COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
A - 134/CENIPA/2014

OCCURRENCE:	**ACCIDENT**
AIRCRAFT:	**PR-AFA**
MODEL:	**CE 560XLS+**
DATE:	**13AUG2014**

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 item 3.1, 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 13 August 2014 accident with the CE 560XLS+ aircraft, registered as PR-AFA. The accident was classified as “Loss of Control in Flight”.

After discontinuing the approach for landing, the aircraft flew over the SBST runway and turned to the left. Then, it lost altitude and crashed into the ground.

Both pilots and the five passengers perished in the crash site.

The aircraft was completely destroyed.

An accredited representative of the National Transportation Safety Board –NTSB (USA) and another of the Transportation Safety Board – TSB (Canada) were designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AC	Advisory Circular	
ACB	Audio Compressor Board	
ACC	Area Control Center	
ADPCM	Adaptive Differential Pulse Code Modulation	
AFIS-ST	Santos Aerodrome Flight Information Service (Santos Radio)	
AGL	Above Ground Level	
AIS	Aeronautical Information Service	
ANAC	(Brazil's) National Civil Aviation Agency	
ANP	National Agency for Petroleum, Natural Gas and Bio-fuels	
AP	Acquisition Processor Board	
APA-E	Aeronautics and Space Institute's Engineering Subdivision	
APP	Approach Control	
ARC	Area Route Chart	
ARINC	Aeronautical Radio, Incorporated	
ATC	Air Traffic Control	
ATCO	Air Traffic Controller	
ATPL	Airline Transport Pilot License	
ATS	Air Traffic Services	
BARO ALT	Barometric Altitude	
BIMTRA	Air Traffic Movement Database	
BIT	Built-in Test	
BT	Technical Bulletin	
C525	Cessna 525 Citation Jet (CJ) aircraft	- ICAO type: C525 - ANAC: C525
C525A	Cessna525 Citation Jet (CJ2) aircraft	- ICAO type: C25A - ANAC: C525
C560 Citation V	Cessna560 Citation V	- ICAO type: C560 - ANAC: C560
C560 Encore	Cessna 560 Citation (Encore) aircraft	- ICAO type: C560 - ANAC: C560
C560 Encore+	Cessna 560 Citation (Encore+) aircraft	- ICAO type: --- - ANAC: C560
C560XL	Cessna 560 Citation (Excel) aircraft	- ICAO type: C56X - ANAC: C56X - FAA: CE560XL
C560XLS	Cessna 560Citation(XLS) aircraft	- ICAO type: C56X - ANAC: C56X - FAA: CE560XLS

C560XLS+	Cessna 560 Citation (XLS+) aircraft	- ICAO type: --- - ANAC: C56+ - FAA: CE560XLS+
CA	Airworthiness Certificate	
CBA	Brazilian Code of Aeronautics	
CCF	Physical Capability Certificate	
CENIPA	Aeronautical Accident Investigation and Prevention Center	
CHT	Technical Qualification Certificate	
CIAAR	Aeronautics' Instruction and Adaptation Center	
CINDACTA	Integrated Center of Air Defense and Air Traffic Control	
CIRCEA	Airspace Control Normative Circular	
CIV	Pilot's Flight Logbook	
CMA	Aeronautical Medical Certificate	
CMA-GR	Guarulhos Meteorological Center	
CMV-CW	Curitiba Weather-Watch Center	
COMAER	Comando da Aeronáutica	
CSMU	Crash Survivable Memory Unit	
CSN	Cycles Since New	
CVR	Cockpit Voice Recorder	
DAC	Civil Aviation Department	
DCERTA	DCERTA Departure System	
DCU	Data Collection Unit	
DE	Spatial Disorientation	
DECEA	Airspace Control Department	
DOU	Federal GovernmentGazette	
DTCEA-ST	Santos Airspace Control Detachment	
EASA	European Aviation Safety Agency	
ECTM	Engine Condition Trend Monitoring	
EFIS	Electronic Flight Instrument System	
EGPWS	Enhanced Ground Proximity Warning System	
EMS	Ground Meteorological Stations	
EPI	Personal Protection Equipment	
FAA	Federal Aviation Administration	
FADEC	Full Authority Digital Engine Control	
FAF	Final Approach Fix	
FAP	PilotEvaluationSheet	
FCS	Flight Control System	
FL	Flight Level	
FMS	Flight Management System	
FPS	Frames Per Second	

FSB	Flight Standardization Board
GAMET	General Aviation Meteorological Information
GEIV	Special Inflight Inspection Group
GND	Ground Control
GOES	Geostationary Operational Environmental Satellite
GPS	Global Position System
HASP	São Paulo Hospital ofAeronautics
HSN	Hours Since New
IAC	Civil Aviation Instruction
IAE	Aeronautics and Space Institute
IAM	Annual Maintenance Inspection
IAS	Indicated Airspeed
ICA	Command of Aeronautics' Instruction
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
INSPAC	Civil Aviation Inspector
INSPSAU	Health Inspection
IS	Supplementary Instruction
JS	Junta de Saúde
LABDATA	Flight Data Recorders Read-out and Analysis Laboratory
Lat	Latitude
LCL	Fuel and Lubricants Analysis Laboratory
Long	Longitude
MANINV	Brazilian Flight Inspection Manual
MAPT	Missed Approach Point
MDA	Minimum Descent Altitude
MDR	Master Differences Requirements
METAR	Aerodrome Routine Weather Report
MLTE	Airplane, Multi-Engine, Land (AMEL)
MMEL	Master Minimum Equipment List
MSG-3	Maintenance Steering Group-3rd Task Force
NDB	Non-Directional Radio Beacon
NDT	Non-Destructive Testing
NOTAM	Notice to Airmen
NPA	Standard Action Norm
NTSB	National Transportation Safety Board
NuBAST	Santos Air Base
NVRAM	Non-Volatile Random Access Memory

OAT	Outside Air Temperature
OEA	Aeronautical Station Operator
PAME-RJ	Park of Electronic Materials of the Aeronautics - Rio de Janeiro
PCM	Commercial Pilot (airplane category)
PIC	Pilot in Command
PLA	Airline Transport Pilot
PNF	Pilot Not Flying
PPH	Private Pilot (helicopter category)
PPL	Private Pilot License (FAA)
PPR	Private Pilot (airplane category)
QDM	Magnetic Heading
QDR	Magnetic Bearing
QNH	Barometric pressure adjusted to sea level by means of a vertical gradient of the standard atmosphere
RAB	Brazilian Aeronautical Registry
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Aeronautical Homologation Regulation
REDEMET	Command of Aeronautics' Meteorology Network
RNAV	Area Navigation
SBJD	ICAO location designator –Jundiaí Aerodrome
SBKP	ICAO location designator –Campinas/Viracopos Airport
SBRF	ICAO location designator – Recife International Airport
SBRJ	ICAO location designator –Santos Dumont Airport
SBSP	ICAO locationdesignator –São Paulo/Congonhas Airport
SBST	ICAO location designator –Santos Air Base
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Information
SIPAER	Aeronautical Accident Investigation and Prevention System
SISCEAB	Brazilian Airspace Control System
SPO	ANAC's Operating Standards Superintendence
SRPV-SP	Regional Flight Protection Service (São Paulo)
STAR	Standard Instrument Arrival
TAF	Terminal Aerodrome Forecast
TCAS	Traffic Collision Alert and Avoidance System
TLA	Thrust Lever Angle
UTC	Coordinated Universal Time
VANT	Unmanned Aerial Vehicle (UAV)
V_{APP}	Minimum landing approach climb speed
VFR	Visual Flight Rules
VHF	Very High Frequency

VMO	Maximum Operating Limit Speed
V_{REF}	Minimum final approach speed. Reference speed to be maintained 50ft above the touchdown point with the landing gear lowered and the flaps extended (it corresponds to 1.3VSO with landing configuration)
V_{SO}	Stall speed with landing configuration
WS	Wing Station

1. FACTUAL INFORMATION.

Aircraft	**Model:** CE 560XLS+ **Registration:** PR-AFA **Manufacturer:** Cessna Aircraft Company	**Operator:** *AF Andrade Empr. e Participações Ltda.*
Occurrence	**Date/time:** 13 Aug 2014 / 13:03 UTC **Location:** Boqueirão District, Santos **Lat.** 23º57'35"S **Long.** 046º19'37"W **Municipality–State:** Santos – São Paulo	**Type:** Loss of control in flight.

1.1 History of the flight.

The aircraft took off from Santos Dumont Airport (SBRJ) at 12:21 UTC, on a transport flight bound for Santos Aerodrome (SBST), with two pilots and five passengers on board.

During the enroute phase of the flight, the aircraft was under radar coverage of the approach control units of Rio de Janeiro and São Paulo (APP-RJ and APP-SP, respectively), and no abnormalities were observed.

Upon being released by APP-SP for descent and approach toward SBST, the aircraft crew, already in radio contact with Santos Aerodrome Flight Information Service (Santos Radio), reported their intention to perform the IFR ECHO 1 RWY 35 NDB approach chart profile.

After reporting final approach, the crew informed that they would make a go-around followed by aholding procedure, and call Santos Radio again.

According to an observer that was on the ground awaiting the arrival of the aircraft at Santos Air Base (BAST) and to another observer at the Port of Santos, the aircraft was sighted flying over the aerodrome runway at low height, and then making a turn to the left after passing over the departure end of the runway, at which point the observers lost visual contact with the aircraft on account of the weather conditions.

Moments later, the aircraft crashed into the ground.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Third parties
Fatal	2	5	-
Serious	-	-	-
Minor	-	-	3
Uninjured	-	-	-

1.3 Damage to the aircraft.

The aircraft was completely destroyed.

1.4 Other damage.

Substantial damage to several buildings located near the point of impact.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Captain	Copilot
Total	6,235:55	5,279:45
Total in the last 30 days	53:00	54:40
Total in the last 24 hours	00:42	00:42
In this type of aircraft	130:05	95:45
In this type, in the last 30 days	53:00	54:40
Inthis type, in the last 24 hours	00:42	00:42

N.B.:The information on the flight hours is based on the crew's personal records, as well as on the records contained in the BIMTRA (Air Traffic Movement Database) generated by the DECEA (Airspace Control Department).

1.5.2 Professional formation.

The captain earned his private pilot license (airplane category) in 1994, and started his aviation career in the City of Maringá, State of Paraná. He earned a commercial pilot license (airplane category) in 1995,and an Airline Transport Pilot (airplane category) in 2001. In 2005, he earned a HelicopterPrivate Pilot License.

In 2008, he started operating Cessna C525 Citation Jet - CJ aircraft as a copilot for an air taxi company. In 2010, he underwent pilot-in-command training and, at the same time, did the training of the differences in order to operate Cessna C525A CJ2 aircraft.

In 2011, he completed a C525 and C525A aircraft flight instructor training program, and started training to become a pilot of Cessna CE 560XLS aircraft. His training for becoming captain in this type of aircraft was completed in 2012.

The copilot did the course to earn a Private Pilot License (PPL) and a Commercial Pilot Certificate from the Federal Aviation Administration (FAA) atAirMates Flying Club Inc., in Atlantic City,New Jersey,USA in 1994. In 1997, he earned an IFR rating and an AMEL certificate at the ATP Flight School, in Richmond,Virginia,USA.

In 1999, he was accredited as Ground Instructor by the FAA, and in 2005 he was qualified as a Flight Instructor also by the FAA (ASEL category).

Still in 2005, he did a Commercial Pilot course (airplane category) and an IFR Flight course at the Flying Club of BragançaPaulista, State of São Paulo. He did the Cessna C525 aircraft Citation Jet - CJ ground school course at EWM Aviation in São Paulo, State of São Paulo.

In 2006, he was selected and didthe Airbus A319/320 aircraft ground school course at a regular air transport company, but did not complete the training program for not having reached the minimum levels required inthe flight simulator training, and was dismissed by the company.

In 2008, he earned an Airline Transport Pilot license (ATPL) from the FAA.

In 2012, in the USA, he did the initial Cessna C560 Encore aircraft pilot course simultaneously with the course of differences between the Encore and the Cessna C560 Citation V.

In 2013, in Brazil, he did the pertinent practice training and started flying the Cessna C560 Encore+ aircraft.

Still in 2013, he earned an Airline Transport Pilot License(airplane category) from the ANAC, equivalent to the FAA Airline Transport Pilot License (ATPL) that had been granted to him in 2008.

1.5.3 Category of licenses and validity of certificates.

The captain had an Airline Transport PilotLicense (airplane category). His technical qualification certificates relative to C560 type aircraft, AMEL and IFR rating were valid.

The copilot had an Airline Transport Pilot License (airplane category). His technical qualifications relative to C560 type aircraft, AMEL and IFR rating were also valid.

1.5.4 Qualification and flight experience.

The captain was 42 years old, and had been a pilot for twenty years. Between 2008 and 2014, he flew jet aircraft (under the RBAC 135) for air taxi companies, and accumulated 2,085 flight hours in Cessna C525, C525A and CE 560XLS, flying as a copilot and a captain.

In this period, he flew both in Brazil and abroad, and operated in several aerodromes, including Santos Air Force Base (SBST).

In May 2014, he started operating the CE 560XLS+ aircraft (PR-AFA) as a captain on general aviation flights (under the RBHA 91), accumulating a total of approximately 130 hours on the type. In this period, he conducted several IFR and VFR flights.

The copilot was 44 years old, and had also been a pilot for twenty years. Between 2012 and 2013, he operated jets on air-taxi flights (under the RBAC 135), accumulatingapproximately 200 hours on Cessna C560 aircraft (Citation V and Encore+) as a co-pilot.

In this period, he operated flights in Brazil and, at least, two flights to countries in South America. There are no records regarding any operation at SBST in this same period.

In June 2014, he started operating the CE 560XLS+ aircraft (PR-AFA) as a copilot on general aviation flights (under the RBHA 91), accumulating a total of approximately 95 hours on the type. In this period, he conducted several IFR and VFR flights.

During the periodin which both pilots operated the accident aircraft, they performed several flights to airfields that had runways with lengths between 3,300 and 930meters.

As far as meteorological conditions are concerned, the investigation commission verified that on ten occasions the pilots operated the PR-AFA under instrument flight rules. On one of these occasions, they flew in minimum conditions of ceiling and/or visibility, as shown in Table 1.

DEP ADRM	DESTINATION ADRM		DEP DATE/TIME (UTC)	ARR DATE/TIME (UTC)	RWY	1P	2P	LDG RWY LENGTH (m)	WEATHER
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SIMK	SBRF	Recife - PE	18/05/2014 16:30	18/05/2014 19:14	18	---	---	3007 X 45	18/05/2014SBRF181900Z METAR SBRF 181900Z 15012KT 9999 SCT025 BKN070 28/22 Q1011=
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SBSP	SDLU	Barra Bonita - SP	19/05/2014	19/05/2014				1400 X 25	Missing or not found...
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SBSP	SBRF	Recife - PE	25/05/2014 13:20	25/05/2014 16:18	18	**02:58**	---	3007 X 45	25/05/2014SBRF251600Z METAR SBRF 251600Z 14010KT 9999 FEW025 28/22 Q1013=
SBRF	SBSP	São Paulo - SP	25/05/2014 19:26	25/05/2014 22:34	17R	**03:08**	---	1940 X 45	25/05/2014SBSP252200Z METAR SBSP 252200Z 14005KT 5000 -RA BR BKN004 BKN009 BKN070 16/14 Q1020=
SBSP	SBBR	Brasília - DF	27/05/2014 19:30	27/05/2014 20:58	11L	**01:28**	---	3200 X 45	27/05/2014SBBR 272100Z 19004KT 9999 FEW030 26/18 Q1018=
SBBR	SBRP	RibeirãoPreto - SP	28/05/2014 10:57	28/05/2014 11:54	18	**00:57**	---	2100 X 45	28/05/2014SBRP281200Z METAR SBRP 281200Z 09004KT 5000 BR SCT010 OVC016 16/13 Q1021=
SBRP	SBSP	São Paulo - SP	28/05/2014 14:22	28/05/2014 14:59	17L	**00:37**	---	1435 X 45	28/05/2014SBSP281500Z METAR SBSP 281500Z 17010KT 140V200 9999 SCT017 BKN030 17/11 Q1023=
SBSP	SIMK	Franca - SP	29/05/2014 11:37	29/05/2014 12:30	5	**00:53**	---	2000 X 30	Missing or not found...
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SBAQ	SBGR	Guarulhos - SP	---	30/05/2014 02:31	09R	**00:30**	---	3000 X 45	30/05/2014SBGR300200Z METAR SBGR 300200Z 08007KT 9999 BKN015 14/12 Q1023=
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SBSP	SBBR	Brasília - DF	30/05/2014 20:28	30/05/2014 22:00	11R	**01:32**	---	3300 X 45	30/05/2014SBBR302200Z METAR SBBR 302200Z 18003KT 9999 SCT045 24/11 Q1019=
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SBGO	SBBR	Brasília - DF	31/05/2014 17:00	31/05/2014 17:22	11R	**00:22**	---	3300 X 45	31/05/2014SBBR311700Z METAR SBBR 311700Z 04008KT 9999 BKN035 26/14 Q1018=
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SNCS	SBJU	Juazeiro do Norte - CE	---	31/05/2014 22:58	13	**00:15**	---	1800 X 45	31/05/2014SBJU312300ZMETAR SBJU 312300Z 22002KT CAVOK 26/21 Q1016=
SBJU	SBRF	Recife - PE	01/06/2014 23:29	02/06/2014 00:17	18	**00:48**	---	3007 X 45	02/06/2014SBRF020000Z METAR SBRF 020000Z 13008KT 9999 BKN030 SCT070 27/21 Q1012=
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SBSP	SBRJ	Rio de Janeiro - RJ	03/06/2014 11:33	03/06/2014 12:11	20L	**00:38**	---	1323 X 42	03/06/2014SBRJ031200Z METAR SBRJ 031200Z 22005KT 9999 SCT025 BKN040 21/15 Q1017=
SBRJ	SBPA	Porto Alegre - RS	04/06/2014 11:42	04/06/2014 13:40	11	**01:58**	---	2280 X 42	04/06/2014SBPA041300ZMETAR SBPA 041300Z 00000KT 8000 NSC 14/10 Q1015=

DEP ADRM	DESTINATION ADRM		DEP DATE/TIME (UTC)	ARR DATE/TIME (UTC)	RWY	1P	2P	LDG RWY LENGTH (m)	WEATHER
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SBBR	SBRF	Recife - PE	07/06/2014 02:23	07/06/2014 04:44	18	**02:21**	---	3007 X 45	07/06/2014SBRF070500Z METAR SBRF 070500Z 12008KT 9999 BKN023 26/23 Q1012=
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SBRF	SBMO	Maceió - AL	21/06/2014 12:53	21/06/2014 13:21	12	**00:28**	**00:28**	2602 X 45	21/06/2014SBMO211300ZMETAR SBMO 211300Z 15005KT 9999 SCT020 24/19 Q1018=
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DEP ADRM	DESTINATION ADRM		DEP DATE/TIME (UTC)	ARR DATE/TIME (UTC)	RWY	1P	2P	LDG RWY LENGTH (m)	WEATHER
SBRF	SBSG	São Gonçalo do Amarante - RN	24/06/2014 13:14	---	---	00:25	00:25	3000 X 60	24/06/2014SBSG241400Z METAR SBSG 241400Z 20012KT 170V230 9999 SCT017 BKN080 26/23 Q1016=
SBSG	SBRF	Recife - PE	---	24/06/2014 21:12	18	00:25	00:25	3007 X 45	24/06/2014SBRF242100Z METAR SBRF 242100Z 20010KT 9999 VCSH BKN015 BKN060 23/22 Q1015=
SBRF	SBBR	Brasília - DF	25/06/2014 17:07	25/06/2014 19:46	11L	02:39	02:39	3200 X 45	25/06/2014SBBR252000Z METAR SBBR 252000Z 04003KT CAVOK 27/09 Q1018=
SBBR	SBTE	Teresina - PI	27/06/2014 17:38	27/06/2014 19:29	02	01:51	01:51	2200 X 45	27/06/2014SBTE271900Z METAR SBTE 271900Z 17001KT 9999 FEW020 FEW025TCU 35/20 Q1010=
SBTE	SBBR	Brasília - DF	27/06/2014 22:45	28/06/2014 00:50	11L	02:05	02:05	3200 X 45	28/06/2014SBBR280100Z METAR SBBR 280100Z 00000KT CAVOK 20/08 Q1022=
SBBR	SBRF	Recife - PE	30/06/2014 00:05	30/06/2014 02:30	18	02:25	02:25	3007 X 45	30/06/2014SBRF300200Z METAR SBRF 300200Z 23003KT 9999 FEW020 23/22 Q1015=
SBRF	SBBR	Brasília - DF	03/07/2014 21:00	03/07/2014 23:43	11L	02:43	02:43	3200 X 45	04/07/2014SBBR040000Z METAR SBBR 040000Z 10002KT CAVOK 21/09 Q1024=
SBBR	SBSP	São Paulo - SP	04/07/2014 14:08	04/07/2014 15:39	35R	01:31	01:31	1435 X 45	04/07/2014SBSP041600Z METAR SBSP 041600Z 01004KT CAVOK 28/09 Q1024=
SBSP	SBBR	Brasília - DF	05/07/2014 21:31	05/07/2014 23:00	11L	01:29	01:29	3200 X 45	05/07/2014SBBR052300Z METAR SBBR 052300Z 08006KT CAVOK 22/09 Q1022=
SBBR	SBRF	Recife - PE	07/07/2014 19:45	07/07/2014 22:09	18	02:24	02:24	3007 X 45	07/07/2014SBRF072200Z METAR SBRF 072200Z 15011KT 9999 FEW020 25/22 Q1018=
SBRF	SBSL	São Luis - MA	10/07/2014 10:12	10/07/2014 12:11	06	01:59	01:59	2386 X 45	10/07/2014SBSL101200Z METAR SBSL 101200Z 09011KT 9999 SCT017 28/23 Q1014=
SBSL	SBRF	Recife - PE	10/07/2014 21:24	10/07/2014 23:07	18	01:43	01:43	3000 X 60	10/07/2014SBRF102300Z METAR SBRF 102300Z 20005KT 9999 SCT023 SCT070 24/19 Q1016=
SBRF	SBSG	São Gonçalo do Amarante - RN	11/07/2014 12:20	---	---	00:25	00:25	3000 X 60	11/07/2014 SBSG 111200Z METAR SBSG 111200Z 19012KT 170V230 9999 FEW030 SCT080 27/21 Q1016=
SBSG	SBRF	Recife - PE	---	12/07/2014 00:56	18	00:25	00:25	3007 X 45	12/07/2014SBRF120100Z METAR SBRF 120100Z 19005KT 9999 FEW023 BKN060 25/23 Q1016=
SBRF	SNHS	Serra Talhada - PE	12/07/2014 19:41	---	---	00:35	00:35	1593 X 30	Missing or not found...
SNHS	SBRF	Recife - PE	---	13/07/2014 03:59	18	00:35	00:35	3007 X 45	13/07/2014SBRF130400Z METAR SBRF 130400Z 00000KT 9999 FEW010 SCT015 OVC060 23/23 Q1017=
SBRF	SBJD	Jundiaí - SP	14/07/2014 00:40	---	---	03:00	03:00	1400 X 30	Missing or not found......
SBJD	SBSP	São Paulo - SP	---	18/07/2014 14:05	35R	00:20	00:20	1435 X 45	18/07/2014SBSP181400Z METAR SBSP 181400Z 35011KT CAVOK 19/11 Q1021=
SBSP	SBJU	Juazeiro do Norte - CE	18/07/2014 16:52	18/07/2014 19:43	13	02:51	02:51	1800 X 45	18/07/2014SBJU182000Z METAR SBJU 182000Z 19004KT 9999 BKN020 32/20 Q1018=
SBJU	SBRF	Recife - PE	19/07/2014 01:21	19/07/2014 02:09	18	---	00:48	3007 X 45	19/07/2014SBRF190200Z METAR SBRF 190200Z 10010KT 9999 VCSH BKN015 SCT060 25/22 Q1018=
SBRF	SBMO	Maceió - AL	19/07/2014 12:27	19/07/2014 12:54	12	---	00:27	2602 X 45	19/07/2014SBMO191300Z METAR SBMO 191300Z 13014KT 9999 SCT025 BKN070 24/20 Q1020=

DEP ADRM	DESTINATION ADRM		DEP DATE/TIME (UTC)	ARR DATE/TIME (UTC)	RWY	1P	2P	LDG RWY LENGTH (m)	WEATHER
SBMO	SBRF	Recife - PE	19/07/2014 16:15	19/07/2014 16:40	18	---	**00:25**	3007 X 45	19/07/2014SBRF191700Z METAR SBRF 191700Z 13012KT 9999 BKN023 28/22 Q1015=
SBRF	SBJD	Jundiaí - SP	20/07/2014 00:21	---	---	**03:00**	**03:00**	1400 X 30	Missing or not found...
SBJD	SBSP	São Paulo - SP	---	20/07/2014 18:46	17L	**00:20**	**00:20**	1435 X 45	20/07/2014SBSP201900Z METAR SBSP 201900Z 16011KT 9999 FEW012 17/06 Q1024=
SBSP	SBML	Marília - SP	22/07/2014 12:30	22/07/2014 13:10	03	**00:40**	**00:40**	1700 X 35	22/07/2014SBML221300Z METAR SBML 221300Z 07015KT CAVOK 23/12 Q1023=
SBML	SBAU	Araçatuba - SP	22/07/2014 15:30	22/07/2014 17:50	05	**02:20**	**02:20**	2120 X 35	Missing or not found...
SBAU	SDAI	Americana - SP	22/07/2014 19:42	---	---	**00:35**	**00:35**	1100 X 18	Missing or not found...
SDAI	SBJD	Jundiaí - SP				**00:20**	**00:20**	1400 X 30	Missing or not found...
SBJD	SBRF	Recife - PE	---	23/07/2014 04:11	18	**03:00**	**03:00**	3007 X 45	23/07/2014SBRF230400Z METAR SBRF 230400Z 15016KT 9999 SCT023 SCT060 25/21 Q1018=
SBRF	SBSP	São Paulo - SP	25/07/2014 11:52	25/07/2014 15:08	17R	**03:16**	**03:16**	1940 X 45	25/07/2014SBSP251500Z METAR SBSP 251500Z 19005KT 9999 SCT015 BKN030 16/11 Q1021=
SBSP	SBJF	Juiz de Fora - MG	26/07/2014 15:43	26/07/2014 16:22	03	**00:39**	**00:39**	1535 X 30	26/07/2014SBJF261600Z METAR SBJF 261600Z 32003KT 4000 -DZ BCFG FEW004 BKN006 OVC070 16/15 Q1024=
SBJF	SBSP	São Paulo - SP	26/07/2014 20:51	26/07/2014 21:50	17R	**00:59**	**00:59**	1940 X 45	26/07/2014SBSP262200Z METAR SBSP 262200Z 15007KT 9000 OVC005 14/11 Q1023=
SBSP	SBVT	Vitória - ES	29/07/2014 12:29	29/07/2014 13:59	23	**01:30**	**01:30**	1750 X 45	29/07/2014SBVT291400Z METAR SBVT 291400Z 21011KT 9999 4000SW -RA FEW010 BKN025 OVC070 21/17 Q1028=
SBVT	SBBR	Brasília - DF	30/07/2014 01:22	30/07/2014 03:06	11L	**01:44**	**01:44**	3200 X 45	30/07/2014SBBR300300Z METAR SBBR 300300Z 17004KT CAVOK 19/12 Q1026=
SBBR	SBNF	Navegantes - SC	30/07/2014 20:25	30/07/2014 22:15	07	**01:50**	**01:50**	1701 X 45	30/07/2014SBNF302200Z METAR SBNF 302200Z 04005KT 9999 FEW030 20/18 Q1023=
SBNF	SBPA	Porto Alegre - RS	31/07/2014 02:26	31/07/2014 03:11	11	**00:45**	**00:45**	2280 X 42	31/07/2014SBPA310300Z METAR SBPA 310300Z 00000KT 3000 BR FEW005 BKN060 16/15 Q1020=
SBPA	SBPK	Pelotas - RS	01/08/2014 12:28	01/08/2014 13:01	24	**00:33**	**00:33**	1980 X 42	01/08/2014SBPK011300Z METAR SBPK 011300Z 32005KT 5000 -TSRA BR FEW030 FEW040CB OVC100 18/18 Q1014=
SBPK	SJRG	Rio Grande - RS	01/08/2014 19:04	---	---	**00:10**	**00:10**	1500 X 30	Missing or not found...
SJRG	SBSP	São Paulo - SP	---	02/08/2014 00:47	35L	**01:45**	**01:45**	1940 X 45	02/08/2014SBSP020100Z METAR SBSP 020100Z 01002KT CAVOK 21/10 Q1021=
SBSP	SDJA	Itirapina - SP	02/08/2014 13:53	---	---	**00:20**	**00:20**	1400 X 21	Missing or not found...
SDJA	SDSC	São Carlos - SP	---	02/08/2014 15:15	20	**00:10**	**00:10**	1600 X 45	Missing or not found...
SDSC	SBRF	Recife - PE	02/08/2014 17:32	02/08/2014 20:18	18	**02:46**	**02:46**	3007 X 45	02/08/2014SBRF022000Z METAR SBRF 022000Z 13011KT 9999 FEW025 SCT100 26/21 Q1016=
SBRF	SBJU	Juazeiro do Norte - CE	02/08/2014 21:07	02/08/2014 21:58	13	**00:51**	**00:51**	1800 X 45	02/08/2014SBJU022200Z METAR SBJU 022200Z 20006KT 9999 FEW021 29/16 Q1018=
SBJU	SBRF	Recife - PE	03/08/2014 04:34	03/08/2014 05:26	18	**00:52**	**00:52**	3007 X 45	03/08/2014SBRF030500Z METAR SBRF 030500Z 11008KT 9999 FEW025 25/20 Q1016=

DEP ADRM	DESTINATION ADRM		DEP DATE/TIME (UTC)	ARR DATE/TIME (UTC)	RWY	1P	2P	LDG RWY LENGTH (m)	WEATHER
SBRF	SBJD	Jundiaí - SP	04/08/2014 02:00	---	---	03:00	03:00	1400 X 30	Missing or not found...
SBJD	SBSP	São Paulo - SP	---	04/08/2014 20:12	35R	00:20	00:20	1940 X 45	04/08/2014SBSP042000Z METAR SBSP 042000Z 31010KT CAVOK 28/06 Q1018=
SBSP	SBRJ	Rio de Janeiro - RJ	05/08/2014 11:39	05/08/2014 12:16	20L	00:37	00:37	1323 X 42	05/08/2014SBRJ051200Z METAR SBRJ 051200Z 18004KT 4500 -RA BR FEW008 BKN012 BKN040 19/18 Q1025=
SBRJ	SBBR	Brasília - DF	05/08/2014 23:32	06/08/2014 01:03	11L	01:31	01:31	3200 X 45	06/08/2014SBBR060100Z METAR SBBR 060100Z 21003KT CAVOK 22/07 Q1023=
SBBR	SBSP	São Paulo - SP	07/08/2014 00:24	07/08/2014 01:45	17R	01:21	01:21	1940 X 45	07/08/2014SBSP070200Z METAR SBSP 070200Z 08005KT CAVOK 15/07 Q1025=
SBSP	SBSV	Salvador - BA	07/08/2014 16:41	07/08/2014 18:55	17	02:14	02:14	1518 X 45	07/08/2014SBSV071900Z METAR SBSV 071900Z 16014KT 9999 SCT015 FEW020TCU BKN070 25/18 Q1019=
SBSV	SBRF	Recife - PE	07/08/2014 19:47	07/08/2014 20:53	18	01:06	01:06	3007 X 45	07/08/2014 SBRF 072100Z 14005KT 9999 SCT023 SCT060 24/20 Q1017=
SBRF	SNAL	Arapiraca - AL	08/08/2014 12:23	---	18	00:25	00:25	930 X 18	Missing or not found...
SNAL	SBRF	Recife - PE	---	08/08/2014 19:47	18	00:25	00:25	3007 X 45	08/08/2014SBRF082000Z METAR SBRF 082000Z 14010KT 9999 BKN023 26/22 Q1016=
SBRF	SBJP	João Pessoa - PB	09/08/2014 13:38	09/08/2014 14:02	16	00:24	00:24	2515 X 45	09/08/2014SBJP091400Z METAR SBJP 091400Z 13011KT 9999 FEW010 BKN020 24/21 Q1018=
SBJP	SNTS	Patos - PB	09/08/2014 16:20	---	---	00:25	00:25	1600 X 30	Missing or not found...
SNTS	SNCS	Campos Sales - CE	09/08/2014	09/08/2014		00:35	00:35	1200 X 30	Missing or not found...
SNCS	SBRF	Recife - PE	---	09/08/2014 23:59	18	00:55	00:55	3007 X 45	10/08/2014SBRF100000Z METAR SBRF 100000Z 20007KT 5000 -RA BKN008 BKN060 23/22 Q1017=
SBRF	SBJD	Jundiaí - SP	11/08/2014 00:21	---	---	03:00	03:00	1400 X 30	Missing or not found...
SBJD	SBSP	São Paulo - SP	---	11/08/2014 19:04	35L	00:20	00:20	1940 X 45	11/08/2014SBSP111900Z METAR SBSP 111900Z 29004KT CAVOK 27/03 Q1019=
SBSP	SBRJ	Rio de Janeiro - RJ	12/08/2014 00:16	12/08/2014 00:55	02R	00:39	00:39	1323 X 42	12/08/2014SBRJ120100ZMETAR SBRJ 120100Z 32004KT CAVOK 24/16 Q1017=
SBRJ	**SBST**	**Santos - SP**	**13/08/2014 12:21**	---	**20L**	00:42	00:42	**1390 X 45**	**13/08/2014 SBST131300Z METAR SBST 131300Z 23007KT 3000 RA BR BKN008 OVC032 19/18 Q1022 RERA=**

	Data not recorded in the system, but inferred based on legs of earlier and subsequent flights.
---	Data not recorded in the system
	Ceiling and visibility above the required for VFR operations.
	Ceiling and/orvisibility below the required for VFR operations, and above the required for IFR operations
	Ceiling and/or visibility at the minima required for IFR operations.
	Information not available in the REDEMET database.
00:00	Flight time calculated from the times of departure and landing.
00:00	Flight time calculated based on the expected aircraft performance relative tothe leg flown.

ICA 100-12
10.3 AERODROME WEATHER MINIMA
10.3.1 The aerodrome weather minima for VFR operations are the following:
a) CEILING—450m (1,500 feet); and
b) VISIBILITY —5,000 meters

10.3.3 the Aerodrome weather minima for IFR approach operations are those contained in the respective AIP MAPIFR approach procedures in accordance with the aircraft category.

Table 1 – Data relative to the PR-AFA movements between 17 May and 13 August 2014 extracted from the BIMTRA.

There are neither records nor accounts concerning operation of the CE 560XLS+ (PR-AFA) in SBST by the pilots composing the same crew before the date of the accident. Nor was it possible to determine whether they had, as a crew, performed and/or trained the missed approach procedure on that type of aircraft.

1.5.5 Validity of medical certificate.

The pilots had valid aeronautical medical certificates (CMA).

1.6 Aircraft information.

The aircraft belonged to Cessna Finance Export Corporation. According to the ANAC's Brazilian Aeronautical Registry, it had been leased to and was being operated by AF Andrade Empr. e Participações Ltda.

The aircraft had the following features: low wing, all metal, conventional tricycle landing gear, pressurized cabin, powered by two turbofan engines (PW545C). The flaps, speedbrakes, landing gear, 2-position horizontal stabilizer, and thrust reversers were electrically controlled and hydraulically actuated, while the primary flight controls (roll, pitch and yaw) were controlled by means of cables.

The secondary flight controls were electrically actuated. The aircraft was also equipped with a three-axis autopilot. Its maximum takeoff weight was 20,200 pounds; Number of seats: 2 + 8; Total Hours Flown as of 16 July 2014: 434.5 hours; Total Cycles as of 16 July 2014: 392.

The aircraft was equipped with an Enhanced Honeywell Mark V System, an Enhanced Ground Proximity Warning System (EGPWS), an L3 Communications Cockpit Voice Recorder, and a Pratt & Whitney Canada Data Collection Unit (DCU) installed on each engine.

The aircraft (SN560-6066) was manufactured by Cessna Aircraft Company in 2010.

It was registered as a Private Aircraft in the Brazilian Aeronautical Registry (Private Air Services category). Its Airworthiness Certificate was valid until 22 February 2017.

The airframe and engine logbook records were up-to-date.

The last inspection of the aircraft ("Annual Maintenance Inspection - AMI") was done at the Japi Aeronaves workshop (certified by the ANAC) in the municipality of Jundiaí, State of São Paulo on 14 February 2014. The aircraft flew 30 hours and 10 minutes after the inspection with validity up to 14 February 2015.

In this inspection, the following services were provided: replacement of the main landing gear breath vent, AD2012-26-15, AD2013-09-11, SL-27-20 560XL, 560XL SL-27-05; washing of the compressors; inspection of the engines (“1,000 hours/12 months”); “250-hour” inspection; replacement of the nose landing gear tire, NDT of the nose-wheel.

1.7 Meteorological information.

The GOES-12 Meteorological Satellite images show a cold front approaching the State of São Paulo, as can be seen in Figures 1 to 6. The images are sequential in half-hour intervals from 11:00 UTC until 13:30 UTC, respectively, from 08:00 until 10:30, local time (Brasilia Standard Time).

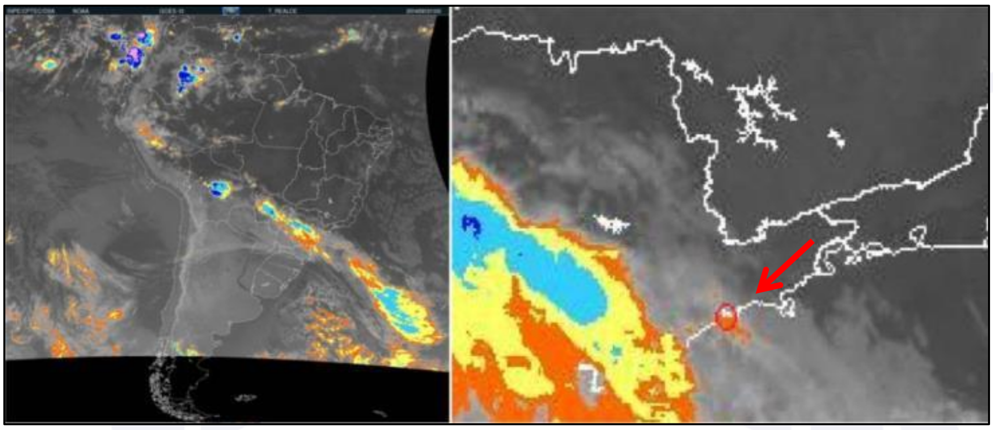


Figure 1 – 11:00 UTC Satellite Image - Zoom of the crash site (red circle).

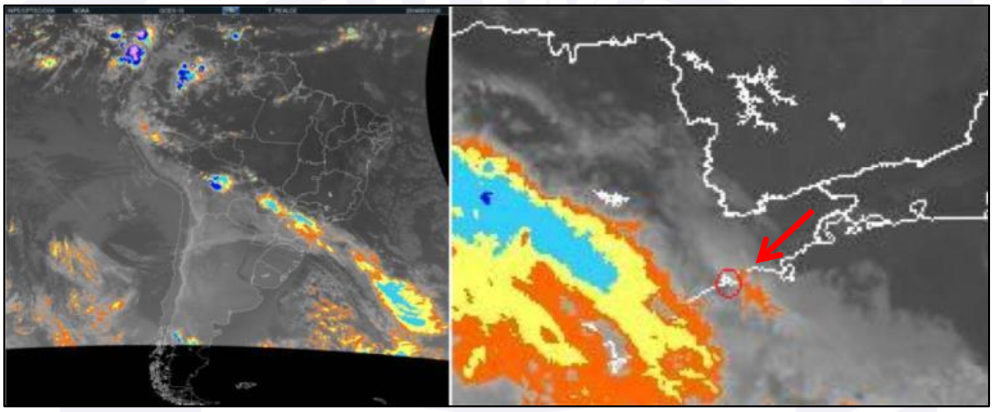


Figure 2 – 11:30 UTC Satellite Image - Zoom of the crash site (red circle).

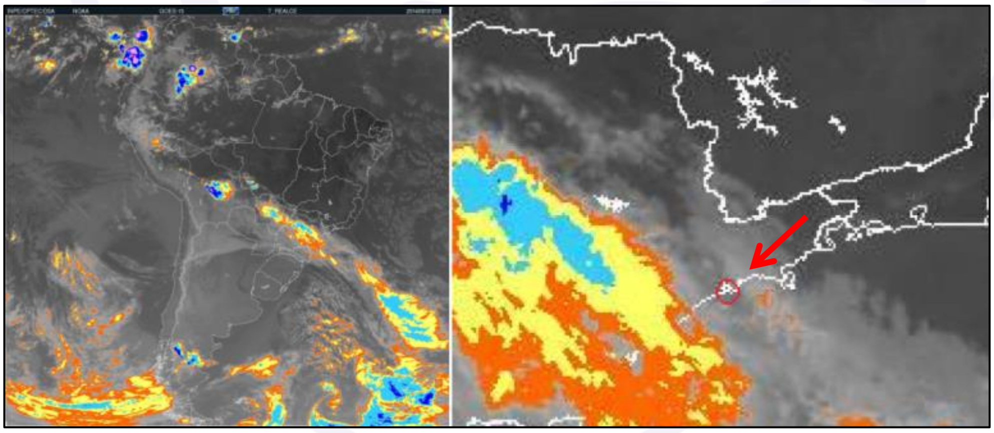


Figure 3 – 12:00 UTC Satellite Image - Zoom of the crash site (red circle).

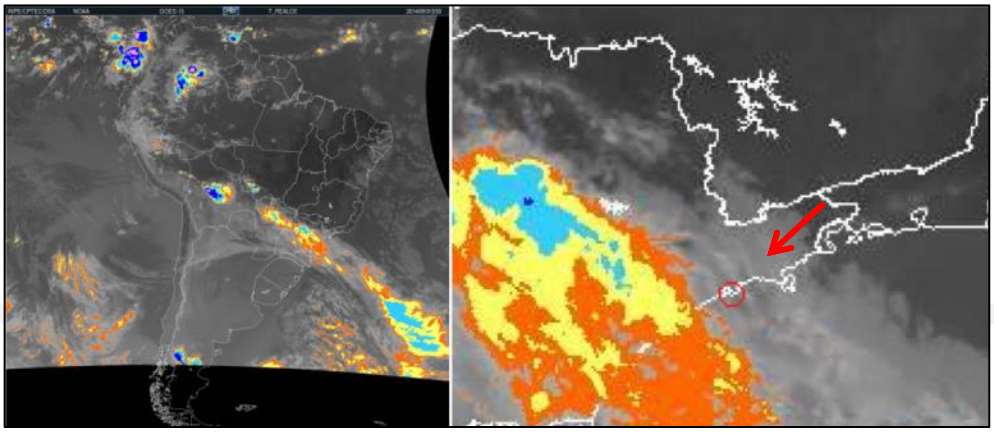


Figure 4 – 12:30 UTC Satellite Image - Zoom of the crash site (red circle).

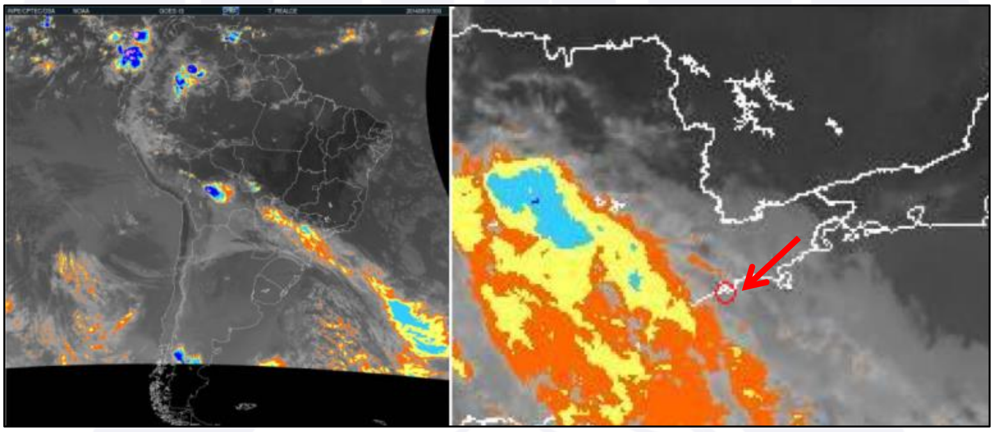


Figure 5 – 13:00 UTC Satellite Image - Zoom of the crash site (red circle).

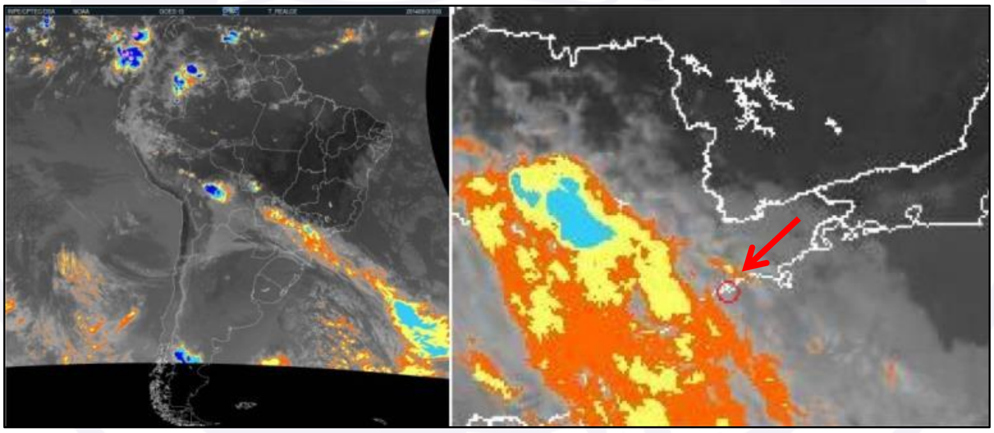


Figure 6 – 13:30 UTC Satellite Image - Zoom of the crash site (red circle).

The nebulosity over the municipality of Santos consisted predominantly of stratus/stratocumulus type low altitude stratiform clouds, covering more than half the sky from 11:00 UTC until 13:30 UTC, as shown in the figures above.

Weather reports (METAR) made by meteorological observers of the Ground Meteorological Stations (EMS) of SBRJ and SBST are shown below:

13/08/2014 SBRJ 131100Z METAR SBRJ 131100Z 21018G28KT CAVOK 26/17 Q1015 WS R02=

13/08/2014 SBST 131100Z METAR SBST 131100Z 00000KT 8000 BKN022 BKN070 20/20 Q1018=

The SBRJ and SBST 11:00 UTC weather reports show that both aerodromes were in VMC conditions, that is, there were no meteorological restrictions for takeoff and landing operations under visual flight rules (VFR).

> 13/08/2014 SBRJ 131200Z METAR SBRJ 131200Z 27020G30KT CAVOK 27/18 Q1017=
>
> 13/08/2014 SBST 131200Z METAR SBST 131200Z 20006KT 4000 RA BR BKN018 BKN070 20/19 Q1019=

The 12:00 UTC SBRJ METAR showed that the weather conditions remained good, without restrictions in terms of ceiling and visibility, with a surface wind at 20kt, gusting to 30kt. On the other hand, the 12:00 UTC SBST METAR reported rain associated with mist, restricting visibility to 4km at Santos Ground Meteorological Station (EMS-ST). The ceiling was determined by broken clouds at 1,800ft. At that moment, SBST was already operating IFR on account of a visibility of less than 5km.

> 13/08/2014 SBST 131300Z METAR SBST 131300Z 23007KT 3000 RA BR BKN008 OVC032 19/18 Q1022 RERA=

The 1300 UTC SBST METAR presented considerable degradation of the weather. The wind was light, visibility was reduced to three kilometers (3km) due to moderate rain associated with mist, with broken clouds at eight hundred feet (800ft.) and sky overcast at 3,200ft.

> 13/08/2014 SBST 131400Z METAR SBST 131400Z 22008KT 2000 RA BR BKN008 OVC070 18/17 Q1023 RERA=
>
> 13/08/2014 SBST 131500Z METAR SBST 131500Z 22009KT 2000 RA BR BKN008 BKN070 17/17 Q1024 RERA=
>
> 13/08/2014 SBST 131600Z METAR SBST 131600Z 22008KT 6000 -RA BKN010 BKN020 16/15 Q1024 RERA=
>
> 13/08/2014 SBST 131700Z METAR SBST 131700Z 23006KT 7000 -RA BKN011 OVC023 16/15 Q1025=
>
> 13/08/2014 SBST 131800Z METAR SBST 131800Z 19004KT 8000 -RA BKN012 OVC023 16/15 Q1024=

After 13:00 UTC, the rain continued falling steadily until 18:00 UTC, with intensity ranging from moderate to light, and the ceiling varying from eight hundred to twelve hundred feet.

The Aerodrome Weather Forecast for SBST (TAF SBST) was prepared by Guarulhos Meteorological Center (CMA-GR), with a prognostic of rain and mist, visibility reduced to four kilometers (4km), and ceiling of seven hundred feet (700ft) between 12:00 UTC and 22:00 UTC, indicating the possibility of degradation of the SBST weather parameters. The above mentioned forecast was issued and made available to users at 08:15 UTC (05:15 local time), as shown below:

> TAF SBST 130815Z 1312/1324 24015KT 6000 BKN012 TX18/1315Z TN15/1324Z
>
> PROB40 1312/1322 18015KT 4000 RA BR BKN007 BECMG 1322/1324 17010KT BKN008 RMK PGS=

Additionally, the Area Meteorological Forecast (GAMET) prepared by CMA-GR contained visibility and ceiling restrictions for Sectors 5 and 6, valid from 12:00 UTC until 18:00 UTC. It should be noted that Sector 5 (Figure 7) covers the municipality of Santos.

SBCW GAMET COR VALID 131200/131800 SBGR-SBCW CURITIBA FIR/SECTORS 5,6 AND 12 BLW FL100 SECN I SFC VIS: 4000M RA ON S5 AND S6 SIG CLD: BKN 0400/1500FT AGL ON S5 AND S6 MT OBSC: SERRA DO MAR SECN II PSYS: NIL

WIND/T: S5 AND S6-2000FT 180/10KT PS21 5000FT 210/18KT PS11 10000FT 0/25KT PS09

S12-2000FT 330/10KT PS23 5000FT 340/15KT PS25 10000FT 320/15KT PS10

CLD: BKN SC 1500/5000FT AGL S OF S23 FZLVL: ABV 10000FT AGL MNM QNH: 1016 HPA VA: NIL=

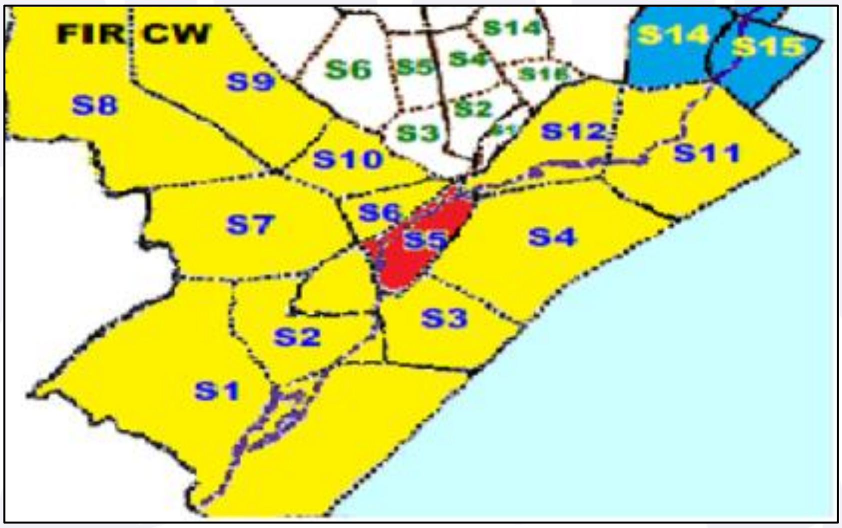


Figure 7 – Sector 5 (highlighted in red) includes the municipality of Santos.

The Meteorological Surveillance Center of Curitiba (CMV-CW) issued the SIGMET alert number 6 valid between 10:30 UTC and 13:30 UTC on 13 August 2014, available for consultation on the REDEMET website, forecasting convective cells moving northeast at an average speed of 12kt, as shown below:

SBCW SIGMET 6 VALID 131030/131330 SBCW - SBCW CURITIBA FIR EMBD TS FCST WI S2805 W04450 - S2010 W05808 - S1750 W05743 - S2052 W05042 - S2330 W04656 – S2645 W04346 - S2805 W04450 TOP FL420 MOV NE 12KT WKN=

The graphic representation of the area dealt with in the SIGMET-6 message indicated possibility of stricter weather restrictions to the west of the municipality of Santos (in red, at the bottom left side of Figure 8).

Figure 8 – Graphic representation of the SIGMET 6 (validity 131030 UTC - 131330 UTC).

Below, the evolution of the weather conditions is related to specific times of the PR-AFA flight between SBRJ and SBST:

a) ATC clearance request – 12:06 UTC

The 11:00 UTC satellite image (Figure 1) shows an active Cold Front in the Southeastern region. There was a stratiform cloud layer over the municipality of Santos. At that time, the METAR indicated the presence of mist, with horizontal visibility of 8km, and a ceiling resulting from broken clouds at2,200ft.

At 12:00 UTC, the aerodrome was operating in the presence of rain associated with mist, and the horizontal visibility diminished to 4km. The height of the base of the cloud layer changed to 1,800ft.

b) From actual departure time (12:21 UTC) until the time of the accident (13:03 UTC)

Between 12:00 UTC and 13:00 UTC, horizontal visibility reduced considerably (3km). The ceiling also had a considerable reduction to 800ft on account of moderate rain associated with mist.

c) After the accident, at approximately 13:03 UTC

Between 13:00 UTC and 15:00 UTC, rain continued falling steadily, and horizontal visibility was further reduced to 2km. After 15:00 UTC, rain was still falling; however, horizontal visibility increased to 5km, and the ceiling varied between 1,000ft. and 1,200ft.

From the information above, it is possible to observe that around the time of the accident (13:03 UTC), SBST was operating under important weather restrictions, with rain and mist significantly affecting both visibility and operational ceiling from 12:00 UTC onwards. Such unfavorable weather conditions lasted more than eight hours in a row.

Figure 9 – Visual comparison of meteorological conditions over the crash site (indicated by the arrow) in two different moments: shortly after the accident (left) and on the day after (right). In the left image, it is possible to see the smoke generated by the aircraft after the crash.

The TAF/GAMET Weather Forecasts valid from 12:00 UTC showed possibility of degradation of the visibility and ceiling parameters on account of rain associated with mist, encompassing the period of duration of the flight, especially in the area of interest.

1.8 Aids to navigation.

An IFR approach procedure is a series of predetermined maneuvers performed with the assistance of aircraft instruments, containing specific protection against obstacles, from the initial approach fix or, when applicable, from the start of an arrival route, up to a point from which it is possible to make a landing or, if the landing is not made, up to a position where criteria for a holding procedure or obstacle clearance enroute are applied.

For IFR aircraft operations in SBST, the aerodrome had a non-precision approach procedure, that is, an IFR approach procedure in which the crew relied just on horizontal guidance, and there was no provision of vertical guidance. The marker of the procedure was a Non-Directional Beacon (NDB), for landing on runway 35. The procedure was identified as ECHO 1 (published by the DECEA on 23 September 2010). Under certain conditions, the procedure allowed aircraft to “turn around” and land on runway 17 (Figure 10).

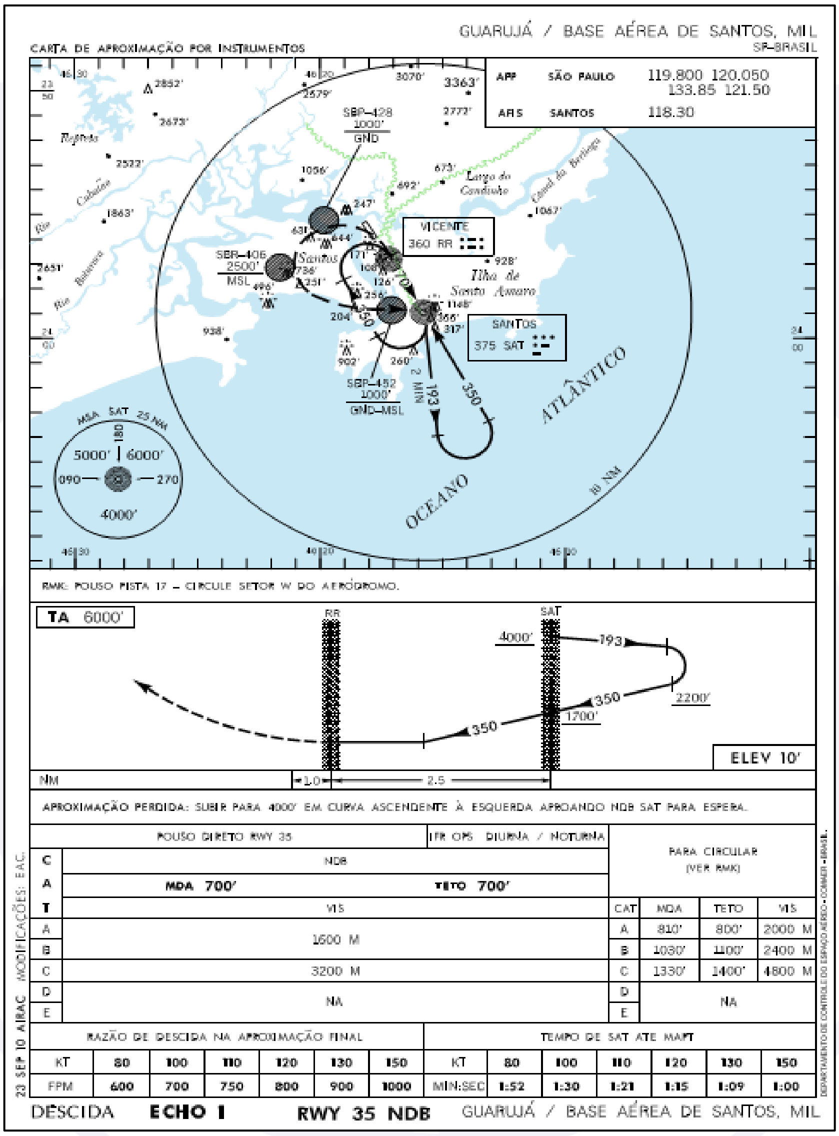


Figure 10 – IFR ECHO 1 RWY 35 NDB Descent of 23 Sept. 2010.

For compliance with Brazilian regulations, and in accordance with the Brazilian Inflight Inspection Manual (MANINV-BRAZIL) of 30 July 2014, the aids to navigation available at SBST were inspected by the Special Inflight-Inspection Group (GEIV) shortly after the accident.

This inflight inspection revealed that all aids to navigation were operative throughout the accident aircraft flight, with the exception of the Vicente Non-Directional Beacon (RR NDB).

Thus, a technical team from the São Paulo Regional Flight Protection Service (SRPV-SP) was called to inspect the aids to navigation. They verified that the shelters of the two navaids inspected in SBST (SAT NDB and RR NDB) were duly sealed.

The SRPV-SP technical team verified that the transmitter number 2 of SAT NDB, which is the main Fix of the IFR ECHO 1 RWY 35 NDB approach procedure, and that had been inspected in flight by the GEIV shortly after the accident, had been operating uneventfully all the time.

As for the RR NDB, the SRPV-SP technical team found that the equipment had switched off, a condition made evident by the recorded alarm signal after commutation due to lack of an identification code. Such alarm signal could be visualized in the radio beacon equipment, but was not being transmitted to Santos Flight Information Service (Santos Radio).

This inoperative condition corroborated with what had been found during the inflight inspection by the GEIV shortly after the accident; however, it was not possible to determine the date and exact time at which the equipment became unavailable for use, since there was no remote monitoring of the navigational aid in question by the ATS unit, nor any reports by users concerning inoperability or malfunctioning of the RR NDB on the first days of August.

The technicians identified that the equipment was inoperative because the TONE selector switch was in the OFF position in both transmitters. Thus, the position of the TONE selector switch was changed for restoring identification.

Then, readings of the levels of modulation, direct and reflected power for the 2 (two) transmitters of the equipment were performed by the technicians. From the results obtained, the RR NDB technical conditions of operation were considered adequate. The navaid was subjected to a new inflight inspection by the GEIV, with a satisfactory result, and its normal operating condition was restored.

According to inoperability records kept by the Rio de Janeiro Park of Electronic Materials of Aeronautics (PAME-RJ), the last condition of inoperability of the RR NDB was registered on 16 October 2013 due to a failure of the main transmitter, with a high reflected power in the main and reserve transmitters. The problem of inoperability was solved, and operation of the navaidwas resumed on 25 November 2013. After that date, there are no records of any problems with the equipment.

Specifically in relation to Aid to Navigation equipment, the Doc 8071 of the International Civil Aviation Organization (ICAO) sets out the parameters to be verified, the tolerances to be applied, and the frequency with which the parameters have to be inspected. Thus, maintenance services were provided to the RR NDB in accordance with the manufacturer’s manual guidelines, and with the Technical Bulletin of the SAT NDB, which has procedures similar to the ones of the RR NDB, and in conformity with the ICAO Doc 8071.

It was verified that the routine maintenance activities were performed by the DTCEA-ST on a weekly basis, with technical visits (inspections) to the sites where the navaid equipment was installed, as prescribed in the Standard Action Norm (NPA) - DTCEA-ST - 01 (effective from 16 February 2011) dealing with the duties of the sectors composing the DTCEA-ST (item 2.2.4.2) and the responsibility of the Technical Section (STEC) maintenance providers (letter "J").

With regard to the RWY 35 ECHO 1 NDB IFR procedure (Figure 10), the SAT NDB is the main navigation aid and the marker in the IFR approach chart in question. The RR NDB is one of the types of references to mark the Missed Approach Point (MAPT).

Nevertheless, the availability of the RR NDB was not essential for determining the MAPT, since this latter could be calculated by means of the Table of Time and Speed (located at the bottom right of the Instrument Approach Chart – Figure 11) whose count begins when the aircraft passes overhead the basic aid to navigation (SAT NDB).

TEMPO DE SAT ATE MAPT						
KT	80	100	110	120	130	150
MIN:SEC	1:52	1:30	1:21	1:15	1:09	1:00

Figure 11 – Table of time and speed for calculation of the MAPT of the ECHO 1 procedure.

The existence of a MAPT marker is not a requirement for the operation of NDB procedures. Most of the time, the Final Approach Fix (FAF), a MAPT marker beacon is not presented, and the MAPT is determined solely in terms of time, taking into account the respective speeds and rates of descent contained in the IFR approach chart.

The publications establishing the above mentioned criteria for the preparation of procedures are: ICAO Doc 8168 Vol. II (Chapter 5, Section, 5.5 Promulgation - Chapter 6 Missed Approach Segment) and CIRCEA 100-54.

There was radar coverage throughout the flight of the PR-AFA, from takeoff (SBRJ) up to the moment the aircraft passed 5,500ft exiting TMA-SP on its descent toward SBST, as required for the provision of radar monitoring service in those sectors.

In addition, although the aircraft was flying in G airspace (provision of Flight Information and Alert Services), the Radar System continued to detect the aircraft until it was 2.5 nautical miles short of passing overhead SAT NDB on the final approach, a point at which radar contact was lost. After the aircraft started the missed approach procedure, the radar system generated a target representation in the West sector. The representation, however, proved not dependable.

All primary and secondary air traffic radar systems work with statistical forecasts to determine the location of targets in advance. This anticipation renders detection faster and more accurate, reducing the time difference (delay) between the visualization on the radar screen and real time detection to a minimum.

For this to be achieved, a statistical forecast named Kalman filters utilized with the purpose of using measurements of quantities taken over time (contaminated with noise and other uncertainties), and generate results that tend to get close to the real values of the measured quantities and associated values. The application to RADAR makes it useful in terms of statistical probability of the future position of a target at a given time.

For the Kalman filter to be effective, one must utilize at least three statistical data of position for the sequence to be reliable, that is, before one can confirm the initialized digital target representation as a real target, one has to have three confirmations of the possible target. After an initial assessment, the filter is able to accurately estimate the future positions of the aircraft in flight. The same holds true for the finalization of a digital representation after a lack of detection: usually, one to three radar sweeps are necessary for the filter to ‘understand’ that the target no longer exists, and interrupt the extrapolation of future positions.

The Kalman filter works with noise-contaminated forecasts, which are very common in radar systems due to external factors and temperature (thermal noise). In order to make detection even more accurate, another forecast (conditional probability) is used which is a mechanism to rationalize the result of an experiment from partial pieces of information.

This type of probability stipulates a condition for that particular target to be considered true in the temporal region of the radar reception by means of mathematical statistics in a variable ratio between 10^{-3} and 10^{-6} confirming the accuracy of the information between the random points of noise.

