight experience. 8
1.5.5 Validity of medical certificate. 8
1.6 Aircraft information. 8
1.7 Meteorological information. 13
1.8 Aids to navigation. 13
1.9 Communications. 13
1.10 Aerodrome information. 13
1.11 Flight recorders. 13
1.12 Wreckage and impact information. 13
1.13 Medical and pathological information. 14
1.13.1 Medical aspects. 14
1.13.2 Ergonomic information. 14
1.13.3 Psychological aspects. 14
1.14 Fire. 14
1.15 Survival aspects. 14
1.16 Tests and research. 15
1.17 Organizational and management information. 16
1.18 Operational information. 16
1.19 Additional information. 20
1.20 Useful or effective investigation techniques. 23

2. ANALYSIS. 23

3. CONCLUSIONS. 27
3.1 Facts. 27
3.2 Contributing factors. 28

4. SAFETY RECOMMENDATION. 28

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN. 29

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ANAC	Brazil's National Civil Aviation Agency
APA	Aeronautical Propulsion Division
CA	Airworthiness Certificate
CAD	Computer Aided Design
CAVE	Experimental Flight Authorization Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CG	Center of Gravity
CHT	Type Rating Certificate
CIV	Pilot's Flight Logbook
CMA	Aeronautical Medical Certificate
DAC	Civil Aviation Department
DECEA	Airspace Control Department
DCTA	Department of Science and Airspace Technology
GGCP	General Product Certification Management
IAM	Annual Maintenance Inspection
IAE	Aeronautics and Space Institute
ICA	Command of Aeronautics' Instruction
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating – Airplane
INFRAERO	Brazilian Airport Infrastructure Company
IS	Supplementary Instruction
METAR	Meteorological Aerodrome Report
MNTE	Airplane Single Engine Land Rating
NTSB	National Transportation Safety Board (USA)
PBV	Empty Basic Weight
PCA	Accredited Airworthiness Professional
PET	Experimental Private Aircraft Registration Category
PLA	Airline Pilot License - Airplane
PMD	Maximum Take Off Weight
PPR	Private Pilot License – Airplane
RAB	Brazilian Aeronautical Register
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Certification Regulation
RIAM	Annual Maintenance Inspection Register
ROTAER	Air Routes Auxiliary Manual
RWY	Runway
SBJD	ICAO Location Designator – Jundiaí Aerodrome - SP

SBMT	ICAO Location Designator - Campo de Marte Aerodrome, São Paulo -SP
SBRJ	ICAO Location Designator - Santos-Dumont Aerodrome, Rio de Janeiro - RJ
SDSM	ICAO Location Designator - Nossa Senhora da Conceição Farm Aerodrome, São Manuel - SP
SIPAER	Aeronautical Accident Investigation and Prevention System
TGC	Transcription of Communications Recording
TWR-MT	Campo de Marte Control Tower
UTC	Universal Time Coordinated
VRF	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** CA-9 **Registration:** PR-ZRA **Manufacturer:** Amateur Construction Aircraft	**Operator:** Private
Occurrence	**Date/time:** 19MAR2016 - 1823 UTC **Location:** Jardim São Bento Neighborhood **Lat.** 23°30'20"S **Long.** 046°38'41"W **Municipality – State:** São Paulo – SP	**Type(s):** [LOC-I] Loss of Control In-Flight **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Campo de Marte Aerodrome (SBMT), São Paulo - SP, to the Santos-Dumont Aerodrome (SBRJ), Rio de Janeiro - RJ, at about 1820 (UTC), in order to transport personnel, with a pilot and six passengers on board.

During takeoff from SBMT runway (RWY) 30, the aircraft described a curved trajectory to the right without gaining altitude. After about ten seconds of flight, the plane crashed into a building, in a residential area, 370 meters from threshold 12.

The aircraft was destroyed.

The crewmember and the passengers died at the site.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	1	6	-
Serious	-	-	-
Minor	-	-	-
None	-	-	-

1.3 Damage to the aircraft.

The aircraft was destroyed due to the impact and the subsequent fire.

1.4 Other damage.

The aircraft crashed against a residence, built of masonry, causing substantial damage to the property. The residence next to the one directly impacted by the plane, also had damage to its wall and gate.

In addition, four vehicles were hit by fire.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown	Pilot
Total	215:30
Total in the last 30 days	Unknown
Total in the last 24 hours	00:15
In this type of aircraft	Unknown
In this type in the last 30 days	Unknown
In this type in the last 24 hours	00:15

N.B.: The Data related to the flown hours were obtained through the records in the CIV Digital system of the National Civil Aviation Agency (ANAC).

In interviews conducted, it was stated that the pilot claimed to have more than 13,000 flight hours total. This information could not be verified, since his personal documentation was not found.

The flight logbook of the aircraft was destroyed in the accident, which made it impossible to verify the data related to the flights recently performed by the pilot in the crashed model.

It was also verified that the information contained in the CIV Digital system did not correspond to the airplane movements registered in SBMT.

1.5.2 Personnel training.

The pilot took the PPR course, in 1987.

1.5.3 Category of licenses and validity of certificates.

The pilot had the PLA, obtained in 1994, and had valid MNTE and IFRA Ratings.

1.5.4 Qualification and flight experience.

The ANAC reported that the pilot had experience on C-150, C-172, C-182 and PA-28 aircraft.

According to reports, he was flying the crashed aircraft with weekly basis. In this way, it was considered that the pilot was qualified and had experience in the type of flight.

1.5.5 Validity of medical certificate.

The pilot had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 0420109T01, was assembled from a kit traded by the US manufacturer Comp Air LLC in 2012, and was registered in the Private Experimental category (PET).

The aircraft did not have an Airworthiness Certificate (CA), since it was from an amateur manufacturing.

The company that imported and traded the PR-ZRA Aircraft Kit was SITREX *Comércio e Representação Comercial* Ltd., distributor of the US manufacturer in the country, based at Nossa Senhora da Conceição Farm (SDSM), and located in the municipality of São Manuel - SP.

The company SITREX executed the assembly of the airplane and also made a control of Annual Maintenance Inspection (IAM). An Annual Maintenance Inspection Report (RIAM) from 08DEC2014 was presented to the Investigators. The performance of this inspection was not mandatory.

There were airframe, engine, and propeller logbooks with outdated notes as to the hours flown after the last inspection. Nor was there any obligation for such records to be kept in order and in good time, once the applicable legislation did not require them.

It was found that the engine and aircraft had approximately 300 total flight hours.

The manufacturer said that the aircraft had flown about 50 hours before its owner received it.