In this particular case, the investigation commission verified that the recording scenario difference between the ATC systems of the APP-SP and ACC-CW was explained by the difference of the radar sensors which compose the radar synthesis of each one of the ATC units aforementioned, in addition to their different processing logic.

On account of the aspects presented, the PR-AFA radar data recorded by the APP-SP and ACC-CW ATC systems after the aircraft flew over Santos Air Base runway were not considered as accurate.

1.9 Communications.

According to the transcripts of the recordings, the crew maintained continuous radio contact with the air traffic control units. There were no reports of any technical abnormalities involving the communication equipment throughout the flight.

The communications between PR-AFA and GND-RJ, TWR-RJ, and APP-RJ were done in a coordinated, clear manner. Nothing of significance was reported in this respect.

While enroute, after being handed over from APP-RJ to APP-SP, the aircraft crew made an initial call, and stated that they were maintaining FL240. APP-SP instructed them to fly to SAT NDB direct and call back when ready for descent.

The PR-AFA, still in contact with APP-SP, called Santos Radio, stating that they were in contact with APP-SP, and requested SBST weather conditions. Santos Radio reported that SBST was operating IFR, wind 210 degrees at 7 knots, altimeter setting 1021, and said that there was no information of any other traffic. They finally requested PR-AFA to inform when released by APP-SP.

Then, PR-AFA called APP-SP to inform that they were at the ideal point of descent, and informed that they had two-way radio contact with Santos Radio.

APP-SP cleared PR-AFA to descend to FL100, and the crew made a correct readback of the message. While the aircraft was descending, APP SP instructed the PR-AFA aircraft to call the adjacent sector of APP-SP on the frequency 134.900 MHz. In the sequence, the PR-AFA called the adjacent sector of APP-SP, stating that they had already passed FL200,descending to FL100. APP-SP cleared PR-AFA down to FL090.

From that moment on, the PR-AFA aircraft reported to APP-SP that they intended to perform the ECHO 1 procedure to land on runway 35, and said that they would cross SAT NDB, and orbit until crossing the fix again. APP-SP affirmed to be aware of the PR-AFA crew's intentions, and cleared the aircraft to descend to 6,000ft on a QNH of 1022 hectopascal.

PR-AFA called APP-SP to report reaching 6,000 ft. "with visual references”, and requested to change to the Santos Radio frequency. APP-SP instructed PR-AFA to change definitively to the Santos Radio frequency of 118.300 MHz.

The aircraft operating at Santos Aerodrome were provided with AFIS (Aerodrome Flight Information Service). The AFIS was designed to provide information that would ensure the efficient movement of air traffic in approved or registered non-controlled aerodromes.

According to the legislation in force at the time, the AFIS was provided by a station of aeronautical telecommunications located at the aerodrome and identified as "RADIO". The aeronautical telecommunications station provided aerodrome traffic with flight information service as well as alert service. The AFIS was provided to all traffic operating on the movement area and to all aircraft flying in the lower airspace within a radius of 27NM radius (50km) around the airfield.

The PR-AFA aircraft was the only traffic operating within the limits of the airspace under the responsibility of Santos Radio at that moment.

The limits were established in an Area Route Chart (ARC), but the control handovers were made before or after the aircraft reached these limits, depending on operating agreements or coordination of traffic.

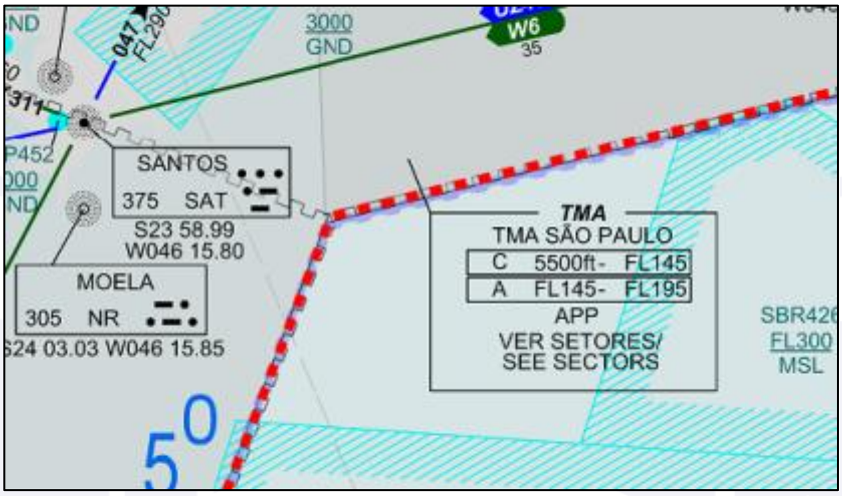


Figure 12 – Extract of the ARC - TMA SP.

In the ARC extract above (Figure 12), it is possible to observe that the lower and upper limits of the TMA-SP (airspace under the responsibility of APP-SP) in the region of Santos were 5,500ft. and FL195, respectively. In other words, an aircraft flying below 5,500ft. would be traveling in G airspace, in coordination with ACC-CW. In this airspace, according to the NOTAM E1842 / 2014 (Figure 13), valid at the time of the accident, the aircraft would only call ACC-CW in case of emergency.

```
SBCT E1842/2014 NOTAMR SBCT E0814/2014
Q)SBCW/AFXX/IV/NBO/E /000/999/2521S04949W999
A) SBCW - /FIR CURITIBA,
B) 27/05/14 18:27 - C) 25/08/14 23:59
E) FIR CURITIBA:
   1 - O VOO VFR OPR NO ESPACO AEREO DE CLASSE G NOS SECT
   1,2,3,4,5,6,9,10,11 E 12 DA FIR CURITIBA.
   1.1 - SOMENTE EM EMERG DEVERA CONTATAR O ACC-CURITIBA
   1.2 - CASO POSSUA EQPT RDO COMUNICACAO DEVERA MONITORAR A
   FREQ DO SECT CORRESPONDENTE AO ACC-CURITIBA
   2 - O VOO VFR REALIZADO NOS SECT 7 E 8 DA FIR CURITIBA DEVERA
   EFETUAR, CASO POSSUA EQPT RDO, CONTATO COM O ACC-CURITIBA)
   DT EXPED: 27/05/14 18:27 STATUS: REPLACED BY E2714/2014 ORIGEM:
   SBCTZXBN
```

Figure 13 – SBCT E1842/2014 NOTAM.

Since the service provided by an AFIS is flight information, any maneuvers performed by aircraft are under responsibility of the crew, who must inform the Radio about the positions of the aircraft during VFR and IFR approaches (first pass overhead the fix, second pass overhead the fix, outbound track, procedure turn, and final approach) as described in published official charts, so that the Radio is able to provide the information service appropriately.

Thus, when the aircraft passed FL060 during the descent, APP-SP instructed PR-AFA to call Santos Radio, transferring the responsibility for the aircraft to Santos Radio.

Upon establishing definitive radio contact with Santos Radio, the PR-AFA aircraft informed that they were descending from 6,000ft to 4,000ft after having been released by APP-SP. Santos Radio acknowledged, and reported that the wind in SBST was 240 degrees at 7kt, the aerodrome was operating IFR, the altimeter setting was 1021, and that there was no other known traffic. Santos Radio then requested PR-AFA to report crossing SAT NDB at 4,000ft, which was the altitude provided in the official chart for the start of the IFR approach procedure. The PR-AFA aircraft answered the message with a “roger”.

Then, PR-AFA reported crossing SAT NDB, and informed that they would report crossing SAT NDB again. Santos Radio acknowledged receipt of the message.

Later, the PR-AFA crew reported that they had just crossed SAT NDB anew, and that they were already on the approach “35”. Santos Radio answered with a “roger” and warned the PR-AFA crew of the possibility of birds over the runway threshold, as well as of fauna along the runway. It also informed that the wind was 230 degrees at 11 kt. Then, it asked PR-AFA to report reaching the Minimum Descent Altitude (MDA) at 700 ft. The PR-AFA acknowledged.

Sometime later, the PR-AFA called Santos Radio and said: "the *FauFo* .... Alpha Fox Alpha is going around. OK? ". Santos Radio asked whether they would make a go-around, and the answer was affirmative.

Santos Radio acknowledges receipt of the PR-AFA message, and asked whether they would make a new attempt to land. The PR-AFA said: "due to the conditions, we will su ...- *eehh* - .... we will wait and…and... call again, okay?"

This was the last recorded transmission from the aircraft to Santos Radio. In the sequence, the Radio made sixteen (16) attempts to contact the aircraft. There was no reply.

In the communications between PR-AFA and Santos Radio, the aircraft never made any calls to report a contingent emergency condition being experienced by the crew or to request any sort of priority or additional support.

The Command of Aeronautics’ Instruction (ICA 100-37) - Air Traffic Services, dated 18 November 2013, items 7.7 and 7.7.4. –“Basic Information Provided to Aircraft by an Aerodrome Information Service” - establishes that the basic pieces of information provided to aircraft by an aeronautical telecommunications station are the following:

> a) meteorological information related to landing and takeoff operations, including SIGMET information;
>
> - surface wind direction and strength, including any significant variations;
>
> - altimeter setting (QNH), rounded down to the nearest whole hectopascal value;
>
> - air temperature;
>
> - representative visibility in the takeoff and initial climb sectors or in the approach and landing sectors, if less than 10 km, or the RVR current value(s) corresponding to the runway in use;
>
> - significant weather conditions in the takeoff and initial climb sectors, or in the approach and landing sectors; and
>
> - current weather conditions, as well as quantity of clouds, along with height of the base of the lowest layer of clouds for aircraft making an approach under IMC;
>
> b) pieces of information to allow the pilot to select the best runway to use. Such pieces of information may include, in addition to wind direction and speed, the runway and the traffic pattern used by other aircraft, and, when requested by the pilot, the length of the runway and/or the distance between an intersection and the end of the runway;
>
> c) known information about aircraft, vehicles, or people in or near the maneuvering area, as well as about aircraft operating in the vicinity of the aerodrome and that could pose risk to the aircraft receiving the information;
>
> d) information on the aerodrome conditions essential for the safe operation of the aircraft:
>
> - construction or maintenance work in the maneuvering area, or in areas adjacent to the maneuvering area;
>
> - irregular or damaged portions of the runway or taxiway surface(s) whether marked or not;

- water on the runway;

- parked aircraft;

- other occasional hazards including flocks of birds on the ground or in the air;

- defect or irregular operation of a portion/all of the entire aerodrome lighting system; and

- any other relevant information.

e) information about changes in the operating status of visual and non-visual aids essential to aerodrome traffic;

f) VHF-DF information, when the control unit has such equipment in operation;

g) messages, including clearances, received from other ATS units to be relayed to the aircraft; and

h) other information capable of contributing to safety.

As a matter of fact, during the exchange of communications between PR-AFA and Santos Radio, the following items were not informed: the SIGMET 6 issued by CMV-CW, as well as the ceiling and visibility prevailing at the aerodrome.

It was also observed that during the exchange of communications between the PR-AFA aircraft and Santos Radio, the crew never questioned Santos Radio on the missing pieces of information, which would be important as far as crew judgment of the existing conditions during the approach and landing was concerned, considering that at the first contact with the Radio the crew received information that the aerodrome was operating under IMC conditions.

1.10 Aerodrome information.

The runway in SBST is paved with asphalt, measuring 1,390 m x 45 m, at an elevation of 10ft. Thresholds are 17/35.

SBST is a military aerodrome under the administration of the Command of Aeronautics. It Operates VFR and IFR during day- and night-time.

The Northeast (NE) and East (E) sectors of the aerodrome feature natural elevations as high as 3,363 ft., as shown in Figure 14.

Figure 14 – Elevations in the North-East and East sectors of the aerodrome.

The Port canal and the city of Santos lie to the West of the aerodrome. In this sector, there are less significant elevations of up to 736ft. (Figure 15).

Figure 15 – Area to the West of the aerodrome.

The approach axis for runway 35 has a higher obstacle represented in the navigation charts (1,148ft), as well as two lower ones at 355ft and 317ft, respectively. Before the hillocks, the axis of runway 35 is free of any natural obstacles, serving as a boundary between the continent and the Atlantic Ocean (Figure 16).

Figure 16 – Runway 35 approach sector.

Because it is an exclusively military aerodrome, the normal operation of civil aircraft, not considering the service provided in a contingent emergency, was subject to a prior request and authorization of the Air Base commander. In the case of the PR-AFA aircraft, the crew formally made the request, and authorization was granted by the commander.

1.11 Flight recorders.

Complying with the Brazilian legislation in force at the time, the aircraft was equipped with a L3 FA2100CVR (Cockpit Voice Recorder) (PN 2100-1020-02, SN 000 592 600).

This CVR in a normal operating condition is designed to store 120 minutes of voice data or any other sound in the cockpit, including audible alerts.

It is worth noting that the recording reflects the last 120 minutes in which the recorder was energized, with the latest recording replacing the older ones available in the 120-min interval, considering that the specific electronic circuits of the aircraft are working properly.

In the case of the PR-AFA, the recorder was ready to work when the switch in the cockpit connecting the recorder to an external electric power source or to its own battery was turned on. With the aircraft on the ground, every time there are persons in the cockpit providing maintenance services with the aircraft being powered with electricity (from either an external or internal source), any voices or noises will be stored in the recorder.

Similarly, in situations in which the pilots are in the cockpit in flight or on the ground performing procedures with the aircraft energized, voices and noises are recorded.

The FA2100CVR was designed to meet the ED-56A performance requirements, in addition to compliance with the ARINC 557/757A. It consists of an Underwater Locating Device Chassis that shelters the plates and electronic circuits, and a Crash Survivable Memory Unit (CSMU), which contains the solid-state FLASH memories, used as a means of recording (Figure 17).

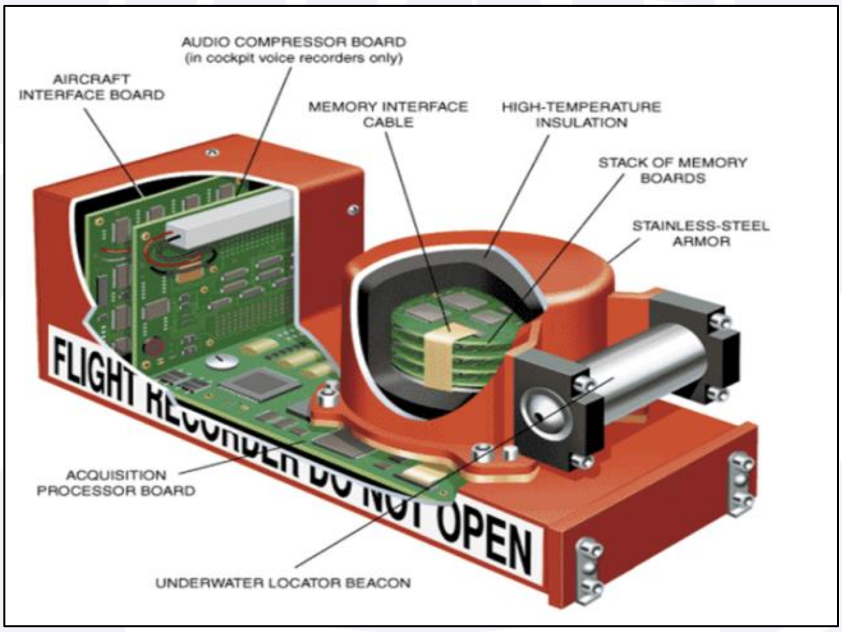


Figure 17 – FA2100 SSCVR.

This recorder can be powered either by 28-volt DC voltage, or 115-volt AC at 400 hertz , and it maintains its operating performance even if there is an interruption of that power, whose recovery takes place in a period not exceeding 200 milliseconds.

The equipment was found in the crash site (Figure 18), and sent to the CENIPA’s LABDATA (Flight Data Recorder Readout and Analysis Laboratory) on the same day. The recorder had been severely damaged due to the high energy of the aircraft impact with the ground (Figure 19).

Figure 18 – General view of the crash site, with indication of the trajectory of the aircraft (yellow line) and the place where the CVR was found after the impact.


Figure 19 – Severely damaged CVR recovered from the crash site.

After removal of the CSMU, each one of the FLASH memories (responsible for storing the 2-hour cockpit-audio recording) was examined in detail by means of a stereoscopic microscope.

Figure 20 – FA2100 SSCVR CSMU.

Although the FA2100CVR was severely damaged after sustaining the action of a force directed to the interior of the recorder, no significant abnormalities were found in the FLASH memories, components, and associated circuitry.

For each FLASH memory module, the following parameters were evaluated and validated:

Side-overhangs: The maximum values of displacement (dimension A) detected were not higher than 50% (dimension W) or .5mm (whichever is smaller).

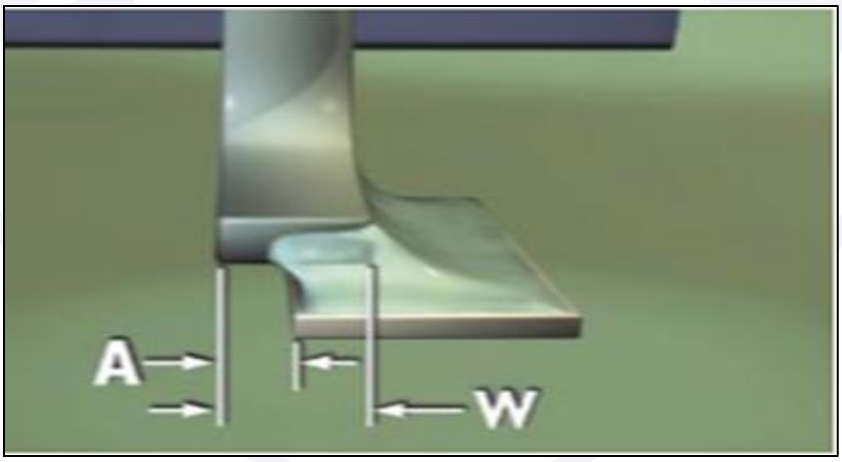


Figure 21 – Side-overhangs.

Toe-overhang: The maximum values detected did not violate the minimum distance of electric permissivity (dimension B).

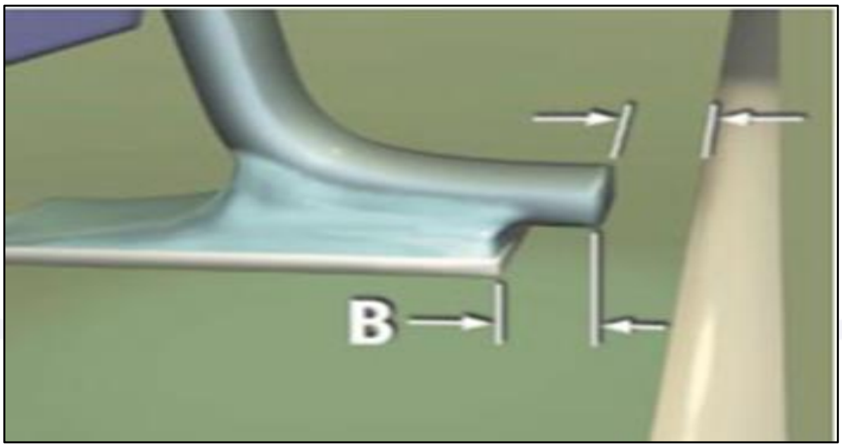


Figure 22 – Toe-overhang.

Heel Fillet Height: Although the solder is uniformly spread over the surface of the associated circuit track, favoring an appropriate attachment between the terminals of the FLASH memory and respective track, the examination did not find fractures nor points whose solder fillings had physical contact with the encapsulation of memory (dimension E).

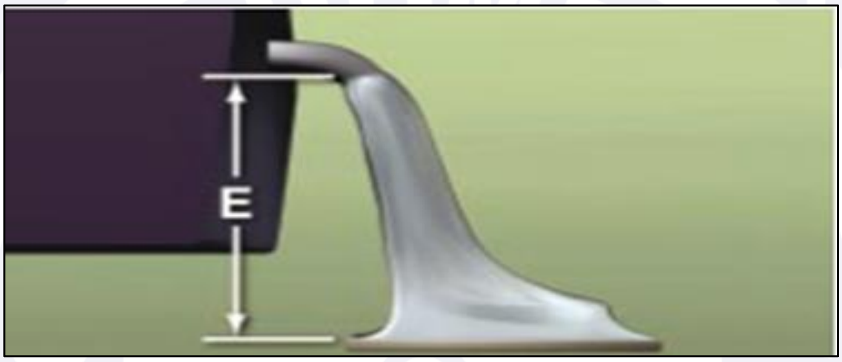


Figure 23 – Heel Fillet Height.

End-joint width: No terminals were detected whose maximum values of the contact surface (dimension C) were less than 75% of the area prescribed for the terminal attachment - associated circuit track (dimension W).

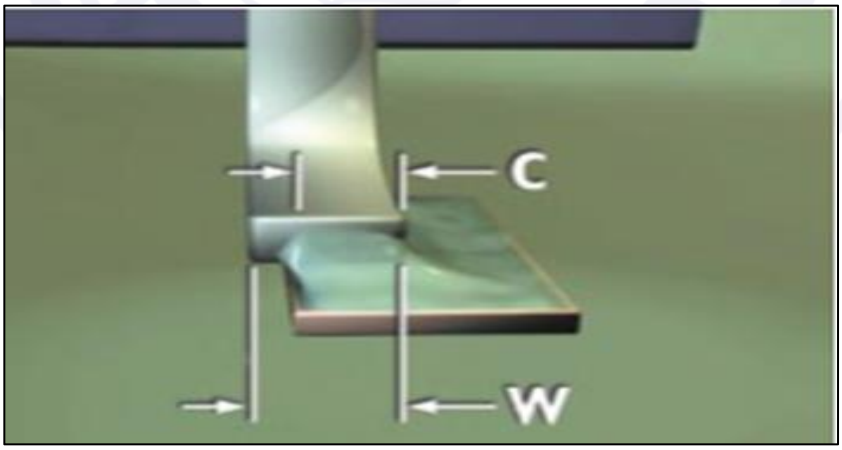


Figure 24 – Minimum End-joint width.

Side-joint length: There was no detection of terminals with signs of discontinuity of solder fillings along their length.

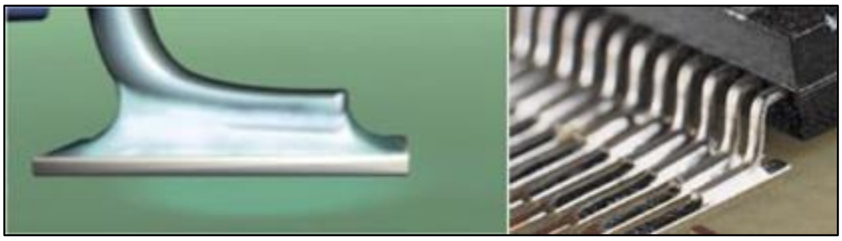


Figure 25 – Minimum Side-joint length.

It is observed, however, the need of a technical intervention for the replacement of the wiring that makes the interface between the FLASH memory modules and the Acquisition Processor Board (AP), due to the damage sustained in the accident (Figure 22).

Figure 26 – FLASH memory modules with respective wiring damaged.

The wiring, with the respective connector, was duly replaced in accordance with the procedures and techniques described in 165E1436-22 L-3 Aviation Recorders Technical Publication, manufacturer of the FA2100CVR, thus allowing the cockpit audio recording of 120 minutes to be successfully retrieved.

The FA2100CVR is used in an ARINC 557/757A configuration, whose interface with the aircraft is provided by means of a DXPB connector with 57 pinslocated on its back. This recorder is configured to receive four (04) audio channels, distributedas follows:

Channel 1 - Cockpit Spare Audio (3rd member of the crew);

Channel 2 - Copilot Audio;

Channel 3 - Pilot Audio; and

Channel 4 - Cockpit area microphone(CAM).

The audio applied to the inputs of the respective channels are duly amplified and converted into digital Adaptive Differential Pulse Code Modulation (ADPCM) so that they can be stored in the memory.

When the FA2100CVR is energized, a continuous Built-In-Test (BIT) is initialized to evaluate all the bits contained in the FLASH memories located in the CSMU.

An additional BIT is also provided when the Green Push-to-Test Button on the front panel of the control unit (S251 model) is pressed by a crew member. A green LED light, also located on the front panel of the control unit mentioned, and illuminates to indicate that manual test was successful.

It is worth pointing out that failures of Audio Recording, Failure Control Unit, and CVR Recording Mode (CVR Record Enable) are detected by pressing the "Push-to-Test" button.

The FA2100CVR also possesses a counter of the power-up's sustained by the CVR, including the date of the first power-up (Power-up ZERO) and a fault history (History Fault Log), in addition to several recurrent Built-In-Test methods, in order to ensure that the communication of a failure will be appropriately processed, recorded, and stored in a Non-Volatile Random Access Memory (NVRAM).

The Aircraft Flight Manual utilized by the Brazilian operator contains the items of information necessary for the operation of the Cessna Citation 560XLS+.

In Section III, Normal Procedures, the manual establishes that after the start-up of the engines, and prior to starting taxi, a functional test of the CVR is to be carried out (Figure 27), which consists of pressing a button on the CVR control panel in the cockpit central console (Figure 28), and check the illumination of a green light on the very panel.

Once the test button is pressed, a 620 - 660 Hz tone is generated in order to check the operation of the unit. The test tone is processed in the Audio Compressor Board (ACB), and applied to each channel individually, then stored in the memories, read and checked in relation to the respective values of frequency and amplitude.

SECTION III - OPERATING PROCEDURES
NORMAL PROCEDURES

MODEL 560XL

Before Taxi

1. AVIONICS Button . . . . ON
2. INTERIOR Button . . . . ON
3. Flight Controls/Speedbrake/Flaps . . . . Check/Set
4. Rudder Bias System . . . . Check*
5. Anti-Ice/Deice . . . . Check/Set As Required*
6. ECS. . . . . As Required
7. Pressurization Controller. . . . . Set landing field elevation
8. ATIS/Clearance/FMS . . . . As Required
9. CVR/TCAS/TAWS. . . . . Test
10. Avionics Cooling Fans. . . . . Check
11. Avionics/Flight Instruments . . . . Check/Set*
12. Lavatory Doors . . . . Latched Open
13. EICAS . . . . Check
14. V Speeds. . . . . Set

Simplified Criteria - Flaps 15° Takeoff

If the following conditions are met, the simplified performance may be used.

1. No obstacle in flight path.
2. Throttles - TO detent.
3. Anti-ice - OFF.
4. Flaps - 15.
5. Takeoff field length available - 5000 feet or longer.
6. No tailwind.
7. No runway gradient.
8. Dry paved runway.

The values to be used are as follows:

WEIGHT	20,200 POUNDS OR LESS	20,200 POUNDS OR LESS	20,200 POUNDS OR LESS
ALTITUDE OF AIRPORT	2000 FEET OR BELOW	4000 FEET TO 2001 FEET	6000 FEET TO 4001 FEET
AMBIENT TEMPERATURE	25°C OR LESS	20°C OR LESS	10°C OR LESS
V_1	102 KIAS	103 KIAS	102 KIAS
V_R	107 KIAS	107 KIAS	107 KIAS
V_2	118 KIAS	118 KIAS	118 KIAS
SINGLE-ENGINE CLIMB SPEED	160 KIAS	160 KIAS	160 KIAS

Taxi

1. PASS SAFETY Switch . . . . ON
2. Exterior Lights . . . . As Required
3. Brakes. . . . . Check
4. Steering. . . . . Check
5. Thrust Reversers . . . . Check*
6. Flight Instruments . . . . Check

3-710-12 Configuration AA FAA APPROVED 56XFMB-02

Figure 27 – Aircraft Flight Manual - CVR Test.

Figure 28 – Front Panel of the CVR control unit

After the CVR data were retrieved, the investigators found that they were related neither to the accident flight nor to previous legs. There were only conversations and noises associated with services being provided by a particular workshop.

In view of this scenario, two hypotheses were raised: there was either an internal operational failure of the CVR or the CVR was not energized.

In both hypotheses, when the Green Push-to-Test Button is pressed at the BEFORE TAXI phase, the operational test of the CVR results in failure if there is any. The results of such test are stored in the NVRAM located in the Acquisition Processor Board (AP).

Therefore, there was a need to retrieve the Fault History log recorded in the non-volatile memory.

However, due to the severity of the aircraft impact with the ground, the CVR chassis (which houses the AP with its respectiveNVRAM) was completely damaged.

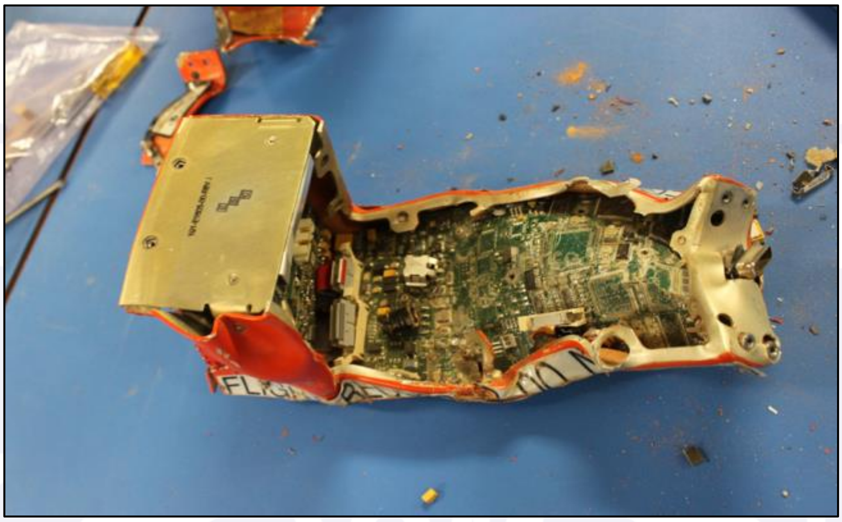


Figure 29 – Chassis damaged on account of the severity of the impact with the ground.

Since then, the LABDATA research efforts were directed to the evaluation of an effective method to retrieve the Fault History Log recorded in the NVRAM.

Through the cooperation and support between the CENIPA's LABDATA and the L-3 Aviation Recorders Product Support, with the mediation of the National Transportation Safety Board (NTSB) of the USA, full priority was given to the retrieval of the history fault log support, in the premises of the equipment manufacturer in Sarasota, Florida, with the assistance of the L-3 staff of engineers.

The procedure began with the removal of the Acquisition Processor Board (AP) in order to get access to the NVRAM, where the CVR fault logs are stored. After a detailed exam of non-volatile memory, the decision was to withdraw the chip and then install a new AP in order to continue with the process of extracting the fault log.

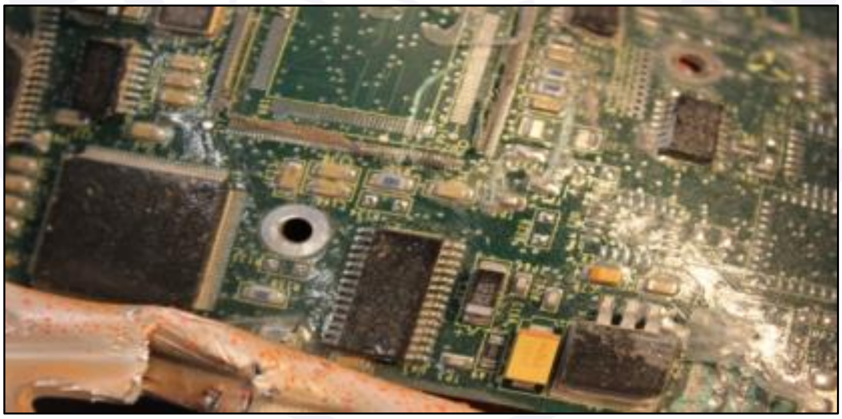


Figure 30 – Acquisition Processor Board after being removed.

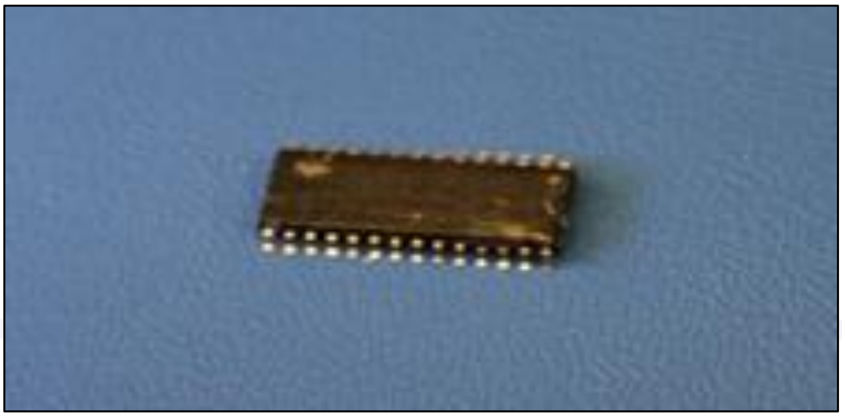


Figure 31 – NVRAM after being removed.

After the NVRAM was successfully removed, a new AP was installed for the extraction of the Fault History Log from the component.

The extraction of the fault history log was successful.

The engineers found records of the date and time of the first energization of the CVR life at the manufacture plant (Power-Up ZERO).

However, they did not find any technical evidence of failure of the CVR operation.

```
000:02:55.776  FaultMgr > >>>
000:02:55.776  FaultMgr > Flt Log Hdr = 10 words, Flt Ltch Strct = 4 words
000:02:55.776  FaultMgr > Event Log Size = 160 words, Number of Entries = 20
000:02:55.776  FaultMgr > Fault Log Size = 684 words, Number of Entries = 224
000:02:55.776  FaultMgr > Primary Entries = 214, Secondary Entries = 10
000:02:55.776  FaultMgr > Secondary Log Offset = 652
000:02:55.776  FaultMgr > The current Powerup Number is 1408
000:02:55.776  FaultMgr > Fault Log Currently Contains 2 Entries
000:02:55.776  FaultMgr > First Latched Fault (0x89d2) stored at Pwrup Num 1408
000:02:55.776  FaultMgr > >>>
000:02:55.776  FaultMgr > >>> Fault Log Follows
000:02:55.776  FaultMgr > >>>
000:02:55.808  FaultMgr > Powerup Number 0 on 02-05-2009 at 19:58:11
000:02:55.856  FaultMgr >   Fault at Minute 0, Second 0
000:02:55.856  FaultMgr >      0x89d1 LN CVRExec  Sys Error    0017  Cnt = 1
000:02:55.859  FaultMgr > >>>
000:02:55.859  FaultMgr > >>> Non-Faulting Event Log Follows
000:02:55.859  FaultMgr > >>>
000:02:56.459  FaultMgr > >>>
000:02:56.459  FaultMgr > >>> Event Log Contains 0 Active Entries
000:02:56.459  FaultMgr > End of Fault Log Dump
000:03:02.392  IdleTsk  > <<StkMon>> ----------------------------------------
```

Figure 32 – History Fault Log extracted from the NVRAM.

With the absence of evidence of an internal failure in the operation of the recorder, the investigation was directed to the possibility that the CVR was not energized from the start-up of the engines until the time of the accident.

The FA2100CVR operates at a voltage of 28 DC and in its feeding circuitry it has circuit breaker, which 'jumps' in case of overcurrent, thereby disconnecting the CVR from the feeding circuitry.

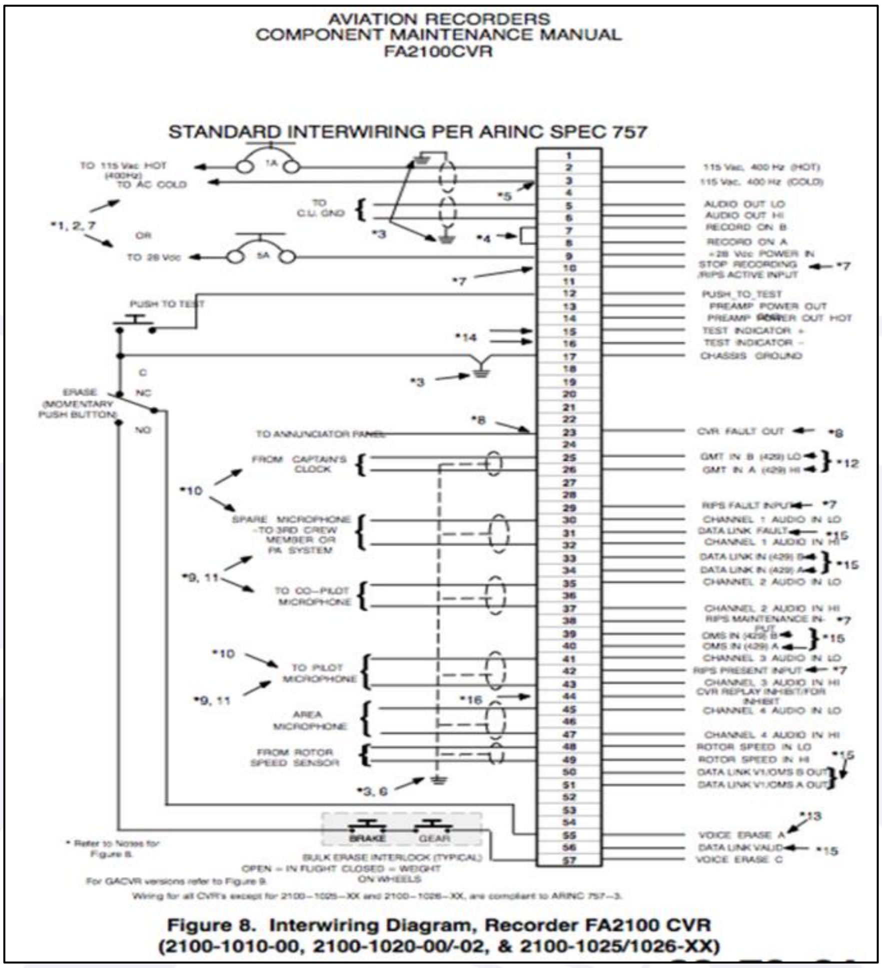


Figure 33 – Internal wiring diagram of the FA2100CVR.

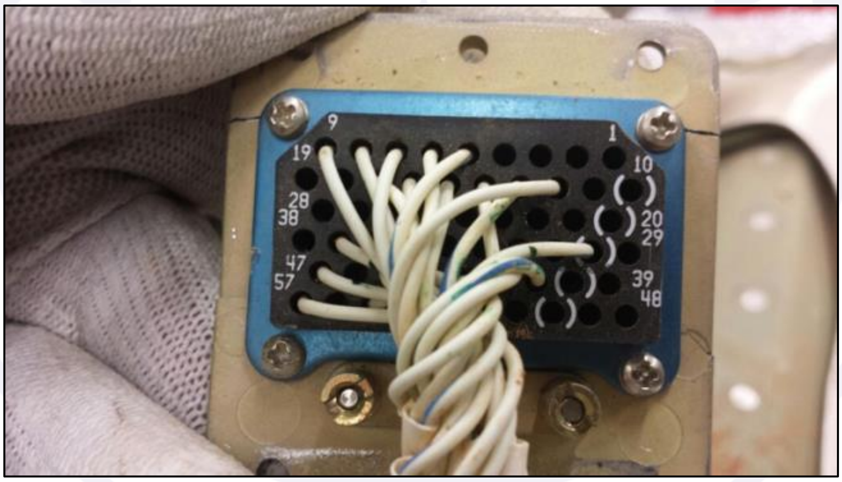


Figure 34 – Rear connector of the FA2100CVR with respective wires and pins.

In order to have access to ALL the Power-Up's to which the FA2100CVR was submitted in the last two (02) hours of recording (total storage capacity), it was necessary to scan the Raw Audio Data retrieved from the CVR by means of a special algorithm developed by L-3 Aviation Recorders.

By means of this algorithm, it was possible to identify 24 (twenty four) Power-Up's (from 1384 to 1407), and relate them to each of their respective audio intervals.

Power Up	Timestamp	GMT Seconds	Hours	Minutes	Seconds	Rotor Speed	Real TS	Bit 11	Odd Parity	Label 150	GMT Word	Raw RS1	Raw RS2	ENAB	TIME
1384	4934489	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934561	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934633	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934705	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934776	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934848	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934920	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4934992	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4934
1384	4935065	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935137	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935209	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935281	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935349	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935421	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935493	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935565	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935638	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935710	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935782	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935854	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935927	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4935999	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4935
1384	4936071	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936143	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936216	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936288	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936360	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936432	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936501	0	0	0	0	-1	1	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936573	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936645	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936
1384	4936717	0	0	0	0	-1	0	0	0	0	0x00000000	0x0000	0x0000		4936

Figure 35 – Power-Up’s recovered by means of a special L-3 Aviation Recorders algorithm.

Each Power-Up obtained by means of the special algorithm developed by L-3 Aviation Recorders was duly synchronized to the Power-Up’s contained in the audio extracted from the CVR.

Continuing with the investigation and according to the information gathered, the commission found that the aircraft had been sent to an authorized service center on 26 December 2012, where it stayed until 23 January 2013 for the provision of maintenance services.

On that occasion, the aircraft had a total 218.5 hours of operation. According to maintenance records, on 18 January 2013, the aircraft underwent a maintenance service named Task 2390-70-710 - Cockpit Voice Recorder System Operational Check. Such task was planned in the Maintenance Manual Model 560XL, which was applicable to the PR-AFA. During the provision of the service, tests are conducted that identify whether all functions of the recorder are in conformity, and the recorded content of the CVR is deleted.

The commission verified that the recorded content of the CVR was deleted on 18 January 2013, and that the most recent recording stored in the equipment was compatible with the date of 23 January 2013. Therefore, it follows that the recorded content stored in the CVR referred to the period between 18 and 23 January 2013.

A search in the aircraft maintenance records showed that the recorded data was consistent with maintenance tasks performed in January 2013, even with recognition of the voices of the technicians responsible for the work done.

The last moments of the recording contained the voices of a technician and a pilot who were performing maintenance actions in the PR-AFA's cockpit on 23 January 2013. The situations cited in the conversations were also compatible with the registrations of other aircraft that underwent maintenance services during the month of January 2013 in that workshop.

It was not possible to determine the reason why the CVR of the aircraft was no longer being energized from 23 January 2013 onwards and, as a result, stopped recording voice data.

Considering the scenario presented in the CVR, the commission verified that 18 months and 21 days had elapsed from the last recording until the date of the accident, a period in which the aircraft flew a total of 216 hours.

With the objective of getting some reference which could support a new line of investigation to clarify the factors that led the CVR to stop recording the voices and noises as observed, the commission focused on verifying proper operation of the CVR of other CE 560XLS + aircraft operating in Brazil.

According to the Brazilian Aeronautical Registry (RAB), thirteen CE 560XLS+aircraft with Brazilian registrations were being operated in Brazil.

The verification of the functioning of the CVR in these CE 560XLS+ aircraft consisted in doing the read-out of the data stored in the voice recorders remotely and check whether the content was consistent with the last two hours of operation of the recorders in accordance with the engineering design.

Teams of investigators and technicians of the CENIPA's LABDATA traveled to the various locations where each aircraft was based, and downloaded the voice data files to remote storage devices to be analyzed in the laboratory.

12 out of the 13 CE 560XLS+ aircraft operating in Brazil had their respective recorders verified, a number representing 92% of the aircraft in operation. With just one exception, all the other operators and/or owners voluntarily agreed to cooperate with the investigation voluntarily. The commission verified that the recordersof all 12 aircraft were functioning properly and in accordance with the engineering design.

It is worth to point out that the primary aircraft certification authority (Federal Aviation Administration) establishes a minimum equipment list (Master Minimum Equipment List - MMEL) which must meet certain conditions of operation so that the aircraft can be dispatched and start a flight.

In the case of CE 560XLS+ aircraft, the same model of the PR-AFA, the aircraft is allowed to start a flight with an inoperative cockpit voice recorder as long as the repairs are made in 15 days, and no more than an additional 15 days under special conditions.

The Brazilian legislation establishes the same conditions of operation. According to the "RBHA 91.609 - Brazilian Aeronautical Homologation Regulations – General Operating Rules for Civil Aircraft":

> "…in relation to the flight data and cockpit voice recorders, it is established that an aircraft operator from whom a voice recorder is required is allowed to operate the aircraft for up to 15 days with a CVR inoperative and/or removed for repair as long as the aircraft maintenance records contain a notation indicating the date of the failure and a placard is placed on the pilot's view to show that the cockpit voice recorder cabin is inoperative. And up to an additional 15 days since the above requirements are met, and a qualified pilot or an authorized person return the aircraft to service, certifying in the aircraft maintenance records that the additional time is required to complete the repair or get a replacement unit."

In accordance with instructions issued by the primary certification authority (FAA), and based on the MSG-3 Inspections - General Criteria, the manufacturer established general parameters and intervals regarding the maintenance of the aircraft and its installed components.

For the scheduled maintenance of the CVR system, as contained in the Maintenance Manual (Rev. 37) of the Model 560XL aircraft, verifications are to be conducted in order to determine whether the component (or system) is serving the prescribed purpose.

This scheduled maintenance has to be provided 24 months after the last inspection of the system. In the 24 months between inspections, the verification of the proper operation of the cockpit voice recorder is the responsibility of the crew when checklisting the normal procedures before starting the aircraft taxi (BEFORE TAXI checklist). If the recorder is inoperative and the crew does notrealize or does not notify the problem in the aircraft logbook, the CVR may remain in the inoperative condition until the expiration of the next period of 24 months.

Later, it was found that the maintenance records of the aircraft did not have any notification concerning an inoperative condition of the CVR. Nor did the workshops where the aircraft was provided withmaintenance services have any reports of abnormalities in the functioning of the voice recording system and/or of contingent corrective measures adopted. Considering the PR-AFA maintenance records, no reports were found relative to malfunction of the voice recording system.

Despite the finding that all scheduled maintenance of the aircraft was up-to-date, the cockpit voice recorder was not operating properly, that is, it stopped recording from 23 January 2013 onwards. Thus, it is possible to affirm that the aircraft did not meet the airworthiness requirements established by the Brazilian legislation in force.

The investigation of the FA2100CVR revealed that:

a) No evidence of internal operational failure was identifiedin the History Fault Log extracted from the NVRAM of the FA2100CVR;

b) The Power-Up's, obtained by means of aspecial algorithm developed by L-3 Aviation Recorders, refer to the last two (02) hours of audio extracted from the FLASH memories;

c) The Power-Up's, numbered from 1384 to 1407, and obtained by means of a special algorithm developed by L-3 Aviation Recorders, correspond to those audio transcripts extracted from the FLASH memories;

d) The last energization provided to the recorder was the Power-Up 1407 of 23 January 2013, i.e., 18 months and 21 days before the date of the accident;

e) No evidence was found that the recorder would have been energized after the Power-Up 1407;

f) No anomaly of this type was ever identified in aircraft of the same model of the Brazilian fleet; and

g) In light of the Brazilian legislation in force, the aircraft was not airworthy.

1.12 Wreckage and impact information.

The accident site was located in a densely populated residential/business area, consisting of buildings of varying heights. The main wreckage was in a courtyard located on Vahia de Abreu Street, close to number 50, immediately behind 111,AlexandreHerculano Street, Boqueirão District, Santos, São Paulo.

Impact and fire damage were observed to buildings immediately adjacent to the point of impact in the courtyard.

Inspection of the accident site revealed damage to the roof of a building. The upper surface of the concrete ceiling was located 25 feet 5 inches above ground level (location of the first impact).

The GPS coordinates of the roof edge were 23°57.568'S, 046°19.605'W.An energy path from the roof contact point to the ground impact crater was oriented on a magnetic heading of approximately 220 degrees, and the flight path angle from the roof to the ground contact point was approximately 26 degrees. The main impact crater was located at 23°57.583'S, 046°19.615'W.

A portion of the right main landing gear fairing was located on the top of the upper surface of the concrete ceiling (first point of impact); the part was located at 23°57.545'S, 046°19.595'W.

Figure 36 – Crash site looking to the northeast (NE), with the red arrow showing the point of first impact (on the roof).

Figure 37 – Trajectory from the first point of impact on the roof to the point of collision with the ground (red arrow), looking to Southeast (SE).

The left engine was recovered from the second floor of the building forward of the impact site and concentration of the wreckage (Figure 38). It exhibited heavy crushing of the diffuser, and its N2 shaft was protruding (Figure 39), while the other engine, found on the ground close to most of the wreckage (Figures 40 and 41), exhibited one impeller visible and had dirt adhered to it. Both engines and separated engine parts were secured for inspection by the investigators and the Pratt & Whitney representative.

Figure 38 – Spot where the left engine was found (red arrow) and place where the right engine and most of the wreckage were located (yellow arrow).

Figure 39 – Spot where the left engine came to rest.

Figure 40 – View of the right engine close to most of the wreckage.

Figure 41 – View of the right engine close to most of the wreckage.

Due to the high degree of damage, the wreckage items were collected for installations of SBST with the intention of separating them according to system composition for a better understanding of the marks left and of the aircraft pre-impact configuration (Figure 42 and 43).

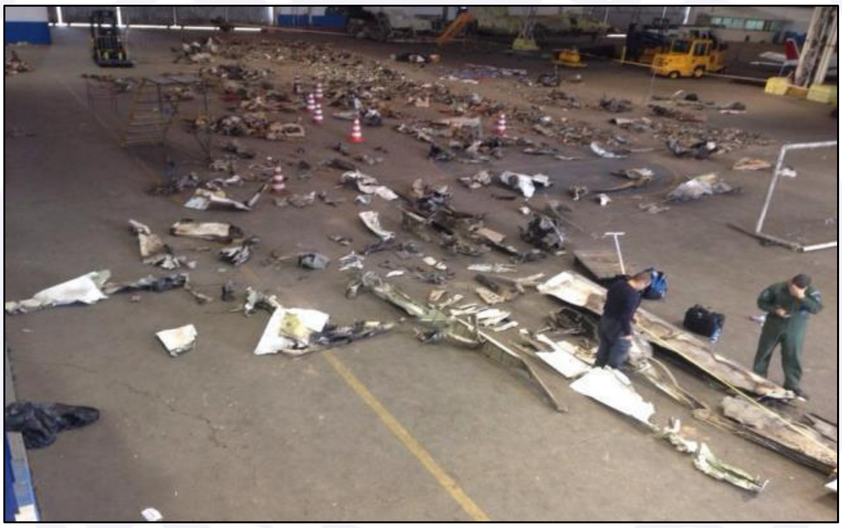


Figure 42 – Wreckage items arranged according do system composition in Hangar at SBST.

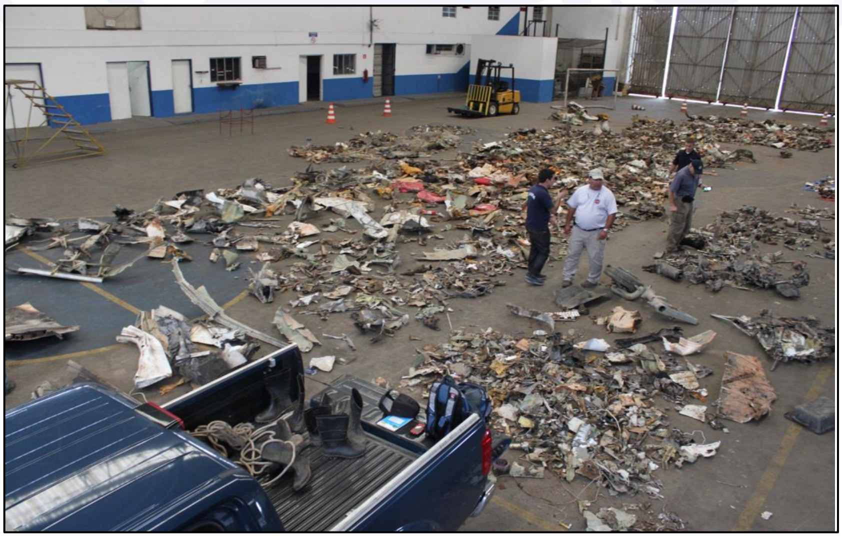


Figure 43 – Wreckage Deposited in Hangar at SBST.

The aspects observed in the examination of the wreckage are listed below:

Airframe / Flight Controls / Systems

The entire airframe was completely fragmented; the largest pieces consisted of the thrust reversers, two sections of the right wing, sections of structure and primary flight controls, both strakes, and both engines, all of which were heavily impact damaged.

The fuselage was completely fragmented. A section of fuselage with one window frame was noted.

- Left Wing

The left wing was completely fragmented, with about 35 inches of main spar from the wing attach point outboard identified. The main and aft spars were fragmented. The flaps, flap actuator, landing gear, aileron, aileron trim actuator, and speedbrakes were separated.

A recovered portion of the left aileron measured 56 inches in length, and it exhibited chordwise crushing and semi-circular indentations.

Additionally, a recovered portion of the aileron trim tab was noted to have fire damage. A portion of the wingtip measuring approximately 20 inches in length was recovered and it exhibited impacts on the leading edge but there was no evidence of soft body impacts.

The aileron trim actuator (Figure 44) had both actuation rods bent; both measured 1.750 inches extended as measured from the housing to the center of the rod end attach bolt parallel to the rod. The speedbrake actuator was retracted (Figure 45).

All of the examined fracture surfaces exhibited features consistent with overstress failures with no evidence of fatigue.

Figure 44 – Left Aileron Trim Actuator.

Figure 45 – Left Speedbrake Actuator in the retracted position.

- <u>Right wing</u>

The right wing consisted of 2 large pieces; fire and impact damage was noted to both sections. The main and aft spars were fragmented. The flaps, flap actuator, landing gear, aileron, speedbrake actuator and speedbrakes were separated.

The inboard section began at wing station (WS) 136 to WS 287, and the outboard section from WS 287 to WS 335.02, which contained the outboard aileron bracket. Impact damage was noted to the wing at WS 253, and the main spar was fractured at WS 255.

The outboard section of the wing had about 48 inches of main spar attached and 135 inches of aft spar attached. The largest piece of identified flap consisted of the outboard flap with attached flap track and push rod measuring approximately 43 inches.

The aileron was fragmented and three pieces were identified. Both aileron control cables were attached to the bell-crank near the control surface; however both cable strand separations exhibited 45 degree slant plane about 17 inches from the bell-crank attach point.

A section of lower wing skin between WS 156 and WS 171 exhibited very coarse chord-wise scratches. The speedbrake actuator was retracted (Figure 46). All of the examined fracture surfaces exhibited features consistent with overstress failures with no evidence of fatigue.

Inspection of the leading edge of both sections of right wing revealed multiple impacts; however, there was no evidence of soft body impact.

Figure 46 – Right Speedbrake Actuator in retracted position.

- <u>Vertical stabilizer / Rudder</u>

The forward and aft spars of the vertical stabilizer (Figure 47) were fragmented and separated. The canted bulkhead was fractured in several areas and was noted to be impact and fire-damaged.

The rudder was separated, fragmented into 3 pieces; a 26 inch length of trim tab remained attached. Fire damage was noted to the lower half; the counterweight was not located.

The rudder trim tab actuator (Figure 48), which was separated, was measured and found to be symmetrically extended approximately 1.7/8 inches as measured from the housing to the center of the rod end attach bolt, corresponding to be minus 1.8 degrees tab trailing edge right deflection.

The rudder bias actuator was fully extended to the right 6.3/4 inches, a control cable remained attached to the piston on the right side but the cable exhibited tension overload. All of the examined fracture surfaces exhibited features consistent with overstress failures with no evidence of fatigue.

Figure 47 – Forward and Aft Spars of Vertical Stabilizer with section of Horizontal Stabilizer attached.

Figure 48 – Rudder Trim Actuator.

- <u>Horizontal Stabilizer/Elevator/Strakes</u>

The horizontal stabilizer was fragmented, but some structure remained attached to the aft side of the forward spar at the scissor links, and the forward side of the main spar at the pivot links. The left horizontal stabilizer was separated but approximately 82 inches of it was accounted for; it was in the shape of a “V” and was displaced aft.

The main spar of the left horizontal stabilizer was fractured about 41 inches inboard of the end cap attach. The leading edge of the left horizontal exhibited a flat impact between 6 and 15 inches inboard from outboard rib, and also a semi-circular indentation between 17 and 26 inches inboard from the outboard rib.

The full span of the left horizontal stabilizer exhibited heavy chord-wise crushing, and fire damage was noted to both sections. Fire damage was also noted to main spar of the left horizontal stabilizer at the inboard end.

The left elevator was separated from the horizontal and was fragmented and heat damaged. It consisted of two pieces measuring approximately 84 inches, and was fractured 20 inches inboard from the tip. Chord-wise crushing was noted on the inboard section, which exhibited fire damage. The middle hinge and counterweight remained attached, but the trim tab and trim tab actuator were separated.

The left elevator trim tab actuator measured approximately 1.27/32 inches extended as measured from the housing to the center of the rod attach bolt. All of the examined fracture surfaces exhibited features consistent with overstress failures with no evidence of fatigue.

The horizontal stabilizer hydro-mechanical actuator (Figure 49) was separated, and no motor was recovered. One piston measured 1.19/32 inches extended while the other side measured 1.17/32 inches extended, which equates by engineering drawing to +1 degree horizontal stabilizer position. The actuator was heat damaged. The right side attach to the vertical spar has a bolt with cotter pin in place, while the left side attach was fractured.

Figure 49 – Horizontal Stabilizer hydro-mechanical actuator.

The left strake was separated at the attach point, and the outboard portion was missing; impact damage was noted. The right strake was also separated at the attach point, and impact and fire damage was noted.

Figure 50 – Left Elevator Trim Tab Actuator.

The right horizontal stabilizer was separated and fragmented, and the elevator was separated. It measured approximately 49 inches in length and exhibited heavy chord-wise crushing.

The main spar was crushed aft to the rear spar. A portion of de-ice boot remained attached. Approximately 27 inches of elevator was accounted for, it did not exhibit fire damage and the trim tab was not attached. The inboard torque tube was also recovered.

The leading edge of the right elevator was crushed aft. The elevator trim tab actuator was separated but recovered. One rod measured approximately 2.20/32 inches extended as measured from the housing to the center of the rod end attach bolt; the rod was noted to rotate freely. The other rod was bent and measured approximately 1.3/4 inches extended (did not move). The rod that was bent had a fractured rod end, but the opposite rod was full span.

The left and right actuators of the elevator trim tab were stuck on account of the impact, and their positions corresponded to zero degree and +1.8 degree, respectively.

Figure 51 – Right Elevator Trim Tab Actuator.

Inspection of elevator horn revealed a push/pull rod remained connected at the forward end, but the horn (Figure 52) was separated from the elevator torque tube. One rod remained connected to the elevator horn, but the other rod was separated; the bolt and bearing were in-place.

Figure 52 – Elevator Horn.

- <u>Cabin Entry Door</u>

The cabin entry door was completely fragmented. Pieces that were recovered consisted of the door handle, and sections of door and door frame, and a door pin.

- <u>Emergency Exit Door</u>

The emergency exit door (Figure 53) was heavily crushed forward to aft, and the upper 2/3's was crushed towards the interior. The door handle linkage was fractured, and no fire damage was noted. The door had dirt adhering to it, and the interior portion of the latch mechanism was broken.

Figure 53 – Emergency Exit Door.

- Landing Gear

All landing gears were separated but recovered. Inspection of the actuators revealed one of the main landing gear actuators was retracted. The other main landing gear actuator and nose landing gear actuators were damaged during the impact and the pistons were pulled from their respective housings. No pre-impact anomaly was observed to the recovered components.

Figure 54 – Landing Gear Components.

- Flap Actuators/Flap Interconnect/Flap Brackets

Neither flap actuator had a rod end attached, though one actuator has structure attached. That actuator was extended 14/32 inch as measured from the housing to the shiny portion of the piston and 1.17/32 inches as measured from the housing to the end of the jam nut. The other actuator was extended 20/32 inch as measured from the housing to the shiny portion of the piston and 1.24/32 inches as measured from the housing to the end of the jam nut.

Both flap actuators (Figure 55) were separated; therefore, no positional determination could be made.

Figure 55 – Flap Actuators.

The flap interconnect was separated at the left and right sides. The left side cables were fractured in tension overload and the pushrod arm was heat damaged.

The pushrod attach was also heat damaged. The right flap interconnect rod end for the pushrod remained connected, and one cable remained connected to the sector but exhibited tensionoverload. The sector at the other cable attach point was fractured.

Unidentified sections of flap with attached rod ends were found in the recovered wreckage.

Eleven of the 16 flap tracks were recovered and identified with letters (A through K) and inspected for evidence of witness marks from the rollers.

The flap trackmarked "A" had scars on the upper and lower portion of the track with approximately 7.1/2 inches forward of the aft end of the track.

The flaptrack marked “B” had scars on the upper and lower portion of the track 2 13/16 inches forward of the aft end of the track.

Flaptrack marked “C” had a scar on the upper portion of the track 5.3/4 inches forward of the aft end of the track.

Flaptrack marked “D” has scars on the upper and lower portion of the track between 1.7/16 and 1.15/16 inches forward of the aft end of the track.

Flaptrack marked “E” had a piece of flap attached; no scars were noted.

Flaptrack marked “F” had a piece of flap attached with no scars.

Flaptrack marked “G” has a scar on the lower portion of the track 5 inches forward of the aft end of the track.

Flaptrack marked “H” had a scar on the upper portion of the track approximately 10 inches forward of the aft end of the track.

Flaptrack marked “I” had scars on the upper and lower portion of the track between 1 1/2 and 2.3/4 inches forward of the aft end of the track.

Flaptrack marked “J” had no scars.

Flaptrack marked “K” had a scar on the lower portion of the track at 1 inch from the forward end.

- <u>Speedbrakes</u>

A complete section of upper speedbrake from an unidentified side was recovered, along with one section of upper and three sections of lower speedbrakes.

- <u>Seats / Interior</u>

All seat frames were fragmented.

- <u>Bleed Air, Pneumatics, and Pressurization</u>

All bleed air lines were separated from the engines and displayed thermal and impact damage. Seven (POV) pressure regulating valves were recovered.

The valves are electro/pneumatic in operation and their operating positions are affected by the lack of electricity and air pressure. Their positions as recovered have little or no investigative value.

One of two pressurization control valves was recovered with impact and thermal damage. They are electro/pneumatic in operation and recovered positions are unreliable.

Three duct outflow valves were recovered and exhibited impact damage. Both flow control valves were recovered and exhibited impact and thermal damage.

All four temperature controllers were recovered and one temperature controller was still connected to its valve; all were impact damaged. The air pressure regulator was recovered undamaged.

The condition of the recovered pneumatic system items and their method of operation resulted in limited investigative value. No pre-impact anomalies were noted to the recovered components.

Figure 56 – Bleed Air, Pneumatic, and Pressurization System Components.

Figure 57 – Bleed Air, Pneumatics, and Pressurization System Components.

- <u>Fuel System</u>

The fuel system components were fragmented in the impact sequence. One of two fuel filters was recovered; the screen and bowl were clean and free of debris. The base portion of both auxiliary fuel pumps, as well as the base and horn of 2 fragmented motive flow pumps were recovered.

Both motive flow control valves were recovered and exhibited slight impact damage; the valves were electrically operated.

Ten of the 14 fuel probes were recovered, and exhibited impact damage. All three fuel firewall shutoff valves were recovered; two were in the open position and one was 3/4 closed.

The valve location on the airplane could not be determined. The valves are electrically operated and their operating positions as recovered are not reliable.

The single point refueling port and one of two overflow prevention valves were recovered and exhibited impact damage. No pre-impact anomalies were noted to the recovered components of the fuel system.

Figure 58 – Fuel System Components.

Figure 59 – Fuel System Components.

Figure 60 – Fuel System Components.

- Hydraulic System

The hydraulic system was fragmented in the impact sequence. The hydraulic manifold with three separated electrical solenoid valves, and both thrust reverser control valves were recovered.

The reservoir, one engine driven hydraulic pump, three hydraulic filters, and the brake control valve were also recovered. The hydraulic filter screens and bowls were all clean and free of debris. The control valves are all electrically operated.

No pre-impact anomaly was noted to the recovered hydraulic system components.

Figure 61 – Hydraulic System Components.

Figure 62 – Hydraulic System Components.

- <u>Fire Detection and Extinguishers</u>

One fire bottle was impact damaged and discharged. The second bottle was damaged but retained its charge.

No pre-impact anomalies were noted to the fire control system. The fire detect system was too damaged to evaluate.

Figure 63 – Aspect of the fire extinguishing bottles.

- <u>Autopilot</u>

The autopilot system was fragmented and displayed thermal damage. All autopilot servos were recovered and exhibited impact and fire damage. In all cases the control cables were separated in tension overload, but remained secured to the servo capstans.

No pre-impact anomalies were noted to the recovered autopilot servos and control cable system components.

Figure 64 – Components of the autopilot system.

- Electrical System

The electrical system was fragmented and extensively damaged which precluded a complete evaluation. All three starter/generators and two alternators were recovered and exhibited impact and fire damage.

One bank of unidentified current limiters was recovered; all displayed intact fuses. One bank of circuit breakers with numbers 135-138, 142-144, 149-150 from the “J” box (tail cone) were recovered. No pre-impact anomaly was noted to the recovered electrical system components.

Figure 65 – Recovered wire bundle.

- Thrust Reversers

Both thrust reversers were separated and exhibited impact and fire damage. The hydraulic actuators for both were intact and in the overcenter (locked) or stowed position. No pre-impact anomalies were noted to the recovered thrust reverser components.

Figure 66 – Thrust Reverser Components.