During the assembly and registration process, a Responsible Engineer, also called Accredited Airworthiness Professional (PCA), provided technical advice to the airplane's buyer and to the flying pilot, as an employee of the manufacturer / operator.

The structure of the airplane had as main raw material the carbon fiber.

The engine of the PR-ZRA, Honeywell TPE 331-10, serial number P-38297C, was similar to the model used in other aircraft, among them the Mitsubishi MU-2B and Dornier 228. Its nominal power was 1,000 SHP at sea level.

The manufacturer of the aircraft kit envisaged the possibility of installing two Honeywell models: TPE 331-10 or TPE 331-12. In both cases, there were no performance charts for operation on CA-9.

Although the US manufacturer's specifications prevised the installation of a Hartzell four-bladed propeller, the aircraft was equipped with a MTV-27-1-E-C-F-R- (G) / CFRL250-103 propeller MT-Propeller, five-bladed.

According to information obtained, the PCA of the nationalization process of this Kit would have recommended the exchange of the propeller. There was mention of a performance improvement that would reduce the takeoff runs between 80 and 100 meters and in 150 meters the landing races. In addition, the cruising speed would be increased in 10kt. This data could not be verified.

Different information on the characteristics and performance of the aircraft has been identified. Figure 1 shows the data disclosed by the kit manufacturer.

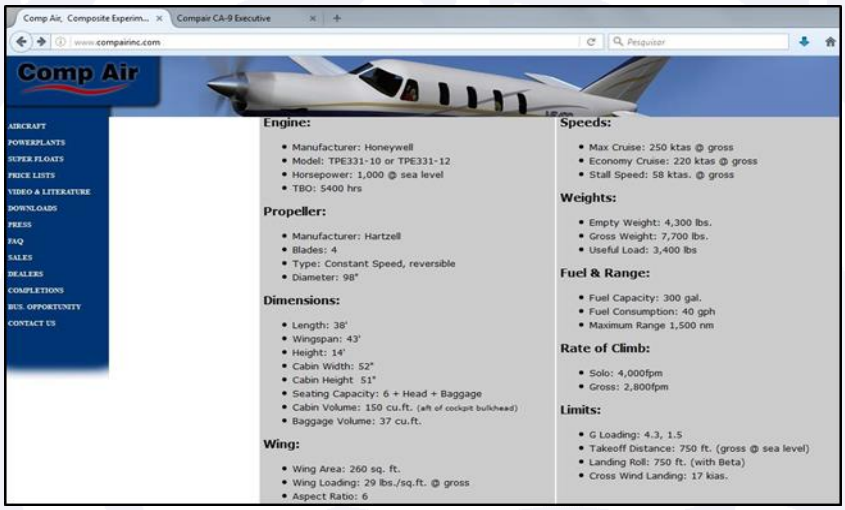

Figure 1 - File with characteristics of CA-9 model disclosed by the manufacturer.

Figure 2 shows the data disclosed by the company that traded and assembled the aircraft.

O ***Compair CA-9 Executive*** é um avião destinado principalmente ao transporte pessoal, atendendo às necessidades de negócio ou lazer, com elevada velocidade de cruzeiro, grande carga útil, interior amplo e confortável, versátil e silencioso.
A sua construção, totalmente feita em fibra de carbono, confere à estrutura um formato aerodinâmico que, em conjunto com a turbina de 1.000 hp (ao nível do mar) possibilita velocidade de cruzeiro de 250 nós, mesmo com o trem de pouso fixo.

Por sua vez, o trem de pouso fixo, de grande resistência, possibilita a operação em pistas mais rústicas, onde seria impossível a operação de aeronaves com trem retrátil, e a alta carga paga possibilita o carregamento de tudo o que seja necessário em viagens pessoais. A turbina Honeywell oferece a potência para a rápida subida até a altitude de cruzeiro e a decolagem em pistas curtas, sem qualquer problema.

A cabine, com largura de 1,37 metros, acomoda confortavelmente 8 pessoas (incluindo o piloto), podendo 4 dos assentos dos passageiros serem colocados frente a frente ou todos no sentido de voo.

ESPECIFICAÇÕES TÉCNICAS:

Fabricante do motor	HONEYWELL
Modelos do motor	TP331-10
Combustível	JET A1
Potência do motor (SHP) - nível do mar	1000 hp (*3)
TBO (h)	5.400
Tipo do trem de pouso	Triciclo (fixo)
Peso máximo de decolagem (kgf)	3.500
Peso máximo de pouso (kgf)	3.500
Peso vasio (kgf)	1.950
Capacidade de combustível utilizável (l)	1.120
Carga útil (kgf)	1.540
Consumo médio horário de combustível (*1) (l/h)	152
Envergadura (m)	13,1
Comprimento total (m)	11,6
Capacidade de assentos	6 ou 7
Portas de acesso à cabine	3

Figure 2 - File with characteristics of CA-9 model disclosed by the company that assembled the aircraft.

Figure 3, below, shows values of weight, load, number of seats and propeller characteristics found in three different sources of information.

Line A shows the initial data of the kit assembly process, production of operation documentation and weighing.

Line B contains the data of the application for opening the registration process and the H.03 experimental aircraft registration process. The latter ones were recorded in the Brazilian Aeronautical Registry (RAB).

Line C carries the technical data sheet of the aircraft disclosed on the websites of the companies on the internet, according to the manufacturer of the Kit and its distributor.

¤	Documentação¤	PBV·em·kg·(*)¤	Carga·útil·em·kg·(**)¤	Nº·assentos¤	Pás·da·hélice¤	PMD·em·kg¤
A¤	Manual·de·Operação¶(elaborado·pelo·PCA)¤	--¤	--¤	--¤	--¤	3.970¤
	Placard·na·aeronave¶(***)¤	--¤	1.450¤	--¤	--¤	3.860¤
	Foto·da·balança·(***)¤	2.434¤	--¤	--¤	--¤	--¤
B¤	Req.·abert.·proc.·(experimental)¤	2.360¤	--¤	1·+·7¤	4¤	3.260¤
	H.03·3825¶F-100-85·(vistoria·inicial)¤	2.434¤	--¤	1·+·7¤	4¤	3.900¶(3.894·na·planilha)¤
	RAB·¤	--¤	--¤	1·+·7¤	4¤	3.900¤
C¤	Fabricante·EUA·–·*COMP·AIR*¤	1.950¤	1.542¤	1·+·6¤	4¤	3.492¤
	Distrib.·Brasil·–·SITREX¤	1.950¤	1.540¤	6·ou·7¤	4¤	3.500¤

Figure 3 - Discrepancy values of PR-ZRA parameters.

Page 1 of process H.03 described the aircraft's Empty Basic Weight (PBV) as the sum of the masses of the following items: airframe, manuals, checklists, residual fuel, engine lubricating oil, coolant fluid and brake fluid.

Two weight and balance worksheets were elaborated by the PCA, which contained the values of 2,410kg and 2,434kg for the PBV, being the latter one the value informed in the evaluation process of the aircraft design, construction and operation.

The photo of the scale with the PBV record was from the H.03 process.

Thus, the declared PBV of the PR-ZRA was 2,434kg, while the manufacturer's forecast would be 1,950kg.

The manufacturer anticipated an average consumption of 40gph (152l / h) and the file with features of the airplane, produced in Brazil, reported the same average consumption.

In both cases, there was no detail on the relationship of this parameter to power regimes or flight phases.

Depending on the data sheet considered, the fuel capacity of the CA-9 ranged from 1,120 liters by the assembler to 300 gallons (1,136 liters) by the manufacturer.

The weight and balance sheet was prepared by the PCA responsible for the assembly.

In the documentation provided to the Investigation team, two Weight and Balance worksheets were found, with different dates and values. They showed different values for both the Center of Gravity (CG) and the force arms used in the loading calculations (Figures 4 and 5).

The numbers 1 to 3 after "Passengers" in Figures 4 and 5 relate to the number of the row of two passenger seats.

FICHA DE PESO E BALANCEAMENTO - AERONAVE COMPAIR CA-9 PR-ZRA

Estação	m	-0,89	2,88	1,98	1,40	2,23	3,14	4,04	5,46	5,98
Bequilha	Kgf	367								
Trem Principal	Kgf		2.043							
Combustível	Kgf			800						
Pilotos	Kgf				180					
Passageiros 1	Kgf					180				
Passageiros 2	Kgf						180			
Passageiros 3	Kgf							180		
Bagageiro 1	Kgf								50	
Bagageiro 2	Kgf									50
Peso pilotos e pax	180									
Peso Vazio (Kgf)	2.410									
Peso Total (Kgf)	4.030	367	2.043	800	180	180	180	180	50	50
Momento com carga	9.659	-327	5.884	1.584	252	401	565	727	273	299
Momento vazio	5.557									
	m									
Limite CG Dianteiro	2,15									
CG vazio	2,31									
CG carregado	2,40									
Limite CG Traseiro	2,51									

Eng. Aer. Benedicto Ivan Perotti - CREA 0600154522

Figure 4 - First Weight and Balance Worksheet, dated 03NOV2012.

AERONAVE VAZIA

Item	Braço em Polegadas	Peso Kg	Momento
Bequilha	-35,00	355,00	-12.425,00
Trem principal	113,19	2.079,00	235.322,01
TOTAL	91,58	2.434,00	222.897,01

TABELA DE CARREGAMENTO

Item	Braço em Polegadas	Peso Kg	Momento
Avião Vazio	91,58	2.434,00	222.897,01
Piloto	57,00	200,00	11.400,00
Passageiro 1	91,00	180,00	16.380,00
Passageiro 2	128,00	160,00	20.480,00
Passageiro 3	165,00	160,00	26.400,00
Bagageiro 1	223,00	50,00	11.150,00
Bagageiro 2	244,00	50,00	12.200,00
Tanque de Combustível	93,00	800,00	74.400,00
TOTAL	97,99 CG	4.034,00	395.307,01

PASSEIO DO CG : 87,77" a 102,77"

PESO MÁXIMO DE DECOLAGEM : 3.900 Kg

Figure 5 - Second Weight and Balance Worksheet, dated 06DEC2012.

There was the prevision of a pilot warning system that would provide inadequate loading information. From the weight and balance parameters entered, the display would show a red stripe when the CG ride was exceeded in the PR-ZRA. It was not possible to confirm if this system (Figure 6) was being used in the aircraft.

Figure 6 – Aircraft's loading warning system, installed in another aircraft model of the Kit's manufacturer.

The seats were fixed on rails, allowing more or less space between them, according to Figure 7.

Figure 7 - Aspect of the seats assembly in the floor of the aircraft, in a similar model to the CA-9.

The Kit's manufacturer indicated that the aircraft could receive seven seats, one for the pilot and six for the passengers.

From what was found, the responsible PCA modified these loading parameters. The aircraft was registered with eight seats, one for the pilot and seven for passengers.

The responsible PCA also performed the propeller exchange. The original, specified by the Kit manufacturer, was a four-bladed, and a five-bladed, replaced it.

According to the aircraft assembler, many decisions were made between the PCA and the pilot. In this context, a checklist and an operation manual were designed by the PCA, with the participation of the pilot.

The engineer qualified as PCA had died before the occurrence with the PR-ZRA, which made it impossible to clarify the parameters established for the operation of the airplane.

During the investigation, the Kit manufacturer was consulted, directly and through the NTSB, on technical issues that could clarify the aircraft operating parameters, but there was no response.

1.7 Meteorological information.

The Local Meteorological Bulletin (METAR) in force at the time of takeoff registered a 290° wind with 7kt, a temperature of 31° C, ceiling and visibility favorable for the visual flight.

The prevailing wind at the time of takeoff, as reported by the Marte Tower (TWR-MT), was 330º with 5kt of intensity.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The Transcription of Communications Recording (TGC), obtained from the air traffic control agencies, did not show any abnormality.

1.10 Aerodrome information.

The Campo de Marte Aerodrome was public/military, administered by the Brazilian Airport Infrastructure Company (INFRAERO), and operated under Visual Flight Rules (VFR), during daytime and nighttime periods.

The runway was made of asphalt, with thresholds 12/30, dimensions 1,600m x 45m, with elevation of 2,369ft.

According to the Air Routes Auxiliary Manual (ROTAER), the runway used was operating with the following restrictions in its dimensions:

> RWY 12 interdicted FST 300M for LDG and RWY 30 in the last 300M for DEP, virtue obstacles in approach RWY 12;
>
> RWY 30 interdicted FST 150M for LDG and RWY 12 over the last 150M for DEP, virtue obstacles in approach RWY 30.

Thus, the length available for the takeoff of the PR-ZRA was 1,300 meters.

1.11 Flight recorders.

Neither required nor installed.

1.12 Wreckage and impact information.

After takeoff, the aircraft did not gain altitude as expected and first collided against shrubs of a land, and later against a two-story residence, located about 240 meters to the right of the original threshold of SBMT runway 12 (Figure 8).

Figure 8 - Final trajectory and impact location of the aircraft.