- <u>Flight Control Cables</u>

The flight control cable system was fragmented. The cables displayed multiple tension overload separations. The observed cable ends remained secured in their fixtures which include: turnbuckles, swaged fittings, clevis terminals, bridal cable clamps, and bell cranks.

All cable securing hardware consisting of nuts, bolts, etc., were observed in place and secure. No pre-impact anomalies were noted to the observed cable components.

Figure 67 – Flight Control Cables and Components.

- <u>Avionics</u>

Avionics equipment that was recovered exhibited impact and fire damage. Most components were highly fragmented stripping the printed circuit boards from most boxes.

The only identified component of the Honeywell EGPWS consisted of an access door, and a portion of the case frame. No identifiable circuit boards attributed to the EGPWS were recovered. The CVR was recovered from the wreckage and sent to the CENIPA's LABDATA.

Figure 68 – Recovered Avionics.

Figure 69 – Layout of the avionics on the front avionics bay. Front view: see the EGPWS cover to the left of the oxygen bottle.

- <u>Throttle Quadrant</u>

The throttle quadrant was damaged in the impact rendering the throttle positions unreliable. Both piggyback control levers were in the “stowed” position. The throttle levers were forward of the idle cutoff position. The right throttle lever was slightly forward of the left.

Figure 70 – Box of the throttles.

- <u>Engines</u>

The engines separated during the impact sequence and were recovered before the teams arrival; the engine pylons were fragmented. Sections of each engine were separated, along with engine accessories.

Both Fuel Control Units were fragmented. The N2 fans were fragmented; one separated from the drive shaft. The blades separated or were bent opposite direction of travel.

Only one FADEC unit was recovered; it exhibited impact and heat damage. The other FADEC was not recovered. One of two DCU’s was recovered. It was impact damaged and will be returned to P & W for evaluation and data retrieval. One of two fuel filters and one of two hydraulic filters were recovered; the screens and bowls of both were clean and free of debris. Two of four igniter boxes were recovered with impact and thermal damage. The engines and identified separated engine components were sent to Sorocaba for examination by Pratt & Whitney representatives with CENIPA oversight. Data relative to the analysis of the engines are presented in the item 1.16 of this report.

Figure 71 – Fragmented engine components.

Figure 72 – The only DCU (left engine) found amid the wreckage.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

The PR-AFA pilots had 1st class ATP category aeronautical medical certificates. According to data provided by the medical aspect and records of the pilots health check-ups done in Brazil and in the USA, both pilots were found to be healthy in physical and mental terms and their medical certificates were valid.

Upon publication of the RBAC 67 (Requirements forGranting of Aeronautical Medical Certificates, Accreditation of Physicians and Clinics, and Agreement with Public Entities) of

9 December 2011, the then Physical Capability Certificate (CCF) was renamed to Aeronautical Medical Certificate (CMA).

The validity of the CMA, taking into account the classes, categories and age of the airmen is expressed in the referred document, as follows:

Classes	Categorias	Idade	Validade
1ª Classe	Piloto Comercial (PC) Piloto de Linha Aérea (PLA)	> 60 anos	6 meses
		Demais casos	12 meses
	Piloto Privado com habilitação IFR (PP-IFR)	< 40 anos	60 meses
		≥ 40 e < 50 anos	24 meses
		> 50 anos	12 meses
2ª Classe	Piloto Privado (PP) Comissário de Voo (CMS) Piloto de Balão Livre (PBL)	< 40 anos	60 meses
		≥ 40 e < 50 anos	24 meses
		> 50 anos	12 meses
	Operador de Equipamentos Especiais (OEE) Mecânico de Voo (MCV)	Sem limite de idade	12 meses
4ª Classe	Piloto de Aeronave Leve (CPL) Piloto de Planador (PPL)	< 40 anos	60 meses
		≥ 40 e < 50 anos	24 meses
		> 50 anos	12 meses

Nota: CMA de 3ª classe é aplicável à categoria de Controladores de Tráfego Aéreo, cuja regulação compete ao Departamento de Controle do Espaço Aéreo (ICA 63-15/DECEA).

Table 2 – Validity of the Aeronautical Medical Certificate in Brazil.

According to the Federal Aviation Administration (FAA), the American government entity responsible for the certification and regulation of civil aviation in the USA, the classes of airmen are the following:

Classes	Categorias	Idade	Validade
1ª Classe	Piloto de Linha Aérea (*ATP*) atuando como comandante Piloto de Linha Aérea (*ATP*) atuando como copiloto em operação FAR 121 onde são requeridos 3 ou mais pilotos	< 40 anos	12 meses
		≥ 40 anos	6 meses
2ª Classe	Piloto de Linha Aérea (*ATP*) atuando como copiloto em operação FAR 121 Piloto Comercial (*CP*) Controlador de Tráfego Aéreo (*ATCTO*)	Sem limite de idade	12 meses
3ª Classe	Piloto Privado (*PP*) Piloto de Aeronave Leve (*RP*) Instrutor de Voo (*FI*) Piloto Aluno (*SP*) Piloto Checador (*EX*) Qualquer categoria (*ATP, CP, PP, RP, FI*) quando realizando voo de cheque na condição de piloto checado	< 40 anos	60 meses
		≥ 40 anos	24 meses

Fonte: 14 CFR 61.23 - *Medical certificates: Requirement and duration - Federal Aviation Administration (FAA).*
Nota: *Airline Transport Pilot (ATP) / Commercial Pilot (CP) / Private Pilot (PP) / Air Traffic Control Tower Operator (ATCTO) / Recreational Pilot (RP) / Flight Instructor (FI) / Student Pilot (SP) / Examiner (EX).*

Table 3 – Validity of the Aeronautical Medical Certificates issued by the FAA

Captain:

The captain underwent his first health check-up (INSPSAU) on 27 December 1993 at CINDACTA II in order to get a 2nd class Private Pilot CCF. On 13 June 1994, again at CINDACTA II, he underwent a new initial health check-up, this time as a candidate for a Commercial Pilot License. Four years later, on 13 August 1998, he underwent an initial health check-up as a candidate for a 1st class ATP Pilot CCF.

He was considered “fit for the intended purpose” in all three afore mentioned health check-ups. The captain did his medical exams regularly (once a year), as required by the Brazilian legislation in force (RBAC 67), and always in military organizations of the Command of Aeronautics (CINDACTA II and São Paulo Hospital of Aeronautics - HASP), as well as in the USA (2010 and 2012), in order to receive the qualifications issued by the FAA.

At the health check-up of 2006, he was reported with an anxiety condition, associated with a temporary and irregular use of anti-depressants for a period of three months. On the occasion, after an evaluation by the clinical psychiatry, his case was considered solved. The use of anti-depressants was discontinued and he received medical guidance on his health condition. There are no further references to this issue in the records of his other health-checkups.

According to information gathered in post-accident interviews, the captain operated flights to Africa from September 2011 to March 2014, being exposed to endemic diseases in that continent, and even fell ill with malaria in 2012.

On the occasion, he had to return to Brazil, where he was hospitalized for treatment of the disease. There is no account of this fact in any of his health check-up records. It is a fact not related to the accident, since it occurred two years earlier. In addition, although malaria has the potential to become a serious condition, proper treatment leads to full recovery without sequelae.

In his last health check-up, done at the HASP on 28 April 2014, with validity up to 28 April 2015, the captain was considered “fit for flying”, without restrictions or recommendations.

Copilot:

In his aviation career, the copilot underwent seventeen health-checkups in the USA and six in Brazil.

His first health check-up was done in the USA on 19 November 1992 for the obtainment of a Private Pilot 3rd class certificate from the FAA (Table 3), and he was considered “fit”.

The FAA third-class certificate is equivalent to the ANAC second-class certificate. In Brazil, the 3rd class aeronautical medical certificate is regulated by the Department of Airspace Control (DECEA), and is intended solely for air traffic controllers (see Table 2).

The copilot was considered “fit” in two health check-ups done in the USA in 1995 (14 February and 14 August). However, there is no information regarding his class or category. After 1995, he did health check-ups in the following sequence: in the USA, from 1996 to 2009, and in February and August 2011; in Brazil, in the years from 2003 to 2006, as well as 2012 and 2013.

In 1997, he did a 2nd class health-checkup for a Commercial Pilot license. In 1999, he underwent a 1st class health-checkup for an ATP license from the FAA.

On 5 November 2003, the copilot did the initial health check-up as a candidate for an ATP license in Brazil. He was considered “not apt” due to the presence of a polyp in his right side maxillary sinus. Four months later, he did a new health check-up, and was considered “fit for the intended purpose”.

On 31 August 2012, the copilot did a health check-up in Brazil for the purposes of the letter "Q" (serious aeronautical incident). On the occasion, he was evaluated in accordance with the prescriptions of the ICA 160-1of 2003 and RBAC 67 of 2011, and his performance was considered “insufficient” in two intelligence tests. In addition, his performance was considered “poor” in the focused-attention test, and “average” in the diffuse-attention test.

Notwithstanding the results of copilot’s psychological evaluation, the psychiatrist (supported by the psychologist’s opinion) issued the following report:

> “adequate, calm, lucid, globally oriented, and with aggregated thought without deliriums. Memory and intelligence without deficits.Globally oriented. Psychiatric exams’ result: normal.”

Hence, the final opinion regarding the letter “Q” was “fit” (without restrictions or recommendations). The details of the psychological evaluation results are described in the item 1.13.3 of this report.

The judgment made by the psychiatrist was based on the RBAC 67, which states that only the accredited physician has the prerogative of issuing opinions and judgments for purposes of granting an aeronautical medical certificate. Therefore, he not only can but should take advantage of pertinent and necessary exams from complementary health areas. So, the psychological evaluation served just to subsidize the opinion of the psychiatrist.

The last health-checkup done by the copilot before the accident was at theCIAAR in Belo Horizonte, State of Minas Gerais, on 30 August 2013. He was considered fit for flying, without any diagnostics or remarks. His aeronautical medical certificate was valid until 30 August 2014. It was therefore valid at the time of the accident.

<u>Death certificates, necropsies, anatomopathological, radiological, toxicological exams, biochemical dosages</u>

A request was made to the Federal Police with regard to the crew’s necropsy exams and reports, however, only fingerprint technical reports were provided.

<u>Routine and general conditions of the pilots in the days preceding the accident.</u>

In the Brazilian civil aviation, the crews’ duty time is regulated by the Law 7183 of 5 April 1984, which, in its aspects applicable to the PR-AFA crew, is presented below:

> Law 7183, of5April1984
>
> Regulates the profession of aeronauts, and makes other provisions.
>
> Art. 1 The exercise of the aeronaut’s profession is regulated by the present Law.
>
> Art. 2 Aeronaut is the professional qualified by the Ministry of Aeronautics that performs activities aboard national civil aircraft by virtue of a work contract.
>
> ....
>
> Art. 11 Simple crew is the one composed, basically, of a minimum staff, complemented, whenever necessary, with additional crewmembers required for the conduction of the flight.
>
> ....
>
> Art. 20 Duty time is the duration of an aeronaut’s work period, counted from the time he/she reports to the workplace until the time the work is finished
>
> § 1º The duty time on the home base will be counted from the time the aeronaut reports to the workplace
>
> § 2º Out of the home base, the duty time will be counted from the time the aeronaut reports to the workplace defined by the employer.
>
> § 3º In the cases mentioned in the above paragraphs, the reporting to the airport must take place at least 30 minutes before the time prescribed for the start of the flight.
>
> § 4º The duty time will be considered closed 30 (thirty) minutes after the final shutdown of the engines.
>
> Art. 21 The duration of an aeronaut’s duty time will be:
>
> a) **11 (eleven) hours, when he/she composes a minimum or simple crew.**

....

Art. 22 The duty time limits may be extended up to 60 (sixty) minutes, at the exclusive discretion of the aircraft captain, in the following cases:

a) Inexistence of appropriate rest accommodations for the crew and passengers at the stopover location;

b) Excessively long waiting, at a regular intermediary location, caused by unfavorable weather conditions or provision of maintenance services; and

c) On account of imperative necessity.

(...)

§ 3º For simple crews in mixed timeperiods (day and night), the night-time hour will have 52 (fifty-two) minutes and 30 (thirty) seconds.

Art. 29 The flight time and number of landings allowed for the duty time will be as follows:

a) 9 (nine) hours and 30 (thirty) minutes of flight, and 5 (five) landings, in the case of simple or minimum crew;

....

Art. 32 Rest is a continuous time period after the duty time, in which the crewmember is under no obligation of providing any type of service.

Art. 33 Out of the home base, rest accommodation, as well as transportation to-and-from the airport are guaranteed to the crewmember

§ 1 The provision of this article will not apply to the aeronaut of air-taxi or specialized service companies when the transportation and lodging costs are reimbursed by the companies.

§ 2 When transportation is not available at the end of the duty time, the rest period will be counted from the moment transportation is made available to the aeronaut.

Art. 34 The duration of the rest period relates directly to the duration of the previous duty time period, within the following limits:

a) **12 (twelve) hours of rest, after a duty time period of up to 12 (twelve) hours**;

b) **16 (sixteen) hours of rest, after a duty time period longer than 12 (twelve) hours, up to 15 (fifteen) hours**; and

c) 24 (twenty-four) hours of rest, after a duty time period of more than 15 (fifteen) hours.

Taking into consideration the operational routine in the first days of August, the duty time periods of the accident crew corresponded to the values expressed in Table 4. For purposes of calculation, the duty time was considered to have started 30 minutes before the scheduled takeoff time.

The red highlights mark the limits (in bold type) of the Law 7183 that were extrapolated.

Workday	Date	Departure		Landing		FlightDuration		Duty Time		
		Location	Time (Local)	Location	Time (Local)	Legs	Total in theworkday	Start time	Finish time	Total
1	01/08/14	SBPA	09:28	SBPK	10:01	00:33	02:28	08:58	22:17	**13:19**
		SBPK	16:04	SJRG	16:14	00:10				
		SJRG	20:02	SBSP	21:47	01:45				
Rest period between workdays								**12:06**		
2	02/08/14	SBSP	10:53	SDJA	11:13	00:20	04:59	10:23	02:56	**16:33**
		SDJA	12:05	SDSC	12:15	00:10				
		SDSC	14:32	SBRF	17:18	02:46				
		SBRF	18:07	SBJU	18:58	00:51				
	03/08/14	SBJU	01:34	SBRF	02:26	00:52				
Rest period between workdays								**19:34**		
3	03/08/14	SBRF	23:00	---		03:00	03:00	22:30	02:30	04:00
	04/08/14	---		SBJD	02:00					
Rest period between workdays								**14:02**		
4	04/08/14	SBJD	17:02	SBSP	17:12	00:10	00:10	16:32	17:42	01:10
Rest period between workdays								**14:27**		
5	05/08/14	SBSP	08:39	SBRJ	09:16	00:37	02:08	08:09	22:33	**14:24**
		SBRJ	20:32	SBBR	22:03	01:31				
Rest period between workdays								**22:21**		
6	06/08/14	SBBR	21:24	SBSP	22:45	01:21	01:21	20:54	23:15	2:21
Rest period between workdays								**13:56**		
7	07/08/14	SBSP	13:41	SBSV	15:55	02:14	03:20	13:11	18:23	05:12
		SBSV	16:47	SBRF	17:53	01:06				
Rest period between workdays								**14:30**		
8	08/08/14	SBRF	09:23	SNAL	09:48	00:25	00:50	08:53	17:17	08:24
		SNAL	16:22	SBRF	16:47	00:25				
Rest period between workdays								**16:51**		
9	09/08/14	SBRF	10:38	SBJP	11:02	00:24	02:19	10:08	21:29	**11:21***
		SBJP	13:20	SNTS	13:45	00:25				
		SNTS	15:49	SNCS	16:24	00:35				
		SNCS	20:04	SBRF	20:59	00:55				
Rest period between workdays								**23:22**		
10	10/08/14	SBRF	21:21	---		03:00	03:00	20:51	00:51	04:00
	11/08/14	---		SBJD	00:21					
Rest period between workdays								**14:33**		
11	11/08/14	SBJD	15:54	SBSP	16:04	00:10	00:49	15:24	22:25	07:01
		SBSP	21:16	SBRJ	21:55	00:39				
Rest period between workdays								**34:26**		
12	13/08/14	SBRJ	09:21	SBST	XXX	00:42	XXX	08:51	XXX	XXX

Table 4 – Analysis of the PR-AFA crew's duty time relative to August 2014, based on the data extracted from the BIMTRA (* extendable to limit of 60min, in accordance with the Art. 22 of the Law 7183).

Notwithstanding the observation that the crew's rest period since the last leg before the accident corresponded to 34 hours and 26 minutes, it was not possible to determine whether they had adequate rest the night before the accident.

Spatial orientation

In aviation, spatial orientation is defined as the pilot's ability to correctly perceive the position of an object and the direction in which it lies, relative to a plane of standard coordinates, in this case, the surface of the earth. On the other hand, the self-orientation perception involves information fromboth the visual and somatosensory systems.

The first system relates one's own position with the position of surrounding objects. When combined with experience (memory), it builds a representation of the body in relation to these objects of the environment. In parallel, the brain receives proprioceptive and vestibular information, which tell whether the individual is standing, lying, head-down, etc. However, such information may be misunderstood in the complex and dynamic flight environment.

The normal process of spatial orientation is vitally important for human beings to have perception of where they are in time and space, so as to facilitate their movement and activities on the earth's surface. For this purpose, they are endowed with a sophisticate system which permanently feeds the brain with information on its orientation. In this way, the brain builds a composition about our relative position in the space. Most of the processes of this orientation system are unconscious, and a failure in its functioning immediately results in loss of spatial orientation.

Under normal conditions, the human being is capable of accurately determining his/her spatial orientation through the use of information provided by three specialized sensory systems (Figure 73):

a) The visual system, which provides 80% of the information on orientation;
b) The vestibular system, related to the inner ear, contributing 10% of the information; and
c) The somatosensory (proprioceptive) system, which contributes the remainder 10%.

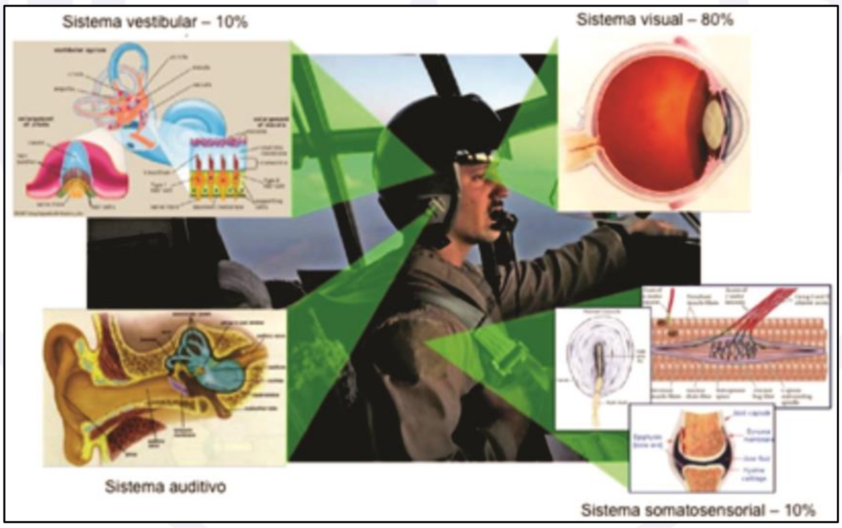


Figure 73 – Integration of the three main environment detecting sensory systems used in spatial orientation (source: *Handbook of Aerospace and Operational Physiology*, US Air Force, 2011).

The visual system is the most important of the human senses as far as spatial localization is concerned, and is sensitive to light stimuli. In addition to luminosity, an accurate vision requires the image to remain stable in the retinae in spite of head movement. This takes place by means of the vestibule-ocular reflex. This reflex detects the rotation of the head and immediately commands a compensatory movement of the eyes in the opposite direction, helping to keep the line of vision firmly focused on a visual target.

The vestibulo-ocular reflex is triggered by the vestibular afference (of the vestibulocochlear nerve). This reflex works amazingly well, even in the dark or when the eyes are shut. By means of this reflex and its effect on the movement of the eyes one is able to focus on object around, even when the objects or the very individual are moving. When this reflex is triggered by the movement of the head (vestibular system), it is called vestibular nystagmus. When it is triggered by the movement of the eye ball, it is called optokyneticnystagmus.

The vestibular system (also called balance-receiver organ) is located inside the temporal bone adjacent to the cochlea, and is one of the components of the inner year. It detects the movements originated in the head. This system consists of two distinct parts (Figures 74 and 75):

a) otolithic organs: detectors of the static position and linear acceleration of the head. There are four of them, two on each side, and are called saccule and utricle (Figure 76);

b) Semicircular canals: detectors of angular acceleration of the head. There are six in all, three on each side (Figure 77);

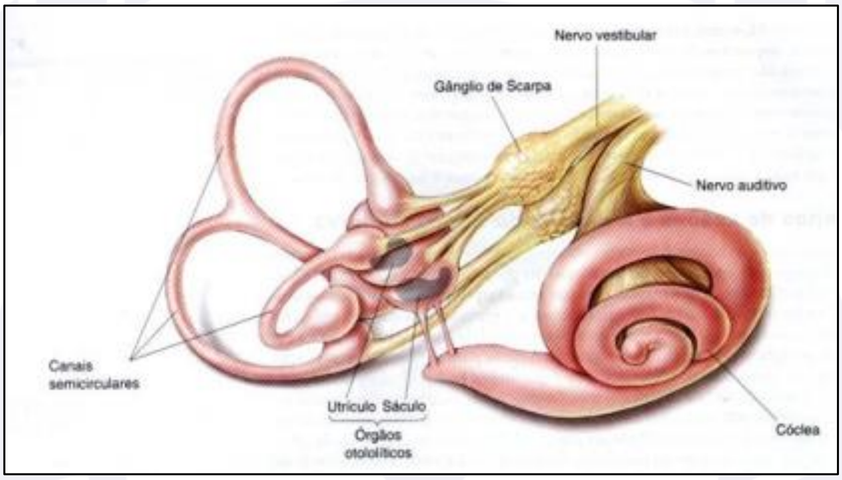


Figure 74 – Details of the vestibular system (semicircular canals and otolithic organs).

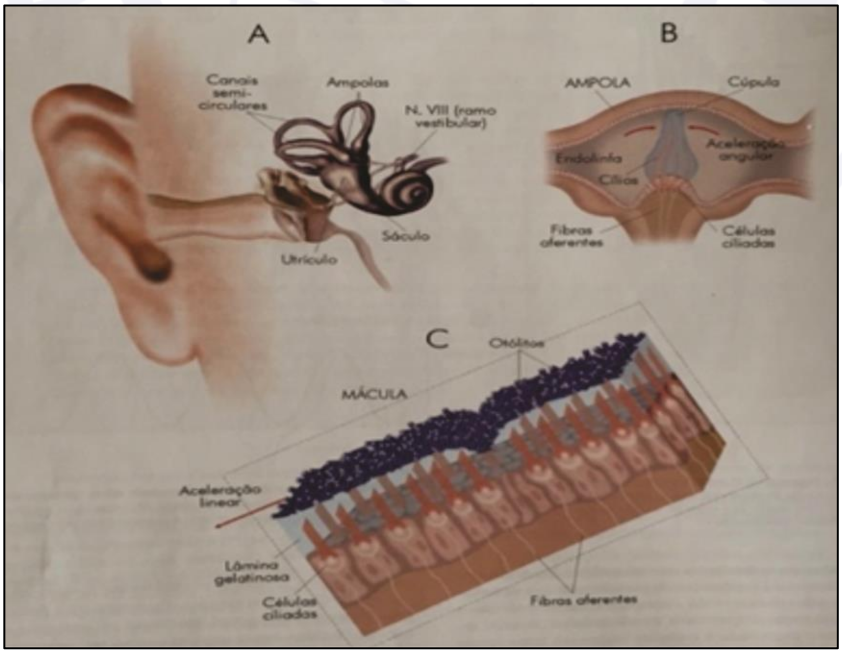


Figure 75 – Location of the vestibular system (A), ampulla of the semicircular canals (B) and otolithic organs (C).

The otolithic organs (utricle and saccule) are small dilatations containing specialized structures, cells coated by a thick gelatinous film (macula) on which thousands of mineral concretions (otoliths) are incrusted. The constant gravity action over the otoliths deflects the cilia, and generates coded information which is transmitted to the brain. An individual moving along a straightline produces a linear acceleration of the head, displacing the otoliths in an opposite direction on account of their inertia.

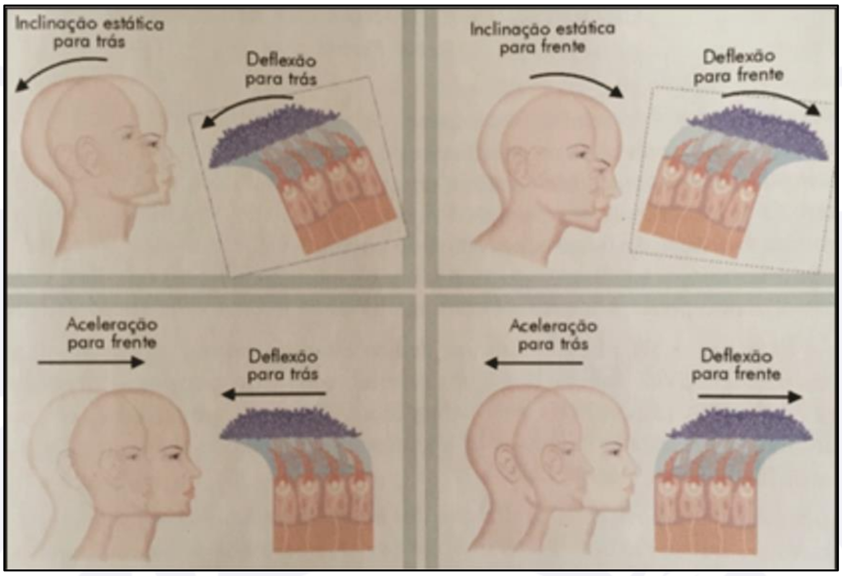


Figure 76 – Deflection of the ciles in the otolithic organs on account of gravity and linear acceleration of the head.

The three semicircular canals on each side are perpendicularly oriented relatively to each other in accordance with the three primary axes of movement (vertical posterior, vertical anterior, and horizontal), being coplanar in relation to the ones of the opposite side, and this guarantees a tridimensional abstraction of the space. Such composition ensures that any rotational spatial movement of the head be detected, provided it is above the canals stimulation threshold, which is 2º/sec^2. Each one of these canals is filled with endolymph, and has a dilatation at the end (ampulla). The ampulla houses sensory hair cells dipped in a gelatinous cupula. Every time the head is rotated in any direction, the endolymph moves within the canals in a direction opposite the inertia, and causes a mechanical deformation of the cupula. This information is sent to the brain by means of specific nerves.

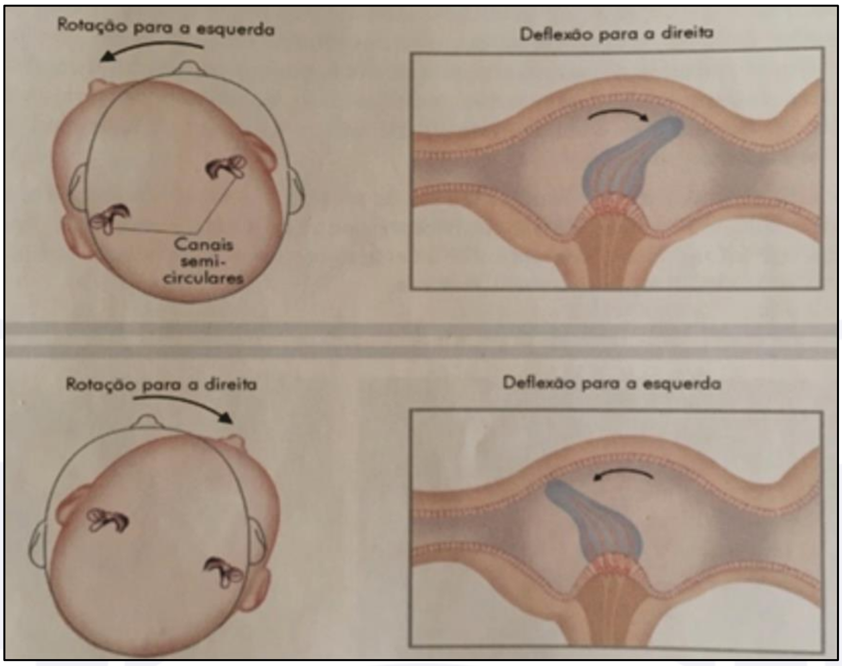


Figure 77 – Opposite deflection of the ciles in the ampulla of the semicircular canals due to inertia of the cupula.

The Somatosensory system is formed by several types of specialized receivers located in the muscles, tendons, joints, and subcutaneous tissue. In general, they do not inform the individual on his/her orientation in relation to the space, but convey information on the position and relative movement of the various parts of his/her body.

The Somatosensory system does this by means of highly specialized receivers (mostly mechano-receivers), which continually provide the brain with information on the level of muscle stretching, position of the various body joints, tension in the tendons, etc.

The most important proprioceptive information, necessary for the maintenance of balance, comes from the articular receivers of the neck. When the head is leaned in some direction by the torsion of the neck, it causes the vestibular system to give the individual a sensation of unbalance, due to the fact that the proprioceptive receivers of the cervical joints transmit signs which are in exact opposition to the signs transmitted by the vestibular system. However, when the body is deviated in a particular direction, the impulses coming from the vestibular system are not in opposition to the ones originated in the proprioceptors of the neck, allowing, in this situation, the person to have a perception of a change of position of the whole body.

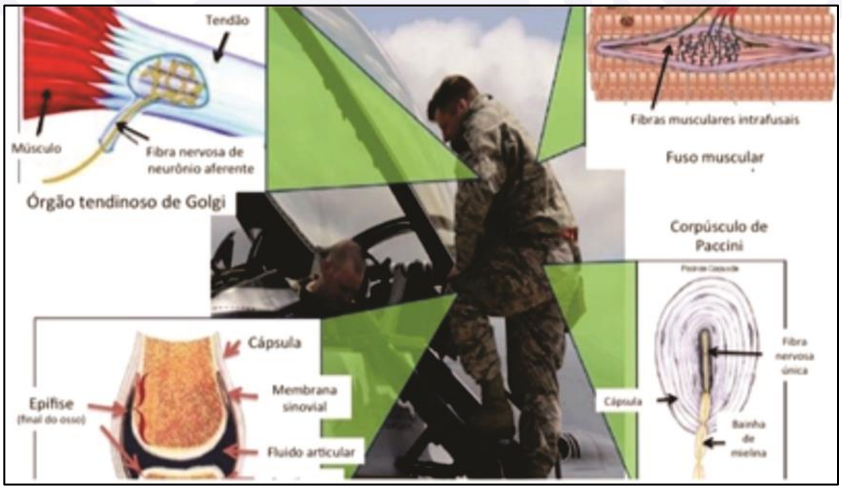


Figure 78 – Somatosensory system - receivers and locations (source: *Handbook of Aerospace and Operational Physiology*, US Air Force, 2011).

These three systems, by means of specialized receivers, continually collect information which is transmitted to the central nervous system (brain). The brain, in turn, under normal conditions, integrates the pieces of information from the three systems in a single orientation model which, also under normal conditions, is highly dependable. This model determines the position of the body in relation to a fixed system of coordinates provided by the surface of the earth (horizontal reference) and by gravity (vertical reference).

It is very important highlighting that such complex and important systems, on which one depends in one's everyday life, were not "designed" to operate in the three-dimensional environment of flight. In this environment, it is possible to remain oriented even without visual references, but the complex flight movements drastically increase the risk of spatial disorientation, on account of the physiological limitations of human beings.

The visual system is the most important, since it accounts for approximately 80% of the information on orientation. The remainder 20% are shared by the vestibular and proprioceptive systems, both prone to illusions and misinterpretation, which can lead to spatial disorientation.

When the visual conditions are limited, such as during bad weather or at night, up to 80% of the normal system of orientation may be lost, due to the lack of the visual system. The remainder 20% is, then, shared between the vestibular and the proprioceptive systems, both of which are prone to illusions and misinterpretation. In the absence of adequate visual conditions, the human being counts just on these less accurate 20% of the complex system of spatial orientation. In this type of situation, each one these systems contributes 50% of the pieces of information.

In flying conditions, situations such as the one described above may result, on the part of the pilot, in certain types of illusions which cause spatial disorientation. This is especially dangerous when the pilot does not realize that he/she is disoriented in space, and gives credit to the information being equivocally provided by his/her brain.

It is evident that the lack of good visual references deprives human beings of most part of the information on spatial orientation. For this reason, the majority of the disorientation events in aviation are associated with poor visual references, such as flying in IMC conditions or at night.

Spatial Disorientation

The *Australian Transport Safety Bureau has the following definition:*

> "Spatial disorientation is a term used to describe a variety of incidents occurring in flight where the pilot fails to sense correctly the position, motion or attitude of his aircraft or of himself within the fixed coordinate system provided by the surface of the Earth and the gravitational vertical. In addition, errors in perception by the pilot of his position, motion or attitude with respect to his aircraft, or of his own aircraft relative to other aircraft, may also be embraced within a broader definition of spatial disorientation in flight."

It is worth considering that the Spatial Disorientation involves not only the correct alignment with a system of coordinates, but also the spatial location within the geographical limits of a three-dimensional (3D) system. In isolation, the geographical disorientation involves only the erroneous perception of information (usually visual information) in two dimensions (2D) without a vertical component.

There are two major groups of illusions directly related to spatial disorientation:

- Vestibular illusions, and
- Visual illusions.

For this investigation in particular, the ones described are those possibly associated with the accident:

a) The Coriolis illusion is a severe “tipping” sensation caused by the movement in a plane of rotation different from the plane of turn of the aircraft leading to the stimulation of a set of semicircular canals and de-activation of the other. It may be both subtle and intense, with a sudden onset, being particularly dangerous when occurring at low altitudes. Frequently, it happens when the pilot gets engaged in turns with a more or less constant acceleration rate. Thus, the endolymph inside the semicircualr canals activated by the turn becomes more stable with the angular acceleration speed, while the other canals are de-activated. The brain interprets such situation as though the head did not move in practical terms. In these conditions, any movement of the head (look back, look up, or look down at the panel) on a plane that is different from the plane on which the aircraft is making the turn, will cause a crossed stimulation of the other semicircular canal. The canals originaly stimulated now signal a deceleration, while the new set of canals is stimulated, transmitting contradictory information to the brain. This leads the pilot to experience the illusion of being moving on a plane of rotation whose angular movement does not really exist. In the attempt to correct this false sensation, the pilot may act in opposition to it, something that may result in loss of control of the aircraft. The intensity of the “tipping” sensation relates directly to the rate of acceleration of the initial turn, the direction and speed of the head movement.

b) The G-excess illusion is potentially dangerous particularly at low altitudes and at high speed. In such circumstances, equivocal commands may have disastrous consequences, especially due to the limit of time available between the recognition of and recovery from the illusion. This illusion occurs when the vestibular system receives multiple stimuli. In practice, it happens when the pilot enters a turn with an accelaration rate higher than 1G (sustained turn) and looks back in the direction of the turn. In these conditions, he/she may experience a sensation that the turn banking is lower than it is in reality. In an attempt to correct this sensation, the pilot may increase the angle of bank, and, as a result, the aircraft may lose altitude and/or lift. Depending on the aircraft altitude and on how quickly the problem is perceived, the situation may become irreversible.

c) The inversion illusion is a type of somatographic illusion which occurs during an abrupt levelling (application of excessive negative G load after a climb. Under these circumstances, the sudden change of the aircraft attitude and the subsequent reduction of the gravitational force, acting downward under the otolithic organs, generates a pitch-up (nose-up) sensation. This situation may lead the pilot to atempt to correct such illusionary attitude by means of a pitch-down command, which will only intensify the sensation and worsen the illusion.

There are basically 3 types of Spatial Disorientation:

- Type I (Not Recognized): the pilot does not perceive being disoriented, and continues to fly the aircraft normally. This type of disorientation is potentially dangerous, since the pilot will not take any adequate corrective action because, in fact, he does not perceive the problem. Thus, the aircraft ends up colliding with the ground.
- Type II (Recognized): in this type of disorientation, the pilot is aware that a problem exists. He may not recognize the “spatial disorientation”, but feels that there is something wrong, and that his sensory system is giving him information not compatible with the information being shown by the instruments. This conflict between his own perceptions and the information provided by the instruments

and/or by his external visual references alert him of the problem, and he is able to deal with it. If the pilot reacts adequately, he may recover from the situation, and the accident does not happen.

- Type III (Incapacitating): the pilot experiences the most extreme form of disorientation. He may even be aware of the spatial disorientation, but is so overwhelmed or stressed in physical and mental terms, to the point of being unable to regain control of the situation. In this condition of extreme stress, the pilot may “freeze” in the controls and not present any kind of reaction, or he may even take actions that worsen the situation instead of reversing it. The pilot may attempt to regain control, but he may not be able to prevent the accident from happening. This type of accident is the result of a rupture of the normal process of cognition, normally on account of the overstressing nature of the situation, especially if other factors, such as fatigue and excessive workload, are present.

The fact that the spatial disorientation phenomenon/situation is not immediately recognized may lead to the loss of control of the aircraft, resulting in irreversible and disastrous consequences.

Finally, there are other contributors to the process of spatial disorientation, such as: excessive workload in the cockpit, stress, deterioration of weather conditions, runway location, alternation between VMC and IMC, and lack of training in the operation of the aircraft.

1.13.2 Ergonomicinformation.

Nil.

1.13.3 Psychologicalaspects.

During the investigation, the commission studied the inter-relation of the human performance factors that may have contributed to the accident.

These factors are the typical characteristics and processes of the human nature, as well as those which are established in the interaction between the individual and the work environment or the environment outside of the workplace.

For the gathering of information, the investigators interviewed family members of the crew and other people who, at different moments, interacted with the pilots. The interviewees voluntarily reported facts and their impressions about the crew. Also, a documental research was conducted covering the crew’s professional life in aviation.

<u>Captain’s individual information:</u>

According to information gathered, the captain was a calm quiet person, who adopted a comradeship attitude in flight and caredabout safety.

Before flying the accident aircraft model, he had worked for an air taxi company in São Paulo where he flew Cessna Citation C525 (CJ) and CE 560XLS aircraft.

In the same period, he did the Citation Jet 525 (CJ) initial course in the USA, and then the initial Pilot-in-Command (PIC) course in the Citation C525 (CJ) with the differences for the Citation C525A (CJ2).

Still in this period,he did the ground school course of the Cessna Citation CE 560XLS at an ANAC-certified aviation school in Sao Paulo, and did not present any learning difficulties, having completed the course with a grade of 96%. His Citation Excel Series (CE-560-XL) Initial Training was done in the premises of Flight Safety (USA) in 2011.

After the transition from the Cessna Citation C525A (CJ2) to the Cessna Citation CE 560XLS, the captain commented that the latter was easier to fly, more comfortable, and more automated. There are no reports of any complaints made by the captain regarding the transition between the two models or the demand of more attention to fly the CE 560XLS aircraft.

He started operating the CE 560XLS in 2011 on domestic flights, as well as on international flights to Europe, the United States, and Africa. In this latter, he operated from September 2011 until March 2014, providing services to a Brazilian company of the engineering and infrastructure sector.

In the air taxi company, he was seen as an experienced pilot, who knew how to manage adverse situations. He had experience operating on shorter runways, such as Angra dos Reis (Rio de Janeiro State), and had also operated a few times in Santos Aerodrome.

He left the company when the CE 560XLS aircraft was transferred to another air taxi company in the State of São Paulo. Since the owner wanted him to continue operating the aircraft, he was indicated for participation in a selective process for composing the crew of the aircraft in the new air taxi company in the beginning of 2014.

During this process of selection, he reported to the interviewers his experiences of flights to non-homologated runways in Africa in order to save money (although compromising safety). He even told about an occasion on which he flew over the ocean with a defective aircraft, assuming a posture of normality.

Approximately two months after the aforementioned selective process in 2014, he was invited to fly the Cessna Citation CE 560XLS+ (PR-AFA) during the candidate's presidential campaign (May 2014).

In the period during which he flew for the presidential campaign, he would rather stay in hotels near the airport so that he could expedite his flight routine. In his moments of rest between flights, he liked to take walks, sleep, and study the aircraft. He would usually go to bed around 10 p.m. and wake up around 9:30 a.m. if schedule permitted.

He was seen as very careful and studious in relation to the air activity, always preparing the flights to be conducted by him. His peers considered him an assertive person, who never gave in to pressure from the passengers.

He applied a personal doctrine of flying with a deep knowledge of the aircraft, and prevented personal problems from affecting the operation. He always focused on the flight, and showed high accuracy in relation to the aircraft performance.

In this period, there were accounts that on some occasions, the captain would utilize the aircraft FMS resources for making direct approaches in VMC conditions.

A copilot who had known him a long time and who had operated with him in the presidential campaign flights said that he was a good professional, who managed well the flight activities, and followed standard procedures.

At the time of the accident, his relationship with his family was good, and he seemed not to have any problems of psychological or financial nature.

His level of comprehension and interpretation of the English language was considered good.

Captain's psychosocial information:

During the six years in which he worked for the first air taxi company in São Paulo, he showed a good interpersonal relationship.

During the selective process following his indication to continue to compose the crew of the aircraft in the new air taxi company, the interviewers identified signs of difficulties in the application of CRM concepts. He did not allowed time for another candidate (copilot) to speak, and showed a more authoritarian way of talking along with excessive self-confidence. He treated errors and violations as similar concepts, and also reported having flown a number of flights without considering the duty time regulations.

His attitude during the interview gave the interviewers the impression that he would have difficulties of integration with the other pilots of the company and, thus, he was not hired. For the company, he did not meet the desired profile.

In the operation of the PR-AFA aircraft a few days before the accident, the captain even commented with other pilots that the copilot's operational capability was not adequate, and that it increased his (the captain's) workload. He also said that their relationship was not good.

Information on the captain's mental-health evaluation for purposes of Aeronautical Medical Certificate (CMA) obtainment/revalidation:

The captain underwent a mental-health check-up in 1993 for the obtainment of a Private Pilot CMA at the beginning of his career in aviation. The records did not show any performance discrepancies.

In 1994, he was subjected to a new mental health exam, this time for earning a Commercial Pilot CMA. In this evaluation, he obtained a result considered as average in the competences of focused attention, intelligence, and space perception, according to the reference manuals. He also displayed characteristics of self-confidence, ambition, enthusiasm, and reserved behavior.

In 1998, he did a mental-health check-up for an airline transport pilot CMA. His reasoning and problem-solving capability was considered satisfactory; his ability to do simple tasks was considered to be above average, but his capacity to perceive the space relations in complex activities was seen as unsatisfactory. For the evaluation board, however, this latter result was not an impediment for him to continue as an ATP, on account of the level of persistence and tolerance he had presented. He also showed to be an active, productive, and mature person.

Copilot's individual information:

According to gathered data, the copilot was considered a person with the following characteristics: observant, simple, well-humored, systematic, studious and well adapted to the activity with which he was involved.

Despite being flexible, he sometimes needed to be convinced of opposite ideas.

He was careful with his health, not drinking alcoholic beverage, nor smoking. He was living a moment with no financial difficulties. He did not seem to be worried or stressed in the time before the accident.

In the aeronautical environment, he was considered an experienced pilot. From 1994 to 2002, he flew in the USA, where he began his professional formation. In this period, he flew Caravan and King Air aircraft.

In July 2005, he did the Cessna Citation C525 (CJ) ground school at an ANAC-homologated aviation school in São Paulo, obtaining a final grade of 98% in the course.

In 2006, he applied to a selective process at an airline company in São Paulo. In this selective process his performance was considered lower than the average reference value of the psychological evaluation manual utilized for assessing reasoning skills.

After the initial tests, he started the Airbus A319/320 ground school, in which he had difficulties comprehending the course content since the beginning, and needed additional training for reinforcement.

The instructors reported that, during the training, it took him a longer time to learn in comparison with the other students, in a slower learning process. He did not show much initiative but, when challenged by the instructors, he would correspond to what was being requested. They also said that it was not common for them to request additional training for the students during the ground school course. On average, out of 200 pilots who did this kind of training in the year, approximately four pilots needed extra reinforcement classes.

After receiving the reinforcement, he completed ground school and started simulator training, where he also needed reinforcement support, but failed to reach the minimum passing level for continuing the training and, therefore, was dismissed by the airline company.

After his dismissal from the airline, he resumed working as a pilot in the USA, and obtained an Airline Transport Pilot license from the FAA.

In 2012, he came back to Brazil, being hired by the air taxi company in São Paulo. All his professional formation and simulator training was done in the USA, where he had good performance. Then, he started working as a copilot of Cessna C560 Citation V aircraft.

During the period he worked for the air taxi company, his behavior in flight was apathetic, inattentive, and he would not warn the other crew member when something deviated from the flight profile (excessive speed, for example). During the preparation of the aircraft, he would forget to perform procedures that were under his responsibility, such as closing the baggage compartment door. In operations under normal conditions, he was relaxed in flight. This type of information was not passed to the company management at the time.

In August 2012, he got involvedin in a serious aeronautical incident (runway excursion after landing) in Jacarepaguá, Rio de Janeiro. According to accounts, he would have behaved passively during the abnormal situation.

After a year in the company, he was laid off due to staff downsizing.

In November 2012, he was invited to fly for a company of Belo Horizonte, State of Minas Gerais, when he flew a Cessna C560 Encore+ aircraft.In this company, he showed good performance in the operating routine. He had a calm passive posture in flight. He flew approximately 130 hours and always as a copilot.

Upon learning that he would be fired by the company, he started studying the Cessna Citation CE 560XLS+ manual, two months before leaving the company. He also did the C560 Encore + re-check in this period.

Before leaving the company of Belo Horizonte, he underwent a new selective process in the air taxi company of São Paulo but did not succeed. During this selective process, he showed to be quiet and calm. He appeared to be a controlled and contained person, but who was also passive, lacking initiative in relation to decision making. He showed to have good interpersonal relationship, good communication, good professional posture, and high motivation to work.

There was no contraindication in his profile, but the other candidates did better than he did, and the company considered the fact that he was still working for another company, differently from the other job applicants.

In June 2014, he began flying the PR-AFA aircraft and, according to his relatives, he was happy with that new job opportunity.

Copilot’s psychosocial Information:

As had been observed in his training of the Airbus 319/320 aircraft, the copilot presented difficulties in cockpit management, operational routine, provision of support as a Pilot Not Flying (PNF), and slowness in the execution of procedures.

In 2012, when he was re-hired by the air taxi company in São Paulo, he had some difficulty understanding the instruction given by ATCO’s and interpreting navigation charts. There were occasions on which he inserted wrong information in the FMS and repeated way points. In view of these facts, the other crew member started to check the tasks performed by him.

During the various times he worked for that air taxi company, he had good interpersonal relationship and dedication to work.

Copilot’s mental health evaluation information:

The copilot underwent a health check-up for the obtainment of an ATP license. He was considered “unfit for the intended purpose”. Despite the final opinion of the board of health, the result of the mental health evaluation indicated that he had an adequate profile for the air activity, highlighting his tendency to effort-based performance, but, at the same time, rigid and undecided.

In 2004, he was subjected to another health check-up for an ATP license. On the occasion, he had satisfactory performance in focused-attention competencies, and showed signs of impulsivity in the evaluation of his own personality. His performance in logic reasoning was insufficient, revealing a possible difficulty with new data and with the internal logic of problems. He also had trouble integrating intellectual and affective aspects.

Following a serious aeronautical incident in 2012, the copilot had his CMA suspended by force of the RBAC 67 in effect at the time, and was subjected to a new mental and physical health check-up for purposes of the letter “Q”. In the psychological evaluation, the copilot was evaluated in the constructs of focused-attention, complex diffuse-attention, intelligence, and space reasoning skills.

In this psychological evaluation his performance was classified as poor in the tests for measuring his focused-attention skills, with a percentage result well below the average reference level contained in the applied test manual. In the tests of intelligence, his result was classified as insufficient (lower limit). In the diffuse-attention test, the result was average.

In the test for measuring his space reasoning skills, he did not wait for the beginning of the count of time by the evaluator, causing the test to be cancelled. He was never submitted to this test or a similar one again.

The board of health judged his health checkup, and he was considered as “fit for the intended purpose”.

1.14 Fire.

There was post-impact fire on account of spread of fuel and the energy present in the collision.

1.15 Survival aspects.

Not applicable.

1.16 Tests and research.

Aircraft engines:

The PW545C Pratt&Whitneyengines(SN DF 0133 – left one, and SN DF 0135 – right one) that equipped the aircraft were disassembled in the Pratt & Whitney company premises in Sorocaba, São Paulo. This job was conducted by the manufacturer's engineers with the participation of CENIPA investigators, DCTA engineers, and monitored by São Paulo Civil Police and Federal Police representatives.

On account of the severe damage sustained by the engines in the accident, and in order to facilitate understanding, illustrative figures of the engine and its components are used in this report.

The engines equipping the accident aircraft had three stages of low pressure compressor turbines. Figures from 79 to 82 depict views of the PW 545C left engine (SN DF 0133).

-Left engine

The engine separated into three distinct sections, as can be seen in the figures bellow due to the energy of the impact with the ground. Another observation is that the place where the engine nameplate was located was not found for identification. The engine was identified by the serial number of the fan disk, which was later compared with the engine logbook records.

Figure 79 – Left hand side view of the left engine.

Figure 80 – Left engine viewed from behind.

Figure 81 – Right hand side view of the left engine.

Figure 82 – Front view of the left engine.

For a better understanding, Figure 83 shows an exploded view of the engine low pressure compressor and fan disk components.

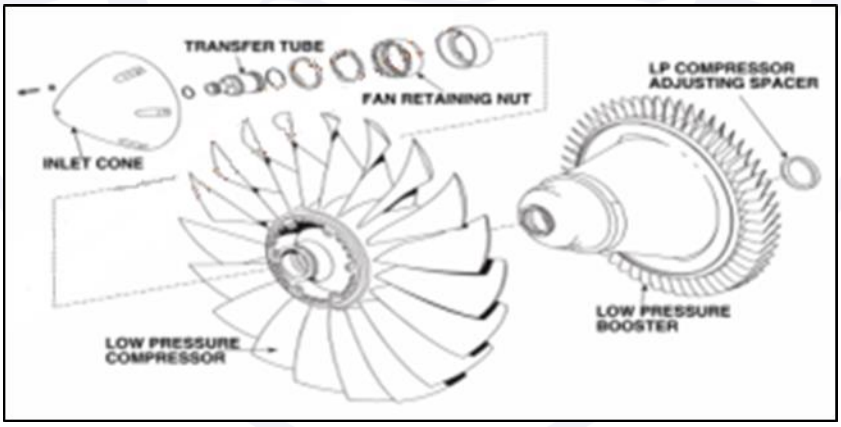


Figure 83 – Exploded view of the engine low pressure compressor and fan disk.

Figure 84 shows the inner side of the fan disk cone. In this figure, it is possible to observe the mark of intense rubbing and the disruption of its structure, in the central section. Figure 85 shows a closer view of the same cone, where one can see in more detail the damage to the rotary assembly and the disruption of the cone structure. Figure 86 shows a view of the torsion fracture of the fan disk drive shaft and low pressure compressor.

Figure 84 – View of the engine fan disk and part of the low pressure compressor.

Figure 85 – Closer view of the internal part of the fan disk.

Figure 86 – View of the low pressure compressor and fan disk activation shaft.

Figure 87 depicts a high pressure engine compressor for better understanding. Figure 88 shows three-stage rotors of a high pressure engine compressor.

Through the cut made in their carcasses, it is possible to see the damage they suffered. The vanes of the three-stage high pressure compressor sustained severe damage, as can be seen in Figure 88. Figure 89 shows a front view of the axial stage of the compressor. In addition to the deformations, it is possible to observe that there was aluminum deposited which melted and settled at this stage.

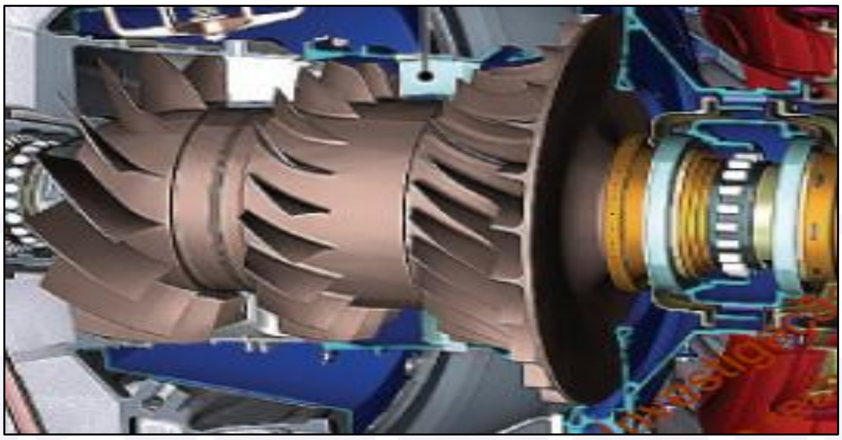


Figure 87 – Picture of a high pressure compressor of an intact engine.

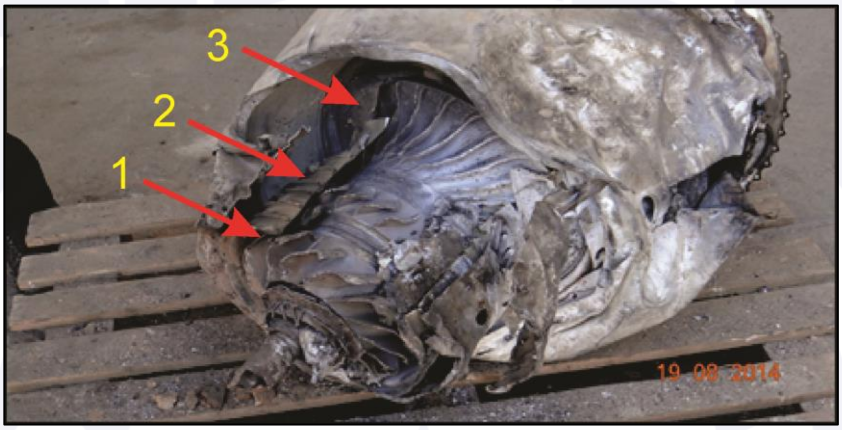


Figure 88 – View of the high pressure compressor stages. (1) First axial stage; (2) Second axial stage; (3) Centrifugal stage.

Figure 89 – Front view of the first axial stage of compression, showing melted aluminum and damaged vanes.

Figure 90 shows that the second and third compression stages ingested earth along with molten aluminum, fragments of stator vanes and other engine components. Figure 91 shows the stator vanes which were broken atthe root. On the right side in highlight, it is possible to see the excessive wear of the inner ring on account of the intense rubbing sustained.

Figure 90 – View of more material which melted and got mixed with dirt in the axial stages of the compressor.

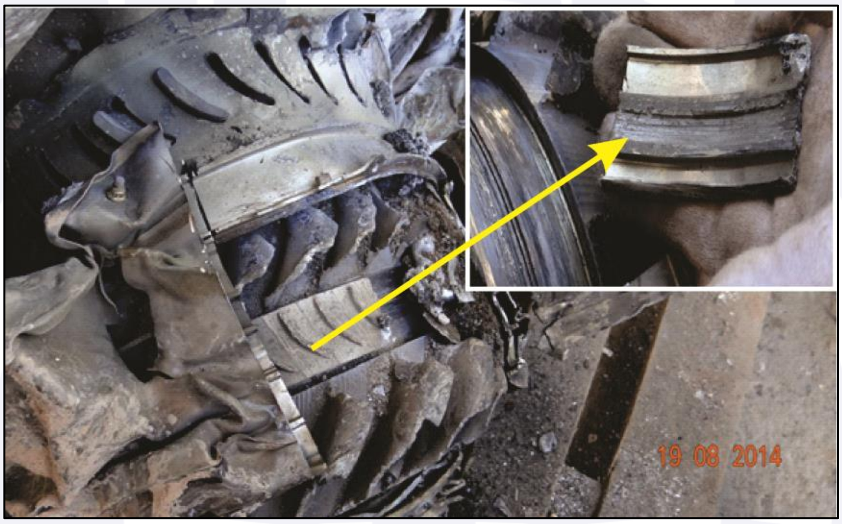


Figure 91 – View of the stator with ruptured vanes. In highlight, the internal side of the stator with pronounced wear and signs of intense rubbing.

Figure 92 shows part of the carcass of the centrifugal compression stage. After the cutting performed for inspection purposes, it was observed that this region of the compressor also sustained intense rubbing with the rotor vanes of this stage. The carcass had a reduction in its thickness.

Figure 93 shows the centrifugal compressor impeller. It was found with its vanes broken or worn on account of the impact and of the deformation sustained.

Figure 92 – View, from the internal side, of part of the carcass of the centrifugal stage which was cut for inspection, showing marks of intense rubbing with the rotor.

Figure 93 – Detail of the centrifugal stage vane with wear caused by rubbing.

Figure 94 shows the stator of the high pressure engine compressor turbine. Marks of rubbing and impact were found, which were caused by the passage of fragments through the region of the vanes.

Figure 94 – General view of the high pressure compressor turbine stator.

Figure 95 shows a back view of the high pressure compressor turbine rotor. It is possible to observe the marks of intense rubbing on the bodies and roots of the vanes and on the central part of the disk. The highlight shows the fracture found in the low pressure compressor and fan disk activationshaft. As can be seen, the surface of the fracture has an angle of 45 degrees.

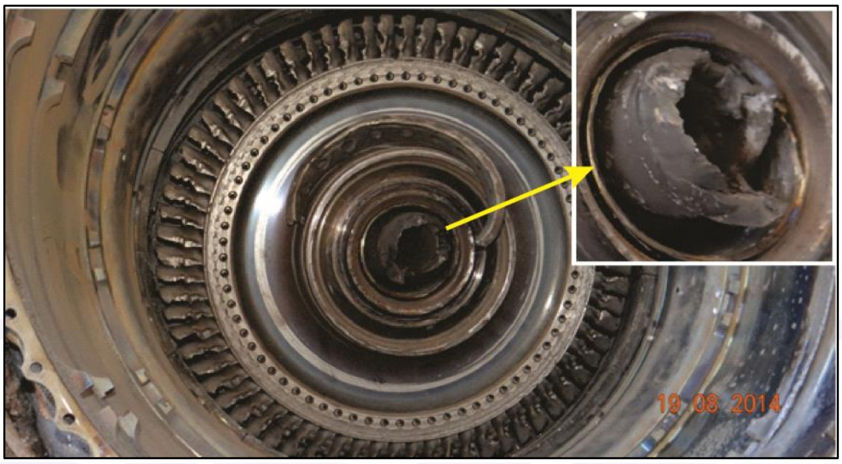


Figure 95 – General view of the high pressure compressor turbine rotor.In highlight, a closer view of the fracture observed in the activation shaft of the low pressure compressor.

It was also observed that it was covered with black soot. Figure 96 shows a front view of the same rotor, with rubbing marks at the root of all the vanes.

Figure 96 – Front view of the same rotor with marks of rubbing at the roots of the vanes.

Figure 97 shows the marks of intense rubbing marks left by the edges of the vanes on the segmented ring. It is also possible to observe that there was misalignment of the rotating assembly due to the impact sustained by the engine.

Figure 97 – Mark of intense rubbing made by the rotor vanes on the sealing rings.

Figure 98 shows the stator of the first stage of the low pressure compressor turbine and the fan disk. It was found with disruption caused by impact with an obstacle on the ground. The diaphragm (central part of the disk) also showed severe damage caused both by rubbing and fracture.

Figure 98 – General view of the stator of the first-stage of the low pressure compressor turbine. It is possible to observe marks of impact caused by fragments which passed through the vanes.

Figure 99 shows a closer view of the diaphragm of the same stator. It is possible to see that the rubbing in this region was intense and that it reached high temperatures.

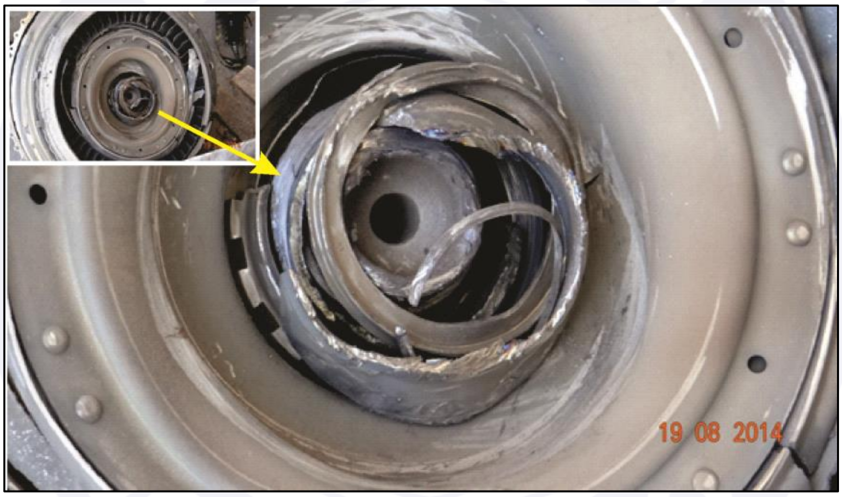


Figure 99 – Closer view of the engine diaphragm, with signs of intense rubbing.

Figure 100 depicts, mainly, the disruption of the glove inside the disk and the rubbing sustained by the engine in that region.

The second stage of the low pressure compressor and fan disk turbine was not disassembled. However, a visual inspection revealed abnormalities, such as dents resulting from the impact sustained by the engine on impact with an obstacle on the ground.

Figure 100 – View of the ruptured glove in the interior of the rotor.

Figure 101 depicts a back view of the third stage low pressure compressor and fan disk turbine rotor. This rotor also had signs of mild rubbing at the roots of the vanes.

Figure 101 – Back view of the low pressure turbine third-stage rotor and fan disk.

Figures 102 and 103 show, in detail, the marks of rubbing and the damage to the root of rotor vanes in this stage of the turbine. It is also possible to see the black soot on the rotor blades in this stage of the turbine.

Figure 102 – Detail of the rubbing observed in the vane roots.

Figure 103 – Detail of the damage to the vane bases. It is possible to observe soot in the vanes, resulting from smoke after impact of the engine.

Figure 104 shows the rear bearing of the engine, in which no anomalies were found, such as lack of lubrication or damage to the rollers or tracks, which could cause malfunction.

Figure 104 – Close view of the rear bearing of the engine, undamaged.

Figure 105 shows the housing of the bearing in the rear support of the engine. There was lubricant oil at the time of the engine collision, as can be observed from the presence of marks of charred oil which had drained through the rear support at the time of the engine collision.

Figure 105 – View of the rear support of the engine, showing oil leakage and the housing of the rear bearing. In the highlight, the oil injector of the rear bearing.

The analysis of the left engine (PW 545C, SN DF0133, 434.5 Hours Since New, and 400 Cycles Since New) revealed that the engine sustained severe damage in the collision with the ground.

The engine broke up into three different sections. About eight blades of the fan disk had deformation and the others were fractured. In the cone, from the internal side of the fan disk, intense rubbing and severe damage could be observed in its central part.

The rupture by torsion observed in the fan disk activation shaft shows that when the engine collided with the ground there was high rotation, and it was developing medium to high power.

The stators of the low and high pressure compressors were examined. From the characteristics of the observed damage, the assembly was rotating at high speed. The large amount of earth mixed with aluminum, which underwent a melting process, together with other metals that were ingested by the compressor, the damage to the vanes of the axial stage of compression, the disruption of all stator vanes of the three stages of compression, the wear observed in the thickness of the high pressure centrifugal stage of the compressor, indicated that the level of rubbing was intense.

In the rotor of the centrifugal impeller all vanes sustained severe wear. All these observations indicate that the rotating assembly, from the side of the compressor, was turning at a high rate at the time of collision with the ground.

In the section of the turbines, both the one of activation of the high pressure compressor and the ones of activation of the fan disk and low pressure compressor showed evidence that they had a lot of energy at the moment of impact with the ground. The intense rubbing and severe damage observed in both the rotors and the stators are characteristic of engines that were developing high power and suffered strong impact, resulting in misalignment, imbalance and abrupt stop.

In the bearings of the engine that were examined there was no evidence of lack of lubrication, fracture, overheating or other anomaly which could have caused cause any malfunction of the rotating assembly.

The observation concerning the bearings can be extended to the engine lubrication system. All sites where the engine was required to be lubricated that were examined revealed the presence of lubricating oil.

During the disassembly of the left engine, the investigators also sought evidence of biological contamination, or the presence of blood or bird remains resulting from a contingent collision with birds. They also sought evidence that this engine could have collided in flight with any other foreign object (such as a drone). Both cases could have resulted in engine malfunction with loss of power and could have resulted in the presence of fire in flight or engine failure. No evidence was found in the course of the left engine analysis.

The Data Collection Unit (54204-01) was found in the crash site. It corresponds to the P&WC part number 30J3419-01, i.e., the left engine. The equipment was not damaged by heat or fire, and was forwarded to the manufacturer’s headquarters with monitoring of CENIPA’s investigators for the read-out of stored data.