The impact and fire that followed caused substantial damage to the front of this property.

The wreckage of the aircraft was concentrated in the ground area, in front of the house, in a space of about 20m².

The fuselage, made predominantly of composite material, became very fragmented in the collision and was destroyed by the ensuing fire.

Only parts of the turbo propeller group and some accessories, damaged by impact and fire, could be recovered.

Fragments of the propeller blades were found 20 meters and 60 meters west of the impact site. These parts were on the roofs of houses near the one hit by the aircraft.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

No evidence of the contribution of medical aspects to the occurrence was found. Necroscopic examination was negative for the presence of undue psychoactive substances in the pilot's organism.

1.13.2 Ergonomic information.

No evidence of the contribution of ergonomic aspects to the occurrence was found.

1.13.3 Psychological aspects.

Nil.

1.14 Fire.

The fire after the impact with the building consumed the aircraft and part of the front area of the two-story building.

Analysis indicated that the fire occurred post-impact.

1.15 Survival aspects.

All occupants perished because of the impact and the aircraft was totally destroyed.

1.16 Tests and research.

The test of the fuel supplied to the aircraft by the distributor that served the PR-ZRA at the Jundiaí Airport (SBJD) - SP, its Aerodrome of origin, found out that the fuel met the characteristics of aviation kerosene, with an adequate degree of purity.

The examination of the powertrain components collected at the accident site revealed that the engine developed high power and torque at the time of the collision against the building.

Friction marks in the compression centrifugal stage rotor and in the three turbine stages, the presence of superheated material deposited on blades and the existence of material that was ingested by the engine inside, among other aspects, corroborated to this conclusion.

The following images were taken from the technical report issued by the Aeronautical Propulsion Division (APA) of the DCTA's IAE. (Figures 9 and 10).

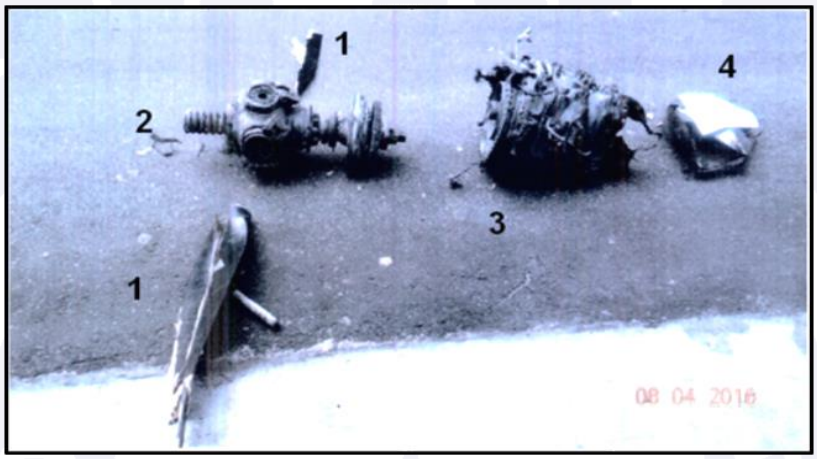

Figure 9 - Powertrain parts: 1) propeller blades; 2) reduction box; 3) hot section; 4) fairing.

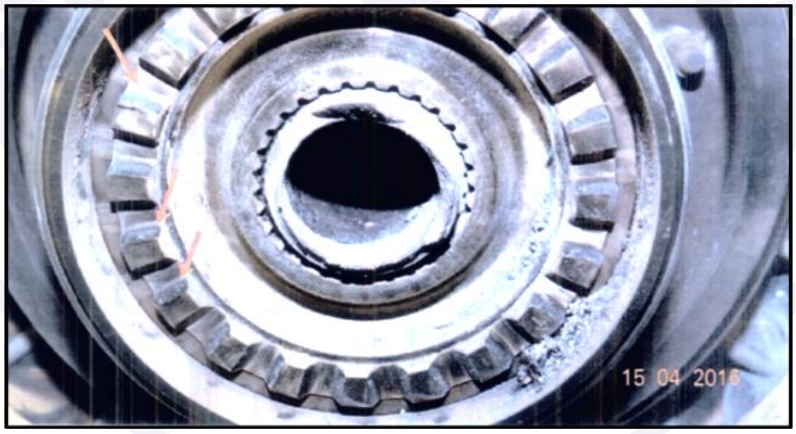

Figure 10 - Centrifugal stage of the compressor showing damage to the trapezoidal teeth, sheared axis by overload and deposit of fragmented material.

Because of the destruction degree caused by impact and fire, it was not possible to examine the components of the aircraft's flight control system.

Comp Air did not provide a script or standard of inspection to be performed on the CA-9 during the cycle of using the Kit once assembled. The assembling company reported that it used Appendix D of the Brazilian Civil Aviation Regulation (RBAC) No. 43, entitled "Item Objectives and Details to be included in the Annual Inspections and 100 Hour Inspections (as applicable for specific aircraft)".

According to the information collected, the mechanics who participated in the assembly of the Kit did not possess any CHT.

It was verified that certain equipment of precision measurements used by the mechanics underwent calibrations on 13OCT2010 and 10DEC2010, but equipment without calibration were found.

1.17 Organizational and management information.

Because the aircraft does not have aeronautical approval or certification, having only the Experimental Flight Authorization Certificate (CAVE), several technical data were not available in the obtained publications, as they were not required by the regulatory agency.

1.18 Operational information.

The purpose of the flight was to transport the owner of the aircraft, accompanied by family members, for social commitment in Rio de Janeiro - RJ.

The pilot had an employment relationship with the owner of PR-ZRA, who accompanied the airplane's post-assembly flights, made from the city of São Manuel - SP.

There was no protocol to be followed on the initial flights. Similarly, there was no standardization of initial training (ground or flight) in CA-9.

On the date of the occurrence, the aircraft took off from SBJD and landed on Campo de Marte, at 1700 (UTC), for boarding passengers.

The flight leg from Jundiaí to Campo de Marte lasted 14 minutes, from 1646 (UTC) to 1700 (UTC).

At SBMT, after routine procedures, the commander boarded six people, started, ran the taxi through taxiways "J", "A" and "B" and positioned the aircraft for takeoff at threshold 30.

The traffic clearance prevised a left turn when crossing 3.200ft. Air traffic controllers on duty at the Marte Tower stated that the aircraft normally taxied, waited for a C-90 King Air landing at the waiting point of threshold 30, and took off about a minute later.

Apparently, the ground exit occurred after the sports club soccer field located near the runway, on the right side, near taxiway "D". This take-off distance was not usually observed when dealing with conventional engine or turbo propeller engines, but rather with jet aircraft.

According to one of these controllers, who watched the aircraft race on the ground, it had difficulty in taking off, which called the attention of other colleagues on duty. Those who observed the take-off of the PR-ZRA also had the impression that the plane left the ground with some difficulty, with a slight curve to the right.

They followed the trajectory to the right until the PR-ZRA left the field of vision, and soon thereafter, they watched the smoke rising from the ground.

It was not observed by the Control Tower anything that denoted fire or smoke with the aircraft in flight.

The height reached by the aircraft was estimated at less than 20 meters. However, considering the parallax effect and the distance from the tower view, this measurement could be imprecise.

Other observers also reported seeing the aircraft coming off the ground, apparently with slow speed, leaning slightly to the left and then describing trajectory to the right, until they saw the smoke coming from the ground. Two airport security cameras, positioned on

the Control Tower (right side of the runway) and on the Airport Administration building (left side of the runway), filmed the take-off run and the initial climb of the PR-ZRA.

These images initially demonstrated an apparent normality at the start of the race on the runway.

Figure 11 - Takeoff run (view of the right side of the runway).

Figure 12 - Takeoff run (view of the left side of the runway).

Figure 13 - Takeoff run (view of the right side of the runway).

The images, made from points to the left and to the right of the takeoff trajectory, were digitally treated in a Computer Aided Design (CAD) program and georeferenced, from a high-resolution satellite image provided by the Aeronautics Institute of Cartography (ICA). This process allowed obtaining measurements of the distance covered by the aircraft during the takeoff run with a margin of error of 5 meters.

Thus, it was estimated that the ground exit occurred about 900 meters from threshold 30 and that during the race on the runway a speed of 87.47kt was reached.

Figure 14 - Sketch of the takeoff trajectory in SBMT.

One of the last images of the takeoff, captured by the camera located in the Control Tower (Figure 15), suggests that by crossing the marks of the displaced threshold 12, the aircraft was still very close to the ground, corroborating the statements about the difficulty that the airplane demonstrated to gain height.

Figure 15 - Takeoff run (right view), ten seconds after Figure 13.

The videos did not record the final segment of the flight until the collision.

In a scanning on the Campo de Marte runway, shortly after the accident, firefighters found no material that could have been detached from the aircraft or bumped into it during the takeoff run.

Although birds were observed in the grass area around the Aerodrome, no evidence was found that a collision with fauna occurred during takeoff.

Flight plans, communications audio files, and radar revision albums, both from the SBJD-SBMT section and from the SBMT-SBRJ excerpt itself, did not bring relevant information to this investigation.

The fueling of the aircraft had been made to complete the two fuel tanks, as was customary when this operation was carried out in Jundiaí. The delivery receipt provided showed that it received a total of 411 liters of aviation kerosene.

According to the calculations of the Investigation Team, at SBMT takeoff, there were 861kg of fuel aboard the aircraft (1,120 liters, equivalent to 896kg minus 35kg of consumption SBJD-SBMT).

Based on camera visualization and interviews, it was estimated that the total weight of the occupants and luggage on board was 520kg (four weighing 75kg, 3 weighing 60kg and 40kg of luggage).

Thus, considering PBV of 2,434 kg, informed in the process of experimental aircraft registration, a further 520 kg (passengers plus luggage), plus 861 kg of fuel, it reached the total of 3,815 kg of approximate takeoff weight.

By this calculation, the PR-ZRA would be close to the Maximum Take Off Weight (PMD) informed to the civil aviation authority upon its registration, at the time of takeoff.

In the interviews, it was found that most of the legs were performed with two or three occupants, however, sometimes the PR-ZRA carried up to seven occupants.

It was not possible to determine the position of the passengers in the aircraft, since the patio camera did not record the position in which the boarding occurred. The interviews with the personnel who accompanied the departure of the plane and with relatives did not contribute to this effect.

Thus, it was not possible to estimate the aircraft balance situation.

1.19 Additional information.

The RBAC nº 21, which dealt with the Certification of Aeronautical Product, foreseen in its section 21.191 Certificates of authorization of experimental flight, the following:

> "[...]
>
> 21.191 Certificates of experimental flight authorization
>
> Experimental flight authorization certificates are issued for the following purposes:
>
> [...]
>
> (g) Amateur construction aircraft operation.
>
> (1) Operation of aircraft whose largest portion was manufactured and assembled by people who have carried out the construction solely for their own education or recreation; or
>
> (2) An aircraft operation that does not meet the criterion of the larger portion, which falls within the definition of an ultralight vehicle according to RBHA 103A and whose construction is completed and evidenced until 01DEC2014, since that the majority of the aircraft's construction tasks are performed in Brazil.
>
> [...]
>
> (i) operation of a light sporting aircraft that:
>
> (1) due to its characteristics, falls within the definition of a sporting light aircraft according to section 01.1 of the RBAC 01 and whose construction is completed and evidenced until 01DEC2016, since that the majority of the aircraft's construction tasks are performed in Brazil ; or
>
> [...] "

The same RBAC nº 21 provided, in its section 21.193, Certificate of experimental flight authorization. General, the following:

> "[...]
>
> 21.193 Certificate of experimental flight authorization. General
>
> The applicant for an experimental flight authorization certificate shall submit, together with the application, the following information:
>
> (a) a statement, in the manner established by the ANAC, defining the purposes for which the aircraft will be used;
>
> (b) sufficient data (such as photographs) to identify the aircraft;
>
> (c) any relevant information, which, after inspecting the aircraft, the ANAC has deemed necessary to safeguard the public interest;
>
> [...] "

On the other hand, Supplementary Instruction (IS) nº 21.191-001A, which dealt with Amateur Construction Aircraft, established, in section 5.12 Operational Restrictions:

> "[...]
>
> 5.12 Operational Restrictions
>
> 5.12.1 The ANAC shall establish the operational restrictions applicable to each aircraft. However, the following restrictions apply without distinction to all amateur construction aircraft:
>
> a) Any operation must comply with the requirements of section 91.319 of RBHA 91, or equivalent document that replaces it, and the other requirements of the said RBAC applicable to the operation being conducted;
>
> [...] "

The Brazilian Regulation of Aeronautical Homologation RBHA No. 91, which provided for General Rules of Operation for Civil Aircraft, established, in section 91.319 - Civil Aircraft with Certificate of Experimental Flight Authorization. Limitations, letter (c):