The retrieved data was sent to the engine manufacturer for analysis of Engine Condition Trend Monitoring (ECTM). Sets of "snapshots" were extracted from the DCU. By design, "snapshots" are grouped according to the condition of the ECTM data generation: "take-off, climb, cruise, descent, and approach".

The analysis of the retrieved data did not reveal any abnormality or trend that could have compromised the smooth operation of the engine during the accident flight.

More specifically, ECTM "snapshots" related to Take-Off, Climb, Descent, and Approach data during the accident flight were retrieved. Other flight parameters, such as "Outside Air Temperature (OAT), Barometric Altitude (BARO ALT), and Indicated Airspeed (IAS)" related to the accident flight were also retrieved and are presented in Figure 106.

Record	Date	Time	TIME_ENG_RUN	TIME_EEC_RUN	TLA	N1_TREND	N2_TREND	SEL_T6	OAT_TREND	BARO_ALT	IAS_TREND	WF_TREND
ECTM Type	UTC	UTC	HR	HR	DEGREE	%N1	%N2	DEG.C	DEG.C	FEET	KNOTS	PPH
TAKEOFF	2014-08-13	12:22:18	566.4985	790.5566	56.532	85.544	96.231	591.272	27.049	687.69	192.75	1615.75
CLIMB	2014-08-13	12:30:28	566.6349	790.6929	55.407	92.009	97.01	568.315	-1.407	21000.98	230	1100.5
DESCENT	2014-08-13	12:46:57	566.9096	790.9677	38.851	79.714	90.874	502.356	3.258	21993.805	290.813	684.75
APPROACH	2014-08-13	13:00:35	567.1368	791.1949	7.233	27.706	54.4	515.918	20.216	527.31	144.438	298.25

Figure 106 – Summary of the ECTM data on 13 August 2014 (accident flight).

Note 1: There was not an ECTM "*snapshot*" for the "*CRUISE*" condition of the accident flight. The lack of such data may be explained by the fact that the aircraft did not remain enough time in the cruise condition, and thus did not have the stability required by design for generating a snapshot for that phase of flight.

Note 2: The data associated with the tables above will be explored in the section 1.18 (Operational Information) of this report.

The right-hand engine

Figures from 107 to 110 present views of the PW 545C engine, SN DF0135 (right). As can be seen, this engine also sustained damage from impact in a way similar to the one sustained by the left engine of the aircraft. It is possible to observe that this engine was broke up into three distinct parts.

Figure 107 – Front view of the right engine.

Figure 108 – Left hand view of the right engine.

Figure 109 – Right hand view of the right engine.

Figure 110 – Back view of the right engine.

Figure 111 shows the fan disk of the engine. It had a broken cone and marks of intense rubbing, fractures and deformation of the vanes, as can be seen in the highlights.

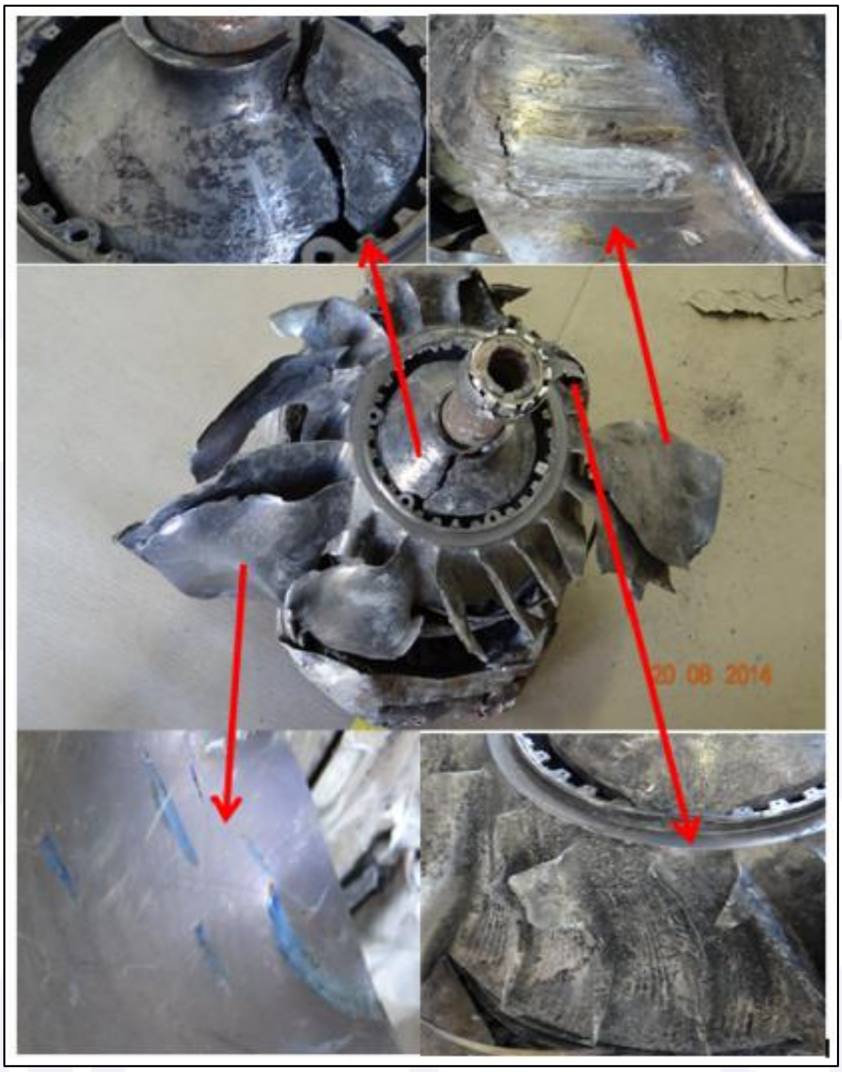


Figure 111 – Views and details of the right engine fan disk.

Figure 112 shows a view from the inside of the stators carcass of the first and second stages of the high pressure compressor. It is possible to observe that all stator vanes were fractured and/or deformed.

Figure 113 shows the inner ring of the same stator. Figure 114 presents a front view of the centrifugal stage rotor of the high pressure engine compressor. It is possible to observe that all impeller vanes were fractured.

Figure 112 – View from the internal side of the first and second stages of the high pressure compressor, with damaged stator vanes.

Figure 113 – General view of the internal ring of the second stage of the high pressure compressor.

Figure 114 – Front view of the centrifugal stage rotor of the high pressure engine compressor.

Marks of intense rubbing were observed both on the disk and in the vanes. Figure 115 shows the detail of the rubbing observed in the vanes and their respective bases.

Figure 115 – Detailed view of the damage to the vanes and of the intense rubbing in the base of the high pressure compressor turbine rotor.

Figure 116 shows back views of the stator of the 1st stage of the low pressure compressorand fan disk turbine. It is possible to see that many vanes sustained rupture resulting from compression affecting the engine at the impact with the ground.

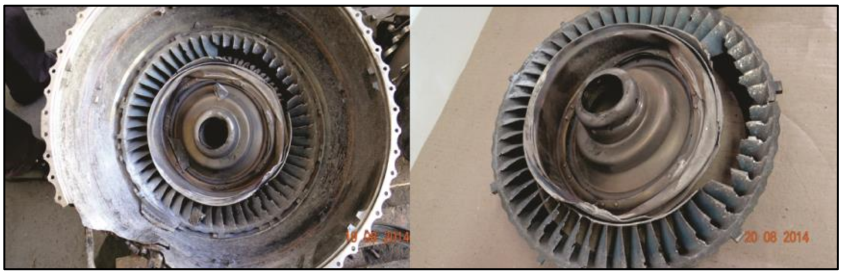


Figure 116 – Back view of the first-stage stator of the low pressure compressor turbine (left). Another view of the same stator, already segregated from the assembly (right).

Figure 117 shows another closer back view of this stator. It is possible to observe in more detail fractures and impact marks. Fragments of the vanes were found inside the engine and are shown (highlight) in the figure.

Figure 117 – Detail of the damage to the vanes and intense rubbing of the diaphragm of the same stator (left). In the highlight, fragments of the vanes which were found inside the engine (right).

Figure 118 depicts the set of turbines of the fan disk and low pressure compressor of the engine. The first stage rotor is shown in the foreground with all its vanes broken.

Figure 118 – General view of the set of low pressure compressor turbines, showing the first-stage rotor with all its vanes ruptured.

Figure 119 shows part of the rotor of the second stage of the turbine. It was not disassembled, and it is possible to observe that all of its blades were fractured.

Figure 119 – View of the low pressure compressor turbine second-stage rotor and fan disk with all vanes fractured.

Figure 120 presents part of the third stage turbine stator of the fan disk and the low-pressure engine compressor. Observe the highlight in the figure showing the severe damage sustained by the stator vanes.

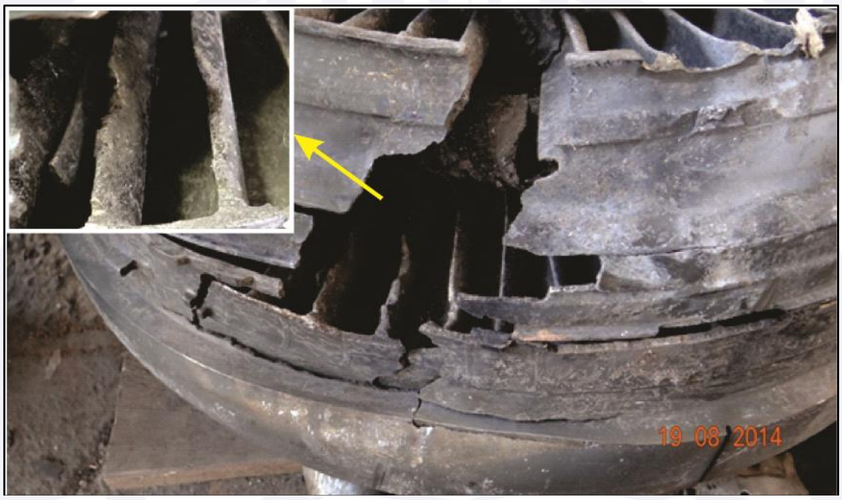


Figure 120 – Damage to the low pressure turbine third-stage stator and fan disk. In the highlight, a closer view.

Figure 121 shows the shaft with the rear bearing of the engine. It had no anomalies capable of having caused engine malfunction.

Figure 121 – View of the low pressure compressor activation shaft and of the engine bearing 5.

In a way similar to the left engine, lubricant oil residues were found inside the housing of bearing 5. When the engine stopped after the collision, the lubricant oil leaked in the engine rear support, as shown in Figure 122.

Figure 122 – General view of the rear support of the engine with signs of lubricant oil leakage (left). Detailed view showing the housing of the engine bearing 5 (right).

The analysis of the aircraft left engine (PW 545C, SN DF0135, 434.5 Hours Since New, 400 Cycles Since New) revealed that it was severelydamaged upon colliding with the ground.

Since the characteristics of the damage found in the right engine are similar to the one sustained by left engine, all the comments and analyses can be equally applied to both engines.

On the fuel:

Two samples of aviation kerosene (1,000ml each), duly collected and sealed on the date of the accident, were sent to the Fuel And Lubricants Analysis Laboratory (Engineering Subdivision) of the Aeronautics and Space Institute (IAE) in order to undergo a physico-chemical analysis.

One of the samples was collected from the fuel truck number 1422, and the other from the tank number 103, both belonging to Petrobras Distribution SA, which provided the service of refueling to the aircraft at Santos Dumont Airport (SBRJ) on 13 August 2014.

The two samples were subjected to physico-chemical testing of Aspect, Flash Point, Specific Mass, Corrosiveness to Copper, Calorific Value and distillation. The methods and procedures used were the ones specified for aviation kerosenein accordance with the Resolution No. 37 of 01 December 2009, which established the aviation kerosene specification by means of the Technical Regulation no. 6/2009 of the Brazilian National Agency for Petroleum, Natural Gas, and Biofuels (ANP).

The results of the tests and physicochemical analysis for both samples were compatible with the values specified by the Technical Regulation no. 6/2009.

On the test conducted in the flight simulator:

During the investigation process, a Flight Test Order was developed by the CENIPA's investigators, with a compendium of collected operational pieces of information, reports from observers, as well as aircraft performance data in order to reproduce the accident flight in a flight simulator.

Complying with international protocols established by the ICAO Annex 13 to the Chicago Convention, the Flight Test Order was sent to the Accredited Representative of the Aircraft Manufacturing State participating in the investigation (NTSB) so that he could verify the possibility of implementing the Flight Test Order in simulated flights at the only company possessing a flight simulator of this aircraft model in the world.

The formal request made by the CENIPA to the NTSB was the following:

> “The Aeronautical Accident Investigation and Prevention Center (CENIPA) is currently conducting the investigation of the 13 August 2014 accident with the CE560 XLS+ Citation aircraft, registration PR-AFA.
>
> After having obtained the data relative to the dynamic of the accident, we need to verify the most probable hypotheses for the sequence of events prior to the impact.
>
> For that purpose, the CENIPA must reconstruct the flight conditions and profiles in a flight simulator of the aforementioned aircraft.
>
> Therefore, I would like to consult you on the possibility of your Agency to assist us by intermediating (facilitating) the scheduling of flight simulator sections to be carried out in the premises of Flight Safety in Orlando, State of Florida, on dates to be set, preferably, in the months of June or July.
>
> The simulator flights will be performed by three of our investigators in three sections, the first with a duration of three hours, and the others with a duration of two hours each, according to the Flight Test Order attached. The flights would be monitored by a Flight Safety simulator instructor with experience in the CE 560XLS+ aircraft, and by an NTSB Accredited Representative (in accordance with provisions of the ICAO Annex 13), with the pertinent costs being the responsibility of the CENIPA.”

Upon completion of the conversations between the NTSB and the company owning the flight simulator, the CENIPA received the answer that the referred company could not accommodate the request made by the CENIPA, as follows:

> “We were made aware of a parallel criminal investigation by the Departmento de Policia Federal regarding this accident. Under the circumstances, we are unable to agree to the requested use of the simulator for such purposes. Therefore, FlightSafety must respectfully decline the request.”

After receiving the answer given by the company via NTSB, the CENIPA received the information that the Brazilian Federal Police Department, responsible for the criminal investigation, had also made a similar request to the same company.

After these facts, the CENIPA made another attempt before the Simulator Owner via the NTSB, clarifying the points listed below:

> “We understand the Simulator Owner position regarding the issue.
>
> Nevertheless, please read below a clarification about the Brazilian Legal Provisions on the subject. Maybe after reading that, Flight Safety may change their opinion and understand how important the simulator testing is to this investigation.
>
> In Brazil, by reason of adherence to the Convention to the International Civil Aviation, and to the Federal Law ruling the subject, the investigations conducted by the Aeronautical Accident Investigation and Prevention Center (CENIPA), under the aegis of the Aeronautical Accident Investigation and Prevention System (SIPAER), are (*) totally autonomous and independent of other investigations or procedures under the responsibility of other constituted public authorities in any of the administrative, civil and criminal fields.
>
> This is the understanding of the articles 88-B and 88-C of the Brazilian Code of Aeronautics (Federal Law 7565/86 – CBA), which read is below:
>
> “Art. 88-B. The SIPAER investigation of a given aeronautical accident, incident, or ground occurrence shall be conducted in a way that is independent of any other investigations of the same event, (*) and no person is allowed to participate in these latter ones that is participating, or has participated, in the former.
>
> Art. 88-C. The SIPAER investigation (*) shall neither hinder (nor supply for the needs of) other investigations, including those with prevention purposes, and, since its aim is to preserve human lives, it shall have precedence over procedures (either concomitant or otherwise) of the other investigations in what refers to the access and custody of items of interest for the investigation.”
>
> Notwithstanding such differentiation, the article 86-A of the CBA establishes the sole purpose of the SIPAER investigation, by stating that:

> “Art. 86-A. The investigation of aeronautical accidents and incidents has the (*) sole purpose of preventing future accidents and incidents by means of the identification of the factors that may have contributed, either directly or indirectly, to the occurrence, and by the issuance of operational safety recommendations.”
>
> Strong as the reasons expressed above certainly are, we must ratify that our requests for support of the investigations conducted by the CENIPA are not correlated to any other investigations, including those under the responsibility of the Federal Police.”

After the clarification given by the CENIPA, the answer received was a ratification of the first one, and thus it was not possible to implement all the observations, conclusions and analyses to be carried out with the application the Flight Test Order in a flight simulator by the CENIPA’s investigators.

1.17 Organizational and management information.

Information on operation and aircraft management.

Since 1 December 2010, a business group from São Paulo was officially the PR-AFA aircraft operator. The aircraft belonged to Cessna Finance Export Corporation and had been leased to the referred business group. According to information collected, the group had informally transferred the operation of the aircraft to another business group (from the State of Pernambuco). According to the Brazilian Aircraft Registry (RAB), the aircraft was being operated by the São Paulo business group.

The aircraft was at the disposal of the electoral campaign of a candidate who was running for President in the next election. According to accounts, there was not a formal contract between the pilots and the official operator of the aircraft, or the ones responsible for the candidate’s presidential campaign.

According to information received, there was no selective process for the hiring of the pilots. The captain had been indicated by another pilot, and was promptly accepted for the job. The copilot in question was directly invited for the position by the very captain.

In mid-2014, the captain started operating the PR-AFA aircraft for the presidential campaign, together with another copilot.

The business group from Pernambuco attributed to the captain the responsibility for managing the aircraft, including contingent maintenance issues. The tasks and/or activities to be performed by the pilots were not formalized.

During the time of the campaign, the captain was the person who coordinated all the issues related to the aircraft directly with the Pernabucano business group. The group was responsible for providing hotel accommodations to the crew.

About one month before the start of the flights with the PR-AFA, the first copilot that had been hired decided to quit the job on account of not accepting certain situations that were taking place on the flights for the presidential campaign, such as delays of flights returning to São Paulo, changes in the schedule, and lack of expectation relative to the formalization of the work contract.

When the copilot left the campaign, the captain himself searched for a substitute. By means of contacts in the aeronautical community, he learned of the availability of a pilot that had the C560 qualification, and that had flown a C560 Encore+ aircraft for a company of Belo Horizonte, capital city of Minas Gerais.

In mid-June 2014, the new copilot accepted the invitation for the position without having to undergo a more detailed selective process, and automatically became a member of the PR-AFA crew.

According to information gathered, the scheduling of flights was under the responsibility of the presidential candidate’s personal advisor, who forwarded the flight schedule directly to the captain, most of the time making use of a cell phone application of instantaneous messages.

The flight schedule usually contained short duration flights, most of which in the day-time period. During the week, the crew stayed in São Paulo, from where they would depart to make three flights per day on average. On the weekends, they either stayed in São Paulo or flew to Recife, in the State of Pernambuco.

According to accounts, the captain did not complain about his work routine, despite having commented on being tired on the social network. He received the periodical program of the campaign directly from the candidate's personal advisors with the flight schedule to be accomplished.

The copilot, when speaking with family members, did not make negative comments on his work routine in the presidential candidate's campaign.

Other members of crews who also flew in the campaign affirmed that the flight legs were neither long nor tiring, and did not exceed the limits established by the rules. Nonetheless, they thought that their waiting between flights was lengthy, since they stayed at the disposal of the campaign timetable.

It was also verified that the candidate's advisors did not make any pressure on the crew. There were no reports of any type of comments made by the captain or copilot about the Pernambuco business group in this respect.

However, pilots who had worked for electoral campaigns stated that this type of activity creates a kind of self-pressure (unconscious, most of the time) relative to the accomplishment of the flight schedule, on account of the commitments to be fulfilled by the candidate in campaign, sometimes visiting more than one city or location on the same day.

The investigation commission did not learn of any information about the places used by the crew to rest while waiting for the next leg.

No records were found concerning any type of training performed by the crew during the time they worked for the business group from Pernambuco.

Information on the regulation of psycho-physical evaluations applied toBrazilian civil aviation pilots.

During the investigation, the commission did not find any professional profiles established by the ANAC for civil aviation pilots, nor any parameters related to minimum mental and behavioral criteria adequate to the air activity or, more specifically, to the functions of Commercial or Airline Transport Pilot that subsidized the evaluation to which the pilots were subjected.

The commission verified that medical certification of civil aviation crews, in accordance with the RBAC 67, could be made by accredited physicians (item 67.3, number 8), accredited clinics (item 67.3, number 9), or by convening entities (item 67.3, number 17).

The Technical-Operational Cooperation Term no. 03/2013 (established between the ANAC and the Command of Aeronautics on 9 October 2013 and effective until 30 September 2016) classifies the Air Force Health Boards in the category of accredited entities (RBAC 67, item 67.57).

In the Command of Aeronautics, the organization and functioning of health boards were in consonance with three main regulations:

a) ICA 160-1 of 2003, Regulating Instructions for Health Inspections, applicable to military and civilians of the COMAER, as well as to Civil Aviation Professionals, as pertinent;

b) ICA 160-6 of 2012, Technical Instructions for Health Inspections of the Aeronautics, to be applied by the "Boards of Health of the Aeronautics' Health System". This ICA regulated the conduction of health inspections of military and civilian personnel of the Aeronautics. However, civil aviation airmen, air traffic controllers, and aeronautical station operators would be judged in accordance with specific legislation, that is, these professionals were not included under the instructions of this ICA; and

c) RBAC 67 (2011), specifically for civil aviation airmen.

The COMAER Boards of Health were composed of two teams:

a) a team of specialists composed of physicians belonging to the specialties of Medical Clinic, Otorhinolaryngology, Ophtalmology, Cardiology, Psychiatrics, and Radiology. There were also dentists, psychologists, speech therapists, biochemists, as well as any other specialists in the area of health necessary for a more comprehensive evaluation of the person being inspected. All these health professionals were aware of the regulations guiding the work of the boards of health, and also received training on the practice and registry of the exam; and

b) a board of judgment, composed of three career military physicians (president, member, and secretary), responsible for analyzing the health information collected by the team of specialists, and judge the items of information in a secret session. According to the item 3.8.17 of the ICA 160-1, the boards of judgement were fully independent from a scientific standpoint in relation to the judgment they had to formulate, based on their professional knowledge and on the results of the specialist evaluations and exams conducted.

The judgement of military personnel was based on the Aeronautics' Health Requirements and the Causes of Incapacity. On the other hand, the judgment of civil aviation personnel was made in accordance with the standards and criteria recommended by ICAO and adopted by the Brazilian State in consonance with specific legislation (ICA160-1, item 3.9, Judgements Performed by Health Boards).

At any moment of the health inspection process, a physician of the specialist team or even of the board of judgment, could request further or complementary exams and opinions for a better evaluation of the inspected person, or clarification of diagnostic doubts. It is worth pointing out that the exam performed by the medical specialist is an exclusive activity of a physician (Law 12842/13, which regulates the exercise of medicine), subsidized by exams and complementary opinions whenever deemed necessary. All the work done by the medical specialists will provide information and subsidies for the medical board of judgment to issue the final opinion.

The RBAC 67 (Subpart C, item 67.71, letter "F"), with regard to the requirements for obtaining a CMA 1st Class, prescribes that for specialist health inspections, one had to take into account the professional activity performed or to be performed by the person being inspected. However, during the investigation, the commission did not find a professional profile established by the ANAC for civil aviation pilots. Similarly, it did not find parameters to be considered as cognitive and behavioral personality criteria, suitable for air the activity and, more precisely, airline transport and commercial pilots, to subsidize the evaluation to which the pilots were submitted. Thus, there was no protocol to establish "what was expected" from a civil aviation pilot or the minimum acceptable levels with respect to psychological testing and evaluations.

In a way similar to the topic of "psychological evaluation", there were other items of the RBAC 67 that were unclear, leading air force board of health physicians to resort to the ICA 160-6 (exclusive of military airmen), as well as to Brazilian and international medical directives and protocols for guidance and support of their opinions and judgments of civil aviation personnel. It is worth noting that the ICA 160-6 was not applicable to non-military airmen.

Information of the C560 type qualification and its prerogatives.

At the beginning of the investigation, the commission verified that the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) had transitional rules for pilots to operate the different aircraft models of the Cessna CE560XL series that might not have been observed in the operation of the PR-AFA aircraft.

Thus, the investigation commission was faced with the need to access the Operational Assessment Report issued by the ANAC regarding this aircraft model in order to verify, among other things, the type qualifications necessary for pilots, the differences (major and minor) between aircraft of the same family, and the training of differences, familiarization and transition required from pilots for the safe operation (or transition between models) of the Cessna 560XL aircraft family (CE 560XL, XLS and XLS+) in Brazil.

On 16 September 2014, a request for access to the Operational Assessment Report was formally forwarded to the ANAC, since the document was not available on the agency website. On 13 October 2014, the ANAC provided a formal answer to the Investigation Commission, stating the following:

> "The Cessna 560 XLS+ aircraft has not been operationally evaluated by the ANAC and, consequently, there is not an Operational Evaluation Report published for this aircraft model. The reason is that the operational evaluation activity began to be performed by the agency only in 2009, after the date of the certification of the aircraft model in Brazil.
>
> There are several aircraft models in the aforementioned situation. In these cases, the Operational Standard Superintendence recommends the utilization of the Operational Evaluation Report issued by the primary civil aviation authority of the aircraft model. In the case in question, the primary civil aviation authority is the FAA (Federal Aviation Administration).
>
> The Operational Evaluation Report (FSB Report) issued by the FAA is available on its website, through the following link:
>
> http://fsmis.faa.gov/PICDetail.aspx?docId=FSB%20CE-560XL."

In view of the information provided by the ANAC in support to the investigation, the commission understood that the Operational Evaluation Report concerning this aircraft model at the time of the accident was the Flight Standardization Board (FSB) Report – Revision 2, 30 September 2009, relative to Cessna 560XL, CE 560XL/Excel/XLS/XLS+ aircraft issued by the FAA, approximately five years before the accident.

By means of the gathering of in-depth information on the pilots' experience, the investigation commission verified that both pilots had the C560 type qualification included in their licenses, and that the captain had started operating the Cessna CE 560XLS+ aircraft (classified as C56+ type aircraft according to the IS 61-004, Revision A) in May 2004, while the copilot had started operating it in June of the same year.

According to preliminary information collected at the time, the captain had 900 hours of flight in CE 560XLS aircraft, and the copilot had approximately 130 hours of flight in C560 Encore+ aircraft; however, neither pilot had done any sort of training of differences and/or specific training before starting operating the CE 560XLS+ aircraft.

The FSB (issued by the FAA, and adopted by the ANAC) established clear criteria relative to training, proficiency verification, and transition, applicable to pilots operating aircraft of the Cessna 560XLS series (CE 560XL / Excel / XLS / XLS+).

In its Appendix B, the FSB (by means of the *Master Differences Requirements – MDR- Table*) illustrated the requirements applicable to the training and qualifications of the pilots with respect to the differences between the aforementioned aircraft models.

Thus, for the transition of the captain from the CE 560XLS model flown earlier to the CE 560XLS+ aircraft model, there were requirements concerning training, experience and level C proficiency verification (*Level C Training, Checking, and Currency*), as shown in Figure 123.

Revision 2 09/30/2009
Cessna Model 560XL FSB Report

APPENDIX 1

Master Differences Requirements (MDR) Table

AIRPLANE TYPE RATING: CE-560XL		FROM AIRPLANE		
		CESSNA MODEL CE-560XL	**CESSNA MODEL CE-560XLS**	**CESSNA MODEL CE-560XLS+**
TO AIRPLANE	**CESSNA MODEL CE-560XL**	A/A/B*	A/A/B	C/C/C***
	CESSNA MODEL CE-560XLS	A/A/B	A/A/B*	C/C/C***
	CESSNA MODEL CE-560XLS+	C/C/C**	C/C/C**	A/A/B*

NOTES

*Differences to accommodate optional equipment and aircraft modifications.

** The currency level for flight crews, who are trained and qualified in both the CE 560XL/XLS and the CE-560XLS+, or who are engaged in mixed fleet flying, is Level C if they have not operated the CE-560XLS+ in the preceding 180 days. If flight crews have not operated the CE-560XLS+ in the preceding 180 days, operators and training providers must ensure they receive the minimum training required by this report to reestablish currency in the CE-560XLS+ avionics system and FMS. If flight crews have operated the CE-560XLS+, in the preceding 180 days and have retained systems proficiency with the Pro Line 21 System and the FMS, the currency level will be Level B.

Figure 123 – Appendix 1 to the FSB Report, Revision 2, Cessna 560XL - CE 560XL / Excel / XLS / XLS+.

According to the FAA Advisory Circular 120-53B (AC 120-53B),the level C training requirement recognized the existence of differences related to the operation of aircraft encompassing knowledge, abilities and/or skills.

The level C training requires self-instruction or assisted instruction, but could not be treated just as a knowledge requirement.

Training strategies were necessary for complementing the instruction, guarantee the acquisition or retention of skills, and perform more complex tasks generally associated with the operation of certain aircraft systems.

Typically, the minimum training methods acceptable were the computer-based interactive training, Cockpit Procedure Trainers (CPT) or Part Task Trainers (e.g., FMS or TCAS).

The Level C Checking requirement indicated the need of verifying the proficiency by means of a device meeting the Level C (or higher) differences requirements after the training.

The Currency Difference Levels requirement was applicable to one or more systems or procedures, and related to skill and knowledge requisites.

According to the Note** in Figure:

> "If crewmembers have not operated CE 560XLS+ aircraft in the last 180 days, the operators and training centers must guarantee that they receive the minimum training required by this report with the purpose of re-establishing their proficiency in the systems of avionics and FMS of CE 560XLS+ aircraft."

It is worth pointing out that the FSB Report does not consider the transition between the C560Encore+ and the CE 560XLS+ models, which would be applicable to the copilot of the accident aircraft. Thus, it would be necessary for the copilot to do the complete CE 560XLS+ aircraft specific training course before he could fly it.

At the time of the accident, the Brazilian Civil Aviation Regulation 67, in its item 61.217(b) prescribed the following:

> "If the type qualification certificate has more than one corresponding aircraft model, the prerogatives of the holder are limited to the aircraft on which the flight training or proficiency check was delivered. In order to become qualified to operate another aircraft belonging to the same type qualification certificate, the holder of the type qualification certificate must have received training of the differences or familiarization training, as applicable, at a training center certified by the ANAC to deliver such training, and the instructor shall declare in his flight records (Pilot's Electronic Flight Data Logging System or Pilot's Fight Logbook) that he or she complies with the requirements for operating the aircraft with safety."

On 4 July 2014, approximately 40 days before the accident, the Brazilian Federal Government Gazette published in its Section 1, page 47, the ANAC Supplementary Instruction – IS 61-004, revision A, in force at the time of the accident, and approved by the Executive Order no. 1505/SPO of 3 July 2014, establishing and publishing the list of qualifications to be registered by the ANAC in pilots' licenses issued in accordance with the RBAC 61 and, consequently, showed the differences to be considered and applied to CE 560XL / XLS / XLS+ aircraft models. Such differences are presented in Figure 124.

04/07/2014 — IS nº 61-004 Revisão A

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)

Fabricante (1)	Aeronave (2)		OBS (3)	Designativo (4)
	Modelo	Nome		ANAC
	C550 CS 550	Citation II		C550
	CS 550 Bravo	Citation Bravo		
	C560 Encore	Citation V		C560
	C560 Encore+	Citation Ultra Encore		
	C560XL C560XLS	Citation Excel C560XLS	D	C56X
	C560XLS+	C560XLS+		C56+

Figure 124 – Extract from the Type Qualification Table (Table X) contained in the IS 61-004 Revision A, which illustrates the Type differences in accordance with the designator established by the ANAC.

According to the referred IS, item 5.3.1:

> “In the Tables from I to XVI, the letter “D” of the OBS (RMK) column (3) indicates that training of the differences is required in the transition between variants or models of the same type of aircraft located in the aircraft (2) cells of the columns in the various tables …”

The item 5.3.4 determined that:

> If the variants are located in the same cell of the “AIRCRAFT” (2) column but in different lines, just familiarization training is required when transiting between variants and models of the same type.

The item 5.3.5 read:

> If the variants are presented in separate cells in different lines of the “AIRCRAFT” (2) column, but connected by a cell in the “OBS” (RMK) column, then training of differences is required upon transition between variants or models of the same type.

Prior to the publication of the IS 61-004, Revision A, there was only one type qualification (C560), which, once included in the pilot’s license, granted them with the prerogative of operating the aircraft model on which the flight instruction or proficiency check had been delivered. In the case of the accident in question, this meant the prerogative of transiting from the C560Encore+ to the CE 560XLS+ (copilot), and from the CE 560XLS to the CE 560XLS+ (captain).

However, the adoption of the C560 type qualification for several aircraft allowed pilots to transit between C560 Encore+, CE 560XLS, and CE 560XLS+ aircraft without attestation of the training necessary for such transition in the pilots’ license, making it difficult to be verified by the civil aviation authority by means of the DCERTA system.

Considering the aforementioned IS, which did not have a transition period for implementation, the PR-AFA crew would only be evaluated on the CE 560XLS+ on the occasion of their type revalidation, which would take place shortly before the expiration of the validity of their C560 qualifications in October 2014 (captain) and May 2015 (copilot).

Among the differences of the aforementioned aircraft models, the following may be highlighted:

a) CE 560XLS – an aircraft with performance characteristics similar to those of the CE 560XLS+, but equipped with Honeywell Primus 1000 avionics;

Figure 125 – Picture of theCE 560XLS panel (Honeywell Primus 1000 avionics) operated in earlier times by the captain.

b) C560Encore+ - an aircraft with performance characteristics different from those of the CE 560XLS+ and equipped with Collins Pro Line 21avioinics; and

Figure 126 – Picture of the C560Encore+ panel (Collins Pro Line 21 avionics) operated in earlier times by the copilot.

c) CE 560XLS+ - a more modern aircraft equipped with Collins Pro Line 21 avionics (the aicraft model involved in the accident).

Figure 127 – Picture of the CE 560XLS+ panel (Collins Pro Line 21 avionics) which was being operated at the moment of the accident.

The differences identified by the FAA (Primary Certification Authority of the State of Manufacturing and Design) which justified the need of specific training for adaptation to the CE 560XLS+ model, led the investigators to infer that pilots flying different aircraft models without proper training might be submitted to difficulties in the operation of the aircraft systems.

Such difficulties, at times of task overload, such as those occurring at certain phases of the flight (e.g., missed approach procedure) might result in unacceptable risks, since contingent failures resulting from poor management of the resources available might occur on account of lack of specific training.

Therefore, taking into consideration:

a) the differences between the models of the CE560XLS aircraft family operating in Brazil with Brazilian marks and registration after the date of issuance of the Type Homologation Certificate of the Cessna 560XL (4 March 1999), revised by the ANAC on 16 May 2007, and clearly described in the FSB Report – Revision 2 – of 30 September 2009, adopted by the ANAC as Operational Assessment Report;

b) the ANAC Supplementary Instruction (IS 61-004, Revision A) published approximately 40 days before the accident, and that differentiated the type qualification for operation of the CE 560XLS+ aircraft model;

c) the Brazilian fleet of the Cessna 560XL aircraft family (CE 560XL, CE 560XLS and CE 560XLS+); and

d) the number of other Brazilian pilots who might be operating these aircraft and that had the same conditions of qualification and training of the pilots of the accident aircraft;

The commission of investigation decided to issue the Safety Recommendation A-134/CENIPA/2014-01 to the ANAC (item 5 of this report).

<u>Information on operational evaluation flights</u>

Upon verifying that the operational history of the copilot, at certain moments, presented a level of performance lower than expected, the investigation commission sought records in his Pilot's Evaluation Sheets (FAP) that could indicate any deficiencies in his evaluations for the obtainment of licenses, Type/IFR qualification (or qualification revalidation) certificates.

The commission observed that there were four FAPs, which are presented below:

On 19 April 2012, the copilot did a flight simulator evaluation for obtainment of a C560 Citation V qualification certificate for operation under the RBAC 135 (Operational Requirements: complementary and on-demand operations). His evaluation sheet had no unsatisfactory items, and had the following comments:

> Emergencies performed as prescribed in the FAP. Good performance in maneuvers. Good at the provision of assistance, familiarized with the aircraft systems.

On the same date, he did a flight simulator evaluation for revalidation of this IFR rating. His FAP did not have any unsatisfactory items, and contained the following comments:

> Pilot showed familiarization with aircraft instruments. Three precision approaches performed in single-engine condition. Non-precision approach performed. Very good performance.Approved in the evaluation.

On 20 April 2013, the copilot did an enroute evaluation for the obtainment of an ATP license, Pilot-in-Command certificate, C560 (C560 Encore+) type certificate, and IFR rating revalidation. His FAP did not present any unsatisfactory items, and contained the following comments:

> Satisfactory flight. The applicant demonstrated technical mastering of the systems, limitations and performance of the aircraft, air traffic control rules, and RBAC91 regulations, as well as of the CBA – Brazilian Code of Aeronautics.
>
> ILS procedure performed in SBCF; RNAV and NDB procedures performed in SBVG.

On 25 May 2014, he did an enroute evaluation for revalidation of C560 type qualification, and revalidation of IFR rating as Pilot in Command. His FAP did not have any unsatisfactory items, and contained the following comments:

> Good performance standard.
>
> Good knowledge of the aircraft and air traffic rules.

Except for the last FAP, in which the INSPAC wrote that the missed approach procedure was not performed on account of the navaids available and existing air traffic, the other FAPs referred to the same procedure as satisfactorily performed without any specific comments.

One of the INSPACs that evaluated the copilot said that three procedures were usually performed for checking takeoff, visual traffic, and landing.

The INSPAC also said that his position in the cockpit during the flight did not allow good visualization of the pilots' actions. For this reason, he was not able to evaluate the performance of the copilot in this respect. However, in relation to the takeoff, visual traffic and landing, he considered the copilot's performance as normal, that is, he did not observe relevant facts, either positive or negative, the could have drawn his attention in relation to the copilot's skills in flying the aircraft. On that occasion, the missed approach procedure was not performed.

In relation to the activity of civil aviation supervision, the Brazilian Aeronautical Homologation Regulation (RBHA 17) of 8 March 2006, which deals with Civil Aviation Supervision, defines Exam as:

> Every supervising activity conducted by a person accredited by the aeronautical authority with the purpose of verifying the proficiency and competence of crews and airmen, in accordance with the legal norms contained in the Brazilian Code of Aeronautics, as well as in complementary legislation, as established in the Article 1 of the referred code.

The item 17.13 of the RBHA 17 has the following text:

> 17.13 – CHARACTERISTICS OF THE ACTIVITY
>
> (a) The ability of the DAC in supervising and controlling commercial air transport operations of public interest relies, mainly, on the professional formation and training of its Inspectors. For an effective accomplishment of the responsibilities, each sector must be organized appropriately and be composed of accredited personnel sufficiently prepared for conducting the required supervision activities.
>
> (b) For adequate accomplishment of his/her functions, it is important for the INSPAC to have educational, operational, and technical experience which put him/her in a position of advantage before the operator's professionals to be checked.

The Supplementary Instruction no. 00-002, revision B, of 1 June 2012, dealing with Pilot's Evaluation Sheets (FAP) has definitions for the following types of checks:

> 4.1.2 ORAL EVALUATION – Oral assessment of the examinee's theoreticalknowledge, delivered by the Inspector/Accredited Examiner with the purpose of confirming whether he/she has the minimum theoretical knowledge for undergoing a practical flight-exam
>
> 4.1.3 LOCAL EVALUATION – or localcheck, consists of at least one flight in which it is verified whether the examinee has an acceptable level of proficiency in the equipment (class or type) to be utilized. The evaluation has to be delivered in the basic aircraft type and model, as well as in the work position designated for the crew member. If the pilot to be evaluated possesses an IFR rating, IFR procedures have to be performed.
>
> 4.1.4 ENROUTE EVALUATION – or enroute check, consists of at least one flight along the route segment utilized by the company, in the case of a regular company, or along any route within the area of activity, in the case of a non-regular company,

> aimed at verifying whether the examinee possesses an acceptable level of proficiency in all the tasks designated by the company to be conducted in the basic aircraft type and model, as well as in the work position designated for the crew member. If the pilots IFR-rated, at least one segment has to be flown on an airway, on an off-airway approved route, or on a route which is partially on and off the airway. The INSPAC/Examiner shall verify whether the pilot under evaluation performs the obligations and responsibilities of a pilot in command conducting operations in accordance with the RBAC governing his/her company; the specific operator procedures contained in the approved General Operating Manual (MGO) of the company, such as the duties of the crews (discipline, responsibilities, etc.) and whether the pilot is knowledgeable of the areas, routes and aerodromes where he/she will operate, such as minimum enroute altitudes, area and aerodrome weather conditions, air traffic procedures, aerodrome obstacles and overflight of densely populated areas.

Here, it is worth highlighting that the INSPAC who had delivered the simulator check on 19 April 2012 was qualified at the time in C525, C525A, C525B and C525C aircraft, and his qualifications were valid until August 2012.

The INSPAC who delivered the enroute check on 20 April 2013 had a CSE5 qualification (no longer in force) which qualified him in C500/C501/C510/C525/C550/C551/C560/C560XL aircraft, but the validity of that qualification had expired in August 1993. His most recent jet aircraft qualification was for B737 aircraft, and had expired in March 1999.

The INSPAC, who delivered the last check on 25 May 2014 for revalidation of C560 type aircraft qualification at the time of the copilot's check, had the DA10 qualification for operation of Falcon 10 aircraft (validity expired since May 2010) as the only jet aircraft included in his license. The Falcon 10 was an aircraft manufactured by Dassault (France), which had a type of avionics predominantly analogical, that is, very different from the avionics of the Cessna CE Encore+ aircraft, which is equipped with an Electronic Flight Instrument System (EFIS). Thus, such qualification did not guarantee all the knowledge necessary for a more precise evaluation of the pilots' level of proficiency in the operation of the C560 Encore+ navigation systems in the various checks prescribed by the Supplementary Instruction 00-002B.

In addition to the RBHA 17 and IS No. 00-002B, the commission found out two other Civil Aviation Instructions (IAC) dealing with the activity performed by Civil Aviation Inspectors (INSPAC). They are: IAC 017-1001 of 11 August 2004 (dealing with the professional formation of civil aviation inspectors and civil aviation supervisors, and the IAC 3201 of 15 January 1998, which deals with the activities performed by INSPAC and accredited examiners. These instructions, established by the former DAC, had many procedures which were no longer used, and were out of reality in relation to the Brazilian civil aviation of the year 2014.

<u>Information relative to the professional formation of the Aeronautical Station Operator.</u>

During the investigation process, the commission verified that the information provided to the aircraft by Santos Radio (AFIS-ST) was not in accordance with the prescriptions contained in the ICA 100-37, since the following items were not informed: SIGMET 6, the height of the lowest layer of clouds, and visibility in the aerodrome.

Thus, upon surveying the professional background of the Santos Radio operator, the investigation commission found out that he completed the Basic Course on Telecommunications (BCO) in the Aeronautics' School of Specialists (EEAR) on 26 November 2013.

Such course qualified him to work as an Aeronautical Station Operator (OEA), in consonance with the item 3.3.8.4 of the Command of Aeronautics' Instruction (ICA) 102-7/2013 – Aeronautical Station Operator Qualification Certificate.

Upon completion of the course and obtainment of the license, he underwent supervised training with an evaluator, and was considered competent to perform the functions inherent to the provision of Aerodrome Information Services, having accumulated approximately 285 hours of training (minimum requirement of two months and/or 80 hours).

His aeronautical medical certificate was valid until 28 November 2014.

The administrative process for the issuance of his Technical Qualification Certificate (CHT), the document legally required for the exercise of the profession, was still under way.

1.18 Operational information.

<u>Preparation for the flight.</u>

The flight plan was filed via telephone to the AIS-RJ Office on 12 August 2014, at 22:26 local time.

According to the flight plan, the crew intended to take off from SBRJ on 13 August at 12:29 UTC, flying direct to NAXOP position, intercepting the W6 airway and flying towards VUKIK position, and then flying to SBST direct.

Their intention was to fly at FL240, the estimated time en route was 40min., and the declared endurance was three hours (Figure 128).

```
                                                        10541.
FF  SBCWZQZX SBSTYSYX SBRJZXIP SBRJZXNB                 ID : 1
80     DATA/HORA : 13/08/14 - 01:26:29
130126 SBRJYOYX
(FPL-PRAFA-IG
-C56X/M-SDGIRX/C
-SBRJ1229
-N0410F240 DCT NAXOP W6 VUKIK DCT
-SBST0040 SBKP
-PBN/B2C2D2S1 NAV/RNP5 OPR/AF ANDRADE EMP LTDA PER/B RMK/C
LR
RJP13780045 RMK/FROM SBSP RMK/AUTH CMTE BASE
)
DADOS DO ITEM 19 :
-E/0300  P/TBN  R/UVE  S/J  J/F
 D/  C
 A/BRANCA AZUL E DOURADA
 N/PRIMEIROS SOCORROS
 C/MARCO  845875)
 ===> PREENCHIDO POR: MAGELLA 115983 ===> TELCTT : 31 8750[redacted]


 ===> ASSINATURA :
```

Figure 128 – Flight plan from SBRJ to SBST transmitted by the AIS-RJ office.

On 13 August, the copilot filed the flight plan for SBST-SBSP leg at the AIS-RJ office at 08:34 local time.

Theplan estimated the departure from SBST at 13:45 UTC of 13 August, then direct USITO position, and then direct SBSP.

The planned flight level was FL090, with an estimate time en route of 30 minutes, with fuel endurance of three hours (Figure 129).

FF SBSTYOYM ID : 193 DATA/HORA : 13/08/14 - 11:34:13
131134 SBRJYOYX
(FPL-PRAFA-IG
-C56X/M-SDGIRX/C
-SBST1345
-N0250F090 DCT USITO DCT
-SBSP0030 SBKP
-PBN/B2C2D2S1 NAV/RNP5 OPR/AF ANDRADE EMPREENDIMENTOS LTDA
PER/B RMK/CLR SPA13780317 RMK/FROM SBRJ RMK/AUTH
DEP SBST
)
DADOS DO ITEM 19 :
-E/0300 P/TBN R/UVE S/J J/F
D/ C
A/BRANCA AZUL E DOURADA
N/PRIMEIROS SOCORROS
C/MARCO 845875)
===> PREENCHIDO POR: MAGELA 115983 ===> TELCTT : 31 8750[redacted]

===> ASSINATURA :

Figure 129 – Flight plan from SBST to SBSP filed at the AIS-RJ office.

The aircraft was refueled with 630 liters (1,109lbs.) of JET A-1 aviation kerosene on 13 August at 08:51 local time, according to the refueling voucher (Figure 130).

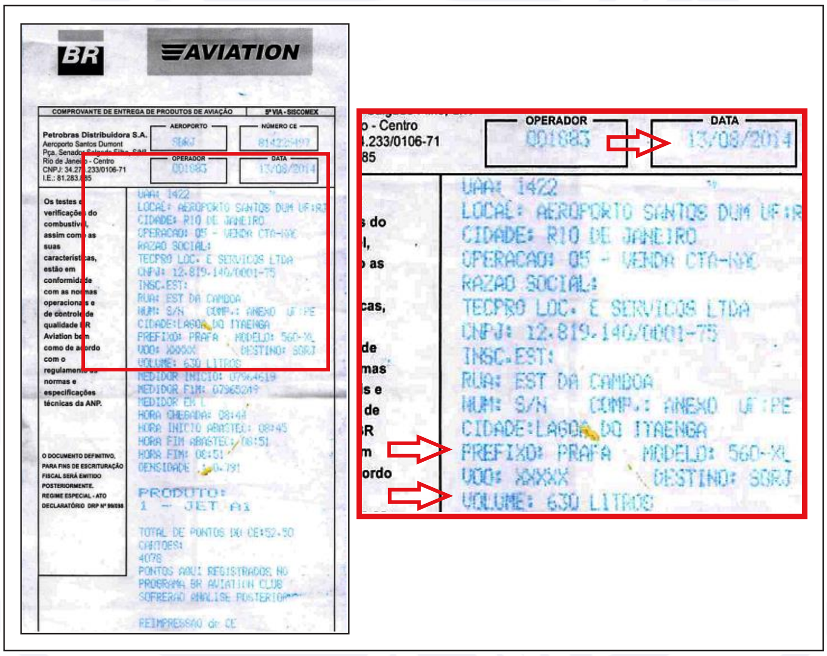


Figure 130 – PR-AFA refueling voucher dated of 13 August 2014 (SBRJ).

According to reports made by individuals who had contact with the crew prior to the flight, they intended to fly the leg from SBST to SBSP without refueling the aircraft in SBST.

In order to estimate the dispatch data at the departure from SBRJ, and obtain more accurate performance data during the descent procedure in SBST, the commission collected data relative to the last four legs flown by the PR-AFA aircraft prior to the accident.

By utilizing the Arinc Direct flight planning software for a CE 560XLS+ aircraft, with characteristics similar to those of the PR-AFA, the commission adopted the regimes of climb, cruise and descent, in accordance with the flight levels and route segments stated in the flight plans. For determining the payload, the commission estimated the number of persons and quantity of luggage on each flight leg. The amount of fuel in the tanks was estimated from the refueling records and estimated consumption of fuel in the previous flight legs.

Thus, the aircraft was estimated to have been refueled with 5,019lb in SBRF for flying a three-hour flight leg to SBJD, and another of twenty minutes from SBJD to SBSP without refueling on 11 August 2014. It was possible, therefore, to infer that the aircraft had its full capacity of fuel (6,740lb) in the tanks before taking off from SBRF. This amount is compatible with the 5-hour endurance declared in the flight plan.

From this number, the amount of fuel consumed on each leg was subtracted, and the amount of fuel received was added.

So, by comparing the flight plan data relative to the four flight legs preceding the accident flight, it is possible to infer that the aircraft had a total of approximately 3.755lb of fuel in the tanks, after being refueled in SBRJ, according to the Table 5.

FLIGHT PLAN DATA FILLED IN BY THE CREW								AMOUNT OF FUEL IN LB					
DATE	DEPARTURE AERODROME	DESTINATION AERODROME	ALTERNATE AERODROME	ROUTE	CRUISE LEVEL	ESTIMATED FLIGHT TIME	FLIGHT PLAN DECLARED ENDURANCE	MAX. FOR THE LEG	MIN. FOR THE LEG	REFUELD AT DEPARTURE AERODROME	ESTIMATED IN THE TANKS BEFORE DEPARTURE	FORECAST CONSUMPTION FOR THE LEG + TAXI	ESTIMATED IN THE TANKS AFTER THE FLIGHT
11/8/14	SBRF	SBJD	SBKP	DCT SIAPA DCT AVILA UZ30 EDINOT DCT MOXEP DCT BGC/N0200F055VFR DCT REA ECHO QUEBEC	F430	03:00	05:00	6740	5435	5018	6740	4276	2464
11/8/14	SBJD	SBSP	SBKP	DCT 2311S04704W/ N0250F070 IFR DCT	A040	00:19	02:30	5960	2310	0	2464	720	1744
12/8/14	SBSP	SBRJ	SBGL	UZ37 VUREP	F270	01:00	04:30	6520	2793	2182	3926	1280	2646
13/8/14	SBRJ	SBST	SBKP	DCT NAXOP W6 VUKIK DCT	F240	00:40	03:00	5655	3283	1109	3755	1365	2390
13/8/14	SBST	SBSP	SBKP	DCT USITO DCT	F090	00:30	03:00	4819	2091	0	2390	529	---
								MAX CAPACITY			6740 LBS		

Table 5 – Estimated refueling in the three legs prior to the accident flight.

With respect to aeronautical information, the SBST NOTAMs in force at the time of the accident, and available to the crew, had the following information:

GUARUJA/BASE AEREA DE SANTOS, SP (SBST)
AGA
D2847/2014
B) 08/08/14 16:00
C) PERM
E) SER COMBATE INCENDIO/SALVAMENTO CNL
REF: AIP MAP ADC
ROTAER 3-G)

GUARUJA/BASE AEREA DE SANTOS, SP (SBST)
AGA
D2543/2014
B) 10/07/14 16:57
C) 09/09/14 23:59
E) SER COMBUSTIVEL AVGAS NO AVBL)

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
CNS
D2168/2014
B) 20/06/14 00:00
C) PERM
E) NDB NR (MOELA) 305KHZ CNL
REF: ROTAER 3-S (SBST/SBXP)
AIP ENR 4.1
ENR 6 L2/H2
AIP-MAP ARC RIO/SAO PAULO)

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
NAV
D2870/2014
B) 11/08/14 12:00
C) 31/08/14 20:00
E) AREA RTO TEMPO (FLT DE VEICULO AEREO NAO TRIPULADO - VANT) BTNCOORD 235326S/0462906W, 235334S/0462920W, 235327S/0462924W E235320S/0462910W ACT
F) SFC
G) 2500FT AMSL)

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
NAV
D2868/2014
B) 04/08/14 18:25
C) PERM
E) AREA RTO SBR 406 (ITARARE) - MODIFICADO TIPO DERESTRICAO/PERIGO DE ASAS VOADORAS PARA ASA DELTA,PARAPENTE E PARAMOTOR
REF: AIP ENR 5.1
F) SFC
G) 2500FT AMSL)

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
NAV
D1848/2014
B) 04/06/14 03:00
C) 27/08/14 23:59
E) AREA RTO SBR 401 DESATIVADA
F) SFC
G) 3000FT AMSL)
GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
OTR
D2804/2014
B) 29/07/14 21:37
C) 26/10/14 23:59
E) FLT VFR TKOF DE AD PROVIDO DE ORGAO ATS, REALIZADO INTEIRAMENTEDENTRO DA PROJECAO VER DOS BDRY LT, FM SFC TIL FL145, DAS TMA SÃO PAULO 1, TMA SAO PAULO 2 E TMA SAO PAULO 3, PODERA APRESENTAR PVS.)

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
OTR
D2688/2014
B) 25/07/14 17:41
C) 22/10/14 23:59
E) AREA DE CTL HEL - PRB INGRESSO E SOBREVOO DE HEL NA AREA DE CTLHELSALVO PARA OPS LDG E DEP NOS HELPN NELA EXISTENTE (EXC OPSMIL,SEGURANCA PUBLICA E DEFESA CIV, OU SER AEREO ESPECIALIZADODE AEROREPORTAGEM, DE AEROINSPECAO OU DE COMBATE A INCENDIO))

GUARUJA/BASE AEREA DE SANTOS,SP (SBST)
OTR
D3787/2013
B) 11/12/13 15:42
C) PERM
E) OBST MONTADO (PORTAINER-GUINDASTE DO PORTO) ALT 128M (420FT) NOPONTO COORD 235531S/0461841W (SANTOS, SP) DIST APRX 824M AZM 272DEGTHR 17
REF: ROTAER 3-S
AIP MAP VAC)

Among other pieces of information, the NOTAM reported that the firefighting service had been permanently discontinued on 8 August 2014; there was a temporarily restricted area for operation of Unmanned Aerial Vehicles (UAV) that extended from sea level to the altitude of 2,500ft (Figure 131); a warning about the possibility of "flying wings" in the SBR 406 Restricted Area extending from the sea level to the altitude of 2,500ft; and warning of a 420ft-high obstacle (crane) at a distance of 824m from the runway 17 threshold in SBST.

Figure 131 – Position of the restricted area for the operation of UAV's (VANT's) in relation to the runway, based on the NOTAM coordinates.

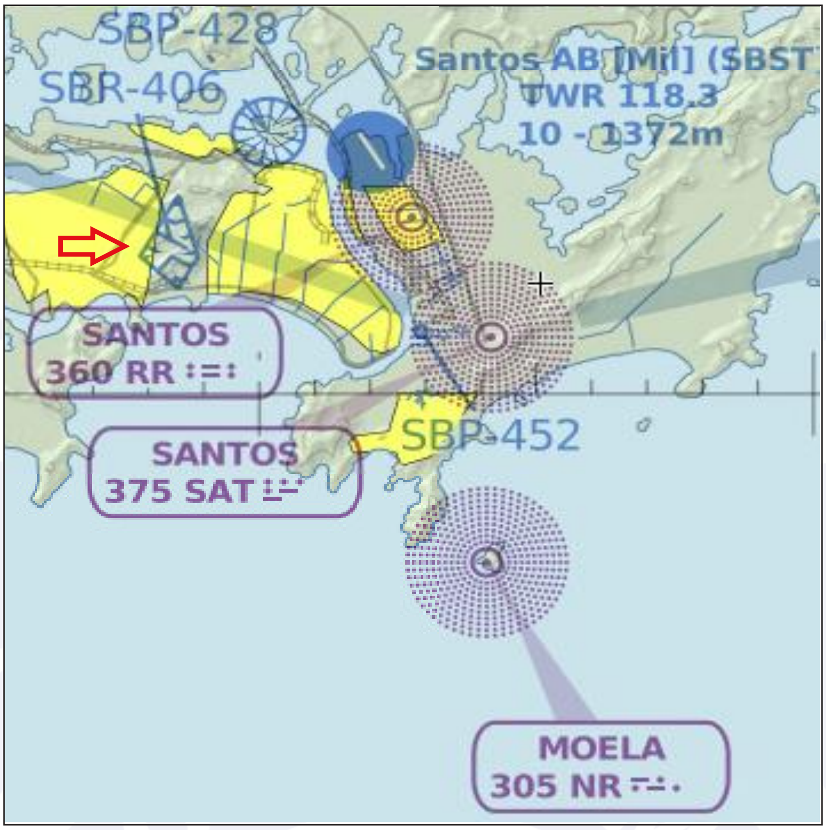


Figure 132 – Position of the SBR 406 area in relation to the runway, in accordance with aeronautical charts.

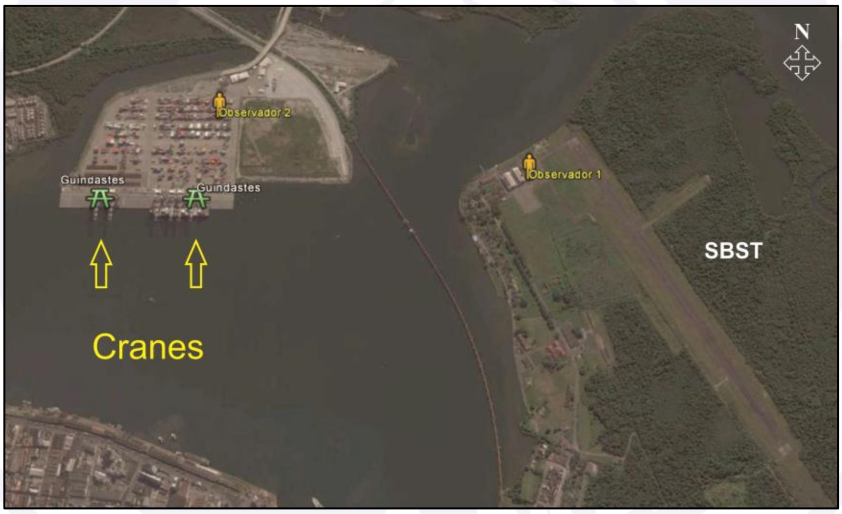


Figure 133 – Position of the cranes in relation to the threshold of runway 17 in SBST, as described in NOTAM.

<u>Flight progress.</u>

The crew requested flight plan clearance from Clearance Delivery at 12:06 UTC, and engine start-up approval from Ground Control at 12:14 UTC. The aircraft took off at 12:21 UTC.

The TMA-RJ radar re-run showed that the aircraft takeoff from SBRJ and subsequent climb to FL240 were uneventful and occurred as coordinated between the PR-AFA and the ATC units.

After the aircraft control handover from APP-RJ to APP-SP, it was observed that the aircraft followed flight profile which is shown hereinafter by means of radar re-runs and illustrations.

At 12:37:34 UTC, the PR-AFA asked Santos Radio for the aerodrome conditions. Radio Santos informed that the SBST aerodrome was operating IFR, with a 210º-wind at 7kt, altimeter setting 1021 hectopascal (QNH), with no other known traffic.

At 12:48:55, the PR-AFA called APP-SP to inform that they would perform the ECHO 1 procedure for landing on runway 35, after crossing SAT NDB twice. The APP-SP (São Paulo Tracon) authorized descent to 6,000ft, and informed a QNH of 1022 hectopascal.

At 12:55:21, the PR-AFA informed reaching 6,000ft with visual references, and requested to change to the Santos Radio 118.3MHz frequency. APP-SP instructed the aircraft to call Radio Santos on that frequency.

At 12:55:23, the aircraft radar target was being seen on the APP-SP radar screens in the way shown in Figure 134. The PR-AFA flew according to the W6 airway profile at FL240, and at a ground speed of 239kt. The Figure also shows a description of the various symbols displayed on the radar screen.

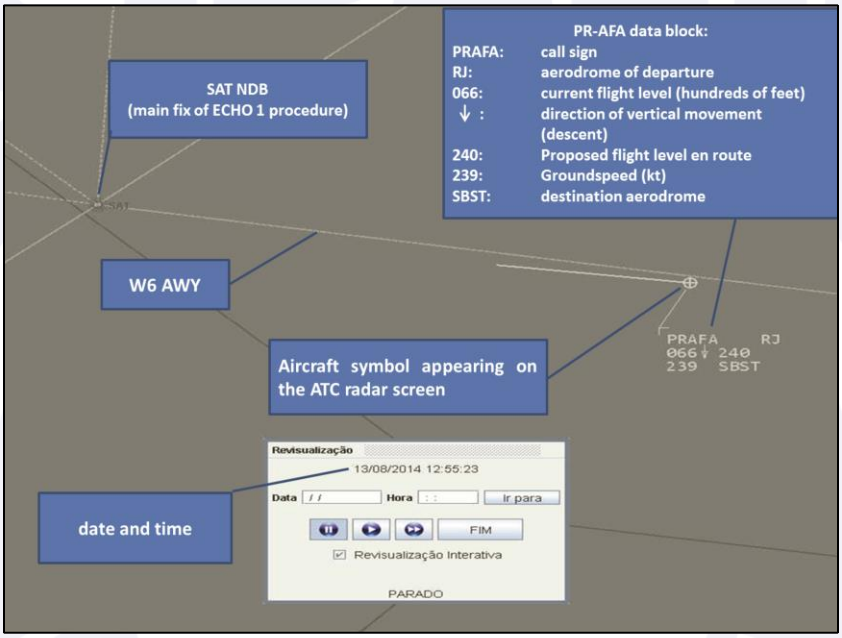


Figure 134 – Radar image of the PR-AFA as of 12:55:23UTC.

At 12:55:34, the PR-AFA called Santos Radio, and said that they were descending from 6.000ft to 4.000ft, and reported having already been released by APP-SP. Santos Radio reported that the aerodrome was operating IFR, with a wind from 240°at 7kt, QNH 1021hPa, with no other known traffic, and requested PR-AFA to inform when crossing SAT NDB fix at 4,000ft.

In the 12:56:20 UTC radar image, it is possible to see that, after coordinating its descent, the PR-AFA made a left turn, moving away from the W6 airway, and descended to an altitude below FL060, as shown in Figure 135.

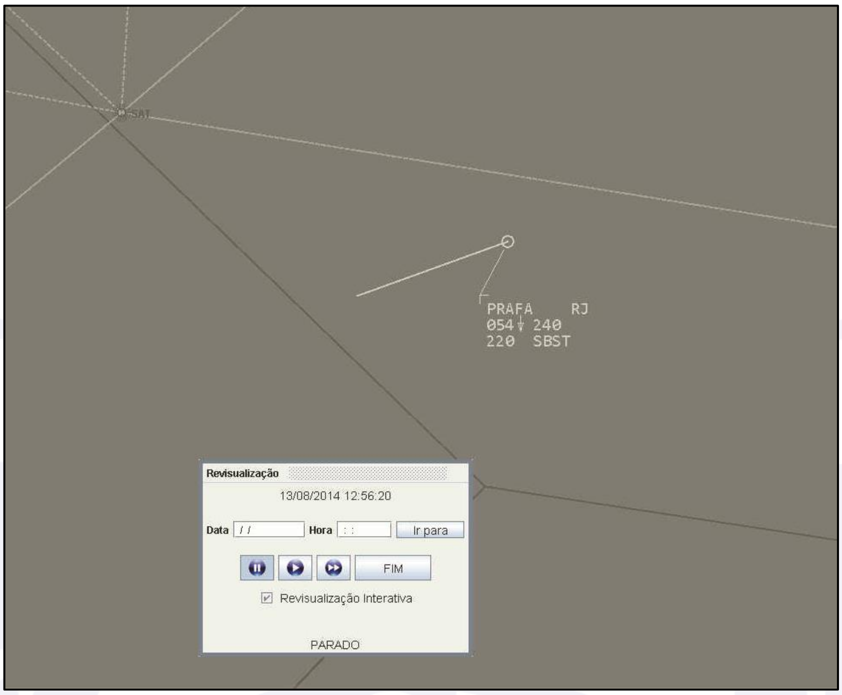


Figure 135 – Radar image of the PR-AFA as of 12:56:20UTC.

At 12:57:37, the PR-AFA called Santos Radio to report crossing SAT NDB, and that they would call crossing the fix a second time.

The flight profile prescribed for (and reported by) the PR-AFA consisted of entering an orbit marked by SAT NDB at 4,000ft, crossing the fix two times before starting the descent, as shown in Figure 136.

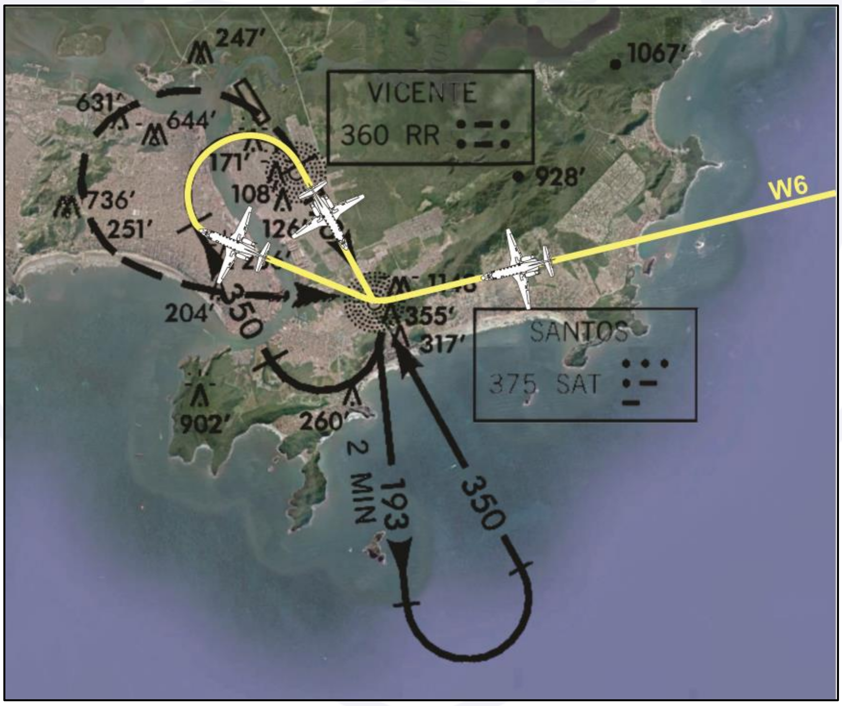


Figure 136 – Expected flight profile of the PR-AFA for starting the orbit of the ECHO 1 procedure in SBST at 4,000ft.

However, the message was not compatible with the 12:57:40 radar image, which showed the aircraft to the left of the W-6 airway and below the minimum prescribed altitude for starting the procedure (Figure 137).

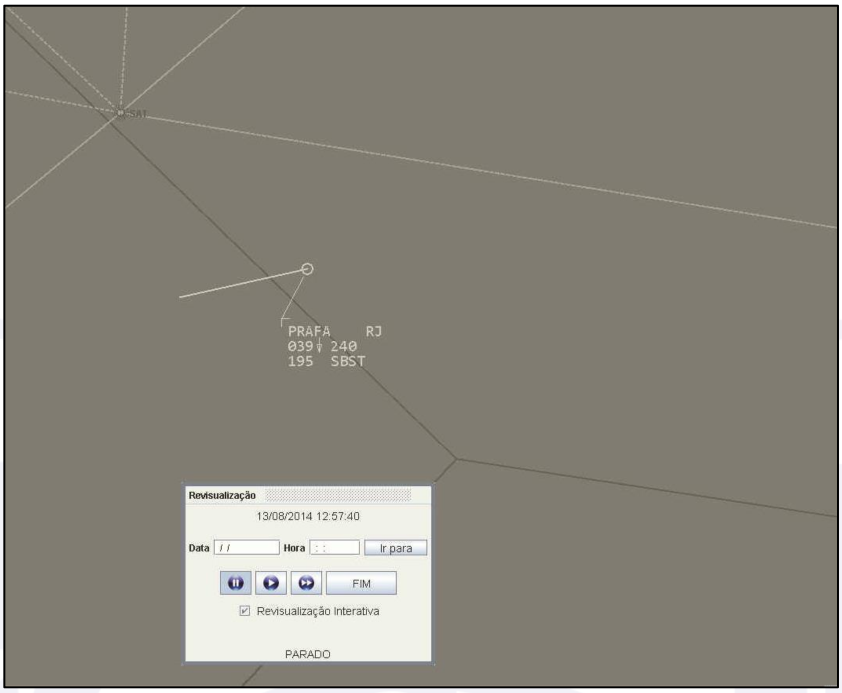


Figure 137 – Radar image of the PR-AFA as of 12:57:40 UTC, showing the aircraft to the left of the W6 airway, away from the prescribed position for crossing SAT NDB, passing the altitude of 3,900ft while descending.

At 12:59:34, the PR-AFA informed Santos Radio that they were crossing SAT NDB on the approach to runway 35. Then, Santos Radio warned the aircraft of the possibility of birds over the runway threshold, as well as fauna along the runway extension, after which it reported wind from 230° at 11kt, and requested the aircraft to report in the MDA at 700ft.

For this phase of the procedure, the aircraft was expected to have crossed SAT NDB a second time, starting the descent on a magnetic bearing (QDR) of 193º for two minutes, and making a left turn, limited to an altitude of 2,200ft, thus joining the final approach on a magnetic heading (QDM) of 350 º, as shown Figure 138.

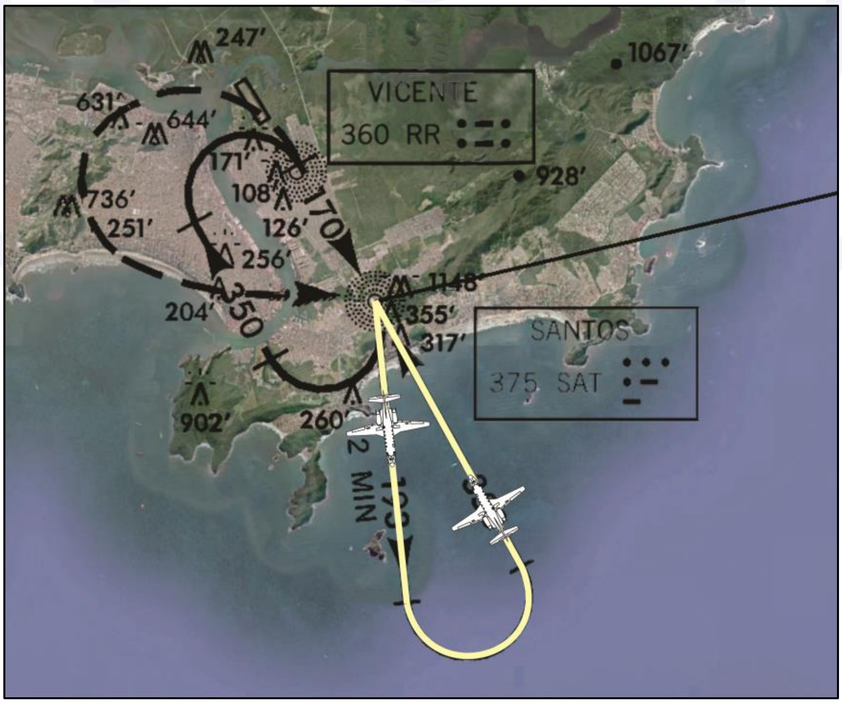


Figure 138 – Expected profile for the outbound segment, descent and final approach of the ECHO 1 procedure in SBST.

The 12:59:13 radar image shows the aircraft descending through 2,600ft at a ground speed of 175kt, at a distance of 2.5 nautical miles from SAT NDB (Figure 139). This was the last image generated by the secondary radar, before the beginning of extrapolations of the aircraft target.

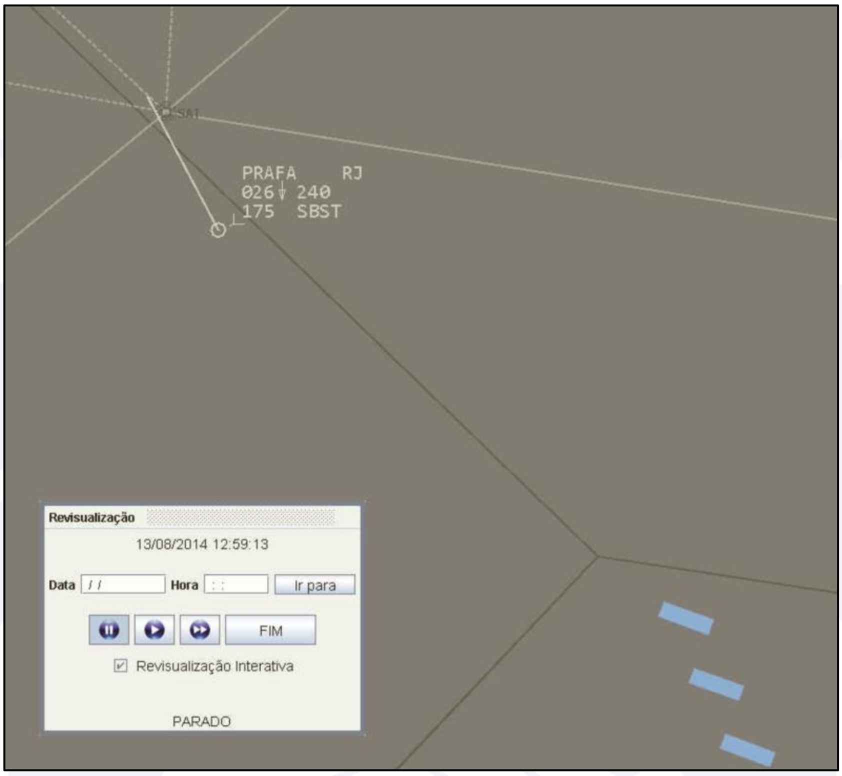


Figure 139 – Radar image (Secondary radar detection) generated at 12:59:13UTC.

At 12:59:43, the radar generated the last (extrapolated) position of the PR-AFA on the approach to runway 35, at a distance of one nautical mile from SAT NDB, when altitude and speed data are no longer considered reliable (Figure 140).

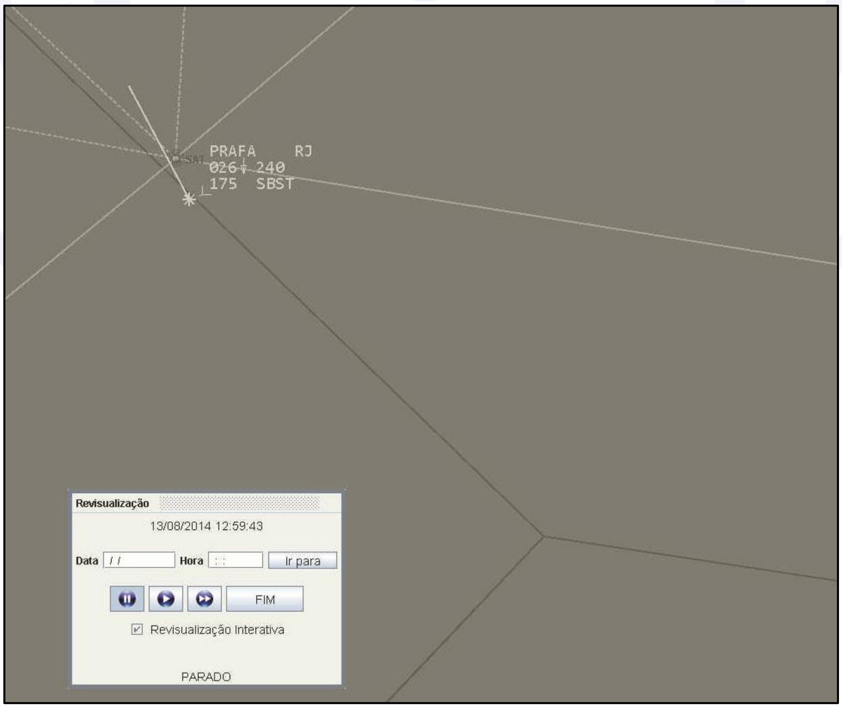


Figure 140 – Radar image of the PR-AFA as of 12:59:43 UTC.

According to the vertical profile of the ECHO 1 procedure, the aircraft would cross the fix at an altitude of 1,700ft on the final approach (Figure 141).

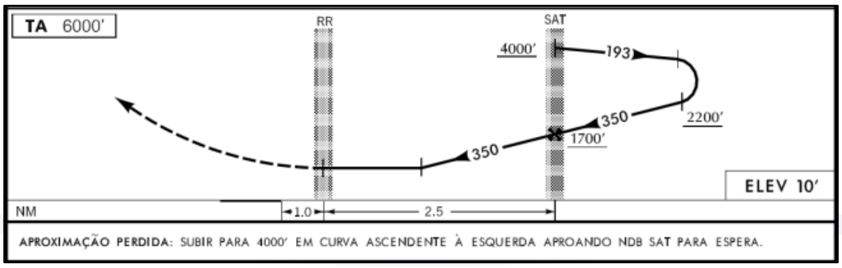


Figure 141 – Vertical profile prescribed for the ECHO 1 procedure in SBST.

According to the manufacturer of the aircraft, the parameters to be held during the final approach of an NDB procedure (non-precision approach) are: landing gear down and locked, flaps at 35º, speed equivalent to V_{REF} + 10kt, and before-landing checklist accomplished.

Upon reaching the MDA, with visual references with the runway, the aircraft should continue on the approach and, if landing is guaranteed, cross the runway threshold at a speed equivalent to V_{REF}. If the runway is not in sight, the pilot must continue flying to the missed approach point (MAPT), and initiate the missed approach procedure (Figure 142).

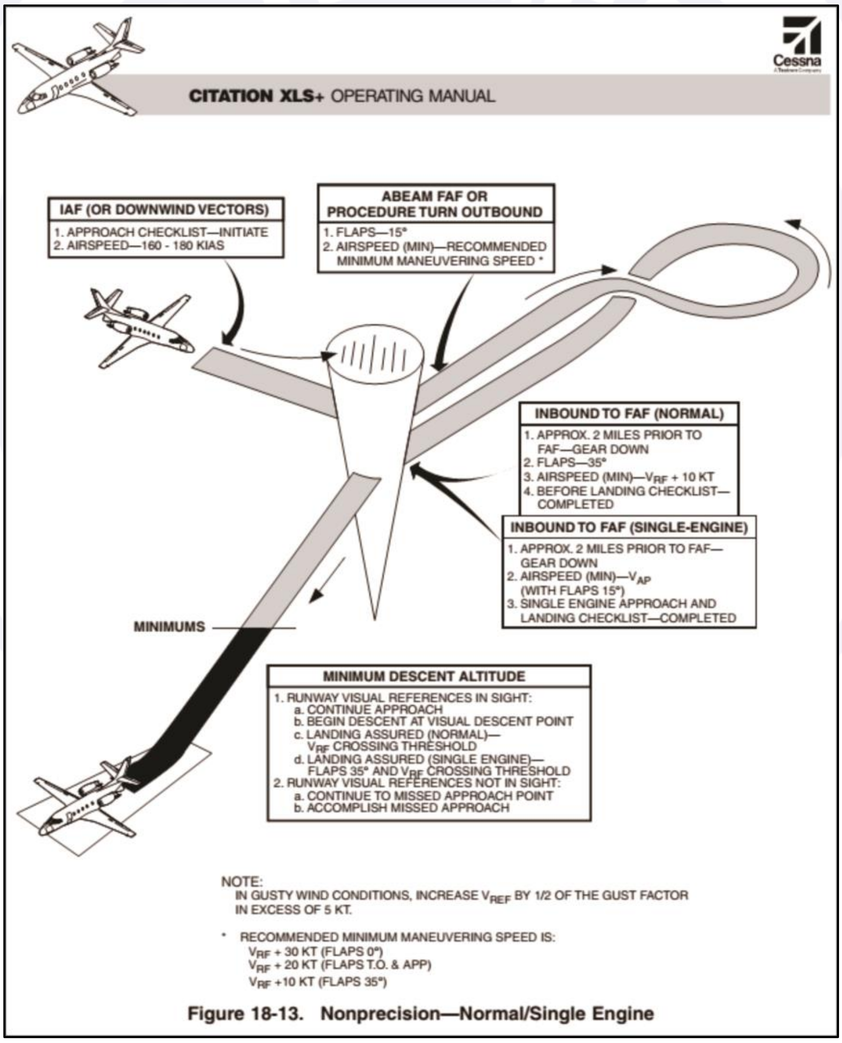


Figure 142 – Parameters to be observed during the execution of a non-precision procedure, established for the CE 560XLS+ aircraft.

According to the 13:00 UTC SBST METAR, the weather conditions on the final approach of the aircraft indicated a ceiling corresponding to 100ft above the Minimum

Descent Altitude (MDA) and maximum horizontal visibility of 3,000 meters (1,400 meters above the minimum prescribedin the ECHO 1 procedure for a category "B" aircraft (such as the CE 560 XLS+), as shown in Figure 143.

In relation to the circle-to-land procedure, it is possible to observe that the ceiling was 300ft below the minima, while visibility was 600 meters above the minimum required for a category “B” aircraft.

	POUSO DIRETO RWY 35	IFR OPS DIURNA / NOTURNA	PARA CIRCULAR (VER RMK)			
C	NDB					
A	MDA 700'	TETO 700'				
T	VIS		CAT	MDA	TETO	VIS
A	1600 M		A	810'	800'	2000 M
B			B	1030'	1100'	2400 M
C	3200 M		C	1330'	1400'	4800 M
D	NA		D	NA		
E			E			

Figure 143 – Table demonstrative of ceiling and visibility minima for the execution of the ECHO 1 procedure in SBST.

By associating the aircraft position data generated by the radar at 12:59:43 with: -the vertical profile of the terrain on the final approach; - with the MDA and SAT NDB crossing limits; - the projection of a final approach path towards runway 35 at an angle of 3.5º; and - the ceiling and visibility data reported in the METAR, it is possible to determine the scenario represented in Figure 144.

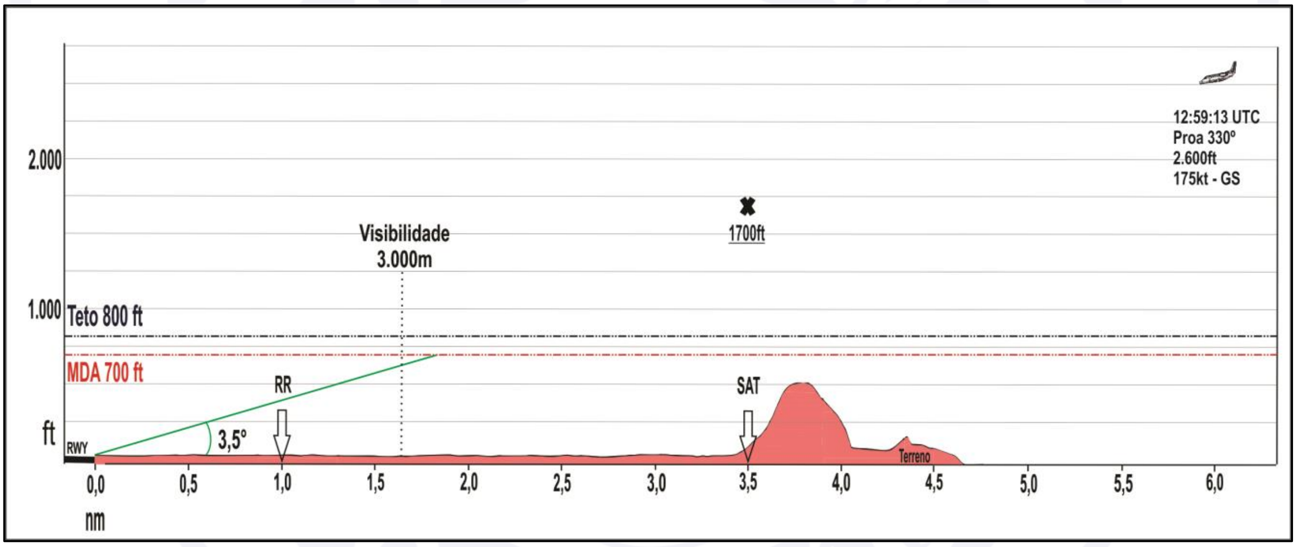


Figure 144 – Vertical Profile of: - the meteorological conditions; - ECHO 1 procedure restrictions, and - aircraft position detected by the radar at 12:59:13UTC (not to scale).

At 13:00:35, according to data retrieved from the left engine DCU, the aircraft was flying with an approach configuration, with the engines developing low power as a result of a throttle position corresponding to 7.233º (TLA - Thrust Lever Angle), and about 27.7% of N1 (rotation percentage in the primary stage of the engine turbine). The aircraft was flying at an altitude of 527.31ft, at a speed of 144.438KIAS (Figure 145).

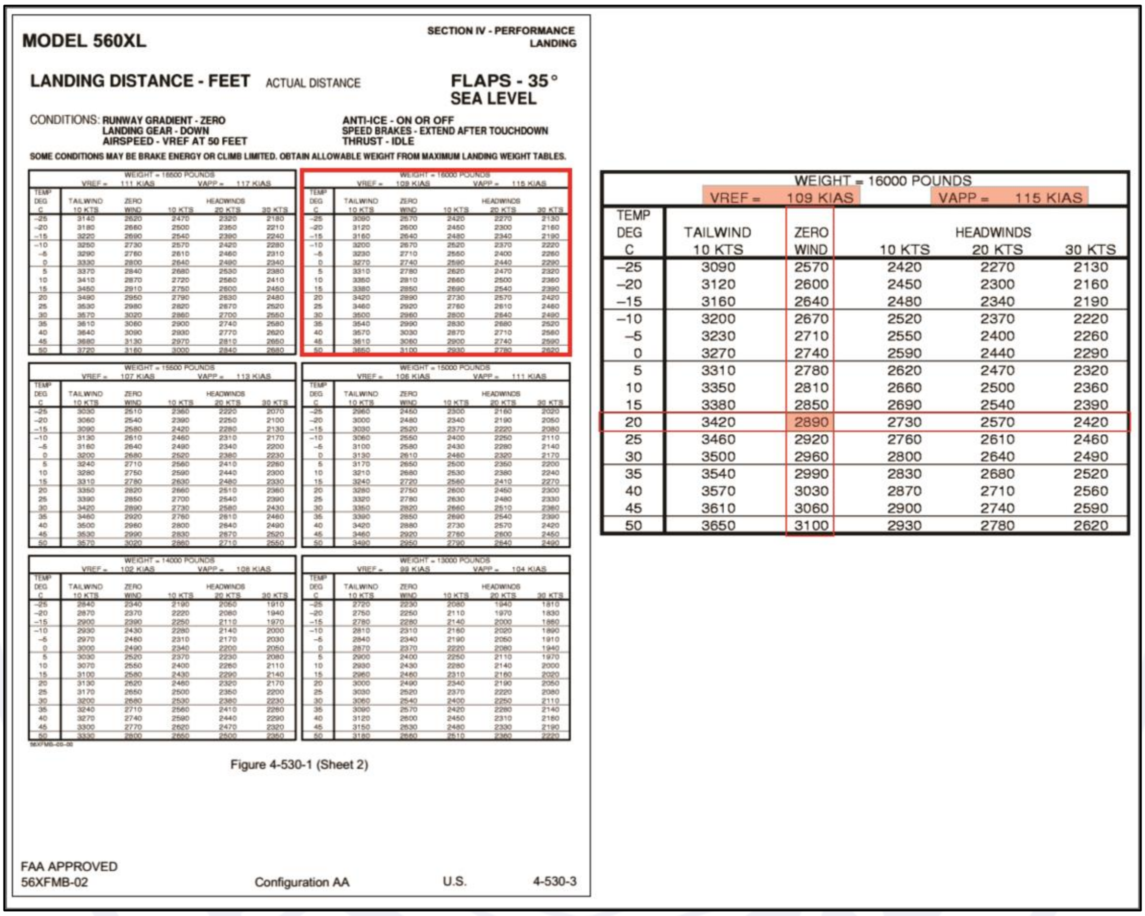
Record	Date	Time	TIME_ENG_RUN	TIME_EEC_RUN	TLA	N1_TREND	N2_TREND	SEL_T6	OAT_TREND	BARO_ALT	IAS_TREND	WF_TREND
ECTM Type	UTC	UTC	HR	HR	DEGREE	%N1	%N2	DEG.C	DEG.C	FEET	KNOTS	PPH
TAKEOFF	2014-08-13	12:22:18	566.4985	790.5566	56.532	85.544	96.231	591.272	27.049	687.69	192.75	1615.75
CLIMB	2014-08-13	12:30:28	566.6349	790.6929	55.407	92.009	97.01	568.315	-1.407	21000.98	230	1100.5
DESCENT	2014-08-13	12:46:57	566.9096	790.9677	38.851	79.714	90.874	502.356	3.258	21993.805	290.813	684.75
APPROACH	2014-08-13	13:00:35	567.1368	791.1949	7.233	27.706	54.4	515.918	20.216	527.31	144.438	298.25

Figure 145 – Data recorded in the left engine DCU on 13 August 2014.

Thus, for definition of the landing parameters, the commission considered that the aircraft had five passengers on board,an amount of 3,755lb of fuel in the tanks in SBRJ, with a fuel consumption of 1,215lb on the leg from SBRJ to SBST (Table 6). The landing weight in SBST was estimated to be 16,240lb.

As for the weather conditions reported by Santos Radio (wind from 230º at 11kt), a tailwind component of 2kt was verified in relation to landing on runway 35. The temperature reported was 19°C.

When crosschecking these data with the aircraft's landing performance table, one obtained the following numbers: V_{REF} = 109kt; V_{APP} = 116kt; and landing distance = 2,890ft (881m).



MODEL 560XL

SECTION IV - PERFORMANCE
LANDING

LANDING DISTANCE - FEET ACTUAL DISTANCE

FLAPS - 35°
SEA LEVEL

CONDITIONS: RUNWAY GRADIENT - ZERO
LANDING GEAR - DOWN
AIRSPEED - VREF AT 50 FEET

ANTI-ICE - ON OR OFF
SPEED BRAKES - EXTEND AFTER TOUCHDOWN
THRUST - IDLE

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

WEIGHT = 16500 POUNDS — VREF = 111 KIAS — VAPP = 117 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	3140	2620	2470	2320	2180
−20	3180	2660	2500	2350	2210
−15	3220	2690	2540	2390	2240
−10	3250	2730	2570	2420	2280
−5	3290	2760	2610	2460	2310
0	3330	2800	2640	2490	2340
5	3370	2840	2680	2530	2380
10	3410	2870	2720	2560	2410
15	3450	2910	2750	2600	2450
20	3490	2950	2790	2630	2480
25	3530	2980	2820	2670	2520
30	3570	3020	2860	2700	2550
35	3610	3060	2900	2740	2580
40	3640	3090	2930	2770	2620
45	3680	3130	2970	2810	2650
50	3720	3160	3000	2840	2680

WEIGHT = 16000 POUNDS — VREF = 109 KIAS — VAPP = 115 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	3090	2570	2420	2270	2130
−20	3120	2600	2450	2300	2160
−15	3160	2640	2480	2340	2190
−10	3200	2670	2520	2370	2220
−5	3230	2710	2550	2400	2260
0	3270	2740	2590	2440	2290
5	3310	2780	2620	2470	2320
10	3350	2810	2660	2500	2360
15	3380	2850	2690	2540	2390
20	3420	2890	2730	2570	2420
25	3460	2920	2760	2610	2460
30	3500	2960	2800	2640	2490
35	3540	2990	2830	2680	2520
40	3570	3030	2870	2710	2560
45	3610	3060	2900	2740	2590
50	3650	3100	2930	2780	2620

WEIGHT = 15500 POUNDS — VREF = 107 KIAS — VAPP = 113 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	3030	2510	2360	2220	2070
−20	3060	2540	2390	2250	2100
−15	3090	2580	2420	2280	2130
−10	3130	2610	2460	2310	2170
−5	3160	2640	2490	2340	2200
0	3200	2680	2520	2380	2230
5	3240	2710	2560	2410	2260
10	3280	2750	2590	2440	2300
15	3310	2780	2630	2480	2330
20	3350	2820	2660	2510	2360
25	3390	2850	2700	2540	2390
30	3420	2890	2730	2580	2430
35	3460	2920	2760	2610	2460
40	3500	2960	2800	2640	2490
45	3530	2990	2830	2670	2520
50	3570	3020	2860	2710	2550

WEIGHT = 15000 POUNDS — VREF = 106 KIAS — VAPP = 111 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	2960	2450	2300	2160	2020
−20	3000	2480	2340	2190	2050
−15	3030	2520	2370	2220	2080
−10	3060	2550	2400	2250	2110
−5	3100	2580	2430	2280	2140
0	3130	2610	2460	2320	2170
5	3170	2650	2500	2350	2200
10	3210	2680	2530	2380	2240
15	3240	2720	2560	2410	2270
20	3280	2750	2600	2450	2300
25	3320	2780	2630	2480	2330
30	3350	2820	2660	2510	2360
35	3390	2850	2690	2540	2390
40	3420	2880	2730	2570	2420
45	3460	2920	2760	2600	2450
50	3490	2950	2790	2640	2490

WEIGHT = 14000 POUNDS — VREF = 102 KIAS — VAPP = 108 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	2840	2340	2190	2050	1910
−20	2870	2370	2220	2080	1940
−15	2900	2390	2250	2110	1970
−10	2930	2430	2280	2140	2000
−5	2970	2460	2310	2170	2030
0	3000	2490	2340	2200	2050
5	3030	2520	2370	2230	2080
10	3070	2550	2400	2260	2110
15	3100	2580	2430	2290	2140
20	3130	2620	2460	2320	2170
25	3170	2650	2500	2350	2200
30	3200	2680	2530	2380	2230
35	3240	2710	2560	2410	2260
40	3270	2740	2590	2440	2290
45	3300	2770	2620	2470	2320
50	3330	2800	2650	2500	2350

WEIGHT = 13000 POUNDS — VREF = 99 KIAS — VAPP = 104 KIAS

TEMP DEG C	TAILWIND 10 KTS	ZERO WIND	HEADWINDS 10 KTS	HEADWINDS 20 KTS	HEADWINDS 30 KTS
−25	2720	2230	2080	1940	1810
−20	2750	2250	2110	1970	1830
−15	2780	2280	2140	2000	1860
−10	2810	2310	2160	2020	1890
−5	2840	2340	2190	2050	1910
0	2870	2370	2220	2080	1940
5	2900	2400	2250	2110	1970
10	2930	2430	2280	2140	2000
15	2960	2460	2310	2160	2020
20	3000	2490	2340	2190	2050
25	3030	2520	2370	2220	2080
30	3060	2540	2400	2250	2110
35	3090	2570	2420	2280	2140
40	3120	2600	2450	2310	2160
45	3150	2630	2480	2330	2190
50	3180	2660	2510	2360	2220

56XFMB-05-00

Figure 4-530-1 (Sheet 2)

FAA APPROVED
56XFMB-02 — Configuration AA — U.S. — 4-530-3

Figure 146 – Performance data relative to landing extracted from the CE 560 XLS+ aircraft manual, 56XFMB-02, *REVISION 2,* of 8January 2014.

The aircraft manual had a factorization table of the landing distance with the aircraft crossing the threshold at 50ft at a speed equal to the V_{REF}, as shown in Figure 147. The Table also brings landing distance data for a wet runway in the event of excess speed of up to 10kt.

Upon factoring these data for a wet runway, the commission obtained a corresponding landing distance of 3,300ft (1,005m) for the aircraft crossing the runway threshold at the V_{REF} speed, and 3,750ft (1,143m) for the aircraft crossing the runway threshold with an excessive speed of up to 10kt above the V_{REF}.

SECTION IV - PERFORMANCE
LANDING

MODEL 560XL

DRY RUNWAY DISTANCE - FEET	WET RUNWAY DISTANCE (WITH REVERSERS) - FEET	
	Airspeed - V_{REF}	Airspeed - V_{REF} + 10 KNOTS
1600	1900	2200
1800	2100	2450
2000	2350	2700
2200	2600	2950
2400	2850	3250
2600	3100	3500
2800	3300	3750
3000	3550	4000
3200	3750	4250
3400	4000	4500
3600	4200	4750
3800	4450	5000
4000	4650	5250
4200	4900	5500
4400	5150	5750
4600	5400	6000
4800	5650	6250
5000	5850	6450
5200	6050	6650
5400	6250	6850
5600	6450	7050
5800	6650	7250
6000	6850	7450
6200	7050	7650
6400	7250	7850
6600	7450	8050
6800	7650	8250
7000	7850	8450
7200	8050	8650
7400	8250	8850
7600	8450	9050
7800	8650	9250
8000	8850	9450
8200	9050	9650
8400	9250	9850
8600	9450	10050
8800	9650	10250
9000	9850	10450
9200	10050	10650
9400	10250	10850
9600	10450	11050
9800	10650	11250

Figure 4-550-2

2800	3300	3750
3000	3550	4000
3200	3750	4250

4-550-2 U.S. Configuration AA

ADVISORY
56XFMB-02

Figure 147 – Performance data relative to landing on a wet runway extracted from the CE 560XLS+ aircraft manual, 56XFMB-02, REVISION 2 of 8 January 2014.

All of these pieces of information were available to the crew in the Flight Management System (FMS) of the aircraft.

In relation to landing with a tailwind component on a wet runway, the aircraft manual had a note in which the manufacturer recommended not to land with tailwind components (Figure 148).

NOTE

The published limiting maximum tailwind component for this airplane is 10 KNOTS, however, landings on wet runways with any tailwind component are not recommended.

Figure 148 – Note in the manual of the CE 560XLS+ aircraft, relative to landing on a wet runway with a tail wind component (56XFMB-02, *REVISION 2* of 8 January 2014).

At 13:01:09 UTC, the PR-AFA informed to have started the missed approach procedure. Santos Radio asked the crew to confirm if the aircraft was going around, and the crew answered affirmatively.

The profile of the missed approach procedure prescribed in the ECHO 1 procedure consisted of a climbing turn to be started at the missed approach point (MAPT) marked by RR NDB, or, in case of a final approach at a speed of 119kt (V_{REF} of 109kt + 10kt, as prescribed in the aircraft manual), to be started one minute and 15 seconds after crossing SAT NDB (Figure 149).

<table>
<tr><td colspan="14">APROXIMAÇÃO PERDIDA: SUBIR PARA 4000' EM CURVA ASCENDENTE À ESQUERDA APROANDO NDB SAT PARA ESPERA.</td></tr>
<tr><td colspan="6">POUSO DIRETO RWY 35</td><td colspan="4">IFR OPS DIURNA / NOTURNA</td><td colspan="4" rowspan="3">PARA CIRCULAR (VER RMK)</td></tr>
<tr><td>C</td><td colspan="9">NDB</td></tr>
<tr><td>A</td><td colspan="5">MDA 700'</td><td colspan="4">TETO 700'</td></tr>
<tr><td>T</td><td colspan="9">VIS</td><td>CAT</td><td>MDA</td><td>TETO</td><td>VIS</td></tr>
<tr><td>A</td><td colspan="9" rowspan="2">1600 M</td><td>A</td><td>810'</td><td>800'</td><td>2000 M</td></tr>
<tr><td>B</td><td>B</td><td>1030'</td><td>1100'</td><td>2400 M</td></tr>
<tr><td>C</td><td colspan="9">3200 M</td><td>C</td><td>1330'</td><td>1400'</td><td>4800 M</td></tr>
<tr><td>D</td><td colspan="9" rowspan="2">NA</td><td>D</td><td colspan="3" rowspan="2">NA</td></tr>
<tr><td>E</td><td>E</td></tr>
</table>

<table>
<tr><td colspan="7">RAZÃO DE DESCIDA NA APROXIMAÇÃO FINAL</td><td colspan="7">TEMPO DE SAT ATE MAPT</td></tr>
<tr><td>KT</td><td>80</td><td>100</td><td>110</td><td>120</td><td>130</td><td>150</td><td>KT</td><td>80</td><td>100</td><td>110</td><td>120</td><td>130</td><td>150</td></tr>
<tr><td>FPM</td><td>600</td><td>700</td><td>750</td><td>800</td><td>900</td><td>1000</td><td>MIN:SEC</td><td>1:52</td><td>1:30</td><td>1:21</td><td>1:15</td><td>1:09</td><td>1:00</td></tr>
</table>

Figure 149 – Data to be considered for the missed approach procedure as described in the ECHO 1 IAC.

In the sequence, the aircraft should have remained in the turn until rolling out towards SAT NDB, climbing to 4,000ft to enter a new orbit (Figure 150).

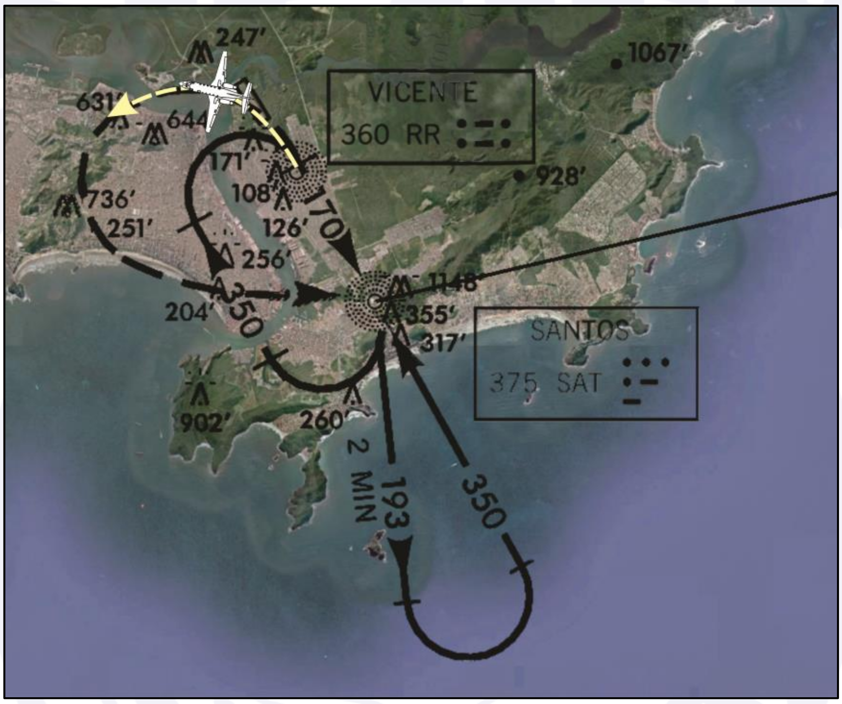


Figure 150 – Profile prescribed for the SBST ECHO 1 missed approach procedure.

According to the aircraft manufacturer, the actions to be performed by the CE 560XLS+ aircraft during the missed approach procedure were (Figure 151):

- press the go-around button simultaneously with the application of maximum power in the engines;

- define a pitch-up angle of 7 degrees, retracting the flaps to 15 degrees, selecting either the HDG or NAV mode in the flight director;

-with a positive rate of climb, retract the landing gear;

- after reaching a pre-determined altitude at a speed above V_{AP}+10kt, retract the flaps, accelerating the aircraft to the climb speed;

- select CLIMB mode; and

-accomplish the checklist.

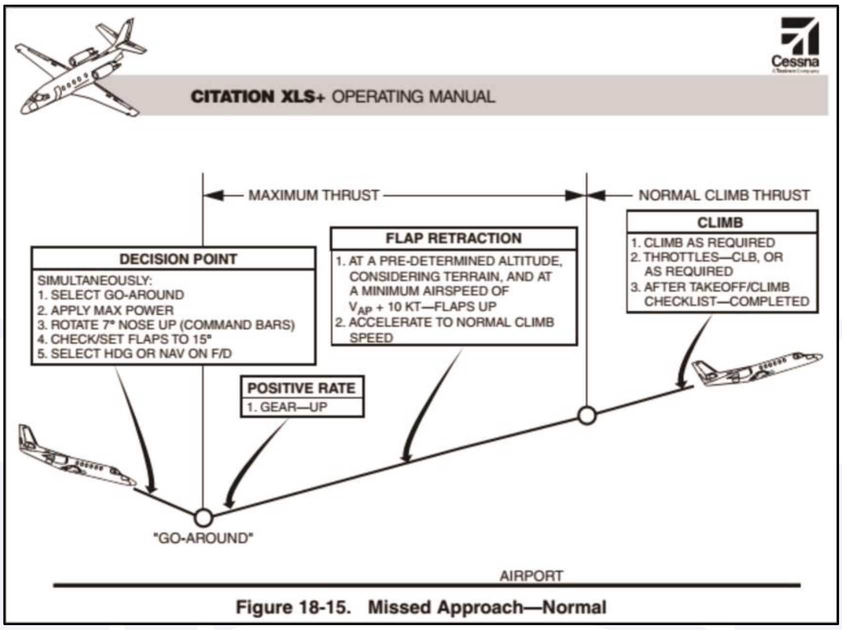


Figure 151 – Parameters to be observed during the execution of a missed approach procedure, as established for the CE 560XLS+ aircraft.

At 13:01:22 UTC, Santos Radio questioned whether the aircraft would make a new attempt to land, and PR-AFA crew answered that, due to the weather conditions, they would wait and call again.

From 13:02:16 on, Santos Radio called the PR-AFA several times, and got no answer.

At 13:02:30, the radar generated an image showing the aircraft in the west sector of the aerodrome, but without sufficient accuracy to determine its position, height or speed (Figure 152).

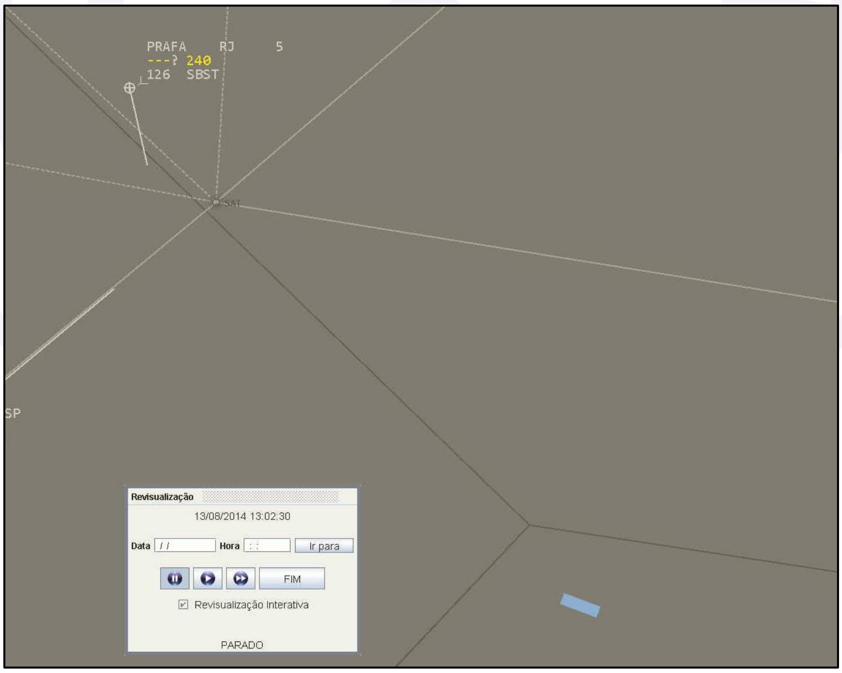


Figure 152 – Radar image of the PR-AFA as of 13:02:30UTC.

At 13:02:42, the radar generated the last image of the PR-AFA, and began to extrapolate the estimated positions of the aircraft (Figure 153).

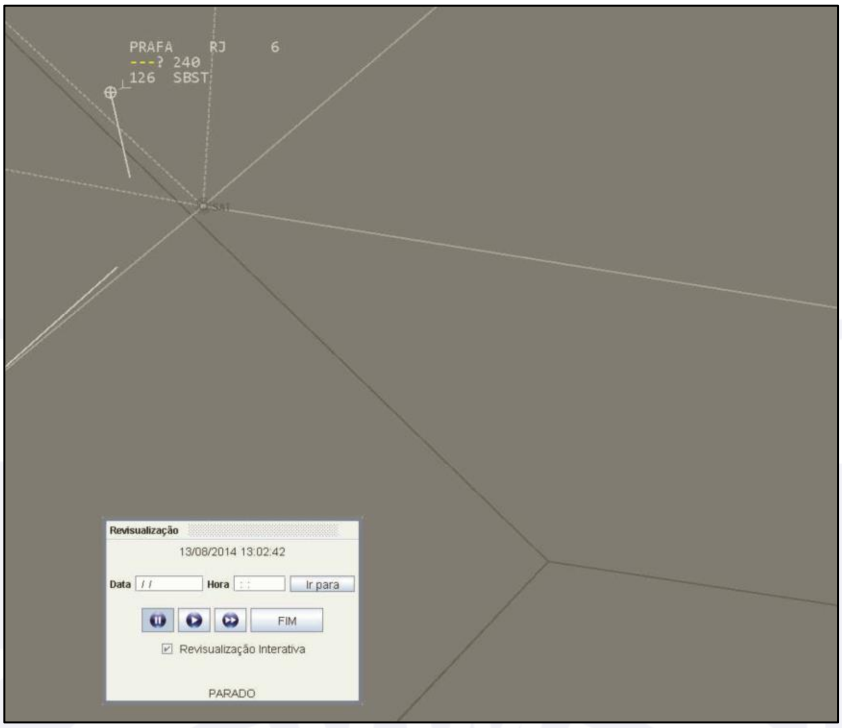


Figure 153 – Last radar image, generated at 13:02:42 UTC, before the start of the extrapolation.

According to accounts made by persons who were in SBST, the aircraft flew at low height along the runway, with its landing lights on, landing gear being retracted, and began a gentle turn to the left after passing over the runway 17 threshold.

Also, according to accounts made by persons who were in the Port of Santos, the aircraft made a level turn to the left, passing near the port cranes. In the sequence, the aircraft leveled the wings, and disappeared in the clouds.

Taking into consideration the distance between the runway 17 threshold and the area of the Port where the cranes are located, an arc of 143 degrees with a radius of 696 meters was estimated, which defined a region through which the aircraft might have traveled (Figure 154).

Figure 154 – Representation of the observers' position, cranes location in the Port of Santos, the runway location, and turn made by the aircraft according to the observers.

Considering a weight of 16,240lb, the aircraft stall speeds were determined for the different angles of bank, in accordance with the Manufacturer's Table (Figure 155).

ANGLE OF BANK DEG	FLAP SETTING - 0° WEIGHT - LBS												
	20200	20000	19500	19000	18700	18000	17500	17000	16500	16000	15000	14000	13000
0	106	105	104	103	102	100	99	97	96	95	92	89	86
10	107	106	105	104	103	101	100	98	97	95	92	89	86
20	109	109	107	106	105	103	102	101	99	98	95	92	88
30	114	113	112	110	110	108	106	105	103	102	99	95	92
40	121	120	119	117	117	114	113	111	110	108	105	101	98
50	132	131	130	128	127	125	123	122	120	118	114	111	107
60	150	149	147	145	144	142	140	138	136	134	130	126	121

Figure 155 – Stall speed as a function of the angle of bank and aircraft weight in lbs. (56XFMB-02, REVISION 2, of 08 January 2014).

For determining the possible profiles flown by the aircraft, the turn was limited to a maximum radius of 696 meters. The aircraft speed was also limited to the minimum necessary for obtainment of lift according to the respective angles of bank.

With these data, one can calculate the possible radii of turn flown by the aircraft, which are determined by the angle of bank / G load, as a function of the different speeds utilized, as seen in Table 6.

Radii of turn above 696 meters (red color), as well as the ones below this value, were ignored, since they would result in aircraft stall (orange color).

	Inclinação			
	30	40	50	60
Fator de carga (G)	1,15	1,31	1,56	2,00
120	675,1	464,5	327,1	225,0
130	792,4	545,2	383,9	264,1
140	919,0	632,3	445,2	306,3
150	1054,9	725,8	511,1	351,6
160	1200,3	825,9	581,5	400,1
170	1355,0	932,3	656,4	451,7
180	1519,1	1045,2	735,9	506,4
190	1692,6	1164,6	820,0	564,2
200	1875,4	1290,4	908,6	625,1
210	2067,6	1422,7	1001,7	689,2
220	2269,3	1561,4	1099,3	756,4
230	2480,2	1706,5	1201,6	826,7
240	2700,6	1858,2	1308,3	900,2
Velocidade(kt)	Raio de curva (m)			

Table 6 – Tabulation of radius-of-turn data as a function of the aircraft speed and angle of bank limited to a maximum radius of 696meters.

The investigators verified that for angles of bank of up to 60 degrees, the aircraft could have flown at speeds varying from 120kt to 210kt, sustaining G loads between 1.15 and 2.0 G.

For reconstruction of the trajectory flown by the aircraft, the investigators considered the data obtained by radars, the data retrieved from the left engine DCU, and the information provided by observers on the ground. The following trajectory was determined up to the point where the aircraft disappeared in the clouds (Figure 156).

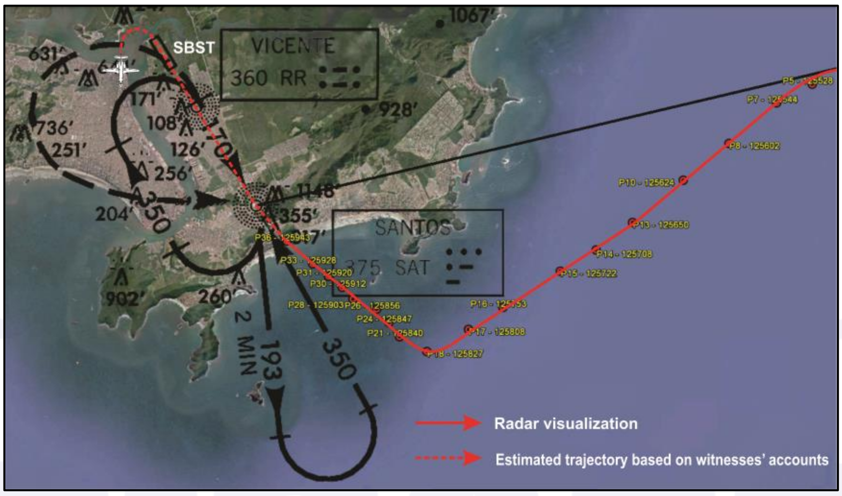


Figure 156 – Profile flown by the PR-AFA based on the radar visualization and accounts by observers on the ground.

A method for determining the aircraft path and speed was applied with the use of a geo-referenced mapping of the accident area.

With the information obtained from this GEOREF mapping and security-camera recordings, it was possible to estimate the angle of the aircraft trajectory (vertical plane) and speed in the moments preceding the crash.

Considering the arrangement of the buildings in the terrain and the information obtained from the analysis of the aircraft wreckage, the investigators concluded that the first part of the aircraft which collided with the roof of the building was a wing section next to the right wing root, while the fuselage hit a small house. From this observation, the aircraft heading was estimated to be 238º at the moment of the collision (Figures 157 and 158).

Figure 157 – Position of the first impacts of the aircraft with the buildings.

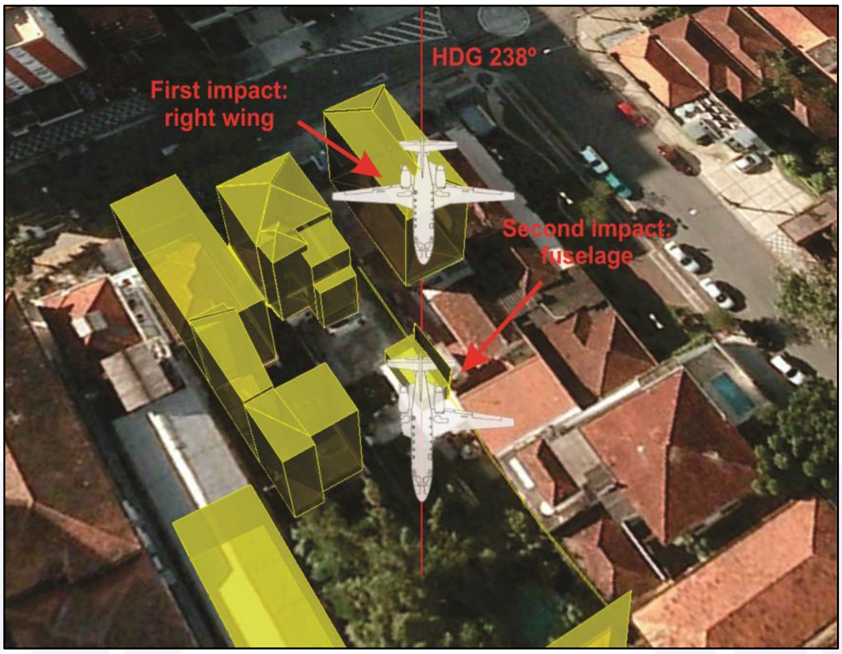


Figure 158 – Reconstruction of the first impacts for determining the aircraft heading before the crash.

The investigators located three security cameras which recorded the last moments of the aircraft before it crashed into the ground.

The first video was recorded by a 30-FPS recording rate security camera located on *Francisco Glicério* Avenue (camera 1).

The second and third videos were recorded by two 30-FPS security cameras located on *Vahia de Abreu* Street (cameras 2 and 3), as shown in Figure 159.

Figure 159 – Position of the cameras in relation to the aircraft trajectory toward the point of impact.

It is worth pointing out that the time displayed in the security cameras was not synchronized with UTC time. Therefore, it is not possible to affirm that the time of the events recorded in the videos would correspond to the effective time at which they occurred.

Figure 160 – Image recorded from a building located on *Francisco Glicério* Avenue (camera 1).

Figure 161 – Footage taken from Vahia de Abreu Street (camera 2).

Figure 162 – Footage taken from Vahia de Abreu Street (camera 3).

Considering that the aircraft flew along a straight line between the area of impact and the locations shown in the images recorded by the cameras, it is possible to project a red straight line to represent the possible trajectory flown by the aircraft, and a blue straight line representing the line of sight from camera 1, which is tangential to the building observed in the images (Figure 163).

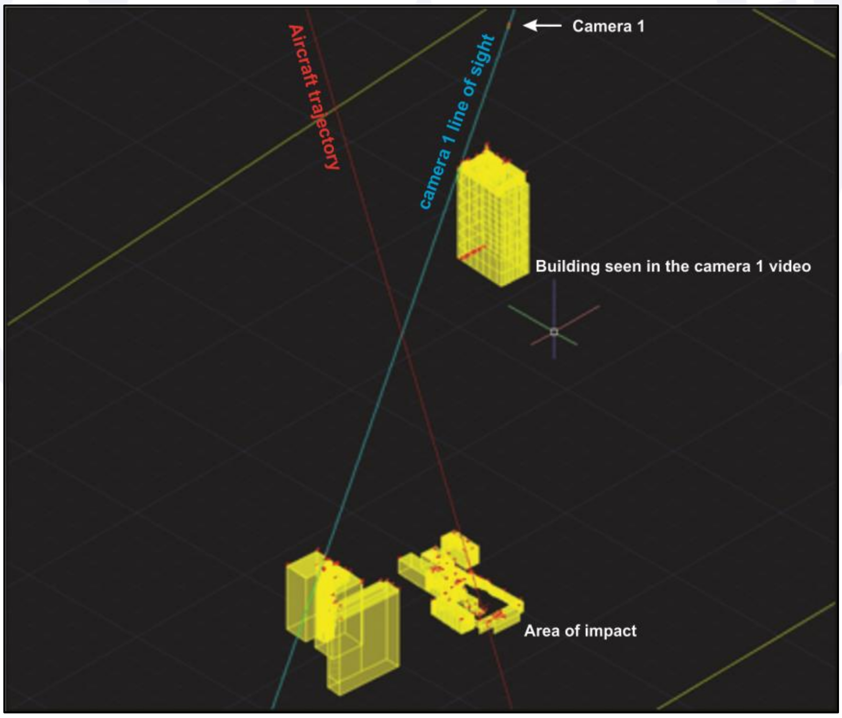


Figure 163 – Geo-referenced reconstruction of the main points for calculation of the aircraft trajectory and speed.

The angle formed between the trajectory vector and its projection on the plane of the terrain was then measured, resulting on a range of possible values due to the uncertainties associated with an estimated vertical trajectory angle ($\gamma = 35 \pm 5°$).

In order to calculate the aircraft speed, the commission made use of the camera 1 video, and measured the time elapsed from the moment the aircraft disappeared behind the building until the first visible sign of explosion in the image.

The investigators measured the distance along the aircraft trajectory from the point of intersection of the aircraft with the line of sight of camera 1 to the point of impact, and divided it by the time interval.

Therefore, the estimated average speed of the aircraft was around 325 ± 30kt from the time it disappeared behind the building to the moment it crashed into the ground.

For each one of the videos in question, two frames were selected by means of video software provided by the manufacturer of the cameras. These frames were selected on account of the quality of the image and the position difference resulting from the aircraft movement. The camera 3 video was not utilized, because it was not possible to take measurement of the length of the aircraft in the image.

Initially, the angle of the aircraft trajectory was measured by means of the image recorded by camera 2. Two frames were selected, which, after being superimposed, allowed determining points of reference on the nose of the aircraft. These points made up a straight line which corresponded to the aircraft flight trajectory.

In order to determine the line of the horizon, a line perpendicular to the wall of a building appearing in the foreground was taken as reference.

The angle formed between the line corresponding to the aircraft trajectory and the line of the horizon was then measured and, after correction of this angle on account of the aircraft position, the value obtained was $\gamma = 22{,}4^{\circ}$.

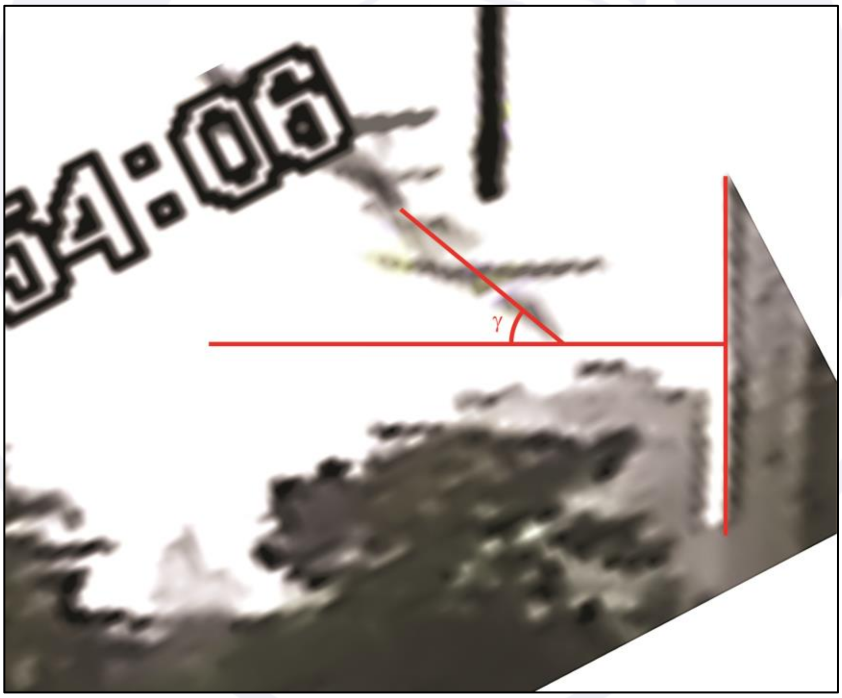


Figure 164 – Measurement of the angle from the building (camera inclination has been corrected).

The image recorded by camera 2 made it possible to measure the angle formed between the longitudinal axis of the aircraft and the line of the aircraft trajectory. After correction of the angle on account of the aircraft position, the resulting angle of attack in relation to the camera line of sight was $\alpha = 5.7^{\circ}$ (Figure).

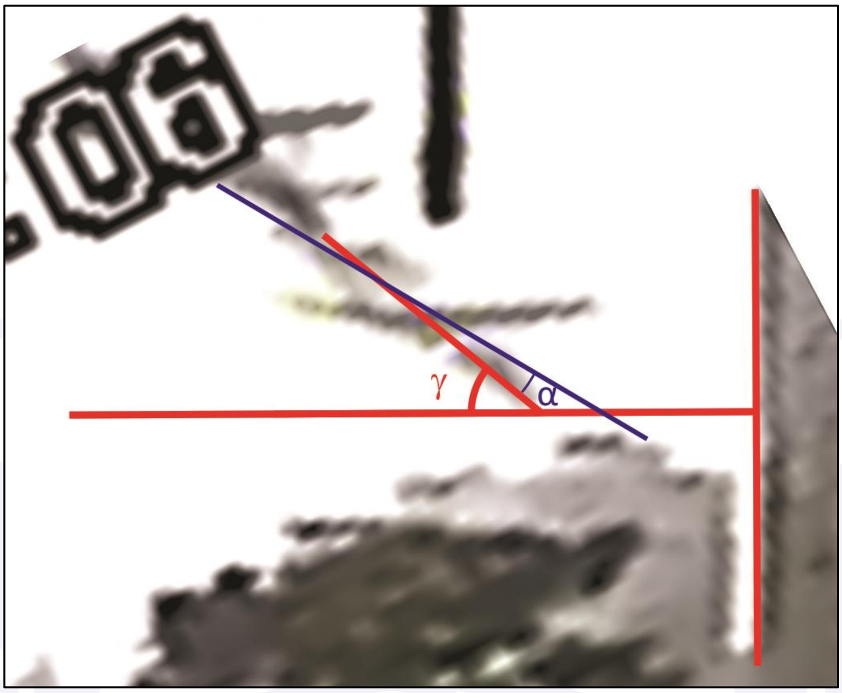


Figure 165 – Measurement of the pitch angle from the projection of the aircraft movement.

For calculating the speed, one measured the movement of the aircraft in relation to two consecutive frames and, also, the length of the aircraft shown in the images recorded by camera 1 (Figure 166).

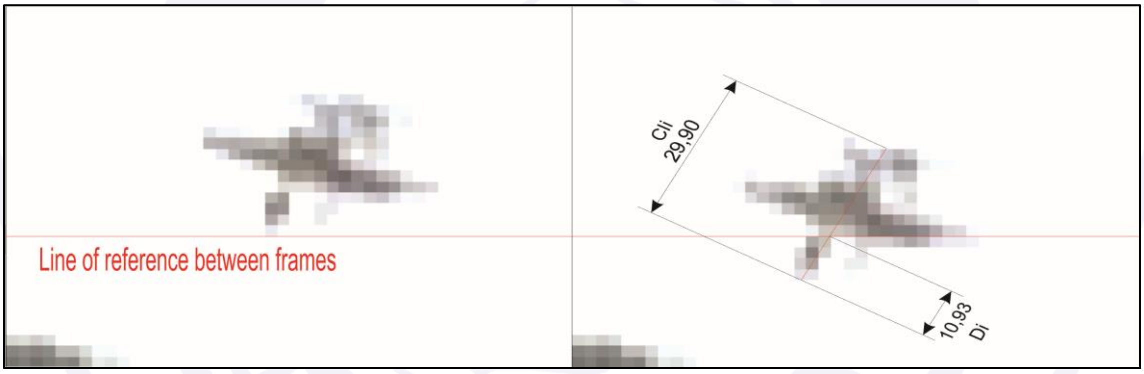


Figure 166 – Movement between frames of the camera 1 image.

The aircraft dimensions contained in the manufacturer's manual were utilized for comparison with the dimensions showed in the images of camera 1.

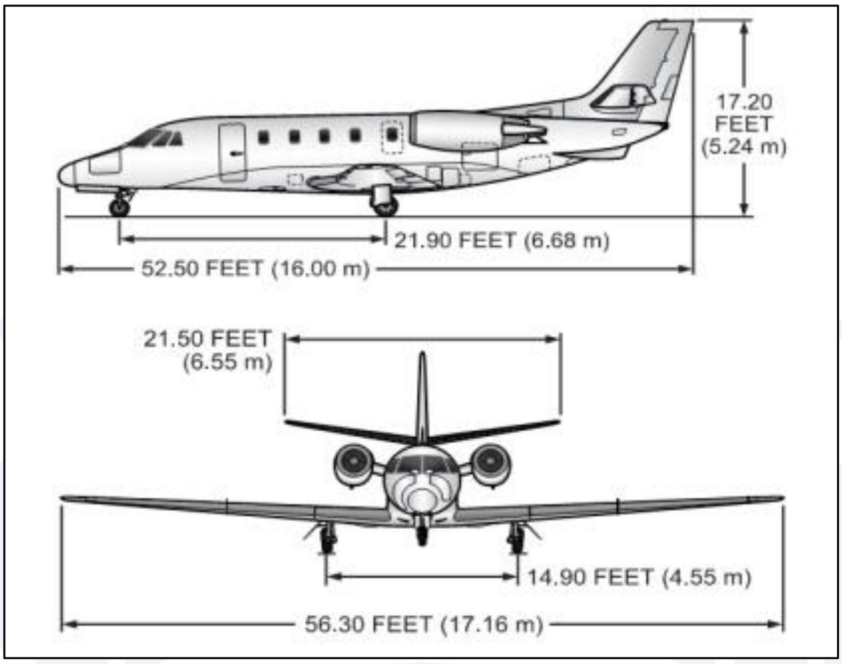


Figure 167 – Dimensions of the Citation CE 560XLS+ aircraft.

Where:

C = Aircraft length (16m)

CIi = length of the aircraft in the image

D = Distance traveled by the aircraft

Di = Distance traveled by the aircraft in the image between two frames

FPS = Frames per second (30FPS)

Thus, by applying proportionality, one has:

$$\frac{D}{C} = \frac{Di}{CIi}$$

$$\frac{D}{16.00} = \frac{10.93}{29.90}$$

D = 5.849 m

Considering the frame interval for a 30-FPS video, the aircraft traveled a distance of 5.849 meters in 1/30 seconds.

Thus, the estimated aircraft speed was 175.46 m/s, corresponding to 341 kt.