> "[...]
>
> 91.319 - CIVIL AIRCRAFT WITH CERTIFICATE OF AUTHORIZATION OF EXPERIMENTAL FLIGHT. OPERATIONAL LIMITATIONS
>
> [...]
>
> (c) Unless otherwise authorized by the CTA under special operational limitations, no person may operate an aircraft with an approved experimental flight authorization certificate on heavily populated areas or on a busy airway. The CTA may issue special operational limitations for a particular aircraft, allowing takeoffs and landings to be performed over densely populated areas or under busy airways, listing in the authorization the terms and conditions under which such operations may be conducted in the interest of safety.
>
> [...] "

In relation to aircraft maintenance and flight safety, IS No. 21.191-001A stated that, among other measures, the manufacturer should:

- prepare a Flight Manual to establish all operational limitations applicable to the aircraft;

- in the case of aircraft equipped with aeronautical products and components approved for aeronautical use, use the criteria for inspection and exchange for life-time limit approved or established by their respective manufacturers;

- develop an aircraft maintenance and inspection program;

- open airframe and powertrain logbooks to record the appropriate notes (revisions, modifications, periodic inspections, etc.); and

- register the IAM according to the form available on the ANAC website.

However, the same IS No. 21.191-001A provided, in its section 5.2 - Applicable Requirements, the following:

> "[...]
>
> 5.2 Applicable Requirements
>
> 5.2.1 An amateur builder do not need to demonstrate compliance with Airworthiness or production requirements for any category of aircraft.
>
> [...] "

The RBHA 103A, which dealt with the operation of ultralight vehicles in the Brazilian Airspace, contained, in its section 103.3 - Definitions, the following information:

> "[...]
>
> 103.3 - DEFINITIONS
>
> For the purposes of this Regulation, the following definitions apply:
>
> (a) [Self-propelled ultralight vehicle (designated in this Regulation, generally, as ultra-light vehicle or simply ultra-light) it means an experimental lightweight manned aircraft used or intended to be used exclusively in private air operations, mainly sports and pleasure, during the daytime hours, in visual conditions, **with capacity for 2 (two) occupants max.** and with the following additional characteristics:
>
> (1) **Single-engine, with reciprocating engine** and propelled by a single propeller;
>
> (2) **Maximum take-off weight equal to or less than 750 kgf;** and

(3) Calibrated stall speed (CAS), without engine, in the landing configuration (Vso) equal or less than 45 knots.]

[...] "**our emphasis**

On the other hand, RBAC nº 01 EMENDA nº 02, that dealt with the Definitions, Rules of Writing and Units of Measure for Use in the RBAC, contained, in section 01.1 Definitions, the following information:

"[...]

01.1 Definitions

Light sporting aircraft means an aircraft, excluding helicopter or aircraft whose lift depends directly on the power of the engine (powered-lift), which, since its original certification, has continuously fulfilled the following characteristics:

(1) **maximum take-off weight less than or equal to:**

(i) **600 kilograms for aircraft to be operated from the ground only;** or

(ii) 650 kilograms for aircraft to be operated from water.

(2) **maximum speed in leveled flight with maximum continuous power (VH) less than or equal to 120 knots CAS**, under standard atmospheric conditions at sea level.

(3) velocity never exceed (VNE) less than or equal to 120 knots CAS for a glider.

(4) stall speed (or stabilized minimum speed in flight), without the use of hyper sustentation devices (VS1), less than or equal to 45 knots CAS in the maximum certificated takeoff weight and most critical center of gravity.

(5) **seats for no more than two people, including the pilot.**

[...] "**our emphasis**

In research carried out with the ANAC's General Product Certification Management (GGCP), it was established that the registration and monitoring of experimental aircraft process was being studied, in order to segment such equipment into sub classifications, with a view to determining regulatory marks depending on the weight and performance of the equipment.

Regarding the specifications of the projects submitted to its evaluation, based on the regulation applicable to amateur construction, the ANAC considered that the engineering professional who performed the PCA activity was competent to guarantee the required degree of safety for an experimental aircraft.

Thus, following internal protocols, the evaluation of the project, the construction of the aircraft and the subsequent issuance of CAVE took place based on the documentation presented. The PCA was responsible for the conformity of the aircraft constructed with the design described in the technical documentation delivered to the Agency.

In short, the PCA was assigned to ensure safety during the construction and registration process; however, this responsibility did not include the equipment continued Airworthiness.

The GGCP received and examined the documentation, issuing the experimental aircraft record.

The inspection of an aircraft being assembled was compulsorily part of the PCA recertification process and occurred on a yearly basis.

The legislation applicable to the granting of experimental flight authorization certificates for amateur aircraft was applying the criterion of the larger portion so that it could be registered as such, on behalf of its constructor/operator.

This criterion, related to the construction of aircraft by amateurs, meant that, when the aircraft was complete, most of the tasks on the manufacturing and assembly checklist had been performed by the amateur builder.

However, there were cases, such as the PR-RZA one, in which the assembly of the Aircraft Kit was carried out by third parties and accompanied by the manufacturer.

During the investigation process, it was observed that on the ANAC website, at the electronic address http://www.anac.gov.br/noticias/2016/voce-conhece-a-aviacao-experimental[1], in an article related to experimental aviation, the Brazilian civil aviation authority highlighted the following aspects:

> "[...]
>
> An experimental aircraft, which is usually characterized by not undergoing a long exhaustive testing campaign, **should expose few people to risk and only those inherent to the project. (our emphasis)**
>
> [...]
>
> Pilots cannot forget that aircraft of this category must be operated within the regulatory limits and other limitations indicated in the Airworthiness Certificate accompanying each aircraft and that the monitoring of the technical aspects, including maintenance, is important to avoid accidents.
>
> [...] "

1.20 Useful or effective investigation techniques.

Nil

_____

[1]ANAC's website: Você conhece a Aviação Experimental? Curiosidades e diferenças para a Aviação Certificada.

Published: 28JAN2016 16h41. Last update: 05SEPT2017 12h00. Accessed on 02OCT2018.

2. ANALYSIS.

It was a passenger transport flight between SBMT and SBRJ.

The data collected in relation to the flight before the occurrence did not show the existence of any type of abnormality that could have contributed to the accident in question.

Based on the result of the scanning performed on the runway after the accident, the possibility that the performance of the aircraft or pilot was affected by the detachment of parts, collision against objects or fauna was ruled out.

In addition, in the last contact with the Control Tower, the aircraft informed the takeoff and used the standard phraseology.

Exams and tests carried out on parts recovered from the powertrain led the Investigation Team to conclude that the engine was running normally and produced high power at the time of impact.