With utilization of the same calculation method for the camera 2 images, one verifies the following:

Figure 168 – Movement between frames of the camera 2 image.

$$\frac{D}{C} = \frac{Di}{CIi}$$

$$\frac{D}{16.00} = \frac{9.79}{24.37}$$

D = 6.427m

Considering the frame interval for a 30-FPS video, the aircraft traveled a distance of 6.427 m in $^{1}/_{30}$s.

Thus, the estimated aircraft speed was 192.83 m/s, corresponding to 375kt.

It is important highlighting that the aircraft Maximum Operating Limit Speed (VMO), described in the manufacturer's manual, has the following definition:

VMO (*Between* 8,000 *and* 26,515 *Feet*)	305 KIAS
VMO (*Below* 8,000 *Feet*)	260 KIAS

Thus, for the region of the accident, the maximum operating limit speed of the aircraft would correspond to 260kt..

1.19 Additional information.

Considerations regarding the utilization of the FMS in CE 560XLS+ aircraft.

The Flight Management System (FMS) provides capability for enroute and terminal navigation, as well as non-precision procedures. The FMS contains a GPS receiver, and processes information obtained from several satellites to calculate the navigation profile.

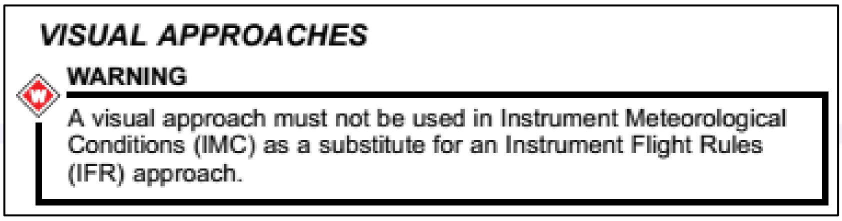
The FMS can manage standard instrument departures (SID), standard instrument arrivals (STAR), and flights on airways.

The route is calculated between waypoints and, for lateral navigation, rolling controls are provided to the flight control system (FCS). The FCS interface also provides the vertical navigation (VNAV) function in different modes. FMS interfaces with electronic displays provide procedure navigation information which is presented in a map.

The FMS also generates lateral and vertical trajectories for visual approaches, similar to an ILS approach to a runway. It also provides lateral and vertical direction controls to the FCS to join and follow the path generated for the approach.

For this specific function, the manufacturer's manual emphasizes that a visual approach generated by the FMS does not correspond to clearance for a visual approach under IFR issued by an ATC unit. The manual also warns that the FMS shall not be used in the visual approach mode under instrument meteorological conditions, and that FMS visual approaches shall only be used in meteorological conditions allowing VFR flights to be conducted.

Finally, the FMS manufacturer's manual has the following warning (Figure 169):


VISUAL APPROACHES

WARNING

A visual approach must not be used in Instrument Meteorological Conditions (IMC) as a substitute for an Instrument Flight Rules (IFR) approach.

Figure 169 – Warning contained in the CE 560XLS+ aircraft FMS manual relative to the use of the visual approach mode.

<u>Considerations regarding the entry of flight experience in the Pilot's Flight Logbook of civil aviation pilots.</u>

According to the IAC 3203 of 19 May 2002, the Pilot's Flight Logbook (CIV) is the legal document for verification of experience and attestation of the hours flown by pilots, when operating aircraft listed in the RBHA 47. The flight hours must be annotated in the CIV in accordance with the different types of licenses.

On 1 December 2011, the ANAC published the IS 61-001, Revision A, dealing with procedures for online declaration of flight experience, also called electronic CIV, with the objective of "providing every pilot with procedures for demonstrating the required flight experience for purposes of obtainment and/or revalidation of licenses and qualifications, or attestation of compliance with the sections 61.65, 61.67, 61.95, 61.97, 61.115, 61.117, 61.173, 61.185 and 61.187 of the RBHA 61, or RBAC superseding it, by means of an online declaration of flight experience."

Such declaration of flight hours via electronic means represents a major breakthrough in terms of logging and attestation of a pilot's experience for the obtainment of licenses and qualifications, since all the records are stored in a databank which allows for a quick and accurate treatment of the information. Nonetheless, the main means of logging is still the physical logbook and, in practical terms, the use of the electronic CIV is restricted to training and check flights.

In the case of the PR-AFA crew, the CIVs did not contain all the records concerning their flight hours. The fact that the physical CIVs were not found made it difficult to attest their experience.

<u>Considerations regarding the DCERTA Departure System (DCERTA).</u>

According to the ANAC website, the DCERTA Departure System is a computerized system for monitoring and verifying the compliance with regulations related to licenses and certificates of aircraft, technical crews, and destination aerodromes, based on the data informed in the flight plan. The system was established with the publication of the Resolution 268 of 18 March 2013.

The Article 2 of the Resolution 268 states that the main objective of DCERTA is:

> "…provide the organizations interested in civil aviation safety with real time opportune information on the adherence to regulations relative to certificates and licenses of aircraft, technical crews and destination aerodromes, as an integral part of the management of risks to the operational safety prescribed the Brazilian Program for Civil Aviation Operational Safety (PSO-BR).
>
> Sole Paragraph. The data obtained by the DCERTA may be utilized as a tool for the supervision and/or management of risks to the civil aviation operational safety."

In this way, when a flight plan is filed, and the data relative to the pilot's qualification and/or the aircraft airworthiness condition is in disagreement with the established safety minimum requirements, such plan may be not authorized.

In the case of the PR-AFA crew, the C560 qualification allowed the operation of C560 Citation V, C560 Encore, C560 Encore+, CE 560XL, CE 560XLS, or CE 560XLS+ aircraft, without differentiating between those aircraft which required additional training for the transition, something that hindered the identification of such condition by the DCERTA System.

<u>Considerations on the requirements relative to flight data recorders and cockpit voice recorders for the operation of aircraft</u>

The Brazilian regulations establish requirements with regard to the installation of flight data recorders and cockpit voice recorders in the aircraft. The primary criteria considered in such requirements are the number of engines, number of pilots required, and the maximum passenger configuration.

As for the accident in question, the commission verified that the regulations did not require the installation of FDR. Nevertheless, the airborne technology and the complexity of the aircraft operation required more information to subsidize the conclusions of the investigation of this aeronautical accident.

The same aircraft model could be utilized for private operations (as was the case with the accident aircraft) or for complementary and on-demand operations that had specific requirements regarding the installation of data recorders. For this reason, the commission considers that the lessons learned from the investigation will have direct application in the prevention of accidents in others types of operation.

1.20 Useful or effective investigation techniques.

For the first time in Brazil, a biometrical identification was performed in an aeronautical accident investigation, by means of analysis of voice, speech, and language parameters, as well as the variation of the characteristics of these parameters. The work was supported by professionals of the academic research field, specialized in analysis of the causal connection between voice alterations and occupational activity.

For purpose of analysis and comparison, the specialists made use of audio files containing dialogs between the copilot and the AIS-RJ office on the evening of 12 August 2014, as well as audio files of the communications between the PR-AFA and all ATC units contacted by the aircraft.

The utilization of this technique aimed at identifying contingent pre-existing conditions that could have affected the crew's performance.

The result of the analysis indicated that the voice data analyzed had parameters compatible with fatigue and somnolence on the part of the copilot of the accident flight.

2. ANALYSIS.

According to the ANAC's Brazilian Aeronautical Registry (RAB), the CE 560XLS+ aircraft was registered as Private – Private Air Services, and was operated by *AF Andrade Empr. e Participações Ltda*., a company with headquarters in Ribeirão Preto, State of São Paulo.

The management of the aircraft was delegated to the captain by a business group of the state of Pernambuco that supported the electoral campaign of a presidential candidate. According to accounts, the tasks and/or activities performed by the crew were not formalized.

According to the maintenance records, the airframe and engine logbooks were up-to-date. The last inspection of the aircraft, Annual Maintenance Inspection (IAM) type, was completed on 14 February 2014, and the aircraft flew 30 hours and 10 minutes after the inspection, which was valid until 14 February 2015. The aircraft airworthiness certificate was valid until 22 February 2017.

Despite the verification that all the programmed aircraft maintenance services were up-to-date, the cockpit voice recorder was inoperative. In the case of the accident aircraft, and in accordance with the RBHA 91.609, it was possible to start a flight with an inoperative CVR, provided that it was subjected to repair services within 15 days, or under special conditions, within 30 days. Since the CVR stopped recording on 23 January 2013, it is possible to affirm that the aircraft did not meet the airworthiness requirements of the Brazilian legislation at the time of the accident, even though this fact did not contribute to the accident.

It is a known fact that the pilots were not submitted to a selective process for being hired. Thus, although they possessed the C560 qualification allowing them to operate the CE 560XLS+ aircraft, neither pilot had his previous experience verified, nor whether they needed to receive a transition and/or specific aircraft training before operating the PR-AFA.

Neither pilot underwent any sort of training relative to the differences and/or specific formation training to fly the CE 560XLS+ aircraft, as established by the primary aircraft certification authority (FAA), by means of the Flight Standardization Board (FSB) Report – Revision 2. According to the ANAC, this latter was used as the criterion for the pilot training levels regarding the operation of aircraft of the CE 560XL family in Brazil.

Since the pilots had a C560 type qualification which granted them the prerogative to fly the CE 560XLS+ aircraft, in addition to those they had previously flown, that is, C560Encore+ (copilot), and CE 560XLS(captain), they were accepted for flying the PR-AFA.

Although they possessed the C560 qualification, the prerogative to transit between the several models of the aircraft would only be valid if they had done the flight instruction or the proficiency check, in accordance with the RBAC 61.

It is worth pointing out that the need of specific training for the transition between these aircraft models was only clarified on 4 July 2014 by means of the publication of the ANAC's Supplementary Instruction 61-004, revision A, in force at the time of the accident, establishing the list of qualifications to be included in the pilots' licenses, and, consequently, showing the differences between the CE 560XL/XLS/XLS+ aircraft models to be considered and applied.

The IS was in consonance with the FAA FSB Report, and was published after the crew involved in the accident started operating the PR-AFA. Therefore, before the publication of the aforementioned IS, the civil aviation pilots would only become aware of the need to receive transition training if they accessed the referred FSB Report.

Since the IS 61-004 Revision A did not have a transition period for its application, the PR-AFA crew members would only be subjected to a proficiency check in the CE 560XLS+ aircraft on the occasion of the revalidation of their type qualifications, which was to take place shortly before the respective expiring dates (October 2014 for the captain, and May 2015 for the copilot).

So, both pilots started operating the PR-AFA without receiving the adequate training prescribed in the FAA FSB Report and in the ANAC Supplementary Instruction. It is worth highlighting that neither the FSB Report nor the Supplementary Instruction contemplated requirements for the transition between the C560 Encore+ and CE 560XLS+ aircraft models, applicable to the copilot of the accident aircraft. Therefore, it would have been necessary for the copilot to do the complete CE 560XLS+ training course before operating the aircraft.

Another issue that was identified relates to the DCERTA System, which allowed the pilots, despite the Supplementary Instruction in force, to operate the PR-AFA without proper training, since the system accepted that any pilot possessing a C560 qualification would have his flight plan approved when flying C560 Citation V, C560 Encore, C560 Encore+, CE 560XL, CE 560XLS, or CE 560XLS+ aircraft.

In the seven days which preceded the accident, the crew was in conformity with the prescriptions of the Law 7183 of 5 April 1984, with respect to duty time and pertinent rest periods. However, after analyzing the crew’s duty time between 1 and 5 August 2104, the commission observed that they had exceeded the limits established by the referred Law.

Despite verification that the rest period between the preceding duty time and the one in which the accident happened corresponded to 34 hours and 26 minutes, it was not possible to determine whether the crew had adequate rest the night before the day of the accident.

Even considering that their duty times were in conformity with the Law 7183 in the seven days preceding the accident, it is worth pointing out that the results obtained in the expert examination of voice, speech and language parameters on the day of the accident, in relation to the normal standards, indicated compatibility with fatigue and somnolence on the part of the copilot in his communications with the ATS units.

The flight plan for the leg SBRJ-SBST was filed via telephone at the AIS-RJ office the day before the accident. The estimated departure time was 12:29 UTC on 13 August, then NAXOP position direct at FL240, joining the W-6 airway to fly up to VUKIK position, then SBST direct. The estimated timeen route was 40 minutes, and the declared endurance was three hours.

On 13 August, at about 11:34 UTC, the pilot went to the AIS-RJ office in order to file a flight plan for the leg SBST-SBSP, and had the opportunity to verify the NOTAM and the weather conditions at the destination and alternate aerodromes.

At that time, there was information available in the AIS-RJ office and on the REDEMET (Command of Aeronautics’ Meteorology Network), as shown below:

- The latest Meteorological Aerodrome Report (METAR) of SBST, 11:00 UTC, indicating the presence of mist, with horizontal visibility of 8km, sky broken, ceiling 2,200ft, that is, the aerodrome could be operated under VFR rules, and there were no weather restrictions for landings and takeoffs at that moment;
- Terminal Aerodrome Forecast (TAF) of SBST, which forecast rain and mist, with reduction of visibility to 4km, with the ceiling reduced to 700ft, in the period between 12:00 UTC and 22:00 UTC, an indication that there might be degradation of the weather parameters in SBST;

- 11:00 UTC satellite image, showing an active cold front in the Southeast region, with layers of stratiform clouds over Santos;
- General Aviation Meteorological Information (GAMET), containing a forecast of ceiling and visibility restrictions for the area of Santos, with validity from 12:00 UTC to18:00 UTC; and
- Significant Meteorological Information (SIGMET), with validity from 10:30 UTC to 13:30 UTC, on 13 August 2014, forecasting convective nuclei to the southwest of Santos, moving northeast at an average speed of 12kt.

The TAF/GAMET code weather forecasts, with validity from 12:00 UTC, indicated the possibility of degradation of the ceiling and visibility parameters due to rain associated with mist, whose duration encompassed the duration of the flight, particularly over the Santos area.

Here, it is worth noting that, considering the 11:00 UTC METAR, which reported conditions favorable to VFR operations, the crew may have missed the opportunity of a more accurate analysis of the weather, which would indicate a swift deterioration of the weather conditions in the period from their departure from SBRJ to the approach in SBST.

The crew requested flight plan clearance from ATC at 12:06 UTC; they probably did not learn of the 12:00 UTC SBST METAR, which was already reporting the presence of rain associated with mist, with restriction of the horizontal visibility to 4km, and celling at 1,800ft. Therefore, at that moment, SBST was already operating IFR, since the visibility was less than 5km.

The PR-AFA took off at 12:21 UTC, and the climb to FL240 was uneventful.

At 12:37 UTC, while still maintaining the APP-SP frequency, the PR-AFA called Santos Radio to request aerodrome weather conditions. Santos Radio reported that the aerodrome was operating IFR, wind 210º/7kt, QNH 1021HPa, without any known traffic.

The commission observed that in this radio contact and in the other ones, the message transmitted did not contain ceiling and visibility information, or SIGMET, as prescribed in the ICA 100-37. The message just informed about IFR operation in the aerodrome, wind direction and strength, and altimeter setting.

It was also observed that, at a certain point, the aircraft crew requested detailed ceiling and visibility information from Santos Radio. These items of information were important for the pilots to become aware of the conditions they would encounter during the descent of the aircraft.

This may have reduced the pilots' situational awareness, since the 11:00 UTC SBST METAR was probably the last information they had access to. It reported VMC conditions at the aerodrome, and the crew may have built a mental model on the SBST weather conditions, with unreal more favorable conditions of operation.

Here, it is worth noting that the 13:00 UTC METAR, around the time of the accident, reported considerable degradation of the weather conditions in SBST. There was light wind, and the visibility diminished to 3km on account of moderate rain associated with mist, sky broken at 800ft and overcast at 3200ft.

The meteorological conditions contained in the 13:00 UTC METAR indicated ceiling at 800ft, which corresponded to 100ft above the (*Minimum Descent Altitude* - MDA), with horizontal visibility of 3,000 meters, that is, 1,400 meters above the minimum visibility prescribed in the ECHO 1 procedure for category B aircraft (such as the CE 560XLS+). Therefore, the weather conditions allowed the aircraft to perform the ECHO 1 procedure for landing on runway 35. For performing the circle-to-land procedure, however, a ceiling of 1,100ft and a horizontal visibility of 2,400 meters were required, that is, 300ft above the reported ceiling, and 2,400 meters below the reported visibility. This made a landing on runway 17 impracticable for the PR-AFA.

So, by not being aware of the ceiling and visibility parameters, the crew was not able to discern that the weather conditions were close to the safety levels for the approach and below the circle-to-land minima, as prescribed in the ECHO 1 procedure.

After establishing two-way radio contact with Santos Radio, the PR- AFA informed APP-SP that they would perform the ECHO 1 procedure for landing on runway 35, stating that they would cross SAT NDB twice. They also informed having visual references. APP-SP cleared them to descend to 6,000ft, and the PR-AFA requested to call Santos Radio on the pertinent frequency. Then, APP-SP instructed the PR-AFA to change definitivelyto the Radio Santos frequency.

In coordination with Santos Radio, the PR-AFA informed to be descending from 6,000ft to 4,000ft, already released by APP-SP.

After coordinating the descent, the PR-AFA made a turn to the left and, for some unknown reason, deviated from the profile of the W-6 airway, descending well below FL060. In the sequence, even thoug hits real position was away from the fix in the southeast sector, the aircraft informed crossing SAT NDB to orbit and cross the fix a second time.

After reporting to have crossed the fix, the aircraft reported that it was on the approach to runway 35. At this moment, according to the radar rerun, the aircraft was joining a final approach, but it never crossed SAT NDB, contrary to what had been reported two times.

According to the radar visualization, the final approach trajectory flown by the aircraft differed from the trajectory defined for the profile of the ECHO 1 procedure, i.e., the aircraft stayed to the right of the prescribed trajectory, as shown in Figure 170.

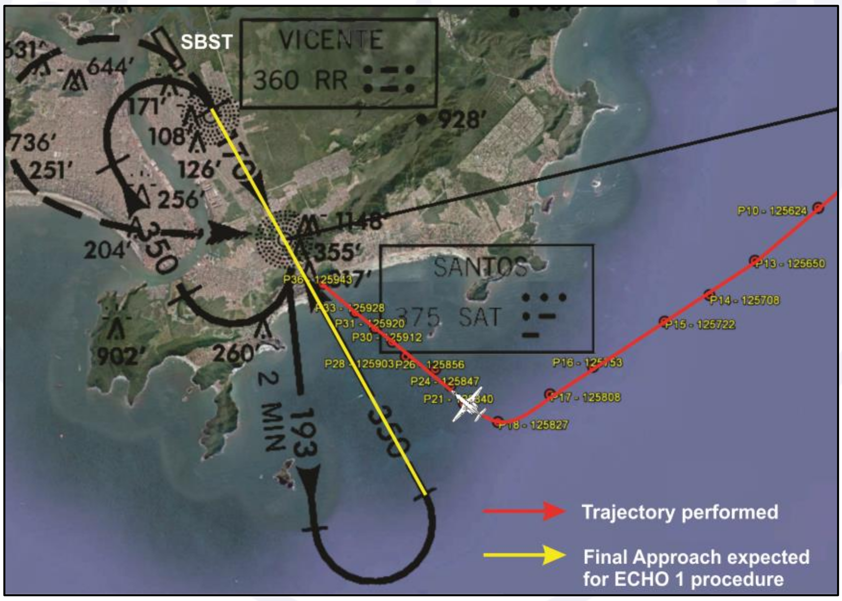


Figure 170 – Profile flown by the PR-AFA based on the radar visualization, in comparison with the profile prescribed in the ECHO 1 procedure.

Taking into consideration a number of accounts of other direct approaches made by the captain utilizing FMS resources for visual approaches, and also considering the difference of the profile of the ECHO 1 final approach in relation to the radar images, the commission raised the hypothesis that the crew might have utilized the FMS visual approach mode with the objective of entering a direct final approach for landing on runway

35 in SBST. The fact that the crew reported being in VMC conditions reinforces such hypothesis.

It is worth stressing that the manual of the equipment contained a warning for alerting the crew that the FMS visual approach mode must not be utilized in IMC conditions as a substitute for IFR approaches.

It is possible that the captain's experience of landing in runways of other countries with precarious infrastructure conditions, in addition to his mistaken assumption of the real meteorological conditions in the aerodrome, may have contributed to his feeling safe upon adopting such procedure.

Since the captain had already performed the aforementioned procedure on other occasions, it is possible that, on account of having succeeded, he felt confident to repeat it, due to the human characteristic of relying on earlier successful experiences.

The adopted profile excluded the orbit, thus, reducing the time spent in the procedure in approximately five minutes. Upon disregarding the prescriptions of the procedure, the aircraft flew a profile not approved for IFR rules, and became exposed to the condition of not having the required minimum separation from the terrain and/or obstacles, as well as being unable to reach the parameters for a stabilized approach.

Even though it was the only aircraft in the sector, the fact that the crew reported unreal positions could have resulted in risk of air traffic conflict if other aircraft had entered the area, considering that Santos Radio provided only information service, and was not aware of the real position of the PR-AFA.

The last non-extrapolated radar visualization on the radar screen (12:59:13 UTC) showed the aircraft descending through 2,600ft, heading 330º, at a groundspeed of 175kt, at a distance of 2.5nm from the SAT NDB. The aircraft was to cross SAT NDB at an altitude of 1,700ft on the final approach.

By associating the aircraft position data generated by the radar at 12:59:43 with: -the vertical profile of the terrain on the final approach; - the MDA and SAT NDB crossing limits; - the projection of a final approach path towards runway 35 at an angle of 3.5º; and - the ceiling and visibility data reported in the METAR, it is possible to determine the scenario represented in Figure 171.

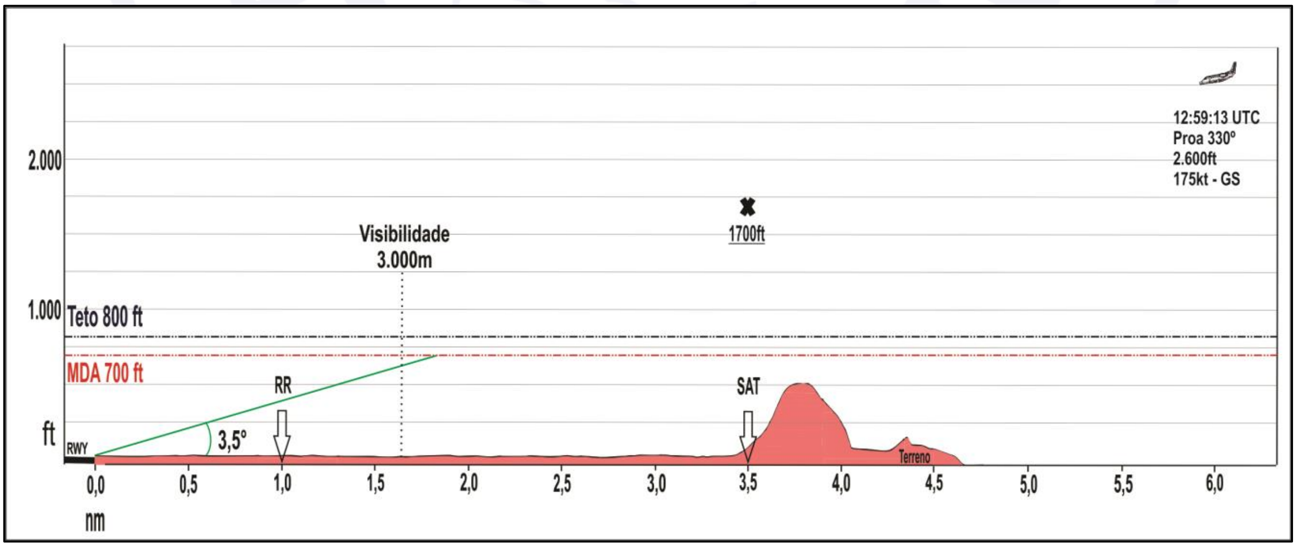


Figure 171 – Vertical Profile of: - the meteorological conditions; - ECHO 1 procedure restrictions, and - aircraft position detected by the radar at 12:59:13 UTC (not to scale).

Considering the ceiling and visibility, the crew would only have the runway in sight with the aircraft positioned to the left of the dotted line representing the 3,000-meter visibility in the graph, and below the blue line representing the ceiling.

By means of data extracted from the left engine DCU, the commission verified that, at 13:00:35 UTC, the aircraft was flying with an approach configuration, developing low power, around 27% of N1, associated with the throttle pulled back. The aircraft was flying at an altitude of 527.31ft, at 144.438KIAS.

According to the aircraft dispatch data calculated for the departure from SBRJ, the speed parameters for the approach would be: V_{REF} = 109kt and V_{APP} = 115kt.

Considering that the aircraft did not follow the profile prescribed in the official chart, and since it is not possible to determine the position of the aircraft relative to the terrain, three hypotheses are admitted with the purpose of clarifying the chances of the aircraft to make a stabilized approach, in accordance with the DCU data.

In the first hypothesis, the aircraft would be below the MDA, in a position that did not allow the crew to sight the landing runway while trying to reduce speed to V_{REF} +10kt.

In this condition, even though there was a possibility for the aircraft to adjust to the parameters for a stabilized final approach, it might be not aligned with the runway, unable to join the final approach axis, and exposed to a possible collision with obstacles (Figure 172).

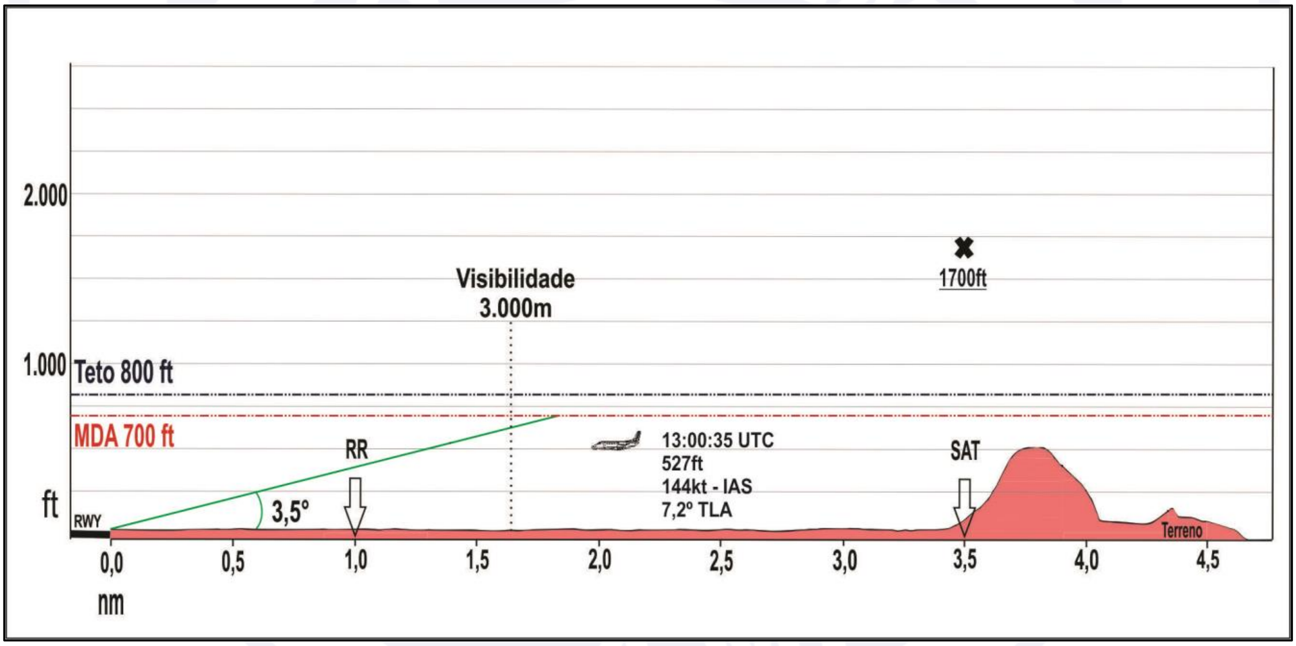


Figure 172 – Hypothesis 1 for the aircraft position relative to the vertical profile, associated with the meteorological conditions and safety limits of the ECHO 1 procedure.

According to the second hypothesis, the aircraft would be on the approach ramp, but with a speed well above the V_{REF} + 10kt and, therefore, on anon-stabilized final approach (Figure 173).

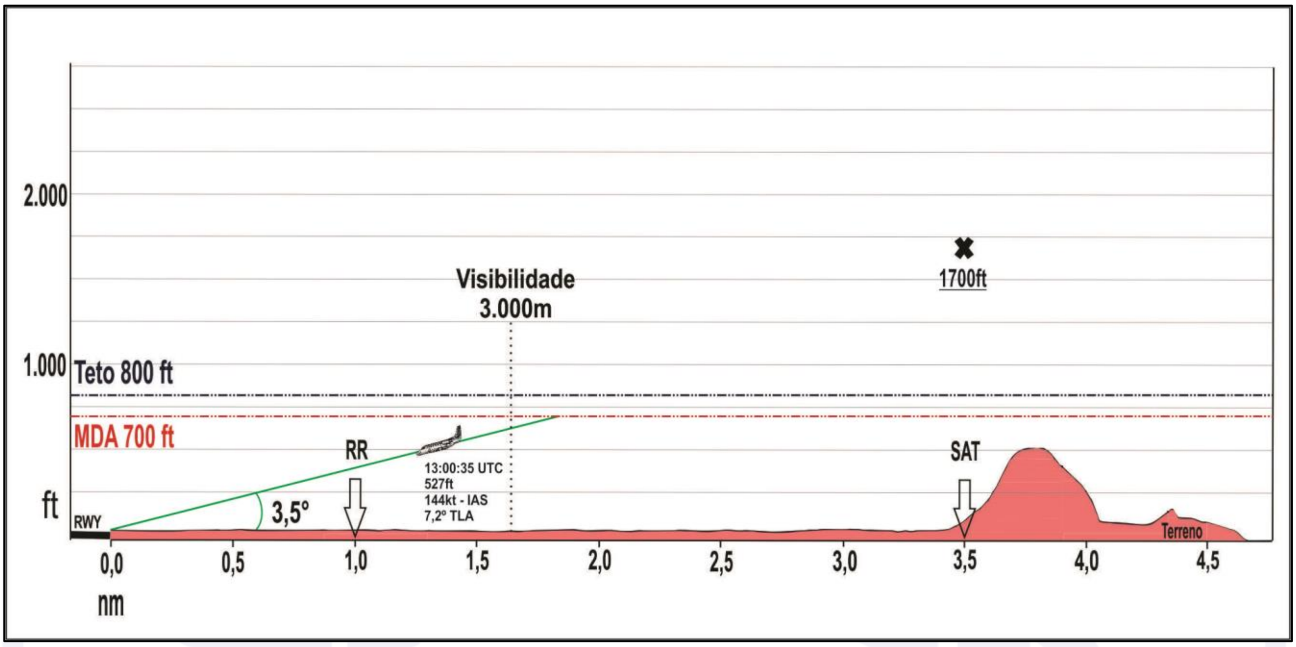


Figure 173 – Hypothesis 2 for the aircraft position relative to the vertical profile, associated with the meteorological conditions and safety limits of the ECHO 1 procedure.

According to the third hypothesis, the aircraft would be above the approach ramp, at a speed well above the V_{REF} + 10kt, being, therefore, unable to make the landing (Figure 174).

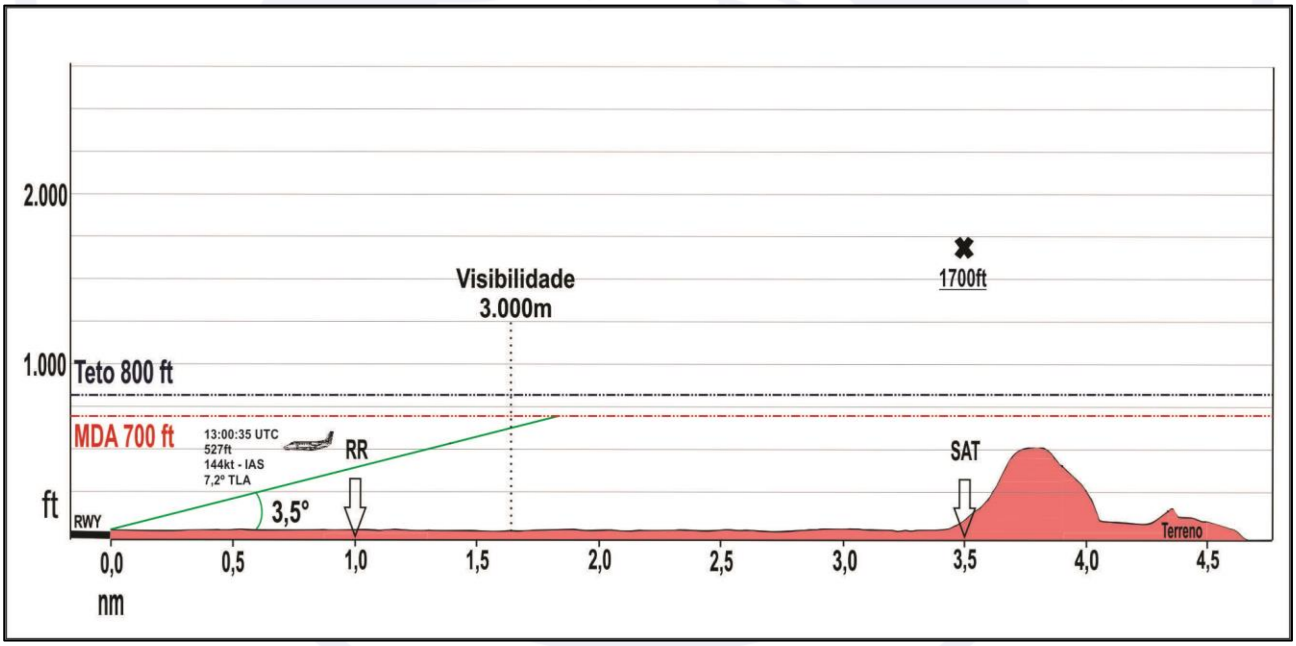


Figure 174 – Hypothesis 3 for the aircraft position relative to the vertical profile, associated with the meteorological conditions and safety limits of the ECHO1 procedure.

Taking into account that the weather conditions were close to the IFR minima, the procedure should be performed in accordance with the official chart in the most accurate way possible. Considering the three hypotheses above, it is possible to see that, for the indicated airspeed and barometric altitude parameters associated with the meteorological conditions in the region, there was low probability that the aircraft would adjust to a stabilized approach.

Another factor to be considered would be that the weather conditions reported by Santos Radio of a wind from 230º at 11kt indicated a tail wind component of 2kt for landing on the runway 35.

Upon factoring the data for a wet runway, a landing distance corresponding to 3,300ft (1,005 meters) was obtained for V_{REF} speed over the runway threshold. The landing distance would be 3,750ft (1,143m) for indicated airspeeds of up to 10kt above V_{REF}over the threshold.

Thus, for the SBST runway, which was 1,390 meters long, the landing would be made with a safety margin of 385 meters with the aircraft passing over the threshold at the V_{REF}, and 247 meters if at a speed of up to 10kt above V_{REF}, considering a no-wind condition in both cases.

In addition, the aircraft manual had a warning of the manufacturer recommending not to land on wet runways with any existing tail wind components.

During the investigation, the commission verified that the RR NDB was inoperative on the day of the accident. Such inoperability could have been confirmed by the crew by means of a check of the audio signal. Then, the crew could use the time and speed table provided in the procedure chart for determining the MAPT. During the communications, the crew did not question Santos Radio on the inoperability of the RR NDB.

Although the SAT NDB was the main navaid marker of the instrument approach chart, the RR NDB was one of the references for marking the MAPT. Therefore, if the crew performed the ECHO 1 procedure as a reference for the approach and did not measure the time on the approach, they would not have a reference for starting the missed approach procedure.

So, the fact that the crew did not follow the profile of the ECHO 1 procedure, along with their difficulty stabilizing the aircraft on a final approach, and the tail wind component condition may have contributed to their decision to discontinue the approach.

Upon starting the missed approach procedure, the PR-AFA crew called Santos Radio to advise. Santos Radio questioned whether they would go around, and received an affirmative answer.

Santos Radio acknowledged the message, and questioned whether the aircraft would make a new attempt to land. The PR-AFA informed that, on account of the weather, they would wait and call again.

The profile of the missed approach procedure prescribed in the ECHO 1 procedure consisted of a left turn climb to 4,000ft to be started at the MAPT, which was marked by the RR NDB or, according to the V_{REF} +10kt, to be started one minute and fifteen seconds after crossing SAT NDB. Then, the aircraft had to fly to SAT NDB direct and start a holding pattern.

According to reports made by witnesses that were in SBST, the aircraft made a low pass over the runway, and started a gentle turn to the left after passing over the departure end of the runway.

According to reports made by persons who were in the Port of Santos, the aircraft made a level turn to the left, passing near the cranes of the port. Then, it was seen leveling the wings before disappearing in the clouds.

Therefore, it became clear that the profile of the missed approach procedure was not followed by the aircraft, indicating the possibility that the crew would have tried to maintain visual conditions, flying through the west sector of the aerodrome to attempt a new approach and landing. Considering, also, the hypothesis that the crew utilized the visual approach mode of the FMS, they would have lost the references of the profile for the missed approach procedure, resulting in degradation of their situational awareness.

It can be inferred that, by making a low pass over the full extension of the runway, and turning left after passing over the departure end, the crew might have been operating the aircraft manually, something that would have increased their workload in the cockpit.

The cockpit actions related to missed approach procedure were the following: - press the go-around button simultaneously with the application of maximum power in the engines; - define a pitch-up angle of 7 degrees, retracting the flaps to 15 degrees, selecting either the HDG or NAV mode in the flight director; - with a positive rate of climb, retract the landing gear; - after reaching a pre-determined altitude at a speed above V_{AP}+10kt, retract the flaps, accelerating the aircraft to the climb speed; - select CLIMB mode; and - accomplish the checklist.

These procedures had to be executed in short time, and required proper training and good coordination of actions from the crew in order to be performed in the correct sequence and in accordance with the attributions of each crewmember. Otherwise, the situation might result in work overload for the pilot-in-command.

Since the crew had not received missed approach training in that type of aircraft, they might not have acquired proper knowledge, skill and competence for performing the procedure, especially in adverse conditions.

Such lack of training may have demanded more cognitive efforts from the crew for dealing with the new characteristics of the equipment, especially from the copilot, for whom full specific training was necessary. This made it difficult for them to take prompt action. The lack of knowledge on the part of the crew may have delayed their actions in relation to the sequence of events in the cockpit.

The complexity of the situation may have required increased attention from the crew, with interference in the structure of cooperation for the coordination of cockpit actions aimed at controlling the aircraft.

The captain’s personal characteristics, indicating a person with a more impositive and confident posture, in opposition to the more passive posture of the copilot, in addition to the more limited knowledge of the equipment on the part of the latter and the possibility that he (the copilot) was fatigued, may also have hindered the dynamics of the crew in the management of the flight.

Since there was no evidence concerning the execution of missed approach procedures by the crew in that type of aircraft, they possibly lacked conditioned behavior for controlling the flight, something which would provide them with more agility in the cockpit actions.

The pilots had been introduced to each other rather recently (they had been flying together for just one month and a half) and had not received the same type of training, something that may have interfered with the structure of cooperation, since they, possibly, did not have the same practices and standardizations, a fact that hinders inflight synergy under adverse conditions.

These pieces of information reinforce the hypothesis that there may have been excessive workload for the pilot in command, since he possibly accumulated tasks as a result of a suspected difficulty on the part of the copilot to provide assistance to him. This would have increased mental and operational demands in the conduction of the flight, after the start of the missed approach procedure.

After analyzing the turn made following the low pass over the runway, between the threshold of runway 17 and the area of the port where the cranes were located, the commission observed that, with angles of bank of up to 60 degrees, the aircraft was possibly flying at speeds which varied between 120kt and 210kt, with G loads between 1.15 and 2.0 G, on what could be considered a “tight” turn for this type of aircraft.

The analysis of theaforementioned data revealed that several conditions existed that favored the onset of spatial disorientation to which a human being may be subjected.

The degraded meteorological conditions, by themselves, already configure a factor predisposing to disorientation, since they compromise the sense of sight, which, under normal conditions, accounts for 80% of the orientation information received by a healthy normal person.

In addition to the weather, the commission observed that other conditions existed that might compromise the crew's cognition and judgment capability.

The stress, anxiety, and work overload created by the conditions already analyzed, in addition to the fact that they were transporting a public person, may have contributed to altering the pilots' physical and mental skills.

After taking into consideration: -the stimuli in the vestibular system as a result of the "tight" left turn performed (with a load of more than 1.15 G); - the speed variations at low altitude, under restricted meteorological conditions, forcing the crew to alternate between VMC and IMC; and - the fact that the pilot possibly had to make movements with his head (looking alternately to the instruments and out of the aircraft) in an attempt to keep visual contact with the runway and obstacles on the ground; the commission considered that all of the aforementioned conditions may have resulted in spatial disorientation of an incapacitating type.

Thus, considering the weather conditions and the human capability to detect and discern on the position of the body in the space by means of the physiological systems of orientation, it is possible to infer that a spatial disorientation situation contributed to leading the aircraft to an abnormal attitude.

After the aircraft disappeared in the clouds, the radar still detected it, showing the corresponding target symbol in the west sector of the aerodrome. The target symbol did not have the necessary accuracy for the visualization of the aircraft position, altitude and speed, but was enough to indicate that the aircraft was flying over that area.

It is worth noting that at that moment, Santos Radio called the PR-AFA several times without receiving any replies. This may indicate work overload in the cockpit leading the crew to ignore the calls made by the ATS unit.

Taking, still, into consideration the high angle of the aircraft trajectory relative to the terrain and the calculated speed, which by far exceeded the operational limit of the aircraft in the moments before the impact, it is possible to infer that, from the time it disappeared in the clouds, the aircraft could only have reached such speed and fly that trajectory, if it had climbed considerably, even to the point of being detected by the radar.

It is important highlighting that, in normal operating conditions, the crew would not have deliberately put the aircraft in such highly pronounced pitch-down angle, even if they had visual references with the ground. The observed flight attitude indicates that, at some point, the crew lost control of the aircraft while flying in IMC conditions.

When the images of the moments before the impact with the ground were analyzed, it was possible to observe that the angle formed between the extension of the longitudinal axis of the aircraft and the line representing the aircraft trajectory (i.e., angle of attack), indicated that there was an action by the pilot for a pitch-up attitude, an evidence that there was flight control authority. Such condition suggests that at that time, the crew could have restored orientation, but, possibly, they had already passed the point of accident irreversibility.

Another fact which shows evidence of an attempt to recover from the pronounced dive is the angular difference found in measurements taken from the first images of the camera 1 in relation to the measurements taken on the images of camera 2 (one second after the camera 1 image). In the first image, the aircraft was diving at an angle of 35°(±

5°), whereas in the second, the dive had an angle of 22.4°, demonstrating an effective action by the crew with the intention of recovering from the pronounced dive.

The analysis of the aircraft wreckage revealed that all fracture surfaces examined had characteristics consistent with failure caused by overload caused by the impact, with no evidence of fatigue.

With regard to the systems of the aircraft and the flight controls, to the point it was possible to observe, all worked in accordance with the engineering design until the impact with the ground. There was no fire or any type of separation in flight.

In relation to the engines, owing to the fact that the characteristics of the damage found in the right engine were similar to the damage sustained by left engine, all comments and analyses based on the DCU data concerning the left engine could be extended to the right-hand engine. At the moment the engines collided with the ground, there was high rotation and they were developing a level of power between medium and high. The data retrieved from the DCU and later analyzed did not show any abnormality or trend that could have compromised the normal operation of the engines in the accident flight.

The characteristics of the wreckage, which had a high degree of destruction, with no evidence of failure of any of the aircraft systems, along with the power being developed by the engines at the moment of impact, support the hypothesis of spatial disorientation.

In parallel with the study of the sequence of events that culminated in the accident in question, the investigation commission sought to verify the physical and mental health requirements for pilots to operate in the Brazilian civil aviation. By the same token, it sought to examine the methods used for evaluating the proficiency of the pilots on check flights.

The reason for this study was the information gathered about the operating performance of the PR-AFA copilot. According to information collected in medical and psychological assessments, and in interviews with people who knew the copilot in the aviation environment, it was found that, with regard to skills inherent to the air activity, the copilot proved to be an individual who had passivity as an important characteristic. This kind of more passive behavior influenced his lack of initiative in decision-making processes, and, probably, could have influenced his interaction with the other pilot.

In psychological evaluations, the copilot scored lower than the normative sample for tests related to the constructs of attention, reasoning, and decision making. This fact was corroborated by the reports obtained in interviews, when his low performance on the aforementioned constructs was reported as a personal characteristic of the copilot on several occasions. These characteristics also became evident when he presented learning difficulties during the transition to more complex aircraft.

When one considers the difficulties presented by the copilot and his experience of more than five thousand flight hours, one may infer that his piloting skills had some limitations which could influence his performance.

Based on this information, the commission verified that the RBAC 67 does not establish a professional profile for pilots of the Brazilian civil aviation, nor cognitive and behavioral parameters considered as personality criteria suitable for the air activity, and that could subsidize the evaluation to which pilots were submitted. Therefore, there was no protocol to inform "what was to be expected" or the minimum acceptable levels for a civil aviation pilot in relation to psychological testing and evaluations. Thus, even with results below the normative sample, the copilot was considered "fit for the intended purpose" in all judgments made by the board of health.

In a way similar to the item of "psychological evaluation", there were other items in the RBAC 67 that were unclear, prompting doctors to resort to military publications and to Brazilian and international directives and protocols in order to obtain guidance and support for their decisions and judgments concerning civil aviation professionals.

The lack of such criteria for physical, mental, and behavioral health to be adopted as the minimum acceptable for the conduction of the air activity leaves the judgment of health inspections at the discretion of the physicians, opening gaps that may allow aircraft operation below the minimum required safety levels.

With regard to the copilot's inflight proficiency check, it was found that in his last three evaluations, only in the first one was the INSPAC updated and qualified on aircraft with features of avionics compatible with the aircraft in which the check was conducted .

On this occasion, the check was done in a flight simulator, a condition that was considered ideal for a thorough observation and evaluation of pilot performance, both in routine and emergency flight situations.

With regard to checks carried out on aircraft, it was observed that there is some difficulty on the part of INSPAC’s to follow all the procedures performed by pilots in some business jets due to the physical characteristics of the cockpit in this type of aircraft.

According to the RBHA 17.13, the capacity of supervision and the effective control of air operations depend to a large extent on the professional formation and training of the inspectors. The same regulation also states that, in order to properly perform his/her functions, it is important for the INSPAC to have qualifications of educational, operational, and technical experience putting him in a favorable position in comparison with the operator pilots he/she is going to check.

Thus, in addition to the restrictions imposed by the cockpit, an INSPAC’s lack of knowledge and/or updates with respect to airborne systems in modern aircraft may not allow him/her to assess the pilot’s performance in more depth.

Therefore, taking into consideration that in the last three checks of the copilot, the INSPACs may not have had the desired qualifications to make a more accurate assessment of his performance and, also, taking into account the copilot’s operational history, it was not possible to attest that the copilot’s level of performance was in accordance with the minimum acceptable in terms of safety.

3. CONCLUSIONS.

3.1 Facts.

a) The pilots had valid aeronautical medical certificates;

b) The copilot had results lower than the normative sample in psychological tests;

c) There was no professional profile established in the RBAC 67 for civil aviation pilots;

d) There were no parameters considered as mental and behavioral criteria apropriate for the air activity to subsidize medical evaluations;

e) The pilots had valid technical qualification certificates (CHT);

f) The three last health inspections to which the copilot was submitted did not have the desirable conditions for an accurate evaluation of his performance;

g) The pilots were not subjected to a selective process prior to operating the CE 560XLS+ aircraft;

h) The C560 qualification allowed the operation of C560 Citation V, C560 Encore, C560 Encore+, CE 560XL, CE 560XLS or CE 560XLS+ aircraft by pilots who had undergone both flight training and a proficiency exam in accordance with the RBAC 61;

i) The pilots did not do training of the differences nor specific qualification training before flying the CE 560XLS+ aircraft;

j) The need of specific training in the transition between aircraft types was only clarified on 4 July 2014 with the publication of the IS 61-004 Revision A;

k) The pilots were not qualified in the CE 560XLS+ aircraft;

l) The pilots were experienced in the type of flight;

m) The aircraft had a valid airworthiness certificate (CA);

n) The airframe and engine logbook records were up-to-date;

o) The aircrat CVR was inoperative in the last one year and seven months, not meeting airworthiness requirements;

p) The aircraft was within the weight and balance limits;

q) In the seven days that preceded the day of the accident, the pilots were in conformity with the prescriptions of the Law 7183 relative to the crew's duty time;

r) the analysis of copilot's voice, speech, and language indicated compatibility with fatigue and somnolence;

s) The DCERTA system allowed the granting of Flight Plan clearance to pilots with C560 aircraft qualification operating CE 560XLS+ aircraft, not requiring specific qualification for the operation;

t) The pilots had access to the 11:00 UTC METAR, which reported VMC conditions for operation in SBST;

u) The 12:00 UTC METAR reported IMC conditions for operation in SBST;

v) The pilots started the takeoff procedures in SBRJ at 12:06 UTC;

w) The flight was uneventful up to the start of the descent towards SBST;

x) The message on the SBST conditions transmitted to the aircraft by Santos Radio did not contain ceiling, visibility and SIGMET information;

y) The crew informed Santos Radio that they would perform ECHO 1 procedure for landing on runway 35;

z) The ECHO 1 procedure was not performed in accordance with the official chart;

aa) The reporting of positions to Santos Radio by the crew was not consonant with the real flight profile flown by the aircraft;

bb) The aircraft made a direct approach to runway 35;

cc) The 13:00 UTC METAR reported ceiling of 800ft, corresponding to 100ft above the MDA, and horizontal visibility of 3,000 meters, corresponding to 1,400 meters above the minimum visibility allowed to the CE 560XLS+ in the ECHO 1 procedure;

dd) The aircraft discontinued the approach and flew along a trajectory which was different from the missed aproach profile defined for the ECHO 1 procedure;

ee) The aircraft crashed into the ground at a high negative pitch angle at a speed well above the VMO;

ff) The analysis of the wreckage did not reveal signs of failure of any of the aircraft systems;

gg) The aircraft engines were developing high power at the moment of impact;

hh) The aircraft was completely destroyed; and

ii) All aircraft occupants suffered fatal injuries.

3.2 Contributing factors.

- **Application of controls – undetermined.**

Considering the pronounced angle formed between the trajectory of the aircraft and the terrain, as well as the calculated speed (which by far exceeded the aircraft operating limit) moments before the impact, it is possible to infer that, from the moment the aircraft disappeared in the clouds, it could only have reached such speed and flown that trajectory if it had climbed considerably, to the point of being detected by the radar. Such condition presented by the aircraft may have been the result of an exaggerated application of controls.

- **Attitude – a contributor.**

The making of an approach with a profile different from the one prescribed shows lack of adherence to procedures, which, in this case, may have been influenced by the self-confidence of the pilot on his piloting ability, given his prior experiences.

- **Task characteristics – undetermined.**

Despite the lack of pressure on the part of the passengers to force compliance with the agenda, it is a known fact that this type of routine creates in the crew a self-pressure, most of the time unconscious, for accomplishing the flight schedule on account of the commitments undertaken by the candidate in campaign, and, therefore, the specific characteristics of this type of flight pose demands in terms of performance that may have influenced the pilots to operate with reduced safety margins.

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

The meteorological conditions were close to the safety minimums for the approach and below the minimums for the circle-to-land procedure prescribed in the ECHO 1 approach. However, such conditions, by themselves, would not represent risk for the operation, if the profile of the ECHO 1 procedure was performed in accordance with the parameters established in the aeronautical publications and the flight parameters defined by the aircraft manufacturer. Upon verifying that the above mentioned parameters were not complied with, one observes that the meteorological conditions became a complicating factor for flying the aircraft, rendering it difficult to be stabilized on the final approach, anda go-around became necessary, as a result.

- **Disorientation – a contributor.**

In the scenario of the aircraft collision with the ground, there were aspects favorable to the occurrence of spatial disorientation, such as: reduction of the visibility on account of meteorological conditions, stress and workload increase due to the missed approach procedure, maneuvers with a G-load above 1.15G, and a possible loss of situational awareness. The large pitch-down angle, the high speed, and the power developed by the engines at the moment of impact are also evidence compatible with incapacitating disorientation, and point towards a contribution of this factor.

- **Team dynamics – undetermined.**

The integration between the pilots may have been hindered by their little experience working together as one crew, and also by their different training background. In addition, the personal characteristics of the captain, as a more impositive and confident person, in contrast with the more passive posture of the copilot, may also have hampered the crew dynamics in the management of the flight.

- **Fatigue –undetermined.**

In the seven days preceding the day of the accident, the crew was in conformity with the Law 7183 of 5 April 1984 in relation to both duty time and rest periods. However, the analysis of copilot's voice, speech, and language indicated compatibility with fatigue and somnolence, something that may have contributed to the degradation of the crew's performance.

- **Training – undetermined.**

Their lack of training of missed approach procedures in CE 560XLS+ aircraft may have demanded from the crew a higher cognitive effort in relation to the conditions required for the aircraft model, since they possibly did not have conditioned behaviors for controlling the flight and that could otherwise provide them with more agility with regard to the cockpit actions. Thus, they probably missed the skills, knowledge, and attitudes that would allow them to more adequately perform their activities in that operational context.

- **ATS Unit Use of Phraseology – undetermined.**

Even though Santos Radio reported, in the first contact with the aircraft, that the aerodrome was operating IFR, the messages transmitted to the aircraft did not include the conditions of ceiling, visibility, and SIGMET information (ICA 100-37). This may have contributed to reducing the crew's situational awareness, since the last information accessed by them was probably the 11:00 UTC SBST METAR, which reported VMC conditions for operation in the aerodrome. Thus, the pilots may have built a mental model of unreal SBST meteorological conditions more favorable to the operation.

- **Flight indiscipline – a contributor.**

After coordination of the descent, the PR-AFA aircraft made a left turn and, for an unknown reason, deviated from the W6-airway profile, reporting six positions that were not compatible with the real flight path until the moment it started a final approach. This approach was different from the trajectory of the final approach defined for the ECHO 1 procedure, and was flown with speed parameters different from those recommended by the aircraft manufacturer. These aspects reduced the chances of the aircraft to align with the final approach in a stabilized manner.

The fact that the aircraft made a low pass over the runway and then a left turn at low altitude in weather conditions below the minimum established in the circle-tolandprocedure instead of performing the profile prescribed in the ECHO 1 approach chart also resulted in risks to the operation, and created conditions which were conducive to spatial disorientation.

- **Memory – undetermined.**

Since the captain had already conducted FMS visual approaches on other occasions, his acquired work-memory may have strengthened his confidence in performing the procedure again, even though in another scenario, on account of the human being tendency to rely on previous successful experiences.

- **Perception – undetermined.**

A poor perception on the part of the pilots relative to the real meteorological conditions on the approach may have compromised their level of situational awareness, thus leading the aircraft to a condition of operation below the safe minimums.

- **Flight planning – undetermined.**

The TAF/GAMET weather prognostics with validity up to 12:00 UTC, and available to the crew at the time the flight plan was filed at the AIS-RJ, indicated a possibility of degradation of the ceiling and visibility parameters on account of rain associated with mist, encompassing the duration of the aforementioned flight, especially in the area of SBST.

The 11:00 UTC satellite image and the SIGMET valid from 10:30 UTC to 13:30 UTC, also showed an active cold front in the Southeast with stratiform cloud layers over SBST and a forecast of convective cells with northeasterly movement at an average speed of 12kt.

Despite the availability of such information, the crew may not have made a more accurate analysis showing the swift deterioration of the weather conditions in the period between their takeoff from SBRJ and the approach to SBST, and thus may have failed to plan their conduct of the flight in accordance with the weather conditions forecast by the meteorological services.

- **Organizational processes – undetermined.**

Despite having the C560 qualification required to operate the CE 560XLS+aircraft, the pilots were not checked by the employers as to their previous experience on this kind of equipment, or as to the need of transition training and/or specific formation to fly the PR-AFA aircraft. The adoption of a formal process for the recruitment, selection, monitoring and evaluation of the performance of the professionals could have identified their training needs for that type of aircraft.

- **Support systems – undetermined.**

Although the RBAC 61 requires pilots to undergo flight instruction and proficiency checks to switch between models of the CE 560XL family, the need of specific training was only clarified on 4 July 2014, with the publication of the ANAC Supplementary Instruction (IS 61-004, Revision A). Until that date, this need could only be determined by means of consultation of the FSB Report, made available only on the FAA website. In this context, the PR-AFA pilots would only be evaluated on the CE 560XLS+ aircraft on the occasion of their type revalidation, which would take place shortly before the expiration date of their C560 qualifications, which were valid until October 2014 (captain), and May 2015 (copilot).

The fact that there was a qualification (C560) that was shared for the operation of C560 Citation V, C560 Encore, C560 Encore+, CE 560XL, CE 560XLS, or CE 560XLS + aircraft was not enough to make the DCERTA system refuse flight plans filed by pilots who lacked proper training to operate one of the aforementioned aircraft models.

The RBAC 67 contained physical and mental health requirements which were not clear, inducing physicians to resort to other publications for guidance and support of their decisions and judgments relative to the civil aviation personnel. The absence of clear requirements to be adopted as the acceptable minimum for the exercise of the air activity, led the physicians responsible for judging the pilots' health inspections' to use their own discretion on the subject, opening gaps that could allow professionals not fully qualified to perform functions in flight below the minimum acceptable safety levels.

- **Task overload – undetermined.**

Considering the possibility that the captain accumulated tasks as a result of a possible difficulty of the copilot in assisting him at the beginning of the missed approach procedure, such accumulation may have exceeded his ability to deal with the tasks, leading him to committing piloting errors and/or experiencing spatial disorientation.

4. SAFETY RECOMMENDATION.

Safety Recommendation is a measure of preventative or corrective nature issued by the SIPAER Investigation Authority (or by a SIPAER-link) within their respective area of responsibility, aiming at suppressing a hazard or mitigating a risk generated by a latent condition, or an active failure. It results from the investigation of an aeronautical occurrence, or from an action of prevention, and shall never be used for apportion of blame or civil, criminal or administrative liability.

In accordance with the Law 7565/1986, the recommendations are issued solely for the benefit of flight safety, and shall be treated pursuant to the provisions of the NSCA 3-13 ("Protocols of Civil Aviation Aeronautical Occurrences Investigations conducted by the Brazilian State").

Recommendations issued prior to the publication of this report:

To the National Civil Aviation Agency (ANAC):

A - 134/CENIPA/2014 - 01 **Issued on 24/Nov/2014**

Ensure faithful and correct compliance with the IS 61-004 in force, with respect to the procedures provided for familiarization training and training of the differences, either in simulators or on the aircraft, as well as the evaluation of proficiency of pilots operating in Brazil, in order to ensure safe operation of Cessna CE 560XL-series aircraft in the Brazilian territory.

Recommendations issued at the publication of this report:

To the National Civil Aviation Agency (ANAC):

A - 134/CENIPA/2014 - 02 **Issued on 11/Jan/2016**

Establish professional profiles in accordance with the categories of licenses of Brazilian civil aviation pilots, aimed at the formation of judgment on the personality, skills and interests of the individual, as well as their suitability, or lack thereof, to the exercise of the activity they intend to accomplish.

A - 134/CENIPA/2014 - 03 **Issued on 11/Jan/2016**

Clarify the physical and mental health requirements of the RBAC 67, in accordance with the professional profiles to be established, in order to reduce discretion on the part of the physicians responsible for judging health inspections, by setting up the minimum acceptable standards for the exercise of the air activity by pilots of the Brazilian civil aviation.

A - 134/CENIPA/2014 - 04 **Issued on 11/Jan/2016**

Check the possibility of applying transitional provisions to regulations and instructions governing civil aviation, in order to provide higher celerity to changes that have impact on flight safety.

A - 134/CENIPA/2014 - 05 **Issued on 11/Jan/2016**

Review the criteria for the definition of similarity, which enable Civil Aviation Flight Inspectors and accredited examiners to conduct evaluations of pilots in various types of aircraft, taking into account the compatibility of the avionics and airborne systems.

A - 134/CENIPA/2014 - 06 **Issued on 11/Jan/2016**

Make sure that all Civil Aviation Flight Inspectors and accredited examiners are kept up-to-date on the aircraft utilized for the evaluation of pilots.

A - 134/CENIPA/2014 - 07 **Issued on 11/Jan/2016**

Make sure that the DCERTA system, as well as other qualification-management systems are updated as soon as there are changes in their reference regulations.

A - 134/CENIPA/2014 - 08 **Issued on 11/Jan/2016**

Review the RBHA 91 requirements concerning the installation of CVR and FDR on aircraft, considering, in addition to the current criteria, the aspects of performance and complexity of operation relative to each type of aircraft.

A - 134/CENIPA/2014 - 09 **Issued on 11/Jan/2016**

Check the possibility of adopting the online flight-experience reporting system (electronic Pilot's Flight Logbook), as the main and official means of attesting pilot's flight experience, so as to allow a quick and accurate treatment of this kind of information.

To the Airspace Control Department (DECEA):

A - 134/CENIPA/2014 - 10 **Issued on 11/Jan/2016**

Ensure that all AFIS operators and air traffic controllers are released for duty only after they meet the protocol formalities prescribed by specific regulations.

A - 134/CENIPA/2014 - 11 **Issued on 11/Jan/2016**

Ensure that all AFIS operators and air traffic controllers keep up-to-date in relation to the standard phraseology to be utilized in the provision of air traffic services.

A - 134/CENIPA/2014 - 12 **Issued on 11/Jan/2016**

Evaluate the possibility of implementing remote alarm systems so as to allow Aeronautical Station Operators to become readily aware of inoperative conditions affecting aids to navigation.

To the Aeronautics' Health Directorate (DIRSA):

A - 134/CENIPA/2014 - 13 **Issued on 11/Jan/2016**

Review and adapt the ICA 160-1, with the objective of re-defining the COMAER competencies in issues related to civil pilots' health inspections, since the referred Instruction was established before the creation of the ANAC.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

Compliance with the Safety Recommendation A - 134/CENIPA/2014 - 01

On 10 August 2015, approximately seven months after the issuance of the Safety Recommendation A - 134/CENIPA/2014 - 01, the CENIPA formally received an answer from ANAC stating that the mentioned recommendation was considered implemented on account of the of the reasons expressed below:

> 1. "After analysis by the competent sector, the Safety Recommendation A-134/CENIPA/2014 – 01, issued on 24/Nov/2014, has been complied with, although this Superintendence of Operational Standards (SPO) deems it necessary to provide clarifications to the investigating agency, as follows:
>
> a) On 31 May 2008, the Resolution no. 30 became effective. In its article 14, it had in its scope the establishment of the Supplementary Instruction (IS) institution, as expressed *ipsis literis* below:
>
> Art.14 The Supplementary Instruction is established as a supplementary norm of general nature, issued by the Superintendent of the competent area, with the objective of clarifying, detailing and providing guidance for the compliance with a requirement contained in an RBAC (Text provided by the Resolution no. 162 of 20 July 2010).
>
> § 1 The regulated entity wishing, for any purposes, to demonstrate compliance with the requirement contained in an RBAC, may:
>
> I – adopt the means and procedures previously specified in the IS; or
>
> II – present a duly justified alternative means or procedure, pending, in this case, the analysis and express concord on the part of the competent ANAC sector (Text provided by the Resolution no. 2 of 20 July 2010).
>
> § 2 the alternative means or procedure mentioned in § 1 of this article must guarantee a level of safety equal to or higher than the one established by the applicable requirement, or accomplish the objective normatized in the IS.
>
> § 3 The IS shall neither establish new procedures nor go against procedures established in RBACs or in any other normative acts.
>
> b) therefore, it follows that the IS has a guiding nature related to the compliance with requirements contained in RBACs, and that, if a duly justified alternative means or procedure exists which guarantees a safety level equal to or higher the one established by the requirement, it may be analyzed by the competent ANAC sector, which may or may not express concordance.
>
> c) In the case in question, the IS 61-004, Revision A, of 3 June 2014, was issued with the objective of providing detailed guidance not only to the crews, but also to the analysts of this Superintendence about what had been expressed in the RBAC 61 requirements, especially the item 61.217 (b)."

Here, before continuing with the answer provided by the ANAC to the CENIPA with respect to the Safety Recommendation A-134/CENIPA/2014 – 01, it is worth highlighting the item 61.217 (b) of the RBAC 61:

> 61.217 Prerogatives and limitations of a type qualification certificate holder:
>
> (a) (...)
>
> (b) If the type qualification certificate has more than one corresponding aircraft model, the prerogatives of the holder are limited to the aircraft on which the flight training or proficiency check was delivered. In order to become qualified to operate another aircraft belonging to the same type qualification certificate, the holder of the type qualification certificate must have received training of the differences or familiarization training, as applicable, at a training center certified by the ANAC to deliver such training, and the instructor shall declare in his flight records (Pilot's Electronic Flight Data Logging System or Pilot's Fight Logbook) that the holder complies with the requirements for operating the aircraft with safety.

The answer provided by the ANAC states that:

> d) Considering the aforementioned, the objective of the IS in question was not to establish new requirements, but provide clarification on the specific training necessary for the operation of each individual aircraft model.
>
> e) Still in the edition of the IS 61-004 Revision A, a transition period did not have to be expressed, since it was a usual practice (tradition) when editing certain IS or RBACs. This form results less traumatic and harmful to the system and pilots affected and, in this specific case, would take place on the occasion of the revalidation within a maximum period of 12 months, on account of the TYPE qualification validity, as established in the item 61.19 (a)(1) of the RBAC 61.
>
> f) Currently, the licenses and qualifications of the crews are adjusted to the instructions of the IS 61-004 Revision C, and, just for information purposes, 55 pilots are qualified in the C560, 45 in the C56X, and 31 in the C56+ (data extracted from the Civil Aviation System – SACI – on 27 July 2015).
>
> g) In light of the foregoing, it is worth noting that the edition of the IS 61-004 sought to present clear guidance on how TYPE aircraft are treated by the ANAC, as well as describe the required training (either of differences or familiarization) for the operation of variants of a same type registered in the pilot's license.
>
> h) In this respect, the aforementioned Safety Recommendation A-134/CENIPA/2014 – 01, issued by the CENIPA, corroborates with the decision made by the ANAC on the occasion of the publication of the IS 61-004."

In view of the answer provided by the ANAC relatively to the A-134/CENIPA/2014 – 01, the CENIPA understands that the Safety Recommendation was fully complied with, since, after seven months of the publication of the Safety Recommendation, the very ANAC affirmed that "currently, the crew licenses and qualification certificates are adjusted to the requirements of the IS 61-004 Revision C, and 55 pilots are qualified in the C560, 45 in the C56X, and 31 in the C56+ (data extracted from the Civil Aviation System – SACI on 27 July 2015)".

However, in at least two points, a caveat is in order relatively to the position of the CENIPA before the aforementioned information provided by the ANAC:

> 1º- Still in the edition of the IS 61-004 Revision A, a transition period did not have to be expressed, since it was a usual practice (tradition) when editing certain IS or RBACs. This form results less traumatic and harmful to the system and pilots affected and, in this specific case, would take place on the occasion of the revalidation within a maximum period of 12 months, on account of the TYPE qualification validity, as established in the item 61.19 (a)(1) of the RBAC 61.

The CENIPA understands that "*an usual practice (tradition) in the edition of certain Supplementary Instructions or RBACs*" may generate an expectation of unclear information in the regulated and supervising entities, resulting in latent conditions which should be expressly clarified in the IS or RBACs, since they are normative documents which regulate a highly complex activity, and, therefore, must have directives and operational standards readily understood by both the regulated and supervising entities.

The CENIPA also understands that even if it is "less traumatic and harmful to the system and pilots involved" the content of the IS 61-004 should be applied immediately upon publication of the referred IS, and not at the moment of revalidation within a maximum period of one year on account of the validity of the type qualification certificates, with the purpose of guaranteeing an immediate level of safety, as well as the safe operation of type aircraft, in addition to the safety of type qualification certificate holders, preventing any latent conditions or exposure of pilots holding such certificates to unsafe conditions.

> 2º - According to the ANAC, "In the case in question, the IS 61-004, Revision A, of 3 June 2014, was issued with the objective of providing detailed guidance not only to the crews, but also to the analysts of this Superintendence about what had been expressed in the RBAC 61 requirement, especially the item 61.217 (b)."

61.217 Prerogatives and limitations of a type qualification certificate holder:

(a) (...)

(b) If the type qualification certificate has more than one corresponding aircraft model, the prerogatives of the holder are limited to the aircraft on which the flight training or proficiency check was delivered. In order to become qualified to operate another aircraft belonging to the same type qualification certificate, the holder of the type qualification certificate must have received training of the differences or familiarization training, as applicable, at a training center certified by the ANAC to deliver such training, and the instructor shall declare in his flight records (Pilot's Electronic Flight Data Logging System or Pilot's Fight Logbook) that he or she complies with the requirements for operating the aircraft with safety.

Here, despite the provision of the regulation which states that "when type qualifications have more than one corresponding aircraft model, the prerogatives of the holder are limited to the aircraft in which the flight instruction or proficiency evaluation has been delivered", the CENIPA understands that the crew members were not the only ones responsible for complying with the content of the requirement. This responsibility also belonged to the supervising agency which allowed the conduction of the flight by pilots who had neither received instruction on the accident aircraft nor been checked as to their proficiency in the operation of the referred aircraft model. This was in discordance with the prescription contained in the item 61.217 (b) of the RBAC 61, which has hierarchical precedence over the IS 61-004 Revision A, considering the ANAC Resolution 30 of 31 May 2008, which establishes the following: "The IS shall neither create new procedures, nor go against requisites established in RBAC or other normative act"

Implementation of the Technical Bulletin of the RR NDB

The item 1.2 of the ICA 66-24 (31 May 2010) "Production and Issuance or Technical Bulletins within the Brazilian Airspace Control System – SISCEAB" reads as follows:

"Technical Bulletin is a standardized publication aimed at publicizing:

a) Changes introduced in the various systems or installed equipment;

b) Changes in routine inspection or maintenance procedures;

c) Maintenance or Inspection procedures not contemplated in Manuals or Technical Orders;

d) Inspections aimed at the provision of maintenance services and procedures to systems or equipment; and

e) Instructions regarding new operating procedures."

PAME-RJ has adopted the practice of regulating the process relative to the provision of preventative maintenance to SISCEAB equipment through the preparation of Technical Bulletins containing additional information for the implementation of the maintenance services, such as description of the services, materials, tools, instruments, and spare parts to be utilized, as well as the personal protection equipment (EPI) necessary for ensuring the safety of technicians during the execution of their tasks.

Thus, even though the maintenance services were already being provided in accordance with equipment manuals, the only document indispensable for the provision of any type of service was approved in September 2014 for refinement of the procedures adopted.

APPENDIX A - FSB Report Cessna 560XL

Flight Standardization Board (FSB) Report
Revision: 2
Date:09/30/2009
Cessna 560XL
CE 560XL/ Excel/ XLS/ XLS+

U.S. Department of Transportation
Federal Aviation Administration
Washington, D.C.

Flight Standardization Board (FSB) Report

Revision: 2
Date:09/30/2009

Cessna 560XL

CE 560XL/ Excel/ XLS/ XLS+

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REVISION RECORD

Revision	Sections	Date	Chairman
Original	All		Doug Edwards
Revision 1	All	01/21/1999	Doug Edwards
Revision 2	All	09/30/2009	Jeff Spangler

Highlights of Change

Original Issue Established Type Rating
Revision 1 Modified prerequisites for transition courses for applicants for the CE-560XL and CE-500 type ratings.
Revision 2 Specified training checking and currency requirements for XLS+, and superseded 560XLS FSB Report by incorporation.

PURPOSE AND APPLICABILITY

The primary purpose of this Flight Standardization Board (FSB) Report is to specify FAA master training, checking and currency requirements applicable to flight crews operating the Cessna Aircraft Company CE-560XL series aircraft. This report provides guidance to operators who will be operating the CE-560XL series aircraft under Title 14 Code of Federal Regulations (14 CFR) Part 91, Subpart K of Part 91, and Part 135.

The guidelines in this report apply to: operations inspectors, principal operations inspectors (POIs), training center program managers (TCPMs), and aircrew program managers (APMs). This Report also applies to 14 CFR 135 air carrier check airmen and instructors, airline transport pilots instructing in air transportation service, certificated flight instructors, aircrew program designees, training center evaluators (TCEs), and 14 CFR Part 61, 135, 141 and 142 training providers.

This FSB Report has been written in accordance with the requirements of Advisory Circular (AC) 120-53. The contents of this FSB Report are applicable on the effective date of its final approval and will remain effective unless amended, superseded, or withdrawn by subsequent FSB determinations. Previous CE-560XL and CE-560XLS reports are superseded by this report.

This FSB report revises the CE-560XL report to revision 2, and incorporates CE-560XLS Report which was previously a separate document.

Provisions of the report include:

- Assigning the same CE-560XL pilot type rating for the Cessna 560 XLS+,
- Setting Master Difference Requirements,
- Providing examples of "Operator Difference Requirement (ODR)" Tables acceptable to the FAA,
- Describing an acceptable training program and device characteristics, when necessary, to establish compliance with pertinent MDRs,
- Setting checking and currency standards including specification of particular check items that must be administered by FAA or qualified training establishments, and
- Providing information to FAA Field Offices regarding CE-560XL (Excel, XLS, XLS+) compliance with 14 CFR requirements.

This report also provides:

Information which is advisory in nature, but may be mandatory (under 14 CFR part 135 operations specifications for particular operators) if the designated configurations apply and if approved for that operator.

ACRONYMS

Relevant acronyms used in this FSB Report are defined as follows:

14 CFR	Title 14, Code of Federal Regulations
AC	Advisory Circular
AEG	Aircraft Evaluation Group
AFM	Airplane Flight Manual
CAS	Crew Alerting System
CHDO	Certificate Holding District Office
EFIS	Electronic Flight Information System
FAA	Federal Aviation Administration
FADEC	Full Authority Digital Engine Controller
FMS	Flight Management System
FSB	Flight Standardization Board
FTD	Flight Training Device
IFIS	Integrated Flight Information System
LED	Light Emitting Diode
LRU	Line Replaceable Unit
MDR	Master Difference Requirements
MFD	Multifunction Display
MKC-AEG	Kansas City Aircraft Evaluation Group
ODR	Operator Difference Requirements
POI	Principal Operations Inspector

Terminology

The term "must" is used in this report and may be used in certain MDR footnotes even though it is recognized that this FSB report, and Advisory Circular AC 120-53 on which it is based, provides one acceptable means, but not necessarily the only means of compliance with 14 CFR 61/135 requirements. This terminology acknowledges the need for operators to fully comply with this FSB report MDR and ODR provisions if this method is to be used by the operator as the means of complying with 14 CFR 135. Operators who choose this method must comply with each applicable MDR provision including the footnotes.

FLIGHT DECK PHOTOS

Flight Deck Photos are available in Appendix 3.

PILOT TYPE RATING DETERMINATION

In accordance with 14 CFR Parts 1 and 61, the pilot type rating designation for the Cessna Model 560XL 560-5001 THRU-5500 (Excel), Cessna Model 560XL 560-5501 THRU-6000 (XLS), Cessna Model 560XL 560-6001 AND ON (XLS+), is designated as CE-560XL.

This determination is based on past XL and XLS report type rating determinations, and the highest difference levels for Excel or XLS to the XLS+ of level C.

The Second-In-Command Pilot Type Rating (CE-560XL SIC PRIVILEGES ONLY) may be issued in accordance with 14 CFR Part 61.55.

Historical type rating determination information

Previous revisions of the CE-560XL FSB and CE-560XLS FSB reports contained type rating determinations for those aircraft. E level differences were determined to exist between CE-500 series aircraft and CE-560XL aircraft. Those determinations are retained in this report for historical reference in Appendix 4.

MASTER DIFFERENCE REQUIREMENTS

MDRs are requirements applicable to crew qualification, which pertain to differences between variants of the same or related type and are listed in Appendix 1.

MDR requirements apply when differences between related aircraft affect flight crew knowledge, skills, or abilities related to flight safety. These differences are expressed in Difference Levels A through E as defined in AC 120-53 as revised.

MDR NOTES

MDR notes define acceptable "required means" of compliance. A note can indicate requirements which are less restrictive than the basic designation, or more restrictive than the basic designation, depending on the significance of the differences between particular aircraft.

OPERATOR DIFFERENCE REQUIREMENTS

ODR Tables are developed by each individual 14 CFR 135 operator when differences exist which affect crew qualification.

The tables are examples and may not include items that are applicable to particular operators.

The example ODR tables in this report are not the only acceptable means of compliance. Operators, who wish to establish a different means of compliance, must request FAA approval through their assigned POI for ODR tables unique to their fleet. The POI should coordinate this action with the FSB chairman and AFS-200.

Sample ODR tables are provided are included in Appendix 2.

FSB SPECIFICATIONS FOR TRAINING

Airmen Experience

The provisions of this section of the report apply to programs for experienced airmen (e.g. airmen who have previous experience in 14 CFR 91/135 operations, former military, commuter or corporate pilots with turbine powered aircraft experience, etc.). For airmen not having such experience, additional requirements may be necessary as determined by the POI, FSB, and AFS-200.

Operator training differences from CE-560XL or CE-560XLS to CE-560XLS+, or from CE-560XLS+ to CE-560XL or CE-560XLS must meet the minimum FSB recommendation of eight hours ground and four hours system integration training. The minimum training hours required for differences from CE-560XL or CE-560XLS to CE-560XLS+, are based on pilots with previous Collins Proline 21 experience. Operator programs using the minimum hours shall include a prerequisite for previous Collins Proline 21 experience as evidenced by successful completion of initial or recurrent training in a Proline 21 equipped aircraft within the preceding 24 months. Programs for differences from CE-560XL or CE-560XLS to CE-560XLS+, for pilots without Collins Proline 21 experience need increased training hours in addition to minimum FSB recommendation of eight hours ground and four hours system integration training. The differences training shall be accomplished in accordance with MDR table in Appendix 1 of this Report.

TRANSITION TRAINING

Guidance was provided in previous CE560XL FSB report revisions for the application of training credit for CE 560XL based on previous experience with certain CE500 series aircraft. Similar guidance was provided for CE500 training based on CE560XL experience. That guidance is retained in this report for historical reference in Appendix 4. Guidance provided in this report is intended to clarify previous guidance and incorporate the XLS and XLS+ aircraft.

In accordance with the following conditions, and at the discretion of Principal Operations Inspectors and Training Center Program Managers having airmen certification responsibility for the CE-560XL (Excel) and CE-560XL (XLS), training credit may be allowed for applicants for a CE-560XL type rating, assuming training in either the Excel or XLS that are CE-500 type rated and have completed an Initial or Recurrent course in either the CE-550 Bravo or CE-560 Ultra within the previous 24 months. This transition credit applies only to the 560XL (Excel) and 560XL (XLS) aircraft with Honeywell Avionics and excludes the 560XL (XLS+) aircraft with Collins Avionics. Alternately, training credits may be given for applicants for a CE-500 type rating, assuming training in either the CE 550 Bravo or CE 560 Ultra when the applicant is type rated in the CE-560XL and has attended either an Initial or Recurrent course in the CE-560XL (Excel) or CE-560XL (XLS) within the previous 24 months. No transition credit will be available for the CE-500 for those applicants with only CE-560XL (XLS+) experience. No transition credit will be available for training in any other CE-500 aircraft other than the CE-550 Bravo and CE-560 Ultra. The minimum course length for these "Transition" courses should be no less than 3 simulator sessions (6 hours left seat and right seat, or 12 hours left seat) and a practical test in accordance with the Practical Test Standards.

FSB SPECIFICATIONS FOR CHECKING

Checking Requirements

All checking requirements (61.58, 61.63, 61.157, and 135.293) will be administered in accordance with the Airline Transport Pilot and Aircraft Type Rating Practical Test Standards.

QUALIFICATIONS OF FAA INSPECTORS OR CHECK AIRMEN

For purposes of airman certification, FAA Inspectors, Designated Pilot Examiners or check airmen should have completed appropriate qualification for the respective XL, XLS, or XLS+.

FSB SPECIFICATIONS FOR CURRENCY

Landing Currency

Currency is required by 14 CFR 61.57 and 135.247.

Landing currency requirements for 14 CFR 135.247 and 14 CFR 61.57 can be met in CE-560XL variants (CE-560XL, 560XLS, and 560XLS+) interchangeably.

FSB SPECIFICATIONS FOR DEVICES AND SIMULATORS

Device and Simulator Characteristics

When variants are flown in mixed fleets, the combination of simulators and devices used to satisfy MDR and ODR provisions should address specific variants flown by that operator. The acceptability of differences between devices, simulators and aircraft operated should be addressed by the POI.

Device Approval

Requests for device approval should be made to the POI/TCPM. If device characteristics clearly meet established FAA criteria and have been approved by the NSET, the POI/TCPM may approve those devices for that certificate holder. Where devices do not clearly satisfy a given level, the POI/TCPM should request advice from the FSB Chairman, NSET or AFS-200.

REGULATORY COMPLIANCE CHECKLIST

Regulatory Compliance checklist is provided as an aid to FAA Certificate Holding District Offices (CHDOs) in identifying those specific rules or policies for which compliance has already been demonstrated to FAA for a particular aircraft type, variant or variant group. The checklist also notes rules or policies which remain to be demonstrated to CHDOs by operators.

Regulatory compliance checklist is located in Appendix 6.

OPERATIONAL APPROVAL INFORMATION

Operational approval information is provided as an aid to FAA Certificate Holding District Offices (CHDOs) for identifying specific regulatory compliance.

Emergency Exits

All CE-560XL aircraft are equipped with, and required to carry a water barrier during all flights per an equivalent level of safety. The water barrier must also be accessible during all flights. The passenger briefing and passenger briefing cards must include instructions on water barrier location and use. The water barrier is required per flight manual procedures to be placed in the cabin door opening in the event of a water landing. The water barrier is part of an equivalent level of safety in lieu of meeting the ditching emergency exits for passengers required by 14 CFR Part 25.807. Flight crews must receive training on water barrier procedures as required by 14 CFR 135.331.

Cessna Aircraft Company CESNAV

The aircraft manufacturer offers computer software for Cessna 560 XL Series aircraft. The software package is the Cessna Aircraft Company CESNAV. CESNAV includes the following programs or documents.

Citation Loading Calculator (CLCalc)
Citation Performance Calculator (CPCalc)
Citation Electronic Operating Manual (EOM)
MMEL O&M Procedures Guide
Operating Manual (Reference Only)
Flight Manual (Reference Only)
Pilots Checklist (Reference Only)

The following is specific information on CESNAV components.

CLCalc is a computer based software program designed to allow users to calculate and graph loading Weight and Balance of their aircraft. The Limitations Section of FAA approved AFM for the each of the 560XL series aircraft indicates the airplane must be operated in accordance with the approved loading schedule and refers to Weight and Balance Data Sheet and FAA Approved Weight and Balance Manual. The FAA Approved Weight and Balance Manuals (56XWB, 56XWBA, and 56XWBB) include references for use of CLCalc software program for computerized loading calculations.

CPCalc is a computer based software program which if used in accordance with Cessna Aircraft Company CPCalc AFMS provides an alternate source to the takeoff and landing data presented in Section IV of the basic FAA approved AFM. The program also provides advisory (not FAA approved) Section VII Wet Landing performance information. For the program to be approved for use, the Airplane Flight Manual Supplement must be issued for the specific airplane flight manual. Operators using CPCalc must adhere to CPCalc AFMS limitations and procedures.

EOM is a computer based software program which provides advisory (not FAA approved) information for planning purposes.

Optional Garmin GMX-200 installation

CE-560XL and 560XLS aircraft can be equipped with single or dual Garmin GMX-200 Multi Function Display. If a GMX-200 is installed, electronic charts are an option available. The FSB has not conducted an operation suitability evaluation of the electronic chart functions to determine if they meet the requirements of AC 120-76A.

Emergency Evacuation

14 CFR Part 135 operators must meet the requirements of 14 CFR 135.123.

Ditching Demonstration

While no specific requirement for a ditching demonstration exists under Parts 91/135, operators/crewmembers must comply with the requirements of 14 CFR 135.331, and must be familiar with the general handling characteristics and procedures outlined in the aircraft flight manual.

Passenger briefing cards

The CHDO will need to verify passenger briefing cards meet requirements of 135.117, and match the interior configuration and emergency equipment installed. If the aircraft was delivered by Cessna with rafts and/or life preservers installed, passenger briefing cards normally include information on raft and/or life preserver location and use.

Forward Observer Seat

Cessna 560 XL aircraft are not equipped with a dedicated forward observer seat, and Cessna does not offer a dedicated forward observer seat as an option. Due to the availability of various passenger configurations, the determination of suitability for use of a forward passenger seat for use in conducting en route inspections will need to be determined by the CHDO or Inspector conducting en route inspections.

Proving Flights

Proving Tests to comply with 14 CFR 135.145 should be conducted in accordance with FAA Order 8900.10.

ALTERNATE MEANS OF COMPLIANCE

Approval Level and Approval Criteria Alternate means of compliance to the provisions of this report, must be approved by MKC-AEG. If alternate compliance is sought, operators will be required to establish that any proposed alternate means provides an equivalent level of safety to the provisions of this FSB report. Analysis, demonstrations, proof of concept testing, differences documentation, or other evidence may be required.

Requires Equivalent Safety In the event alternate compliance is sought, training program hour reductions, simulator approvals, and device approvals may be significantly limited and reporting requirements may be increased to assure equivalent safety. FAA will generally not consider relief through alternate compliance means, unless sufficient lead time has been planned by an operator to allow for any necessary testing and evaluation.

Unforeseen Circumstances In the event of clearly unforeseen circumstances in which it is not possible for an operator to comply with report provisions, the operators may seek an interim equivalent program rather than a permanent alternate compliance method. Financial arrangements, schedule adjustment, and other such reasons are not considered "unforeseen circumstances" for the purposes of this provision.

APPENDIX 1

Master Differences Requirements (MDR) Table				
AIRPLANE TYPE RATING: CE-560XL		FROM AIRPLANE		
		CESSNA MODEL CE-560XL	**CESSNA MODEL CE-560XLS**	**CESSNA MODEL CE-560XLS+**
TO AIRPLANE	**CESSNA MODEL CE-560XL**	A/A/B*	A/A/B	C/C/C***
	CESSNA MODEL CE-560XLS	A/A/B	A/A/B*	C/C/C***
	CESSNA MODEL CE-560XLS+	C/C/C**	C/C/C**	A/A/B*

NOTES

*Differences to accommodate optional equipment and aircraft modifications.

** The currency level for flight crews, who are trained and qualified in both the CE 560XL/XLS and the CE-560XLS+, or who are engaged in mixed fleet flying, is Level C if they have not operated the CE-560XLS+ in the preceding 180 days. If flight crews have not operated the CE-560XLS+ in the preceding 180 days, operators and training providers must ensure they receive the minimum training required by this report to reestablish currency in the CE-560XLS+ avionics system and FMS. If flight crews have operated the CE-560XLS+, in the preceding 180 days and have retained systems proficiency with the Pro Line 21 System and the FMS, the currency level will be Level B.

*** The currency level for flight crews, who are trained and qualified in CE-560XLS+ and the CE 560XL/XLS, or who are engaged in mixed fleet flying, is Level C if they have not operated the CE-560XL/XLS in the preceding 180 days. If flight crews have not operated the CE-560XL/XLS in the preceding 180 days, operators and training providers must ensure they receive the minimum training required by this report to reestablish currency in the CE-560XL/XLS avionics system and FMS. If flight crews have operated the CE-560XL/XLS in the preceding 180 days and have retained systems proficiency with the Honeywell Avionics System and applicable FMS, the currency level will be Level B.

APPENDIX 2
SAMPLE OPERATOR DIFFERENCE REQUIREMENTS TABLES

Definitions used in the ODR Tables:
X = Pilot’s Operating Handbook and or Flight Manual Supplement
FTD 5 = Flight training devices (level 5)

CE-560XL to CE-560XLS

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XL APPROVED BY (POI)______________________________				**COMPLIANCE METHOD**					
				TRAINING				CHKG/CURR	
DESIGN	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Citation 560XLS	More Engine Thrust, Hyd. and Brake System differences, Larger Cockpit Displays, added Body Fairings, Max Gross Weight change (20,200 lbs to 20,400 lbs. ramp load)	None	Minor	X				A	B

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XL APPROVED BY (POI)______________________________				**COMPLIANCE METHOD**					
				TRAINING				CHKG/CURR	
MANEUVER	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
None	No Changes	None	None						

CE-560XLS to CE-560XL

DIFFERENCE AIRCRAFT: CE-560XL BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
Citation 560XL	Less Engine Thrust, Hyd. and Brake System differences, Smaller Cockpit Displays, no Body Fairings, Max Gross Weight change (20,400 lbs to 20,200 lbs. ramp load)	None	Minor	X				A	B

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XL APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
MANEUVER	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
None	No Changes	None	None						

CE-560XL to CE-560XLS+

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XL APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
Engine PW545C replaces PW545A	FADEC controlled. more Engine Thrust. Thrust reverser deployment emergency procedures changed.	None	Minor		X			B	B
Avionics	Collins Proline 21 replaces Honeywell P-1000.	None	Major			FTD 5		C/ FTD 5	C/B
Cockpit Structure	Full span tilt panel added. Emergency gear release controls changed.	None	Minor	X				A	B

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XL APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
MANEUVER	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
None	No Changes	None	None						

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XL APPROVED BY (POI)____________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
SYSTEM	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
Air Conditioning ATA-21	Relocated temperature and pressurization controllers.	No	Minor	X				A	A
Auto Flight ATA-22	Collins autopilot and flight guidance control panel. Single flight guidance panel located below Glareshield replaces dual flight guidance panels located above PFDs.	No	Minor			FTD 5		C/ FTD 5	C/B
Communications ATA-23	Collins radios. Radio tuning through Control Display Units or Cursor Control Panels instead of Radio Management Units.	No	Minor			FTD 5		C/ FTD 5	C/B
Electrical Power ATA-24	Relocated controls and ammeters.	No	Minor	X				A	A
Indicating/ Recording Systems ATA-31	CAS on display unit 3 replaces annunciator panel.	No	Minor			FTD 5		C/ FTD 5	C/B
Landing Gear ATA-32	Relocated emergency gear release and blow down handles.	No	Minor	X				B	B
Lights ATA-33	Lighting controls relocated.	No	Minor	X				A	A
Navigation ATA-34	4 tube Collins displays and controllers replace 3 tube Honeywell displays and controllers. IFIS 5000 system added. Collins radios and FMS. Radio tuning through CDUs and CCPs instead of RMUs. Electronic standby HSI replaces mechanical HSI.	No	Major			FTD 5		C/ FTD 5	C/B

Continued

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Oxygen ATA-35	Relocated oxygen controls and gauge.	No	Minor	**X**				**A**	**A**
Engine Fuel & Control ATA-73	Dual channel FADEC Engines with new throttles.	No	Minor		**X**			**B**	**B**
Engine Indicating ATA-77	Engine Information System on display unit 2. New standby engine gauge.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**

CE-560XLS to CE-560XLS+

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
Engine PW545C replaces PW545B	FADEC controlled.	None	Minor		X			B	B
Avionics	Collins Proline 21 replaces Honeywell P-1000	None	Major			FTD 5		C/ FTD 5	C/B
Cockpit Structure	Full span tilt panel added. Emergency gear release controls changed.	None		X				A	B

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
MANEUVER	REMARKS	FLT CHAR	PROC CHNG	LVL A	LVL B	LVL C	LVL D	CHK	CURR
None	No Changes	None	None						

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)____________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
SYSTEM	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Air Conditioning ATA-21	Relocated temperature and pressurization controllers.	No	Minor	**X**				**A**	**A**
Auto Flight ATA-22	Collins autopilot and flight guidance control panel. Single flight guidance panel located below Glareshield replaces dual flight guidance panels located above PFDs.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Communications ATA-23	Collins radios. Radio tuning through Control Display Units or Cursor Control Panels instead of Radio Management Units.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Electrical Power ATA-24	Relocated controls and ammeters.	No	Minor	**X**				**A**	**A**
Indicating/ Recording Systems ATA-31	CAS on display unit 3 replaces annunciator panel.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Landing Gear ATA-32	Relocated emergency gear release and blow down handles.	No	Minor	**X**				**B**	**B**
Lights ATA-33	Lighting controls relocated.	No	Minor	**X**				**A**	**A**
Navigation ATA-34	4 tube Collins displays and controllers replace 3 tube Honeywell displays and controllers. IFIS 5000 system added. Collins radios and FMS. Radio tuning through CDUs and CCPs instead of RMUs. Electronic standby HSI replaces mechanical HSI.	No	Major			**FTD 5**		**C/ FTD 5**	**C/B**

Continued

DIFFERENCE AIRCRAFT: CE-560XLS+ BASE AIRCRAFT: CE-560XLS APPROVED BY (POI)____________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
SYSTEM	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Oxygen ATA-35	Relocated oxygen controls and gauge.	No	Minor	**X**				**A**	**A**
Engine Fuel & Control ATA-73	Dual channel FADEC Engines with new throttles.	No	Minor		**X**			**B**	**B**
Engine Indicating ATA-77	Engine Information System on display unit 2. New standby engine gauge.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**

CE-560XLS+ to CE-560XL

DIFFERENCE AIRCRAFT: CE-560XL BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Engine PW545A replaces PW545C	EEC controlled instead of FADEC controlled, and less thrust.	None	Minor			**FTD 5**		**C/ FTD 5**	**B**
Avionics	Honeywell P-1000 replaces Collins Proline 21	None	Major			**FTD 5**		**C/ FTD 5**	**C/B**
Cockpit Structure	Full span tilt panel removed. Emergency gear release controls changed.	None	Minor	**X**				**A**	**B**

DIFFERENCE AIRCRAFT: CE-560XL BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
MANEUVER	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
None	No Changes	None	None						

DIFFERENCE AIRCRAFT: CE-560XL BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
SYSTEM	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Air Conditioning ATA-21	Relocated temperature and pressurization controllers.	No	Minor	**X**				**A**	**A**
Auto Flight ATA-22	Honeywell autopilot and flight guidance control panel. Dual flight guidance panels located above PFDs replace single flight guidance panel located below glareshield.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Communications ATA-23	Honeywell radios. Radio tuning through Radio Management Units instead of Control Display Units or Cursor Control Panels.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Electrical Power ATA-24	Relocated controls and ammeters.	No	Minor	**X**				**A**	**A**
Indicating/ Recording Systems ATA-31	Annunciator Panel replaces CAS on display unit 3.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Landing Gear ATA-32	Relocated emergency gear release and blow down handles.	No	Minor	**X**				**A**	**A**
Lights ATA-33	Lighting controls relocated.	No	Minor	**X**				**B**	**B**
Navigation ATA-34	3 tube Honeywell displays and controllers replace 4 tube Collins displays and controllers. Honeywell radios and FMS. Radio tuning through RMUs instead of CDUs and CCPs. Mechanical standby HSI replaces electrical HSI.	No	Major			**FTD 5**		**C/ FTD 5**	**C/B**
Oxygen ATA-35	Relocated oxygen controls and gauge.	No	Minor	**X**				**A**	**A**
Engine Fuel & Control ATA-73	Single channel EEC Engines with different throttles and AUTO/MANUAL switches.	No	Minor			**FTD 5**		**C/ FTD 5**	**B**
Engine Indicating ATA-77	AMLCD or mechanical tape gauges. Standby engine gauge is half of AMLCD or just mechanical N1 tapes.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**

CE-560XLS+ to CE-560XLS

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
DESIGN	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Engine PW545B replaces PW545C	EEC controlled instead of FADEC controlled	None	Minor			**FTD 5**		**C/ FTD 5**	**B**
Avionics	Honeywell P-1000 replaces Collins Proline 21	None	Major			**FTD 5**		**C/ FTD 5**	**C/B**
Cockpit Structure	Full span tilt panel removed. Emergency gear release controls changed.	None	Minor	**X**				**A**	**B**

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)______________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
MANEUVER	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
None		None	None						

DIFFERENCE AIRCRAFT: CE-560XLS BASE AIRCRAFT: CE-560XLS+ APPROVED BY (POI)________________________________				COMPLIANCE METHOD					
				TRAINING				CHKG/CURR	
SYSTEM	**REMARKS**	**FLT CHAR**	**PROC CHNG**	**LVL A**	**LVL B**	**LVL C**	**LVL D**	**CHK**	**CURR**
Air Conditioning ATA-21	Relocated temperature and pressurization controllers.	No	Minor	**X**				**A**	**A**
Auto Flight ATA-22	Honeywell autopilot and flight guidance control panel. Dual flight guidance panels located above PFDs replace single flight guidance panel located below glareshield.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Communications ATA-23	Honeywell radios. Radio tuning through Radio Management Units instead of Control Display Units or Cursor Control Panels.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Electrical Power ATA-24	Relocated controls and ammeters.	No	Minor	**X**				**A**	**A**
Indicating/ Recording Systems ATA-31	Annunciator Panel replaces CAS on display unit 3.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**
Landing Gear ATA-32	Relocated emergency gear release and blow down handles.	No	Minor	**X**				**A**	**A**
Lights ATA-33	Lighting controls relocated.	No	Minor	**X**				**A**	**B**
Navigation ATA-34	3 tube Honeywell displays and controllers replace 4 tube Collins displays and controllers. Honeywell radios and FMS. Radio tuning through RMUs instead of CDUs and CCPs. Mechanical standby HSI replaces electrical HSI.	No	Major			**FTD 5**		**C/ FTD 5**	**C/B**
Oxygen ATA-35	Relocated oxygen controls and gauge.	No	Minor	**X**				**A**	**A**
Engine Fuel & Control ATA-73	Single channel EEC Engines with different throttles and AUTO/MANUAL switches.	No	Minor			**FTD 5**		**C/ FTD 5**	**B**
Engine Indicating ATA-77	AMLCD or mechanical tape gauges. Standby engine gauge is half of AMLCD or just mechanical N1 tapes.	No	Minor			**FTD 5**		**C/ FTD 5**	**C/B**

APPENDIX 3

FLIGHT DECK PHOTOS

CE-560 XLS+

CE-560 XLS

APPENDIX 3

FLIGHT DECK PHOTOS

CE-560 XL

APPENDIX 4

HISTORICAL TYPE RATING DETERMINATION INFORMATION

HISTORICAL TYPE RATING DETERMINATION INFORMATION FROM 560 XL REPORT

The Board determined there were Areas of Operation that met the Advisory Circular criteria of Level E differences.

They are:

1. Preflight Walk Around: The CE-560XL has numerous differences from the Ultra. The Cabin Door is significantly different in operation and warning system logic. There are numerous systems to check in the nose compartment of the XL, some of which are not in the Ultra. In comparison, the nose compartments of the Ultra have a few gauges, but are mostly available for baggage. There is no tailcone compartment on the right side of the Ultra. The right tailcone compartment of the XL contains several critical preflight items. The left side tail compartment of the XL is baggage. Upon first look, the LH tail compartment of the Ultra is baggage. Upon removing a door, several critical preflight items (Fire Bottles, Air Cycle Machine oil level) can be accessed. It is imperative that the nose and tail compartment doors be locked, not just latched, in the Ultra. The XL has 26 VG's and 11 BLE's on each wing that previous CE-500's do not. Level E going from Ultra to XL and Level E going from XL to Ultra.

2. Cockpit Preparation. There are various switches that are either in different locations, or that are not present from one model to the other. The pilot's seat has different positions for fore and aft and for up and down controls. Overall, there is a difference in inside visibility. In the XL, the perspective is one of sitting down and aft. In the Ultra, the perspective is one of sitting up and forward. From a pilot's perspective, this affects not only finding the new switches, but also results in the switches that are in the same panel location being in a different location relative to the pilot's eyes and hands. Aileron and rudder trim controls are significantly different. Oxygen masks are different in location and operation. The rotary test switch is in a different location. The Ultra has a Ground Idle Switch. This function is performed automatically by the Electronic Engine Computers(EEC's) in the XL. Igniter lights are in a different location. Exterior Lighting switches are different, and in a different location. The igniter switches of the XL have an additional position. Up is Secondary, and not used in normal operations. In the Ultra, the up position is used for every takeoff and landing. Level E going from Ultra to XL and Level E going from XL to Ultra.

3. Takeoff. The XL utilizes Electronic Engine Computer (EEC's). There are three detents in the throttle quadrant, "CRUISE", "CLIMB", and "TAKEOFF". In setting power in the XL, there is a tendency for the pilot to go to full throttle and back down to the TO detent. In the Ultra there are no detents. There is a tendency for the Ultra pilot to "hunt" for the proper N1. This can result in fan overspeed. The XL has a two position tail that repositions after the flaps are up. This results in significant pitch control forces different from the Ultra. After the flaps are up, and as the tail repositions, this changes to the need for a significant amount of nose down trim. Level E going from Ultra to XL and Level E going from XL to Ultra.

4. Engine Failure-Takeoff continued. The XL and the Ultra have two different climb out profiles in the event of an engine failure after V1. The Ultra profile requires that the airplane climb at V2 to 400 feet AGL, level off, accelerate to V2 plus 10 knots, retract the flaps, and then accelerate to V enroute (Venr). Venr is a computed speed, ranging from 160 to 172 kts. In the XL, the profile requires that the airplane climb to 1,500 feet AGL at V2, level off, accelerate to V2 plus 10, retract the flaps, and then accelerate to Venr. Venr is always 160 kts. When combined with the lack of takeoff detents, the speed at which this is occurring, and the pitch and trim changes, there is a tendency for the pilot to revert back to the profile with which he/she is most familiar. Level B going from the Ultra to the XL and Level E going from the XL to the Ultra.

5. Stalls. The recommended stall recovery in the two aircraft are different. The XL has sufficient power that the pilot can maintain approximately 10 degrees of pitch, apply power with the aid of the detents, and power out of the stalls. In the Ultra the recommended recovery from the landing configuration stall requires that the nose be lowered to the horizon before calling for approach flaps. Failure to do so may result in secondary stalls and additional altitude loss. Inattention to proper pitch attitude, resulting from fine tuning TO power without the aid of the detents, aggravates this. Level B going from Ultra to XL and Level E going from XL to Ultra.

6. Stabilized Approaches. The XL is powered by two P&W high bypass turbofans rated at 3,800 pounds each. The Ultra has P&W JT15D-5D engines rated at 3,045 pounds of thrust each. As a result, the power appears more responsive in the XL. This affects approach stability. There is more of a requirement to lead power in the Ultra. When not led correctly, the tendency is to slow too much, apply too much power, overshoot, and then accelerate pass the reference speed. Outside visibility in the XL is less than that of the Ultra. The glare shield in the XL is higher, resulting in a feeling of being located "down and back". The differences in visibility and power resulted in flat below glide path approaches. Level E going from Ultra to XL and Level E going from XL to Ultra.

CONCLUSION: The Board recommends that a separate pilot type rating, "CE-560XL" be established for the model 560XL.

HISTORICAL TRANSITION TRAINING GENERAL

The Citation CE-560XL has design/system differences from other 500 series Citations which require different or additional flight crew knowledge. In accordance with the following conditions, and at the discretion of Principal Operations Inspectors and Training Center Program Managers having airmen certification responsibility for the CE-560XL, training credit may be allowed for applicants that are CE-500 type rated, and have attended and completed an Initial CE-560XL course within the previous 24 months, or have a CE-500 type rating and have completed an Initial or Recurrent course in either the CE-550 Bravo or CE-560 Ultra within the previous 24 months. Alternately, training credits may be given for applicants for a CE-500 type rating when the applicant is type rated in the CE-560XL and has attended either an Initial or Recurrent course in the CE-560XL within the previous 24 months. The minimum course length for these "Transition" courses should be no less than 3 simulator sessions (6 hours left seat and right seat, or 12 hours left seat) and a practical test in accordance with the Practical Test Standards.

HISTORICAL TYPE RATING DETERMINATION INFORMATION FROM 560 XLS REPORT

In accordance with FAR Parts 1 and 61, the pilot type rating for the Cessna Model CE-560XLS is designated as the CE-560XL.

The Cessna Model CE-560XLS differs from the basic EXCEL model in the following:

1. Bleed Air Precoolers use engine fan air on the ground as well as in the air , and eliminate the NACA – type ram air scoops and control doors used for in-flight cooling on the Excel.

2. Hydraulic system is functionally identical to the basic Excel, but is reconfigured to reduce hydraulic line plumbing with the use of manifolds. Also the hydraulic lines to the nose gear system has been rerouted outside of the pressurized cockpit and cabin. A short fairing was added to the belly of the aircraft between the wing root and the nose gear well.

3. Fairings were added to the main gear wells for drag improvement.

4. The instrument panel mounted lighted switches have changed from incandescent-type to LED. Operation and nomenclature are unchanged.

5. The aircraft brake system is functionally identical to the basic Excel but has been modified to move hydraulic lines out of the cabin and cockpit by moving the brake system pump, reservoir, and accumulator, and brake control valve from the nose section to the belly of the aircraft of the LH aft wing root. A new access panel is located forward of the battery compartment to check the brake system accumulator pressure and reservoir quantity, and to check for leeks. A cable and quadrant system is added to connect the brake pedals to the brake control valve, and eliminates the master cylinders and associated brake hydraulic plumbing.

6. The auto pilot and flight director system has not changed, but the displays are larger, and the control of the displays has changed to accommodate pull down menus and added functions, described in the Honeywell Pilots Manual.

7. The engines have been up rated to provide about 200 lbs additional thrust, sea level standard day. No changes have been made at this point to take credit for the additional thrust. Engine limits have changed slightly.

8. The aircraft maximum gross weights have increased slightly as follows: Ramp - 20,200 lbs to 20,400 lbs; and takeoff - 20,000 to 20,200 lbs.

9.System control panels and alerts have not changed, lighting controls have not changed.

10. The optional APU is now standard and has a two position bleed air valve.

APPENDIX 5

COLLINS PROLINE 21 WITH IFIS-5000

(Collins Proline 21 with IFIS-5000 Integrated Flight Information System)

CLASS 3 ELECTRONIC FLIGHT BAG OPERATIONAL EVALUATION

Table of Contents

1. Purpose and Applicability

The following is provided for the benefit of FAA Principal Inspectors and aircraft operators for their use in determining the acceptance of EFB applications. As described in AC 120-76A, Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bags Computing Devices, the Collins IFIS is certified Class 3 EFB Hardware and Type C applications. Class 3 hardware is installed equipment and requires AIR involvement and AEG involvement. Applications are classified as Type C due to the interactiveness of the Electronic Charts with the aircraft. The charts can be manipulated (i.e. zoomed, scrolled, etc.) as Type B, but are classified Type C because aircraft present position is provided on the installed display on the airport depictions and charts. Aircraft present position as incorporated into Electronic Charts has been certified as a situational awareness tool and is not intended to alleviate the crew from carrying primary navigational reference materials.

This Appendix is applicable for operational approval of the IFIS-5000 system as an Electronic Flight Bag. This Appendix is applicable only to the XLS+ aircraft.

2. EFB Description

IFIS-5000 SYSTEM

The integrated Flight information System (IFIS) provides supplemental information, such as weather and electronic charts, in the cockpit via Adaptive Flight Displays (AFD). The IFIS functions are intended to provide situational awareness only and do not provide alerts or warnings. The three major functions provided by the IFIS-5000 are; support for navigational charts, enhanced map overlays, and graphical weather images. The charts function allows the viewing of selected Jeppesen aeronautical charts. The Enhanced Maps function is split into an application and a server that together provide map overlays of geopolitical, airspace, airway data and visual navigation information. The Graphical Weather function option provides various weather images, such as NEXRAD. The Graphical Weather System is operator selected as either XM or Universal.

The Collins IFIS-5000 System consists of the following major equipment items:

QTY	Description
1or2*	File Server Unit FSU-5010
2	Cursor Control Panel CCP-3000
2	Data Link Communications System CMU-4000 (ACARS/Universal only)
2	Control Display Unit CDU
2	Adaptive Flight Display AFD-3010E

* Single or Dual FSU-5010 installations will not support EFB operational authorization for "paperless" operation as sole source of aeronautical information since neither an FSU nor cockpit AFD is available for use by the crew while on emergency power.

FSU-5010

The File Server Unit (FSU-5010) is a dedicated LRU with three major functions that provides the processing platform for the Integrated Flight Information Systems: Solid-state memory; a processor capable of running one or more applications, and high-speed Ethernet communications with other avionics. The FSU provides the mass data storage within its Mass Storage hardware, necessary for up-linked graphical weather, enhanced map overlays and electronic charts displayed on the MFD. Ethernet bussing provides the high-speed connection to the MFD. The high speed Ethernet connection minimizes the time taken to respond to a display request from the pilot, while providing a level of integrity to the data being transmitted.

CCP-3000

The Cursor Control Panel (CCP-3000) is mounted in the flight deck to provide additional pilot controls necessary for the chart function. These functions include:

- Selection and de-selection of the chart display on the MFD
- Zooming a specific area of a chart to provide better readability
- Panning a chart to view different areas of the chart while zoomed
- Rotation of charts between landscape and portrait orientation
- Selection of a specific chart from the thousands contained in the database

IFIS-5000 FUNCTIONS

Electronic Charts, Graphical Weather and Enhanced Map Overlay functions each require an active subscription. Collins Integrated Flight Information System IFIS-5000 Operator's Guide must be immediately available to the flight crew.

Electronic Charts

The Electronic Aeronautical Charts and Approach Plates are intended to provide ease of chart access and improved situational awareness by allowing the display of aircraft present position on Geo-referenced charts. Operational Approval for Electronic Flight Bag is required to substitute Electronic Charts for Paper Charts.

The Electronic Charts feature will typically provide information to include (but is not necessary restricted to): the display of charts for arrival, approach, departure, airport and NOTAMS. Access to the Electronic Charts format is via a CCP chart button. Integration with the Collins FMS flight plan data provides easy access to all charts pertinent to the flight plan. Pilot entered station IDs are allowed. The Electronic Chart function provides aircraft position on all geo–referenced charts.

The FMS transmits flight plan information (origin airport, destination airport, destination arrival, destination approach, and alternate airport) used by the electronic chart function. Charts associated with each flight plan element are listed on the MFD's chart selection menu. A single action selects any of these charts for immediate display.
IFIS-5000 electronic chart feature includes:

- Approach Charts
- Terminal Area Arrival / Departure Charts
- Airport Diagrams
- Chart Notices to Airmen (NOTAMs)

If airport diagrams are referenced to geographical coordinates, an aircraft symbol is superimposed on the airport diagram to enhance position awareness. Approach charts referenced to geographical coordinates also have an aircraft symbol superimposed on the chart to enhance situational awareness.

Enhanced Map Overlays

The File Server Unit (FSU) provides several map databases that contain data that can be overlaid on the MFD PPOS & Plan Maps. These databases include:

- Geographic Data (lakes, rivers, and political boundaries)
- Airways ("Victor" airways and "jet" routes)
- Airspace depictions

The Enhanced Map Application does not serve as the primary means in the cockpit for positional information. Enhanced Map overlays are advisory and not to be used for navigation. Navigation data related to Approach is provided by the Charts application.

Graphical Weather Function

The IFIS-5000 system will support several graphical weather functions but the weather radar is the primary means for aiding "tactical" short-range navigation decisions, while the strategic planning is performed using the longer-range graphical weather data. Graphical Weather may not be substituted for weather radar to provide thunderstorm detection and avoidance information in compliance with FAR requirements.

The Graphical Weather function provides weather information to pilots to enhance their awareness of the flight situation to provide a strategic meteorological overview. The intention is to improve operation safety and efficiency. The graphical weather feature provides the display of stored graphical weather images. The pilot is able to select from a menu of available graphical weather images that are stored in the FSU. Stored images are down-linked through the XM or Universal CMU receiver to the FSU. The data received is broadcast from a ground weather service provider. The graphical information can be panned and zoomed using the Cursor Control Panel Joystick and Zoom buttons. The information provided is:

- NEXRAD Radar images
- Echo Tops (Altitude, speed and direction of the tops of major storm cells)
- Graphical and textual METAR
- Graphical and textual Significant Meteorological advisory (SIGMET)
- Textual Airman's Meteorological advisory (AIRMET)
- Textual Terminal Aerodrome Forecast (TAF)

3. EFB Mounting

EFB applications are displayed on either Multi-function Display and have been certified as part of the type design.

4. EFB Display and Reflectivity

The EFB has been evaluated in both low light and full sunlight. The display is readable under the full range of lighting without distraction.

5. EFB Procedures and Database Revisions

The database effectivity format that is displayed on the MFD is designed to allow the flight crew (or maintenance personnel) to ascertain the currency of the installed databases. The databases listed on this page include:

- FMS Database (28 day update cycle)
- Charts (14 day update cycle)
- Airspace (28 day update cycle)
- Geographic (update on user demand)
- Political (update on user demand)
- Graphical Weather (update on user demand)

The database effectivity format provides information regarding the begin date, end date, and currency status of each of the installed databases. When databases are selected on the page, the format also provides detail information regarding the database regions of coverage. When an installed database is out of date, the flight crew is provided a CHECK DATBASE STATUS annunciation (only when on the ground) in the Lower Format Window. When this annunciation is displayed, the operator can select the database effectivity page and a NOT CURRENT annunciation (in yellow) is displayed in the status column.

6. FSB Specifications for Training

As a minimum the crew should use the FMS to flight plan and the EFB electronic chart functions to pull up the airport depiction charts, SID's, Arrival Procedures, and approach charts. Pilots should master the graphic weather depiction functions to obtain METARS and TAF's for origin, destination, and alternate airports

7. FSB Specification for Checking

Recommended tasks include demonstrating competency in using the FMS to integrate use of the electronic chart functions to display departures, arrivals, and approaches, and utilizing the graphical weather text functions.

8. FSB Specification for Currency

Currency level is variable as set in MDR table. If level C currency is indicated by MDR table, recommended tasks include demonstrating competency in using the FMS to integrate use of the electronic chart functions to display departures, arrivals, and approaches, and utilizing the graphical weather text functions.

9. Environmental Testing (HIRF, EMI)

Intensity Radiated Fields and Indirect Effects of Lightning for the IFIS-5000 system were tested per High Intensity Radiated Fields (HIRF) and Indirect Effects of Lightning Test Procedure. The system meets Certification Basis requirements and special conditions for High Intensity Radiated Fields and Indirect Effects of Lightning.

10. Continued Airworthiness

Instructions for Continued Airworthiness for the IFIS-5000 system are addressed in accordance with aircraft certification requirements and available through normal ICA distribution processes.

11. LIST of EFB Affected Document

The following is a list of Procedures, Documents and Affected Manuals concerning Operational Approval of the IFIS -5000 for use as an Electronic Flight Bag:

- Collins Integrated Flight Information System IFIS-5000 Operator's Guide
- Operations Manual
- Flight Crew Training Program
- Training Courseware (Flight Crew, Maintenance Personnel, Operations Personnel)
- Company Maintenance Procedures
- Component Maintenance Manuals
- Minimum Equipment List
- Data Delivery and Management Procedures
- EFB Configuration Control Procedures

APPENDIX 6

AIRCRAFT REGULATORY COMPLIANCE CHECKLIST

FAR	Requirement	Compliance	Remark	FSB Finding
91.9(a)	Compliance with Flight Manual, Markings, and Placard Markings	The airplane meets the 14CFR 25.1545 through 25.1563 and 25.1583 through 25.1587 for Approved Airplane Flight Manual.	FAA Approved Airplane Flight Manuals 56XFM, 56XFMA, 56XFMB, and appropriate Flight Manual Supplements	Agrees
91.9 (b)(1)	Availability of Current Airplane Flight Manual in Aircraft	The airplane meets the 14CFR 25.1581 regulations. A current, approved Airplane Flight Manual and revisions of AFM are distributed to the operator.	Current AFM is furnished with each airplane. Revisions to AFM are distributed to the operator.	Agrees
91.9(c)	Identification of Aircraft in Accordance with 14 CFR Part 45	The airplane is identified in accordance with 14CFR Part 45 regulations.	Fireproof identification plate is affixed to the airplane. Registration markings are painted on aircraft exterior.	Agrees
91.103(a)	IFR Flight Planning and Fuel Requirements	Airplane fuel consumption and speed / range information is contained in the Operator Manual and Electronic Operator Manual in CessNav.		Agrees
91.103 (b)(1)	Preflight Planning Runway Performance Data	Airplane complies with Part 25 for Takeoff and Landing Performance data.	AFM Section IV, Performance	Agrees
91.126(c)	On or In The Vicinity of an Airport in Class G Airspace Minimum Certificated Landing Flap Setting	Normal Minimum Certificated Landing Flap Setting is Flaps 35.	AFM Section IV, Performance	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.191	Category II and Category III Manual	Model 560XL Citation XL, XLS, and XLS+ are currently approved for Category II Operations. It is the operators responsibility to obtain operational approval.	The Category II approved aircraft have an Airplane Flight Manual Supplement regarding operations. None of the XL series aircraft are Category III approved.	Agrees
91.203 (a)&(b)	Valid Airworthiness Certificate, Flight Permit, Registration Certificate.	Cessna issues Airworthiness Certificate upon closure and approval of all engineering and certifying documents. Operator Responsibility.	In order to appropriately identify per 91.9 (c) US Registered aircraft, Cessna completes AC Form 8050-1 and files necessary documents with the FAA.	Agrees
91.203(c)	Fuel Tanks in the Passenger/Baggage Compartment	Not applicable to Model 560XL. Fuel tanks are located in the wing bays.	None	Agrees
91.203(d)	Fuel Venting and Exhaust Emissions Requirements	The airplane meets the 14CFR 34 as amended in accordance with certification basis of the aircraft.	See TCDS for Certification Basis of the aircraft.	Agrees
91.205(a)	Powered Civil Aircraft with Standard Category U.S. Airworthiness Certificates: Instrument and Equipment Requirements: General	The airplane may operate in any operation described in regulations 14CFR 91.205 (b) through (f).	AFM Section 2, Limitations, Operations Authorized	Agrees
91.205(b)	Day VFR Equipment	The airplane is equipped as required in 14CFR 91.205 (b) - Visual-flight rules (day).	AFM Section 2, Limitations, Operations Authorized	Agrees
91.205(c)	Night VFR Equipment	The airplane is equipped as required in 14CFR 91.205 (c) - Visual-flight rules (night).	AFM Section 2, Limitations, Operations Authorized	Agrees
91.205(d)	IFR Equipment	The airplane is equipped as required in 14CFR 91.205 (d) - Instrument flight rules.	AFM Section 2, Limitations, Operations Authorized	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.205(e)	Flight at and Above FL240	The airplane is equipped as required in 14CFR 91.205 (e) - see remark.	Aircraft has both DME and RNAV.	Agrees
91.205(f)	Category II Operations	Model 560XL Citation XL, XLS, and XLS+ are currently approved for Category II Operations. It is the operators responsibility to obtain operational approval.	The Category II approved aircraft have an Airplane Flight Manual Supplement regarding operations. None of the XL series aircraft are Category III approved.	Agrees
91.205(g)	Category III Operations	None of the XL series aircraft are Category III approved.	NA	Agrees
91.207 (a)&(b)	Emergency Locator Transmitter (ELT)	Operator Responsibility, optional equipment from factory	Current production aircraft are normally equipped with Airtex C406-N 3, which meets the requirements of 14CFR 91.207 (a).	Agrees
91.207(c)	Emergency Locator Transmitter (ELT) Batteries	Operator Responsibility		Agrees
91.207(d)	Emergency Locator Transmitter (ELT) Maintenance	Operator Responsibility		Agrees
91.209(b)	Operate an aircraft equipped with an anti-collision light system.	Operator Responsibility	Airplane is equipped with aviation white anti-collision light system (strobe) The ground recognition light (beacon) is not part of the anti-collision light system.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.211	Supplemental Oxygen: General	Operator Responsibility.	The 560XL is a pressurized aircraft. Passenger masks are located above the aisle in the cabin overhead. Crew masks are located in the outboard side panels and are quick donning. The flight manual includes an oxygen duration chart.	Agrees
91.213	Inoperative Instruments and Equipment	Operator Responsibility	An FAA approved MMEL is available on the internet from the FAA Flight Standards Information Management System (FSIMS).	Agrees
91.215	ATC Transponder and Altitude Reporting Equipment and Use	Operator Responsibility	Current production aircraft are equipped with Enhanced Mode S Transponders.	Agrees
91.217	Data Correspondence Between Automatically Reported Pressure Altitude Data and the Pilot's Altitude Reference: ATC Directed Deviation	Operator Responsibility	Current production aircraft are equipped with Enhanced Mode S Transponders.	Agrees
91.219	Altitude Alerting System	The airplane equipment meets Altitude Alerting System requirements of 14CFR 91.219(b).		Agrees
91.221	Traffic Alert and Collision Avoidance System (TCAS) Equipment and Use	Operator Responsibility	Current production aircraft are equipped with TCAS II approved to comply with 91.221(a).	Agrees
91.223(a)	Terrain Awareness and Warning System (TAWS)	Operator Responsibility	Current production aircraft are equipped with TAWS.	Agrees
91.223(b)	Terrain Awareness and Warning System (TAWS)	Operator Responsibility		Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.223(c)	AFM Procedures for TAWS	Operator Responsibility	AFM procedures are contained within the appropriate Flight Manual Supplements.	Agrees
91.223(d)	Exceptions to TAWS	N/A	Model 560XL is not designed or configured for parachuting or firefighting operations.	Agrees
91.409(a) (b) (c) (d)	Inspections	Operator Responsibility		Agrees
91.409(e)	Inspection	Operator Responsibility	Cessna will provide operators with a single approved inspection program at time of aircraft delivery. Inspection information will be in Chapter 5, section 10 of the Model 560XL Maintenance Manual, per ATA specification 2200. Maintenance Manual Chapter 4 will list life limited parts by serial number and part number. All life limited parts are placarded with serial number and part number.	Agrees
91.409 (f) (g) (h)	Inspection	Operator Responsibility	Cessna will provide operators with a single approved inspection program at time of aircraft delivery. Inspection information will be in Chapter 5, section 10 of the Model 560XL Maintenance Manual, per ATA specification 2200	Agrees
91.411	Altimeter System and Altitude Reporting Equipment Tests and Inspections	Operator Responsibility	The tests required by paragraph 91.411(c) were conducted by the manufacturer for issuance for airworthiness certificate.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.413	ATC Transponder Tests and Inspections	Operator Responsibility	FAA Approved AFM includes RVSM limits to comply with paragraph 91.413 (b).	Agrees
91.503	Flying Equipment and Operating Information.	Operator Responsibility	Cessna provided flashlights, cockpit checklists (normal and abnormal/emergency), and FAA approved Airplane Flight Manual comply with flashlights, cockpit checklists, and single engine climb performance requirements of this paragraph. Electronic charts (IFIS 5000) are incorporated into XSL+ aircraft. Guidance on that system is provided in this document, Appendix 5. Garmin GMX 200 systems including charts are also incorporated into some aircraft. Guidance on the GMX system is provided in the body of this report.	Agrees
91.505	Familiarity with Operating Limitations and Emergency Equipment	Operator Responsibility		Agrees
91.507	Equipment Requirement: Over the Top, or Night VFR Operations	The airplane is equipped as required in 14CFR 91.507	AFM Section 2, Limitations, Operations Authorized	Agrees
91.509	Survival Equipment for Overwater Operations	Operator Responsibility	Emergency equipment training and passenger briefing card guidance is contained in the body of this report.	Agrees
91.511	Radio Equipment for Overwater Operations	Operator Responsibility	Current production aircraft are equipped to meet the requirements of 14 CFR 25.511 except those portions requiring HF. HF or dual HF is an option for the aircraft.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.513(a) (b) (c) (d)	Emergency Equipment	Operator Responsibility	Airplane as equipped from the factory complies with requirements of 14 CFR 25.513 (a) (b) (c) (d).	Agrees
91.513(e) (f)	Emergency Equipment	N/A	Model 560XL does not have the seating capacity referenced in 14 CFR 25.513 (e) (f).	Agrees
91.517(a)	Passenger information	N/A	The airplane equipment meets passenger information requirements of 14 CFR 91.517(a).	Agrees
91.517(b)	Passenger information	Operator Responsibility		Agrees
91.517(c) (d) (e)	Passenger information	N/A	These sub paragraphs place requirements on passengers and crewmembers.	Agrees
91.519	Passenger Briefing	Operator Responsibility	Passenger briefing card guidance is contained in the body of this report.	Agrees
91.521(a)	Shoulder Harness	N/A	Each crewmember seat is equipped with restraint system designed and certified to the inertia load factors of the aircraft certification basis.	Agrees
91.521(b)	Shoulder Harness	N/A		Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.525	Carriage of Cargo	Operator Responsibility	The airplane cargo/baggage compartment meets storage requirements of 14 CFR 91.525(a)(1).	Agrees
91.527	Operating in Icing Conditions	Operator Responsibility	The Model 560XL AFM requires the aircraft to be free of frost, snow, or ice prior to takeoff. Takeoff with polished frost per 91.527(a)(3) is prohibited. Refer to FAA approved AFM limitations.	Agrees
91.531	Second in Command Requirements	560XL aircraft meet the definition specified in 14 CFR 91.531 (a)(1) and (a)(2) and require a second in command. All other subparts are Operator Responsibility.	Second in command required for all operations per AFM limitations.	Agrees
91.603	Aural Speed Warning Device	Not required although 560XL aircraft are equipped with aural warning for excessive speed.		Agrees
91.605(a)	Transport Category Civil Airplane Weight Limitations	N/A		Agrees
91.605(b)(c)	Transport Category Civil Airplane Weight Limitations	Operator Responsibility	FAA Approved AFM includes weight limitations in Section 2, Takeoff performance information in Section 4, and additional takeoff performance information in Section 7.	Agrees
91.609(a)(b)	Operation with Inactive Flight Data Recorder or Cockpit Voice Recorder	Operator Responsibility		Agrees
91.609(c)(d)	Requirements for Flight Data Recorder - 10+ passengers	Operator Responsibility	Flight Data Recorders having continuous recording capability are available as optional equipment and may be required based on seating configuration.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.609 (e)&(f)	Requirement for Cockpit Voice Recorder	Cockpit Voice Recorder having continuous recording capability is standard and complies with 14 CFR 25.1457 (a) (1) and (2), (b), (c), (d), (e), (f) and (g).		Agrees
91.609(g)	Accident Reporting	Operator Responsibility		Agrees
91.613 (a)	Materials for Compartment Interiors	N/A		Agrees
91.613 (b)	Materials for Compartment Interiors	Operator Responsibility	Units 560-5587 and on were manufactured in compliance with 25.856.	Agrees
91.801 (a)(2)	Part 36 Applicability	Operator Responsibility	14 CFR 91.801 (a) (2) applies to Model 560XL aircraft. 14 CFR 91.813 as referenced in 14 CFR 91.801 (a) (2) is reserved. See 14 CFR 91.805 for compliance.	Agrees
91.805	Operating Noise Limits for Subsonic Airplanes	Model 560XL aircraft comply to 14 CFR 36 Stage 3 requirements as documented in AFM Section 4.		Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.1033 (a)(1), (a)(2), (b), and (c)	Cockpit Checklist	Operator Responsibility	Cessna provided normal checklists 56XCLNP (560-5001 thru 5500), 56XCLANP (560-5501 thru 6000) and 56XCLBNP (560-6001 and on) and abnormal/emergency checklists 56XCLEAP (560-5001 thru 5500), 56XCLAEAP (560-5501 thru 6000) and 56XCLBEAP (560-6001 and on) and any additional information contained in the appropriate flight manual supplements can be used by the operator to show compliance.	Agrees
91.1033 (a)(3) and (a)(4)	Aeronautical Charts	Operator Responsibility		Agrees
91.1035 (e)	Automated Briefing Recording	Operator Responsibility	Several optional installations for cabin briefers exist for 560XL aircraft. Additional information can be found in the appropriate airplane flight manual supplement if any of these options are installed.	Agrees
91.1035 (f)	Passenger Briefing Cards	Operator Responsibility	Passenger briefing card guidance is contained in the body of this report.	Agrees
91.1045 (b)(1)	Cockpit Voice Recorder	Cockpit Voice Recorder having continuous recording capability is standard, meets 14 CFR 135.151, and complies with 14 CFR 25.1457 (a) (1) and (2), (b), (c), (d), (e), (f) and (g).		Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.1045 (b)(2)	Flight Recorder	Operator Responsibility	Flight Data Recorder having continuous recording capability is available as optional equipment, meets 14 CFR 135.152, may be required based on seating configuration as indicated in 14 CFR 135.152, and complies with 14 CFR 25.1459..	Agrees
91.1045 (b)(3)	TAWS System	Operator Responsibility	Several optional installations for TAWS exist for 560XL aircraft. Additional information can be found in the appropriate airplane flight manual supplement if any of these options are installed.	Agrees
91.1045 (b)(4)	TCAS System	TCAS is installed as standard equipment on all Model 560XL aircraft.	Additional information can be found in the appropriate airplane flight manual supplements.	Agrees
91.1045 (b)(5)	Airborne Weather Radar Equip.	Operator Responsibility	Weather radar is installed on Model 560XL aircraft as standard equipment.	Agrees
91.1115 (a)	Minimum Equipment List	Operator Responsibility	An FAA approved MMEL is available on the internet from the FAA Flight Standards Information Management System (FSIMS).	Agrees
91.1411	Continuous Airworthiness Maintenance Program	Operator Responsibility		Agrees
91.App A	Category II Operations	Operator Responsibility	Category II capability is available as an option on Model 560XL aircraft. If an aircraft is equipped with this option, an airplane flight manual supplement will be provided which includes procedures and limitations.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
91.App C	Operations in the North Atlantic (NAT) Minimum Navigation Performance Specifications (MNPS) Airspace	Operator Responsibility	Model 560XL aircraft can be equipped with optional equipment required for MNPS airspace operations. The applicable Flight Management System Flight Manual Supplements should be referenced to determine if installed equipment meets the requirements for operation in MNPS airspace.	Agrees
91 App G	Operations in Reduced Vertical Separation (RVSM) Airspace	Airplane has Group Approval for RVSM operation as part of type design.	The airplane is approved for operations in RVSM airspace when required equipment is maintained in accordance with airplane maintenance manual. This does not constitute operational approval. Operational approval must be obtained in accordance with applicable operating rules.	Agrees
135. 21	Manual Requirements	Operator Responsibility	Airplane manuals are available from Cessna and can be used to aid the operator in meeting 14 CFR 135.21 regulations.	Agrees
135.75(b)	Inspector's Credential: Admission to pilot's compartment: Forward Observer's Seat.	Operator Responsibility	Forward observer seat information is contained in the body of this report.	Agrees
135.76(b)	DOD Commercial Air Carrier Evaluator's Credentials: Admission to Pilots Compartment: Forward Observer's Seat	Operator Responsibility	Forward observer seat information is contained in the body of this report.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.83 (a)(1), (a)(2), (b), and (c)	Cockpit Checklist	Operator Responsibility	Cessna provided normal checklists 56XCLNP (560-5001 thru 5500), 56XCLANP (560-5501 thru 6000) and 56XCLBNP (560-6001 and on) and abnormal/emergency checklists 56XCLEAP (560-5001 thru 5500), 56XCLAEAP (560-5501 thru 6000) and 56XCLBEAP (560-6001 and on) and any additional information contained in the appropriate flight manual supplements can be used by the operator to show compliance.	Agrees
135.83 (a)(3) and (a)(4)	Aeronautical Charts	Operator Responsibility		Agrees
135.83 (a)(5)	Multiengine Aircraft One-Engine Climb Data	Operator Responsibility	Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) include single engine climb data in Section IV.	Agrees
135.93	Autopilot: Minimum Altitudes for Use	Operator Responsibility	Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) contain autopilot minimum use heights in Section 2 that can be utilized in determining autopilot minimum altitudes for use per 14 CFR 135.93.	Agrees
135.99	Composition of Flight Crew	Operator Responsibility	The FAA approved airplane flight manual specifies minimum crew required for all operations as one pilot and one copilot in section 2.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.113	Passenger Occupancy of Pilot Seat	Operator Responsibility.		Agrees
135.117 (e)	Passenger Briefing Cards	Operator Responsibility	Passenger briefing card guidance is contained in the body of this report.	Agrees
135.117 (f)	Automated Briefing Recording	Operator Responsibility	Several optional installations for cabin briefers exist for 560XL aircraft. Additional information can be found in the appropriate airplane flight manual supplement if any of these options are installed.	Agrees
135.127	Passenger Information	Operator Responsibility	No Smoking signs are installed in all Model 560XL aircraft.	Agrees
135.129 (d)&(e)	Exit Seating Passenger Information Cards	Operator Responsibility	Passenger briefing card guidance is contained in the body of this report.	Agrees
135.143 (a)(b)	Approved/Operable Instruments and Equipment	Operator Responsibility		Agrees
135.143 (c)	ATC Transponder	Transponders meeting the TSO requirements of 14 CFR 135.143(c) are standard equipment on Model 560XL aircraft. All Cessna installed optional transponders that can be installed also meet the requirements of 14 CFR 135.143(c).		Agrees
135.147	Dual Controls Required	Model 560XL aircraft are equipped with functioning dual controls in compliance with 14 CFR 135.147.		Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.149 (a)	Altimeter Adjustable for Barometric Pressure	Model 560XL aircraft are equipped with three adjustable altimeters (pilot, copilot and standby) and all are compliant with 14 CFR 135.149(a).		Agrees
135.149 (c)	Additional Equipment	Model 560XL aircraft are equipped with a standby attitude indicator compliant with 14 CFR 135.149(c).		Agrees
135.151 (a)	Requirement and Installation of CVR	Cockpit Voice Recorder having continuous recording capability is standard and complies with 14 CFR 25.1457 (a) (1) and (2), (b), (c), (d), (e), (f) and (g).		Agrees
135.151 (d)	Boom and Mask Microphone	Operator Responsibility	Model 560XL aircraft are equipped with cockpit voice recorders capable of recording boom microphones as well as oxygen mask microphones and are compliant with 14 CFR 25.1457(c)(5).	Agrees
135.151 (c)&(e)	CVR - Recorded Data	Operator Responsibility		Agrees
135.152	Flight Recorder	Operator Responsibility	Flight Data Recorder having continuous recording capability is available as optional equipment, meets 14 CFR 135.152, will be required for some seating configurations available as indicated in 14 CFR 135.152, and complies with 14 CFR 25.1459.	Agrees
135.154	Terrain Awareness and Warning System	Operator Responsibility	Current production aircraft are equipped with TAWS.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.155	Fire Extinguishers: Type and Suitability of Agent	Model 560XL aircraft are equipped with hand fire extinguishers in the cockpit (under copilot seat) and in the cabin (location dependant on interior configuration).		Agrees
135.157 (b) (c)	Oxygen Equipment Requirements Pressurized aircraft.	Operator Responsibility	Oxygen duration charts are included in section 3 of the Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) for use in determination of compliance with 14 CFR 135.157 (b) and (c). Flight crew can select 100% oxygen on their masks as required per 14 CFR 135.157 (c) (3).	Agrees
135.158 (a)	Pitot Heat Indicating Systems Requirement and Operation	Model 560XL aircraft are equipped with pitot heat indicating systems for pilot, copilot and standby heat systems that are compliant with 14 CFR 25.1326 as dictated in 14 CFR 135.158 (a).		Agrees
135.159 (a) to (g)	Equipment Requirements: Carrying Passengers under VFR at Night or under VFR Over The Top Conditions	The airplane is equipped as required in 14CFR 135.159 (a) through (g).	AFM Section 2, Limitations, Operations Authorized.	Agrees
135.161	Radio and Navigational Equipment: Aircraft Carrying Passengers Under VFR at Night or under VFR Over The Top	Operator Responsibility	The aircraft is equipped with dual two way communications radios as well as both long range and short range navigation equipment. It is the operators responsibility to determine if the installed equipment is compliant with 14 CFR 135.161 for the route to be flown.	Agrees
135.163 (a) to (e) (g)(h)	Equipment Requirements: Aircraft Carrying Passengers Under IFR	The airplane is equipped as required in 14CFR 135.163 (a) to (e), (g) and (h).	AFM Section 2, Limitations, Operations Authorized.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.165	Radio and Navigational Equipment: Extended Overwater or IFR Operations	Operator Responsibility	Aircraft flight manual supplements for navigation equipment specify navigation operational capabilities.	Agrees
135.167	Emergency Equipment: Extended Overwater Operations	Operator Responsibility		Agrees
135.169 (a)	Additional Airworthiness Requirements.	Operator Responsibility	Manufacturer indicates compliance with 121.215, 121.217, 121.219, and 121.221.	Agrees
135.170 (b) (c)	Materials for Compartment Interiors	Operator Responsibility	135 170(b) compliance by cert basis meeting 25.853. 135 170(c) Units 560-5587 and on were manufactured in compliance with 25.856.	Agrees
135.171 (a)	Shoulder Harness Installation at Flight Crewmember Stations	Each crewmember seat is equipped with restraint system designed and certified to the inertia load factors of the aircraft certification basis.		Agrees
135.173	Airborne Thunderstorm Detection Equipment		Weather radar is installed on Model 560XL aircraft as standard equipment.	Agrees
135.175	Airborne Weather Radar Equipment	Operator Responsibility	Weather radar is installed on Model 560XL aircraft as standard equipment.	Agrees
135.179 (a)	Inoperable Instruments and Equipment	Operator Responsibility	An FAA approved MMEL is available on the internet from the FAA Flight Standards Information Management System (FSIMS) for use in development in the operators MEL.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.180 (a) and (b)	Traffic Alert and Collision Avoidance System	TCAS is installed as standard equipment on all Model 560XL aircraft.	Additional information can be found in the appropriate airplane flight manual supplements.	Agrees
135.181 (a)(2)	Performance Requirements: Aircraft Operated Over The Top or in IFR Conditions	Operator Responsibility	Single engine climb gradient information is included in section 4 of the Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) for use in determination of compliance with 14 CFR 135.181 (a) (2). Optional CPCALC is also FAA approved by Airplane Flight Manual Supplement and may be used for use in determination of compliance.	Agrees
135.183 (c)	Performance Requirements: Land Aircraft Operated Over Water	Operator Responsibility	Single engine climb gradient information is included in section 4 of the Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) for use in determination of compliance with 14 CFR 135.183 (c). Optional CPCALC is also FAA approved by Airplane Flight Manual Supplement and may be used for use in determination of compliance.	Agrees
135.185	Empty Weight and Center of Gravity: Currency Requirement	Operator Responsibility	An FAA approved weight and balance manual is provided by Cessna.	Agrees