From what was verified with the professionals who controlled the aircraft in the Marte Tower, no indication of mechanical failure was observed during takeoff.

In addition, no abnormality was found in the fuel used by PR-ZRA.

Thus, the hypothesis of engine failure as a contributing factor to the accident was excluded.

The degree of destruction presented by the aircraft structure prevented the elimination of a fault in the flight controls and / or lift surfaces as a contributing factor to the

occurrence. However, the images taken by the security cameras and the statements of the flight controllers allowed classifying this possibility as remote.

Regarding the Airworthiness conditions of the aircraft, according to the information collected, the company SITREX, which executed the assembly of the airplane, also made a control of Annual Maintenance Inspections (IAM). However, the Annual Maintenance Inspection Report (RIAM) presented to the researchers dates back to 08DEC2014.

The airframe, engine, and propeller logbooks contained outdated annotations as to the hours flown after inspection.

IS No. 21.191-001A stated that an aircraft maintenance and inspection program should be developed and that the IAM be recorded according to the available form on the ANAC website.

Since the manufacturer of the Kit did not provide a roadmap or standard of inspections to be performed on the CA-9 during its operating cycle, the use of Appendix D of RBAC No. 43 as a guide, as stated by the company that assembled the aircraft , would be a suitable way to conduct airplane inspections. However, such records were not available for examination by the Investigators.

IS No. 21.191-001A also recommended the opening of airframe and powertrain registers to record the appropriate annotations (revisions, modifications, periodic inspections, etc.).

However, since the same Instruction clarified that an amateur builder did not need to demonstrate compliance with Airworthiness or production requirements corresponding to any category of aircraft, the non-existence or lack of updating in such documents did not violate the legislation applicable to the operation of an amateur construction aircraft.

Thus, due to the operation conducted under an Experimental Flight Authorization Certificate (CAVE), several technical data were not available in the documents produced by the operator, since there was no obligation for such records to be kept in order and up to date.

This condition made difficult the accurate investigation as to the periodicity and the quality of the maintenance services executed in the airplane.

In light of the regulation for the amateur construction of aircraft, the installation of a five-bladed propeller, replacing the four-bladed specified by the North American manufacturer of the Kit, was within the scope of the PCA's capabilities.

If on the one hand the improvements in takeoff, landing and speed performance could not be proven, since there was no in-flight test data of this new configuration, on the other hand there was also no evidence that this replacement had any influence on the accident.

Under the same view, the participation of professionals without technical qualification in aeronautical construction or maintenance, and the use of precision equipment without calibration in the assembly of the aircraft could be considered as part of the context of the amateur construction aircraft, since there were no requirements that would impede these conditions.

On the aircraft balance, two spreadsheets were found, with different dates and calculation parameters.

The comparison between the values presented in these tables showed that there were significant differences in the force arms, which would affect the calculation of the weight distribution in the aircraft depending on the version used (Figure 16).

Station	Spreadsheet 03NOV2012 (in meters)	Spreadsheet 06DEC2012 (pol converted to meters)
Tail Skid	-0,89	-0,89
Main landing gear	2,88	2,88
Fuel	1,98	2,36
Pilots	1,4	1,45
Passengers 1	2,23	2,31
Passengers 2	3,14	3,25
Passengers 3	4,04	4,19
Cargo compartment 1	5,46	5,66
Cargo compartment 2	5,98	6,20
CG's distance	2,15 to 2,51	2,23 to 2,61

Figure 16 - Comparison table of the weight and balance worksheets found.

In the same way, the maximum limits of forward and backward CG displacement also varied. It was observed that in the spreadsheet drawn up on 06DEC2012, the CG of the aircraft moved backwards.

The force arms referring to the seats could vary, depending on how they were attached to the floor rails. However, it was not possible to determine the reasons for the differences between fuel tank and baggage values, as their positions could not be changed during the Kit assembly.

Despite these discrepancies, assuming the most recent spreadsheet was correct, the Investigation Team concluded, after applying several different combinations to distribute the passengers that the CG of the aircraft was probably within the proper ride limit for the flight.

Regarding the maximum take-off weight, there was a great variation between the data published by the Kit manufacturer and those reported to the ANAC when obtaining the Certificate of Experimental Flight Authorization (CAVE).

Between the information disclosed by the manufacturer (3,492kg - 7,700lbs) and the value for which the aircraft had received its experimental flight authorization (3,900kg) there was a difference of more than 408kg.

Considering the calculations of the Investigation Team, at the time of takeoff, the aircraft would be 323kg above the maximum weight stipulated by the Kit manufacturer (3,815kg - 3,992kg = 323kg) and 85kg below the one specified in the CAVE (3,900kg - 3,815kg = 85kg).

Since there were no performance charts on takeoff, it was not possible to determine if the available track length (1,300m) would be sufficient for a safe departure of the PR-ZRA in those conditions of weight, field elevation and ambient temperature.

However, it is possible that the altitude of the runway (2,369ft) and the elevated temperature (31° C), associated to the weight near the maximum takeoff, have degraded the performance of the aircraft, which would explain the difficulty observed by the flight controllers and registered by the airport cameras, to gain height.

Thus, the absence of a support system in the form of publications that would allow to obtain data on the performance of the equipment and proper planning, added risk to the operations and could have led to an attempt of taking off under unsafe conditions.

In this context, the informality present in experimental aviation, coupled with the absence of support systems, may have caused flight preparation work to be inadequate, particularly in terms of degradation of performance against adverse conditions (weight, altitude and temperature), and compromised the quality of the executed planning, thus contributing to a take-off under marginal conditions.

In addition, due to the absence of manuals and performance charts to limit the operation, the performance based only on the empirical knowledge about the aircraft may have led to an inadequate evaluation of certain parameters related to its operation. In this case, the performance of the aircraft in conditions of weight, altitude and high temperature may have propitiated its conduction with reduced safety margins during takeoff that resulted in the accident in question.

In this scenario, it is possible that the aircraft showed a different behavior from that with which the pilot would be accustomed, performing less than expected, since none of the flight conditions was proven by tests.

In this way, the hypothesis was raised that the aircraft was not able to gain height and overcome obstacles in the takeoff line and that, without adequate control of the airplane, the pilot was not able to avoid the accident.

During the assembly process of the PR-ZRA, changes were incorporated into the original Kit design that directly affected the aircraft's takeoff performance.

Parameters such as basis weight, payload, number of seats and propeller characteristics were modified, the project was submitted to the aeronautical authority and the experimental flight authorization was received.

Since there was no documentation related to flight tests or performance charts for the ANAC-accepted project, once applicable law did not require its presentation, it was not possible to measure the implications of these changes on airplane performance.

In this scenario, it is possible that the experimental nature of the project has propitiated the operation of the aircraft based on empirical and inadequate parameters to its real capabilities.

Regarding the operation of the aircraft in the Campo de Marte, although the expression "densely populated areas" was not well defined, the research team understood that the metropolitan region of the city of São Paulo was unequivocally a densely populated area.

Thus, landing and attempted takeoff of the PR-ZRA in SBMT, without special permission from the competent authority characterized the violation of requirements set out in RBHA No. 91.

Regarding the operation carried out on the flight where the plane accident occurred, the PR-ZRA, registered as an amateur construction aircraft, was being used for private passenger transportation, in disagreement with the provisions of RBAC No. 21, which granted Experimental Flight Authorization Certificates for aircraft constructed by people solely for their own education or recreation.

The analysis of the regulation applicable to the operation of ultralight, light sports and amateur aircraft showed that these equipment were operated by issuing the same Certificate of Experimental Flight Authorization.

Regarding the operation of ultralight vehicles and light sport aircraft, regulatory frameworks have set limits on their use, maximum number of occupants, types of engines, maximum take-off weight and maximum in-flight speed, among others.

However, the legislation that marked the construction of aircraft by amateurs did not contemplate any of these limitations.

According to the ANAC, the incentive to develop experimental aviation, made through an authorization process based on the responsibility of the amateur builder and the responsible engineer for the construction follow-up, had as one of its main objectives to enable technological innovation and to bring international recognition of the aeronautical vocation of Brazil.

However, over time, another model replaced the original concept, where a person recreationally built his aircraft, by one where he bought a Kit that was assembled by third parties (usually a professional).

Many of the new interested people were not aiming to build their own aircraft. What they wanted was just to operate these planes.

With the evolution of technology, aircraft built by amateurs were advancing in complexity, capacity and size, without regulatory adjustments.

In this way, a large range of aircraft, from very light ones to those with more than one ton of PMD, received experimental flight authorization based on the same regulations, as was the case with the CA-9 model.

As a result, private passenger transport was carried out on these aircraft, whose less restrictive requirements did not guarantee the adequate levels of safety for this type of operation.

Thus, this aspect of the use of an experimental aircraft was directly contrary to the philosophy proclaimed by the ANAC in the highlights of the news published in its electronic site, in 2016.

On the other hand, it was observed the fragility of the legislation and the official control mechanisms that allowed the use of these aircraft for the transportation of several people, in operations conducted from Aerodromes located in large urban centers, although they did not pass through an appropriate certification process.

3. CONCLUSIONS.

3.1 Facts.

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

b) the pilot had valid MNTE and IFRA Ratings;

c) the pilot was qualified and had experience in that kind of flight;

d) the aircraft had valid CAVE;

e) according to the calculations made by the Investigation Team, based on the most recent spreadsheet found, the aircraft would be within weight and balance limits;

f) the aircraft was granted experimental flight authorization to operate with a weight 408 kg greater than that reported by the Kit manufacturer;

g) the airframe, engine and propeller logbook records were outdated;

h) the weather conditions were favorable for the visual flight;

i) it was a passenger transport flight, in the SBMT / SBRJ leg;

j) the aircraft flew over a densely populated area and was not authorized to do so;

k) according to the information collected, the aircraft took flight with difficulty and was not able to gain enough height to clear obstacles on the takeoff trajectory after leaving the ground;

l) the examinations and tests carried out on the parts recovered from the power unit led the Investigation Team to conclude that the engine was operating normally and produced high power at the time of impact;

m) the degree of destruction presented by the airplane structure prevented the elimination of a fault in the flight controls and / or support surfaces as a contributing factor to the occurrence;

n) the aircraft deviated to the right of the take-off route and crashed into a residential building, in an urban area, 370 meters from Aerodrome's threshold 12;

o) the aircraft was destroyed; and

p) the occupants had lethal injuries.

3.2 Contributing factors.

- **Piloting judgment – undetermined.**

The lack of manuals and performance charts to limit the operation and the performance based only on the empirical knowledge about the aircraft may have led to an inadequate evaluation of certain parameters related to its operation.

In this case, the performance of the aircraft in conditions of weight, altitude and high temperature may have propitiated its operation with reduced safety margins during takeoff, which resulted in the accident in question.

- **Flight planning – undetermined.**

Informality in experimental aviation, coupled with the absence of support systems, may have resulted in an inadequate flight preparation work, particularly as regards degradation of performance against adverse conditions (weight, altitude and high temperature), compromising the quality of the planning performed, thus contributing to a takeoff under marginal conditions.

- **Project – undetermined.**

During the assembly process of the PR-ZRA, changes were incorporated into the original Kit design that directly affected the aircraft's takeoff performance.

Once the applicable law did not require the presentation of documentation related to flight tests or performance charts, it is possible that the experimental nature of the project has enabled the aircraft to operate based on empirical parameters and being inadequate to its actual capabilities.

- **Support systems – undetermined.**

The absence of a support system, in the form of publications that would allow data to be obtained for the performance of the equipment, in order to carry out adequate planning, added risk to the operations and may have led to an attempt to take-off under unsafe conditions.

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 Airspace Control Department (DECEA):

A-049/CENIPA/2016 - 01 Issued on 04/08/2019

Enhance the supervisory mechanisms adopted by this Department, in order to prevent experimental aircraft without special authorization from operating in densely populated areas or on busy airways.

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

A-049/CENIPA/2016 - 02 Issued on 04/08/2019

Enhance the supervisory mechanisms adopted by this Agency, in order to prevent experimental aircraft without special authorization from operating in densely populated areas or on busy airways.

A-049/CENIPA/2016 - 03 Issued on 04/08/2019

Update the Brazilian Civil Aviation Regulations, especially RBAC 01 and RBHA 91, in order to improve and clarify the definition of the term "densely populated area", in order to solve doubts that may relate to the theme, raising the levels of safety to third parties.

A-049/CENIPA/2016 - 04 Issued on 04/08/2019

Update the Brazilian Civil Aviation Regulations, in order to create limitations for amateur construction aircraft, similar to what is done with light sport and ultralight aircraft, in order to reduce the number of third parties exposed to aircraft flight hazards on not certified aircraft by the Brazilian Civil Aviation Authority.

A-049/CENIPA/2016 - 05 Issued on 04/08/2019

Disseminate the lessons learned in this investigation in order to alert the entire Brazilian society about the risks arising from flight in aircraft that have not undergone the aeronautical certification processes applied by the civil aviation authority.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On April 08th, 2019.