FAR	Requirement	Compliance	Remark	FSB Finding
135.227 (a)(b)(c)(e)(f)	Icing Conditions: Operating Limitations	Operator Responsibility	Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) include limitations specific to operation in icing conditions.	Agrees
135.363 (b)	Turbine Powered Large Transport Category Airplanes Performance Operating Limitations	Operator Responsibility	Cessna provided FAA Approved Airplane Flight Manuals 56XFM (560-5001 thru 5500), 56XFMA (560-5501 thru 6000) and 56XFMB (560-6001 and on) include takeoff and landing performance information in section 4 that can be used in determination of compliance with 14 CFR 135.379 through 135.387 as required by 14 CFR 135.363 (b). Optional CPCALC is also FAA approved by Airplane Flight Manual Supplement and may be used for use in determination of compliance.	Agrees
135.419	Approved Aircraft Inspection Program	Operator Responsibility		Agrees
135.425	Maintenance, Preventive Maintenance and Alteration Programs	Operator Responsibility		Agrees
135.427 (b)	Manual for Maintenance, Preventive Maintenance and Alterations	Operator Responsibility		Agrees

APPENDIX B - IS Nº 61-004

Instrução Suplementar
IS Nº 61-004
Lista de habilitações a serem averbadas pela ANAC nas licenças de pilotos
4 de julho de 2014
Revisão A

INSTRUÇÃO SUPLEMENTAR - IS

IS Nº 61-004

Revisão A

Aprovação:	Portaria nº 1505/SPO, de 3 de julho de 2014, publicada no Diário Oficial da União de 4 de julho de 2014, Seção 1, página 47.
Assunto:	Lista de habilitações a serem averbadas pela ANAC nas licenças de pilotos **Origem:** SPO

1. OBJETIVOS

1.1 Estabelecer e tornar público a lista de habilitações a serem averbadas pela ANAC nas licenças de pilotos emitidas segundo o RBAC 61.

2. REVOGAÇÃO

Não aplicável.

3. FUNDAMENTOS

3.1 A Resolução nº 30, de 21 de maio de 2008, institui em seu art. 14, a Instrução Suplementar - IS, norma suplementar de caráter geral editada pelo Superintendente da área competente, objetivando esclarecer, detalhar e orientar a aplicação de requisito previsto em RBAC ou RBHA.

3.2 O administrado que pretenda, para qualquer finalidade, demonstrar o cumprimento de requisito previsto em RBAC ou RBHA, poderá:

a) adotar os meios e procedimentos previamente especificados em IS; ou

b) apresentar meio ou procedimento alternativo devidamente justificado, exigindo-se, nesse caso, a análise e concordância expressa do órgão competente da ANAC.

3.3 O meio ou procedimento alternativo mencionado no parágrafo 3.2b desta IS deve garantir nível de segurança igual ou superior ao estabelecido pelo requisito aplicável ou concretizar o objetivo do procedimento normalizado em IS.

3.4 A IS não pode criar novos requisitos ou contrariar requisitos estabelecidos em RBAC ou outro ato normativo.

4. DEFINIÇÕES

4.1 Para os efeitos desta IS, são válidas as definições listadas na seção 61.2 do RBAC 61, e as seguintes definições:

4.1.1 Operação *Single Pilot* – operação na qual a tripulação mínima é constituída por apenas um piloto;

4.1.2 Operação *Dual Pilot* – operação na qual a tripulação mínima é constituída por dois pilotos, sendo um na posição de Piloto em Comando (PIC) e outro na posição de Segundo em Comando (SIC);

4.1.3 Piloto em Comando (PIC) – pessoa detentora da apropriada habilitação de categoria, classe ou tipo (se aplicável), para compor a tripulação mínima para a condução de um voo, que tem a autoridade final e a responsabilidade por essa operação e pela segurança do voo; em geral, os fabricantes das aeronaves definem qual assento no posto de pilotagem foi projetado para ser ocupado pelo piloto na função PIC;

4.1.4 Segundo em Comando (SIC) – pessoa detentora da apropriada habilitação de categoria, classe ou tipo (se aplicável), para compor a tripulação mínima para a condução de um voo, que auxilia o PIC e que está apto a assumir as responsabilidades deste, em caso de eventual incapacidade temporária; em geral, os fabricantes das aeronaves definem qual assento no posto de pilotagem foi projetado para ser ocupado pelo piloto na função SIC;

4.1.5 Um treinamento de familiarização é aquele que somente inclui a leitura de material didático sobre as diferenças entre modelos de um mesmo tipo, ou estudo dirigido por computador, de acordo com o relatório de avaliação operacional do grupo de avaliação de aeronaves da ANAC designado ou com relatório de avaliação operacional da autoridade de aviação civil responsável pela certificação de tipo da aeronave; e

4.1.6 Um treinamento de diferenças é aquele que inclui tempo de instrução dedicada em sala de aula, com verificação de conhecimentos teóricos, podendo também incluir tempo de instrução em voo, com a respectiva verificação de proficiência, de acordo com o relatório de avaliação operacional do Grupo de Avaliação de Aeronaves da ANAC designado ou com o relatório de avaliação operacional da autoridade de aviação civil responsável pela certificação de tipo da aeronave.

5. LISTA DE HABILITAÇÕES

5.1 Documentos base

5.1.1 Esta lista está baseada nos resultados das avaliações operacionais conduzidas pela ANAC, bem como na seguinte documentação similar:

a) *European Aviation Safety Agency – EASA – JAA Administrative & Guidance Material, Section Five: Personnel Licensing, Part 2: Procedures, Chapter 16: Class and Type Ratings Aeroplanes and Type Ratings Helicopters and Licence Endorsement Lists, de julho de 2009*; e

b) *Federal Aviation Administration – FAA – Advisory Circular AC nº 61-89E – Pilot Certificates: Aircraft Type Ratings*, de 4 de agosto de 2000.

5.2 Lista de habilitações

5.2.1 A Lista de Habilitações completa é constituída por 20 tabelas que relacionam as habilitações e as diversas aeronaves de acordo com características similares de operação, a saber:

a) Tabela I – Habilitação de Classe (Avião) – Terrestre/Anfíbio – Operação *Single Pilot, Single/ Multi Engine* (Motores Convencionais e Turbo-Hélice);

b) Tabela II – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot*, *Single Engine* (Motor Turbo-Hélice) - Reservada;

c) Tabela III – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot*, *Single Engine* (Motor Turbo-Hélice) - Reservada;

d) Tabela IV – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot*, *Multi Engine* (Motor Turbo-Hélice) - Reservada;

e) Tabela V – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot*, *Multi Engine* (Motor Turbo-Hélice) - Reservada;

f) Tabela VI – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot*, *Single Engine* (Motores Convencional e Turbo-Hélice);

g) Tabela VII – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot*, *Multi Engine* (Motores Convencional e Turbo-Hélice);

h) Tabela VIII – Habilitação de Tipo (Avião) – Anfíbio – Operação *Single Pilot*, *Multi Engine* (Motores Convencional e Turbo-Hélice);

i) Tabela IX – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot*, *Multi Engine* (Motor a Reação);

j) Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot*, *Multi Engine* (Todos os Motores);

k) Tabela XI – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Convencional);

l) Tabela XII – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Turbo-Eixo);

m) Tabela XIII – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Convencionais);

n) Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo);

o) Tabela XV – Habilitação de Tipo (Helicóptero) – *FAA Endorsement Only*;

p) Tabela XVI Habilitação de Tipo (Outras Categorias, exceto Avião e Helicóptero);

q) Tabela XVII – Habilitações de Categoria;

r) Tabela XVIII – Habilitações Relativas à Operação;

s) Tabela XIX – Habilitações Relativas às Atividades Aerodesportiva e Experimental; e

t) Tabela XX – Situações Especiais.

5.2.2 O detalhamento das tabelas listadas no item 5.2.1 segue nos subparágrafos abaixo. A instruções de uso das referidas tabelas seguem no item 5.3 desta IS:

5.2.2.1 Tabela I – Habilitação de Classe (Avião) – Terrestre/Anfíbio – Operação *Single Pilot, Single/ Multi Engine* (Motores Convencionais e Turbo-Hélice):

<table>
<tr><th colspan="4">Tabela I – Habilitação de Classe (Avião) – Terrestre/Anfíbio – Operação Single Pilot, Single/ Multi Engine (Motores Convencionais e Turbo-Hélice)</th></tr>
<tr><th rowspan="2">FABRICANTE (1)</th><th>AERONAVE (2)</th><th rowspan="2">OBS (3)</th><th>DESIGNATIVO (4)</th></tr>
<tr><th>MODELO / NOME</th><th>ANAC</th></tr>
<tr><td rowspan="16">Todos</td><td>Monomotor Terrestre, com hélice de passo fixo, trem de pouso fixo, triciclo</td><td rowspan="8">D</td><td rowspan="8">MNTE</td></tr>
<tr><td>Monomotor Terrestre, com hélice de passo variável</td></tr>
<tr><td>Monomotor Terrestre, com trem de pouso retrátil</td></tr>
<tr><td>Monomotor Terrestre, com motor turbo/super charged</td></tr>
<tr><td>Monomotor Terrestre, com cabine pressurizada</td></tr>
<tr><td>Monomotor Terrestre, com trem de pouso convencional (tail wheel)</td></tr>
<tr><td>Monomotor Terrestre, com EFIS (Eletronic Flight Instrument System)</td></tr>
<tr><td>Monomotor Terrestre, com manete de controle única (SLPC)</td></tr>
<tr><td>Monomotor Anfíbio</td><td rowspan="6">D</td><td rowspan="6">MNAF</td></tr>
<tr><td>Monomotor Anfíbio, com hélice de passo variável</td></tr>
<tr><td>Monomotor Anfíbio, com motor turbo/super charged</td></tr>
<tr><td>Monomotor Anfíbio, com cabine pressurizada</td></tr>
<tr><td>Monomotor Anfíbio, com EFIS (Eletronic Flight Instrument System)</td></tr>
<tr><td>Monomotor Anfíbio, com manete de controle única (SLPC)</td></tr>
<tr><td>Multimotor Terrestre</td><td>-</td><td>MLTE</td></tr>
<tr><td>Multimotor Anfíbio</td><td>-</td><td>MLAF</td></tr>
</table>

5.2.2.2 Tabela II – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot*, *Single Engine* (Motor Turbo-Hélice):

Tabela II – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot, Single Engine* (Motor Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

Reservada

5.2.2.3 Tabela III – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot*, *Single Engine* (Motor Turbo-Hélice):

Tabela III – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot, Single Engine* (Motor Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

Reservada

5.2.2.4 Tabela IV – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot*, *Multi Engine* (Motor Turbo-Hélice):

Tabela IV – Habilitação de Classe (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motor Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

Reservada

5.2.2.5 Tabela V – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot*, *Multi Engine* (Motor Turbo-Hélice):

Tabela V – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot, Multi Engine* (Motor Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**

Tabela V – Habilitação de Classe (Avião) – Anfíbio – Operação *Single Pilot, Multi Engine* (Motor Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

Reservada

5.2.2.6 Tabela VI – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot*, *Single Engine* (Motores Convencional e Turbo-Hélice):

Tabela VI – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Single Engine* (Motores Convencional e Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

* Sem registros até o momento.

5.2.2.7 Tabela VII – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot*, *Multi Engine* (Motores Convencional e Turbo-Hélice):

Tabela VII – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motores Convencional e Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Asta GAF	Nomad-22B Nomad-24A	- -	-	A22T
Beechcraft/ Raytheon	Beechcraft 90 Series	Série 90	AAD D	BE90/ BE99/ BE10/ BE20
	Beechcraft 99 Series	Série 99		
	Beechcraft 100 Series	Série 100		
	Beechcraft 200 Series	Série 200		
	Beechcraft 300 Series	Série 300/350	AAD D	BE30/ BE19
	Beechcraft 1900 Series	Série 1900		
Cessna / Reims Aviation	F406 425	- -	AAD	F406
	441	-	AAD	C441
Dornier, Deutsche	DO 128-6	DO 128 Series	-	D128
	DO 228 Series	DO 228 Series	-	D228

Tabela VII – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motores Convencional e Turbo-Hélice)

FABRICANTE (1)	AERONAVE (2)		OBS (3)	DESIGNATIVO (4)
	MODELO	NOME		ANAC
Aerospace, Friedrickshafen	DO 28-G92	DO 28 Series	-	DO28
Grumman	S2FT	Tracker	-	S2FT
Indústria Aeronáutica Neiva S.A.	EMB-820C	Carajá	-	PAT4
Mitsubishi	MU 2B Series MU 2E/F/K/M/P/S	Marquise/Solitaire	AAD	MU2B
Piaggio	P166	-	-	P166
	P180	Avanti	AAD D	P180
		Avanti II		
Britten-Norman / Pilatus Britten	BN-2A/2B Series	Islander	D	BN2A
	BN-2A Mk III Series	Britten-Norman Trislander		BN2M
	BN2T	Turbine Islander		BN2T
	BN2T-4R BN2T-4S	MSSA Defender		
Piper	PA Série 31T	Cheyenne I/II	AAD D	PA31
	PA Série 42	Cheyenne III		PA42
Rockwell [(1)]	AC 680T/ AC 690B (MET) /AC 690C (MET)/ AC 900 (MET) – Series	Turbo Commander	AAD	AC6T
Short Brothers and Harland Ltd/ Northern Ireland (Bombardier)	SC-7	Skyvan	-	SC7
Swearingen/ Ed Swearingen/ Swearingen Aviation Corporation/ Fairchild	226 T 226 T(B)	Merlin II Merlin IIIB	AAD D	F226 / F227
	226 AT 226 TC	Merlin IV		
	227 TT	Merlin IIIC		
	227 AC 227 AT 227 BC	Merlin IVC		

(1) Models Rockwell Aero Commander 680/680, Super/680E/690F piston engine equipped are not endorsed

in licenses with specific type ratings because they are considered 'class' aircraft.

5.2.2.8 Tabela VIII – Habilitação de Tipo (Avião) – Anfíbio – Operação *Single Pilot, Multi Engine* (Motores Convencional e Turbo-Hélice):

Tabela VIII – Habilitação de Tipo (Avião) – Anfíbio – Operação *Single Pilot, Multi Engine* (Motores Convencional e Turbo-Hélice)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
-	-	-	-	-

* Sem registros até o momento.

5.2.2.9 Tabela IX – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motor a Reação):

Tabela IX – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motor a Reação)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Aerospatiale Morane-Saulnier (France)	MS 760	Paris	AAD	S760
Beechcraft Raytheon	RA-390	Premier	AAD	R390, R390/D
Cessna	C501	Citation I/SP	AAD D	C501, C501/D C551, C551/D
	C551	Citation II/SP – Bravo		
	C525	CJ	AAD D	C525, C525/D
	C525 C525A	CJ1 CJ2		
	C525 C525A C525B	CJ1 Plus CJ2 Plus CJ3		
	C525C	CJ4		
	C510	Citation Mustang	AAD	C510, C510/D
Eclipse Aerospace	EA500	Eclipse 500	AAD	EA50, EA50/D
EMBRAER	EMB 500	Phenom 100	AAD D	EPHN, EPHN/D
	EMB 505	Phenom 300		
Fouga Magister	CM 170	Fouga Magister	-	FOUG

5.2.2.10 Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores):

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Aerospatiale/ Société Nationale de Constructions Aéronautiques du Sud-Est – Sud Aviation	SN 601	Corvette	-	S601
	SE 210 – I/IA/III SE 210 – IIIR SE 210 – VIN/R/VII	Caravelle I/IA/III/VI/VII	D	SE21
	SE 210 – 10A/B/R	Caravelle 10A/B/R		SE10
	SE 210 – 11 Series	Caravelle 11		SE11
	SE 210 – 12 Series	Caravelle 12 / Super Caravelle		SE12
Aerospatiale/ Nord Aviation	Nordatlas 2501	-	-	ND25
	C160 P	Transall	-	ND16
	260 A 262 A-B-C	Nord Nord	-	ND26
Aero Spaceline	377 SGTF	Super Guppy	-	A377
Airbus	A300 – B1/B2/B4 A300 – C4 Série 200 A300 – F4 Série 200	- - -	-	A300
	A300-FFCC	-	-	A3FC
	A310 – Séries 200/300 A300 – B4 Série 600 A300 – C4 Série 600 A300 – F4 Série 600	- - - -	-	A310
	A300-600ST	Beluga	-	A306
	A318 – Série 100 A319 – Série 100 A320 – Séries 100/200 A321 – Séries 100/200	A318 A319 A320 A321	-	A320
	A330 – Séries 200/300	A330	-	A330
	A340 – Séries 200/300/500/600	A340	-	A340
Alenia	C27J	-	-	C27J

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
ATR	ATR 42-200/300	ATR 42-200/300	D	AT47
	ATR 42-500 ATR 72-100/200/212 ATR 72-212 A	ATR 42-500 ATR 72-100/200 ATR 72-500		
	- ATR 72-212 A– Mod 5948	ATR 42-600 (1) ATR 72-600		
Bae/AVRO	Jetstream 41	-	-	BA41
Beech/ Mitsubishi/ Raytheon	Diamond I/II, MU-300, MU-300-10, Beechjet BE-400 and 400T Series	-	-	BE40/MU30
Boeing	B707 – 100/300 Series	-	D	B707
	B720	-		
	B717	-	-	B717
	B727 – 100/200 Series	-	-	B727
	B737 – 100/200 Series	-	-	B737
	B737 – 300/400/500 Series	B737	D	B733/B739
	B737 – 600/700/800/900 Series	B737		
	B747 – 100/200/300 Series	-	D	B747/B74P
	B747-SP	-		
	B747 – 400 Series	-	-	B74F
	B757 – 200/300 Series	B757	D (2)	B757/B767
	B767 – 200/300 Series	B767		
	B767 – 400 ER Series	B767-400ER		
	B777 – 200/300 Series	B777	-	B777
	B777 F	B777F		
Bombardier	BD700-1A10 BD700-1A11	Global Express Global Express 5000	-	BD70
British Aerospace/	ATP 61	Jetstream 61	-	AT61

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
Fabricante (1)	**Aeronave (2)**		**OBS (3)**	**Designativo (4)**
	Modelo	**Nome**		**ANAC**
AVRO	AVRO RJ Serie BAe 146 – 100/200/300 Series	-	-	BA46
	BAC 1-11 200/400/500 Series	-	-	BA11
De Havilland/ Hawker Siddeley/ Bae/ Raytheon	DH 125	-	D	H125
	HS 125	-		
	Bae 125 – Séries 800/1000	-		
	Hawker 800XP	-		
	HS 748	Andover	-	HS74
Canadair (Bombardier)	BD100-1A10	Challenger CL300	-	CL30
	CL 215	-	-	CL25
	CL 215T	-	-	CL2T
	CL 415	-	-	CL45
	CL 600 CL 601-1A CL 601-3A Series	Challenger	-	CL60
	CL600-2B16	Challenger CL604	D	CL64/CL65
		Challenger CL605		
	CL600-2B19	CL 65 Regional Jet Series CRJ-100/200/440/ Challenger 850	D	CRJ1
	CL600-2C10	CRJ-700/701/702		
	CL600-2D15 CL600-2D24	CRJ-705 CRJ-900		
Casa	C212	-	-	C212
	CN-235	-	-	C235
Cessna	C500	Citation I	D (3)	C500

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
	C550 CS 550	Citation II		C550
	CS 550 Bravo	Citation Bravo		C550
	C560 Encore	Citation V		C560
	C560 Encore+	Citation Ultra Encore		C560
	C560XL C560XLS	Citation Excel C560XLS	D	C56X
	C560XLS+	C560XLS+	D	C56+
	C650	Citation III Citation VI Citation VII	-	C650
	C680	Citation Sovereign	-	C680
	C750	Citation X	-	C750
Consolidated Vultee Aircraft	CV 240-4	-	D	V240
Consolidated Vultee Aircraft	CV 340 CV 440	-	D	V34
Consolidated Vultee Aircraft	CV 580	-	-	V580
De Havilland – Canada (Bombardier)	Dh-104	Dove – Devon/Sea Devon	-	DOVE
De Havilland – Canada (Bombardier)	DHC-5 Series	Bufallo	-	DHC5
De Havilland – Canada (Bombardier)	DHC6	DHC Série 6	-	DHC6
De Havilland – Canada (Bombardier)	DHC7	-	-	DHC7
De Havilland – Canada (Bombardier)	DHC8 – 100/200/300 Series	DHC8	D	DHC8
De Havilland – Canada (Bombardier)	DHC8 – 400 Series	DHC8	D	DHC8
Dornier	DO 328-100	328 Jet	-	D328
Dornier	DO 328-300	328 Jet	-	D323
Dassault	Falcon 10	Mystère 10	D	DA10

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)

Fabricante (1)	**Aeronave (2)**		**OBS (3)**	**Designativo (4)**
	Modelo	**Nome**		**ANAC**
	Falcon 100	Mystère 100		D100
	Falcon 20	Mystère 20	D	DA20
	Falcon 200	Mystère 200		D200
	Falcon 50	-	D	DA50
	Falcon 900	-		DA90
	Falcon 900 EX	-		
	DA 900 EX EASy DA 900 DX DA 900 LX	Falcon 900 EX EASy Falcon 900 DX Falcon 900 LX	-	DA9E
	DA 2000	Falcon DA 2000	D (4)	FA20
	DA 2000 EX	Falcon 2000 EX		FA2E
		Falcon 2000 EX EASy Falcon 2000 DX Falcon 2000 LX		F2EY
		Falcon 2000 EX EASy II Falcon 2000 DX EASy II Falcon 2000 LX EASy II Falcon 2000LXS Falcon 2000S		
	DA 7X	Falcon 7X	-	FA7X
Hawker Siddeley/ Bae	Jetstream 3100/3200 Series	-	-	BA31
MacDonnel-Douglas	Douglas A-26B	-	-	DC26
	Douglas 3A-S1C3G	-	-	DC3
	DC4	-	-	DC4
	DC6	-	-	DC6
	DC7 Series	-	-	DC7
MacDonnel-Douglas/ Boeing	DC8-33 – 50/60/70 Series	-	-	DC8
	DC9 – 10-50 Series	-	-	DC91
	DC9-80 Series/MD 80 Series- 81/82/83/88	-	D	MD80
	MD 90 Series	-		MD90
	MD 87 Series	-		MD87

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
Fabricante (1)	**Aeronave (2)**		**OBS (3)**	**Designativo (4)**
	Modelo	**Nome**		**ANAC**
	DC10	-	-	DC10
	MD 11	-	-	MD11
EMBRAER	EMB 110 Series	Bandeirante	-	E110
	EMB 120	Brasília	-	E120
	EMB 121 Series	Xingu	-	E121
	EMB 123	-	-	E123
	EMB 135 EMB 145	- -	-	E135/E145
	ERJ 170-100 ERJ 170-200 ERJ 190-100 ERJ 190-200 EMB 190 ECJ	EMBRAER 170 EMBRAER 175 EMBRAER 190 EMBRAER 195 Lineage 1000	-	E179
Fokker/Fairchild	FH227 F27A/F/J	Friendship	-	FK27
	F28	Fellowship	-	FK28
	F50	-	-	FK50
	F70 F100/ MK28	- -	-	F100
Grumman Gulfstream	Gulfstream G-159	Gulfstream I	-	G159
	Gulfstream 1159	Gulfstream II	D	GII/GIII
	Gulfstream 1159A	Gulfstream III		
	Gulfstream 1159C Gulfstream IV SP	Gulfstream IV G300/G400	-	GIV
	Gulfstream IV-X	G350/G450	D	GV
	Gulfstream V	-		
	Gulfstream V-SP	G500/G550		
Gulfstream Aerospace	Gulfstream 840/900	Rockwell 690 Jet Commander	AAD	AC84
	Gulfstream 980/1000	Rockwell 695 Jet Commander	AAD	AC98

<table>
<tr><th colspan="5">Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação Multi Pilot, Multi Engine (Todos os Motores)</th></tr>
<tr><th rowspan="2">FABRICANTE (1)</th><th colspan="2">AERONAVE (2)</th><th rowspan="2">OBS (3)</th><th>DESIGNATIVO (4)</th></tr>
<tr><th>MODELO</th><th>NOME</th><th>ANAC</th></tr>
<tr><td>Gulfstream Aerospace LP (GALP)</td><td>Gulfstream 150</td><td>G-150</td><td>AAD</td><td>G150</td></tr>
<tr><td>Handley Page</td><td>Herald 300 Serie</td><td>-</td><td>-</td><td>HPHE</td></tr>
<tr><td rowspan="3">Hawker Siddley
Bae
Raytheon
Hawker Beechcraft</td><td rowspan="2">Hawker Série 125</td><td>Hawker 800 XP Proline 21
Hawker 750 Proline 21</td><td rowspan="2">D (5)</td><td rowspan="2">H125</td></tr>
<tr><td>Hawker 900 XP Proline 21 / IFIS 5000
Hawker 850 XP Proline 21 / IFIS 5000</td></tr>
<tr><td>Hawker 4000</td><td>Hawker 4000</td><td>AAD</td><td>HA4T</td></tr>
<tr><td rowspan="3">Israel Aircraft Industry (IAI)</td><td>IAI - 1121
IAI - 1123
IAI - 1124</td><td>Jetcommander
Commodore Jet
Westwind</td><td>-</td><td>AI24</td></tr>
<tr><td>IAI - 1125</td><td>Astra</td><td>-</td><td>AI25</td></tr>
<tr><td>Gulfstream 200/ Galaxy</td><td>G-200</td><td>-</td><td>G200</td></tr>
<tr><td>Junkers</td><td>Junkers52</td><td>-</td><td>-</td><td>JU52</td></tr>
<tr><td rowspan="6">Lockheed</td><td>L188 –A Series</td><td>Electra</td><td rowspan="2">D</td><td>L188</td></tr>
<tr><td>L188 –C Series</td><td>Electra</td><td>L188</td></tr>
<tr><td>L1011</td><td>Tristar</td><td>-</td><td>L101</td></tr>
<tr><td>L1329 A/B</td><td>Jetstar</td><td>-</td><td>L329</td></tr>
<tr><td>L1049</td><td>Constellation</td><td>-</td><td>L149</td></tr>
<tr><td>B-34, PV-1, PV-2</td><td>Ventura/ Super Ventura</td><td>-</td><td>LB34</td></tr>
<tr><td rowspan="6">Learjet (Bombardier)</td><td>Learjet 20 Series</td><td>Learjet 23/24/25/28/29</td><td rowspan="2">-</td><td>LR20</td></tr>
<tr><td>Learjet 30 Series</td><td>Learjet 31/35/36</td><td>LR30</td></tr>
<tr><td>Learjet 45 Series</td><td>Learjet 45</td><td>-</td><td>LR45</td></tr>
<tr><td>Learjet 55 Series</td><td>Learjet 55</td><td>-</td><td>LR55</td></tr>
<tr><td>Learjet LJ 60</td><td>Learjet 60 Series</td><td rowspan="2">-</td><td>LR60</td></tr>
<tr><td>Learjet LJ 60XR</td><td>Learjet 60XR</td><td>L60X</td></tr>
</table>

Tabela X – Habilitação de Tipo (Avião) – Terrestre – Operação *Multi Pilot, Multi Engine* (Todos os Motores)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
LET as Corporation 686 04 Kundovice Czech Republic/ Ayres Corporation, Albany/Leteckee	L410/420 UVP	Turbolet	-	L410
MBB	HFB 320	-	-	HF32
	VFW 614	-	-	VF61
PT Industry	IPTN CN 235-110	-	-	PT35
Rockwell International	NA-265	Sabreliner	-	N265
Saab	SAAB SF340	-	-	SF34
	SAAB 2000	-	-	SA20
Short Brothers and Harland Ltd/ Northern Ireland (Bombardier)	SD3-30	Short 330	D	SD3
	SD3-60	Short 360		
	SC5	Belfast	-	SC5
Vickers-Armstrong	Vanguard	Vanguard	-	VANG
	Viscount	Viscount	-	VISC

(1) Variant not certified by ANAC to date.

(2) The differences training course is valid from the B757/767 "classic" to the B767-400ER for crew members previously qualified on the B757/767 "classic" variants. The 767-400ERto B757/767 "classic" differences training shall be evaluated or the full type rating training shall be accomplished.

(3) The differences training course is valid from the Cessna 560 Encore to the Cessna 560 Encore+ for crew members previously qualified on the Cessna 560 Encore. The CE 560 Encore+ to CE 560 Encore differences training shall be evaluated or the full type rating training shall be accomplished.

(4) The differences training course from the Falcon 2000 (FA20) to the Falcon 2000EX (FA2E) is valid for crew members previously qualified on the Falcon2000. The Falcon 2000EX (FA2E) to the Falcon 2000 (FA20) differences training shall be evaluated or the full type rating training shall be accomplished.

(5) The (D) is valid when the airplanes are equipped with an EFB software package. When the software is not installed level B training is sufficient.

5.2.2.11 Tabela XI – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Convencional):

Tabela XI – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Convencional)

FABRICANTE (1)	AERONAVE (2)		OBS (3)	DESIGNATIVO (4)
	MODELO	NOME		ANAC
Agusta Bell	Agusta Bell 47G-2 Agusta Bell 47G-2A-1 Agusta Bell 47G-3B-1 Agusta Bell 47G-4 Agusta Bell 47G-4A Agusta Bell 47J Agusta Bell 47J-2 Agusta Bell 47J-3	- - H-13 Series Sioux (FAA) - - - - -	-	BH47
Bell Helicopters	Bell 47D/G Bell 47G-1/G-2/G-3 B-1 Bell 47G-4/G-4A Bell 47G-5 Bell 47H-1 Bell 47J/J-2/J-2A	- H-13 Series Sioux (FAA) - - - -	-	BH47
Bristol Aircraft	B-171-B	-	-	B171
Brantly	B-2 B-2B	-	-	BRB2
Breda Nardi	Breda Nardi 269	-	-	H269
Enstrom Helicopter Corporation	F 28A-D F 28C2 F 28F F 280C F 280F F 280FX F 280D	- - - - - - -	-	EN28
Hélicoptères Guimbal	Cabri G2	-	-	HG2
Hiller	UH 12A UH 12B UH 12E	UH-12 Series, H-23 Series (FAA)	-	HL12
Hughes/Schweitzer	269A 269B 269C 300C 300CB 300CBi	- - - - - -	-	HU30

Tabela XI – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Convencional)				
Fabricante (1)	**Aeronave (2)**		**OBS (3)**	**Designativo (4)**
	Modelo	**Nome**		**ANAC**
Robinson	R 22/22A/22B	-	-	R22
	R 44/Raven/Raven II	-	-	R44
Silvercraft	SV 4/SH4	SPA-SH4 (FAA)	-	SV4
Sikorsky	S 55/SK 55	H-19 Series Chickasaw	-	SK55
	S 58/SK 58	H-34 Series Choctaw	-	SK58
Westland	Westland S55 Series 1	(1)	-	WS55

(1) There is a differences training to the model Westland S55 Series 3 – Single Engine with turboshaft engine endorsed with the same rating

5.2.2.12 Tabela XII – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Turbo-Eixo):

Tabela XII – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Turbo-Eixo)				
Fabricante (1)	**Aeronave (2)**		**OBS (3)**	**Designativo (4)**
	Modelo	**Nome**		**ANAC**
Agusta	A 119	Koala	-	A119
Agusta Bell	Agusta Bell 206A Agusta Bell 206B Series	Jet Ranger	D	BH06
	Agusta Bell 206L Series	Long Ranger		
	Agusta Bell 204	UH-1B/D / Iroquois 204	D	BH04
	Agusta Bell 205	H205A / Iroquois 205		BH05
Bell Helicopters	Bell 47T	-	-	BH7T
	Bell 47TA	-		
	Bell 204	-	D	BH04
	Bell 205 A-1	-		BH05
	Bell UH-1D Bell UH-1H	- -		BH04

Tabela XII – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Turbo-Eixo)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
	Bell 206A Bell 206B Bell 206B2 Bell 206B3	Jet Ranger	D	BH06
	Bell 206L	Long Ranger		
	Bell 206L-1			
	Bell 206L-3			
	Bell 206L-4			
	Bell 209	AH-1 Huey Cobra	-	BH09
	Bell 214A/B/C Bell 214B1	Huey Plus / Big Lifter	-	BH14
	Bell 407	-	-	BH07
Breda Nardi	Breda Nardi 369	-	-	H369
Enstrom Helicopter Corporation	F 480	-	-	EN48
EUROCOPTER (Societé Nationale des Construtions Aéronautiques du Sud-Est – Sud Est/ Sud Aviation/ Aerospatiale)	AS 350B AS 350B1 AS 350B2 AS 350D AS 350BA AS 350BB	Ecureuil/Esquilo/Astar	D	H350
	AS 350B3	Astar		
	EC 130	B4	-	EC30
	EC 120	Colibri	-	EC20
	SA 341G SA 342J	Gazelle Gazelle	-	EC34
	SE 3130 SA 313 SA 313B SE 3180 SA 318B SA 318C	Alouette II	(2)	S313/S315/S318
	SA 315B	Lama/Gavião		

Tabela XII – Habilitação de Tipo (Helicóptero) – Operação *Single Engine* (Motor Turbo-Eixo)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
	SE 3160 SA 316A/B SE 316C	Alouette III	D	S316/S319
	SA 319B/C	-		
	SA 360 (1)	Dauphine (SE)	-	S360
	SO 1221	Sud Djinn	-	S221
Hiller	UH 12T	-	-	H12T
Hughes/Schweitzer	330 SP 333	- -	-	SC33
Hughes/McDonnell Douglas/MD Helicopters	Hughes 500 (369D) Hughes 500 (369E) Hughes 500 (369FF) Hughes 500 (369HE) Hughes 500 (369HS)	Hughes 500 369 Series (FAA)	D	HU50
	MD 500 N (NOTAR) MD 520 N	NOTAR MD-500 (FAA)		HU52
	MD 600 N	-		HU60
Robinson	R 66	-	-	R66
Sikorsky	S 58T	-	-	S58T
Westland	Westland S55 Series 3	(3)	-	WS55

(1) FAA defines model SA 360 with the type rating SA-341. Model SA-360C Dauphine (SE) is defined with the rating SA-360. ANAC did not evaluated the differences between models SA 360 e o SA-360C.

(2) FAA defines the following models for rating S-3130: SE 3130, SE 313B, SE 3160, SA 316B, SA 3180, SA 318B, SA 318C e SA 315B.

(3) There is a differences training to the model Westland S55 Series 1 – Single Engine with piston engine endorsed with the same rating.

5.2.2.13 Tabela XIII – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Convencionais):

Tabela XIII – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Convencionais)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**

Tabela XIII – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Convencionais)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Ministry of Aviation Industry of Russia	Kamov KA 26D	-	-	KA26

5.2.2.14 Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo):

Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Agusta	A 109 A A 109 A II A 109 C	- - -	D	A109
	A 109 K2	A 109 K2		
	A 109 E	Power	D	A19S
	A 109 S	Grand		
	AW 109 SP	Grand New		
Agusta Bell	Agusta Bell 212	Iroquois 212	D	BH12
	Agusta Bell 412 Agusta Bell 412SP	- -		BH41
Agusta Sikorsky	Agusta S-61 Series (L/N/T)	SH-3 Sea King (FAA)	-	SK61
Agusta Westland	AB139/AW139	-	-	A139
Bell Helicopters	Bell 206LT Twinranger	Twin Ranger	-	BHLT
	Bell 212	-	D	BH12
	Bell 412 Bell 412SP Bell 412 HP Bell 412EP	- - - -		BH41
	Bell 214ST	Super Transport	-	BHST
	Bell 222	-	D	BH22
	Bell 222A	-		

Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
	Bell 222B	-		
	Bell 222UT	-		
	Bell 222SP	-		
	Bell 230	-		BH23
	Bell 430	-		BH43
	Bell 427	-	-	BH27
	Bell 429	-	-	BH29
Boeing-Vertol	Boeing 234LR	-	-	BV34
EH Industries	EH101	-	-	E101
Erickson Air-Crane	SK64 E analog	AirCrane	D	SK64
	SK64 E digital			
	SK64 F analog			
	SK64 F digital			
EUROCOPTER (Societé Nationale des Construtions Aéronautiques du Sud-Est – Sud Est/ Sud Aviation/ Aerospatiale)	EC 135 T1 CDS EC 135 P1 CDS	- -	D	EC35
	EC 135 T1 CPDS EC 135 P1 CPDS EC 135 T2 CPDS EC 135 P2 CPDS	- - - -		
	EC 155 B/B1	-	-	EC55
	MBB-BK 117A-1 MBB-BK 117A-3 MBB-BK 117A-4 MBB-BK 117B-1 MBB-BK 117B-2	- - - - -	D	BK17
	MBB-BK 117C-1	-		
	MBB-BK 117C-2	EC 145		EC45
	BO 105A BO 105C BO 105D BO 105LS A-1 BO 105LS A-3 BO 105S BO 105CBS	FAA – Messerschmitt Bolkow GMBH (West Germany)	-	B105

Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo)

FABRICANTE (1)	AERONAVE (2)		OBS (3)	DESIGNATIVO (4)
	MODELO	NOME		ANAC
	SA 321	Aérospatiale Super Frelon	-	S321
	SA 330F SA 330G SA 330J	Puma – Sud Aviation (FAA)	-	S330
EUROCOPTER (Societé Nationale des Constructions Aéronautiques du Sud-Est – Sud Est/ Sud Aviation/ Aerospatiale)	AS 332C AS 332C1 AS 332L AS 332L1	Super Puma/Cougar	D (1)	S332
	AS 332L2	-		
	EC 225LP	-		EC25
	AS 355 E AS 355 F AS 355 F1 AS 355 F2	Ecureuil/Esquilo/ Twinstar	D	H355
	AS 355 N	-		
	AS 355 NP	-		
	SA 365 SA 365C1 SA 365C2 SA 365C3	Dolphin/Dauphine (ME) Dauphin	D	S365
	SA 365N SA 365N1 SA 365N2	Dolphin/Dauphine (ME) Dauphin		
	SA 365N3	Dolphin/ Dauphin		
McDonnell Douglas Helicopters	MD 900	-	D	MD90
	MD 902	-		
Sikorsky	S 70 Series/H 60 Series	Sikorsky S-70/ Black Hawk	-	SK70
	S 76A S 76A+ S 76A++	- - -	D	SK76
	S 76B	-		

Tabela XIV – Habilitação de Tipo (Helicóptero) – Operação *Multi Engine* (Motores Turbo-Eixo)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
	S 76C S 76C+ S 76C++	- - -		
	S-92A	-	-	SK92
Kamov	Ka-32A11BC	-	-	KA32
Ministry of Aviation Industry of Russia	MIL Mi-8/9 MIL Mi 17/19 MIL Mi 171 MIL Mi 172	- - - -	-	MMI8
P. Z. L. Swidnik, Poland	MIL Mi-2	-	-	MMI2
	PZL KANIA	-	-	PZKA
	PZL W-3	-	D	PZW3
	PZL W-3A	-		

(1) The evaluated and approved differences training for model EC 225 LP is designed for pilots with type rating S332 current on model AS 332 L2. There is no other variant of Super Puma Family with diferences training evaluated to qualify a pilot on model EC 225LP. There is no differences training evaluated for pilots previously qualified on model EC 225LP to be qualified on any other Super Puma family variant thus an initial type rating training is required.

5.2.2.15 Tabela XV – Habilitação de Tipo (Helicóptero) – *FAA Endorsement Only*:

Tabela XV – Habilitação de Tipo (Helicóptero) – *FAA Endorsement Only*				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Boing Vertol, USA	107-11, H-46 Kawasaki, KV107-H	Vertol 107H	-	BV07
	114, Ch-47A, B and C series	-	-	BV14
	BV-44, H-21	Vertol 44	-	BV44
Sikorsky, USA	H-37 Series	-	-	SK56
	HH-53, CH-53A	Sikorsky S-65 Sea Stallion	-	SK65
Sud Aviation, USA	SA321F	-	-	S321
	SA-332, AS-330	SA330 F/G/J (EASA)	-	S330

Tabela XV – Habilitação de Tipo (Helicóptero) – *FAA Endorsement Only*				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Alaska Helicopters, Inc.	ALAHEL HRP-1 PIASECKI HRP-1, HRP-2	PIASECKI HRP	-	AHRP
Brantly, USA	B-305	Brantely B-305	-	BR05
Fairchild Hiller, USA	FH-1100	-	-	FH11
Kaman, USA	K-190A	Kaman K-190A	-	KM19
	K-225	Kaman K-225	-	KM22
	K-240, HTK-1	Kaman K-240	-	KM24
	K-600	-	-	KM60
Lockheed, USA	Lockheed California 286	Lockheed California 286	-	L286
Omega, USA	12DIA	Omega 12DI	-	OM12
Scheutzow, USA	Model B	-	-	SCB
Sikorsky, USA	R-4B	Sikorsky R-4B	-	SK4
	R-5A, YR-6A, R-64, HOS-1	Sikorsky R-5A	-	SK5
	S-51	Sikorsky SK 51	-	SK51
	S-52 Series	Sikorsky SK 52	-	SK51
	S-62A, HH-52A	Sikorsky SK 62	-	SK62
Westland Helicopters, Inc., Yeoville, England	W-30	Civil Version of Westland Lynx	-	WH30

5.2.2.16 Tabela XVI Habilitação de Tipo (Outras Categorias, exceto Avião e Helicóptero):

Tabela XVI Habilitação de Tipo (Outras Categorias, exceto Avião e Helicóptero)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
American Blimp	ABC Model A-1-50	Dirigível	-	A150

Tabela XVI Habilitação de Tipo (Outras Categorias, exceto Avião e Helicóptero)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Corporation	ABC Model A-60/ A-60+	Dirigível	-	A60+
--x--	--x--	Balão de Ar Quente	-	BLAQ
--x--	--x--	Balão de Gás	-	BLGS

5.2.2.17 Tabela XVII – Habilitações de Categoria:

Tabela XVII – Habilitações de Categoria		
CATEGORIAS	**DESIGNATIVO**	**LICENÇA(S) À(S) QUAL(IS) A HABILITAÇÃO PODE SER VINCULADA**
Avião	LPPA LPCA LPLA LPMA	Licença de Piloto Privado – Avião Licença de Piloto Comercial – Avião Licença de Piloto de Linha Aérea – Avião Licença de Piloto de Tripulação Múltipla – Avião
Balão Livre	LPBL	Licença de Piloto de Balão Livre
Dirigível	LPPD LPCD	Licença de Piloto Privado – Dirigível Licença de Piloto Comercial – Dirigível
Helicóptero	LPPH LPCH LPLH	Licença de Piloto Privado – Helicóptero Licença de Piloto Comercial – Helicóptero Licença de Piloto de Linha Aérea – Helicóptero
Planador	LPPL	Licença de Piloto de Planador
Powered-Lift (Avião de Decolagem e Pouso Vertical)	LPPP LPCP LPLP	Licença de Piloto Privado – Powered-Lift Licença de Piloto Comercial – Powered-Lift Licença de Piloto de Linha Aérea – Powered-Lift

5.2.2.18 Tabela XVIII – Habilitações Relativas à Operação:

Tabela XVIII – Habilitações Relativas à Operação		
OPERAÇÃO	**DESIGNATIVO**	**CATEGORIA(S) À(S) QUAL(IS) A HABILITAÇÃO PODE SER VINCULADA**
Voo por Instrumentos	IFRA IFRH IFRD IFRP	Voo por Instrumentos –Avião Voo por Instrumentos – Helicóptero Voo por Instrumentos – Dirigível Voo por Instrumentos – Powered-Lift

Tabela XVIII – Habilitações Relativas à Operação		
OPERAÇÃO	**DESIGNATIVO**	**CATEGORIA(S) À(S) QUAL(IS) A HABILITAÇÃO PODE SER VINCULADA**
Instrutor de Voo	INVA INVH INVD INVP INPL INVB	Instrutor de Voo – Avião Instrutor de Voo – Helicóptero Instrutor de Voo – Dirigível Instrutor de Voo – Powered-Lift Instrutor de Voo – Planador Instrutor de Voo – Balão Livre
Instrutor de Habilitação de Tipo	TRIA TRIH	Instrutor de Habilitação de Tipo – Avião Instrutor de Habilitação de Tipo – Helicóptero
Piloto Lançador de Pára-Quedista	LPQA LPQH	Piloto Lançador de Pára-Quedistas – Avião Piloto Lançador de Pára-Quedistas – Helicóptero
Piloto Agrícola	PAGA PAGH	Piloto Agrícola (Avião) Piloto Agrícola (Helicóptero)
Piloto Rebocador de Planador	PRBP	Piloto Rebocador de Planador – Avião
Piloto Rebocador de Faixa	PRFA PRFH	Piloto Rebocador de Faixa – Avião Piloto Rebocador de Faixa – Helicóptero
Piloto de Ensaio	PEV1 PEV2	Piloto de Ensaio em Voo – Nível 1 Piloto de Ensaio em Voo – Nível 2
Inspetor de Aviação Civil	IOPS	Inspetor de Aviação Civil – Operações – todas as categorias

5.2.2.19 Tabela XIX – Habilitações Relativas às Atividades Aerodesportiva e Experimental:

Tabela XIX – Habilitações Relativas às Atividades Aerodesportiva e Experimental	
DESIGNATIVO	**DESCRIÇÃO**
EXPA	Avião Experimental
EXPH	Helicóptero Experimental
GIRO	Girocóptero
PAGU	Piloto Agrícola (Ultraleve)
UAAF	Ultraleve Avançado Anfíbio
UAHD	Ultraleve Avançado Hidro
UATE	Ultraleve Avançado Terrestre
UBAF	Ultraleve Básico Anfíbio
UBHD	Ultraleve Básico Hidro
UBTE	Ultraleve Básico Terrestre

Tabela XIX – Habilitações Relativas às Atividades Aerodesportiva e Experimental	
DESIGNATIVO	**DESCRIÇÃO**
ULTK	Trike
ULTL	Ultraleves
UTKA	Trike Aquático
INVU	Instrutor de Voo (Ultraleve)

5.2.2.20 Tabela XX – Situações Especiais:

Tabela XX – Situações Especiais	
DESIGNATIVO	**DESCRIÇÃO**
CSLC	Piloto com Licença Cassada
SUSP	Piloto CHT Suspenso
CSSO	Piloto com CHT Cassado
LSLO	Licença Subst. de Licença Obsoleta

5.3 Instruções para utilização das tabelas de habilitações

5.3.1 Nas Tabelas I a XVI, a letra “D” da coluna “OBS” (3) indica que um Treinamento de Diferenças é requerido quando transitando entre variantes ou modelos de um mesmo tipo de aeronave, que estejam em células das colunas de “AERONAVE” (2) nas diversas Tabelas.

5.3.2 A Tabela I apresenta as habilitações de classe, separando as aeronaves monomotoras em diversas famílias, de acordo com suas características de construção e de certificação. Nestes casos, a letra “D” na coluna “OBS” (3) indica que o piloto que tenha recebido treinamento e obtido a habilitação de classe a partir de um voo de verificação de proficiência realizado em uma família, somente poderá voar aeronaves pertencentes a qualquer outra família, da mesma classe, após a realização de um curso completo em aeronave da nova família, devidamente certificado por um instrutor de voo habilitado e registrado em sua Caderneta Individual de Voo (CIV), ou em outro documento comprobatório da realização do treinamento que seja aceito pela ANAC. Nestas situações, um novo voo de verificação de proficiência não é necessário, bastando a certificação assinada do instrutor de voo. Por exemplo, um piloto que tenha finalizado o curso de Piloto Privado – Avião conduzido em aeronave *Piper PA-28 Cherokee* (monomotor terrestre, hélice de passo fixo, trem de pouso fixo, triciclo) somente poderá voar em aeronave AB115 – Aero Boero (monomotor terrestre, com trem de pouso convencional) após a realização de curso desta aeronave, ministrado e certificado por instrutor de voo habilitado.

5.3.3 As Tabelas II, III, IV e V encontram-se reservadas.

5.3.4 As famílias de aeronaves são apresentadas nas células das Tabelas II a XVI. Caso as variantes ocupem a mesma célula na coluna "AERONAVE" (2) e estejam em linhas separadas, apenas um treinamento de familiarização é requerido quando transitando entre variantes ou modelos de um mesmo tipo. Vide o exemplo da Figura 1: um piloto com a habilitação de tipo A22T, que tenha sido avaliado em voo de verificação de proficiência na aeronave Nomad-22B, poderá voar a variante Nomad-24A desde que realize o respectivo treinamento de familiarização recomendado pelo fabricante das aeronaves. Não há a necessidade de realizar novo voo de verificação de proficiência, pois apenas um treinamento de familiarização se faz necessário e o designativo da habilitação não se altera.

Tabela VII – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motores Convencional e Turbo-Hélice)				
FABRICANTE (1)	AERONAVE (2)		OBS (3)	DESIGNATIVO (4)
	MODELO	NOME		ANAC
Asta GAF	Nomad-22B Nomad-24A	- -	-	A22T

FIGURA 1 – DESIGNATIVO PARA AS AERONAVES NOMAD (ASTA GAF)

5.3.5 Em complemento ao previsto no item 5.3.4 acima, caso as variantes sejam apresentadas em células separadas em linhas diferentes na coluna "AERONAVE" (2), porém conectadas por uma única célula na coluna "OBS" (3), um treinamento de diferenças é requerido quando transitando entre variantes ou modelos de um mesmo tipo. Vide o exemplo ilustrado pela Figura 2: um piloto com a habilitação de tipo DA10, que tenha sido avaliado em voo de verificação de proficiência na aeronave Falcon 10, poderá voar a variante Falcon 100 desde que realize o respectivo treinamento de diferenças recomendado pelo fabricante das aeronaves e seja avaliado em novo voo de verificação de proficiência. O novo designativo de Habilitação de Tipo (D100) será adicionalmente averbado. A fim de revalidar suas habilitações, o piloto deverá realizar treinamento periódico de uma das variantes e o respectivo treinamento de diferenças da outra, além de ser avaliado em voos de verificação de proficiência distintos.

X – Habilitação de Tipo (Avião) – Terrestre – Operação Multi Pilot, Multi Engine (Todos os Motores – Continuação)				
FABRICANTE (1)	AERONAVE (2)		OBS (3)	DESIGNATIVO (4)
	MODELO	NOME		ANAC
Dassault	Falcon 10	Mystère 10	D	DA10
	Falcon 100	Mystère 100		D100
	Falcon 20	Mystère 20	D	DA20
	Falcon 200	Mystère 200		D200

FIGURA 2 – DESIGNATIVOS PARA A AERONAVE FALCON

5.3.6 O símbolo AAD (Aeronave de Alto Desempenho), na coluna "OBS" (3) das tabelas I a XVI, indica que conhecimento adicional é requerido para este modelo de aeronave no caso de o requerente à habilitação não ser detentor de uma licença de PLA ou não ter conhecimento teórico comprovado equivalente ao necessário para a obtenção de uma licença de PLA.

5.3.7 Ainda que a coluna “DESIGNATIVO” (4) das tabelas I a XVI inclua todas as aeronaves listadas na coluna “AERONAVE” (2), o treinamento de familiarização ou de diferenças permanece como requerido para a operação em cada variante ou modelo de tipo específico, conforme o caso.

5.3.8 Na coluna “DESIGNATIVO” (4) das tabelas I a XVI, uma barra (/) indica as averbações que devem ser feitas à licença do piloto como conseqüência de conclusão de um treinamento de diferenças para uma família de modelos de aeronave, caso o piloto voe frota mista.

5.3.9 Na coluna “DESIGNATIVO” (4) das tabelas I a XVI, a vírgula entre registros de habilitação de tipo (,) indica a existência de habilitações distintas para uma mesma aeronave. Vide o exemplo da Figura 3. No caso de aeronaves certificadas para tripulação mínima composta por um piloto, o foco está na diferença de operação: “*single pilot*” ou “*dual pilot*” (/D).

Tabela IX – Habilitação de Tipo (Avião) – Terrestre – Operação *Single Pilot, Multi Engine* (Motor a Reação)				
FABRICANTE (1)	**AERONAVE (2)**		**OBS (3)**	**DESIGNATIVO (4)**
	MODELO	**NOME**		**ANAC**
Aerospatiale Morane-Saulnier (France)	MS 760	Paris	AAD	S760
Beechcraft Raytheon	RA-390	Premier	AAD	R390, R390/D

FIGURA 3 – DESIGNATIVOS PARA A AERONAVE PREMIER

5.3.10 Nos casos especificados em 5.3.9, o designativo sem restrições significa que o piloto recebeu treinamento e demonstrou proficiência na condição “*single pilot*” e poderá exercer plenamente os privilégios de sua licença como piloto em comando (PIC) na operação “*single pilot*” do equipamento. Este piloto poderá, ainda, exercer a função de piloto em comando (PIC) na operação “*dual pilot*”. Já o designativo com a restrição “/D” significa que o piloto recebeu treinamento e demonstrou proficiência na condição “*dual pilot*” e poderá exercer plenamente os privilégios de sua licença como PIC ou segundo em comando (SIC), conforme o caso, na operação “*dual pilot*” do equipamento.

5.3.11 Em qualquer caso, ao receber uma habilitação de tipo, um piloto poderá atuar como PIC ou SIC, de acordo com os requisitos estabelecidos durante a certificação de tipo da aeronave ou definidos pela operação. Assim, por exemplo, uma aeronave poderá ser certificada para uma tripulação mínima composta por um piloto, ou uma tripulação mínima composta por dois pilotos. Da mesma forma, a operação da aeronave poderá requerer uma tripulação mínima composta por um piloto, ou uma tripulação mínima composta por dois pilotos.

5.3.12 Ao averbar uma nova habilitação de tipo, a ANAC usará as designações “PIC” e “SIC” para certificar de que forma foi demonstrada a proficiência requerida em 61.213(a)(3), bem como de que forma serão exercidas as prerrogativas do detentor da habilitação de tipo, conforme a seção 61.217. A averbação se dará da seguinte forma, em que "AAAA" representa a designação da habilitação de tipo:

5.3.12.1 no caso de aeronaves certificadas para operar com tripulação mínima composta por dois pilotos:

a) AAAA (PIC) – para pilotos que tenham recebido treinamento aprovado para habilitação de tipo no posto de pilotagem definido pelo fabricante da aeronave para PIC e que tenham sido aprovados em voo de verificação de proficiência neste posto de pilotagem; e

b) AAAA (SIC) – para pilotos que tenham recebido treinamento aprovado para habilitação de tipo no posto de pilotagem definido pelo fabricante da aeronave para SIC e que tenham sido aprovados em voo de verificação de proficiência neste posto de pilotagem; e

5.3.12.2 no caso de aeronaves certificadas para operar com tripulação mínima composta por um piloto:

a) para pilotos que tenham recebido treinamento "*single pilot*" aprovado para habilitação de tipo:

I- AAAA (PIC) – para pilotos que tenham recebido o treinamento no posto de pilotagem definido pelo fabricante da aeronave para PIC e que tenham sido aprovados em voo de verificação de proficiência neste posto de pilotagem, em operação "*single pilot*"; e

b) para pilotos que tenham recebido treinamento "*dual pilot*" aprovado para habilitação de tipo, se aplicável:

I- AAAA/D (PIC) – para pilotos que tenham recebido o treinamento no posto de pilotagem definido pelo fabricante da aeronave para PIC e que tenham sido aprovados em voo de verificação de proficiência neste posto de pilotagem, em operação "*dual pilot*"; e

II- AAAA/D (SIC) – para pilotos que tenham recebido o treinamento no posto de pilotagem definido pelo fabricante da aeronave para SIC e que tenham sido aprovados em voo de verificação de proficiência neste posto de pilotagem, em operação "*dual pilot*".

5.3.12.3 Importante ressaltar que a averbação de uma determinada habilitação de tipo se dá com base dos resultados do treinamento aprovado para habilitação de tipo e do voo de verificação de proficiência, conforme o processo de certificação de pessoal (processo PEL). Entretanto, a atuação de um piloto devidamente habilitado dependerá do treinamento e aprovação de sua operação. Vide o exemplo de um piloto com a habilitação de tipo R390 empregado em operações segundo o RBAC 135; este indivíduo estará autorizado a compor uma tripulação de dois pilotos requerida para operações de transporte público de passageiros sob as regras de voo por instrumentos

(IFR), desde que tenha passado pelo treinamento operacional contido no Programa de Treinamento Operacional da empresa aérea e aprovado pela ANAC e que tenha sido aprovado em um voo de verificação em rota (processo OPS).

5.4 **<u>Registro de revisões das tabelas de habilitações</u>**

5.4.1 Não aplicável no momento, na medida em que esta é a primeira revisão do documento.

6. DISPOSIÇÕES FINAIS

6.1 Os casos omissos serão dirimidos pela SPO.

6.2 Esta IS entra em vigor na data de sua publicação