COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG-105/CENIPA/2017

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PR-AVC**
MODEL:	**A319-115**
DATE:	**19JUL2017**

NOTICE

According to the Law nº 7565, dated 19 December 1986, the Aeronautical Accident Investigation and Prevention System – SIPAER – is responsible for the planning, guidance, coordination and execution of the activities of investigation and prevention of aeronautical accidents.

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

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

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

This Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with Appendix 2, Annex 13 to the 1944 Chicago Convention, which was incorporated in the Brazilian legal system by virtue of the Decree nº 21713, dated 27 August 1946.

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

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

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

SYNOPSIS

This is the Final Report of the 19JUL2017 serious incident with the A319-115 aircraft, registration PR-AVC. The serious incident was classified as “[CFIT] Controlled Flight Into Terrain”.

During the final approach to landing on runway 28 of Antônio Carlos Jobim Aerodrome (SBGL), Rio de Janeiro - RJ, the crew performed a go-around procedure at low altitude. Soon after initiating the missed approach procedures, the message Too Low, Terrain of the Enhanced Ground Proximity Warning System (EGPWS) was actuated.

After the go-around procedure, an approach procudure was performed for runway 15, where the landing was carried out safely.

The aircraft was not damaged.

All occupants left unharmed.

An Accredited Representative of the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) - France, (State where the aircraft was designed) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

AGL	Above Ground Level
AIC	Aeronautical Information Circular
ALS	Approach Lighting System
ANAC	Brazil's National Civil Aviation Agency
APP-RJ	Approach Control – Rio de Janeiro
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CFIT	Controlled Flight Into Terrain
CMA	Aeronautical Medical Certificate
COMAER	Aeronautics Command
DA	Decision Altitude
DECEA	Airspace Control Department
DFDR	Digital Flight Data Recorder
DOP	Operations Directive
DSO	Safety Disclosure
EGPWS	Enhanced Ground Proximity Warning System
FAF	Final Approach Fix
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Techniques Manual
FL	Flight Level
FMGC	Flight Management and Guidance Computer
FOQA	Flight Operational Quality Assurance
IAC	Instrument Approach Chart
IFR	Instrument Flight Rules
IFRA	Instrument Flight Rating - Airplane
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
MAPT	Missed Approach Point
MDA	Minimum Descent Altitude
METAR	Meteorological Aerodrome Report
MGO	General Operations Manual
NDB	Non-Directional Beacon
NOTAM	Notice to Airmen
PAPI	Precision Approach Path Indicator
PFD	Primary Flight Display
PLA	Airline Pilot License - Airplane

PMD	Maximum Take-Off Weight
PPR	Private Pilot License – Airplane
QAR	Quick Access Recorder
QNH	Reduced pressure at sea level by the vertical gradient of the standard atmosphere
RBAC	Brazilian Civil Aviation Regulation
RNAV	Area Navigation
RS	Safety Recommendation
RVR	Runway Visual Range
SBGL	ICAO Locator designator – Galeão, Antônio Carlos Jobim Aerodrome, Rio de Janeiro - RJ
SBRJ	ICAO Locator designator – Santos Dumont Aerodrome, Rio de Janeiro - RJ
SBSP	ICAO Locator designator – Congonhas Aerodrome, São Paulo - SP
SID	Standard Instrument Departure
SIGWX	Significant Weather Chart
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SPECI	Selected Special Aeronautical Weather Report
TPR	Aircraft Registration Category of Regular Public Transport
TWR-GL	Control Tower of the Galeão Aerodrome - RJ
UTC	Universal Time Coordinated
VFR	Visual Flight Rules

1. FACTUAL INFORMATION.

Aircraft	**Model:** A319-115 **Registration:** PR-AVC **Manufacturer:** Airbus Industrie	**Operator:** OCEANAIR Airlines S/A
Occurrence	**Date/time:** 19JUL2017 – 1122 UTC **Location:** Galeão Aerodrome (SBGL) **Lat.** 22°46'11"S **Long.** 043°07'50"W **Municipality – State:** Rio de Janeiro - RJ	**Type(s):** [CFIT] Controlled Flight Into Terrain. **Subtype(s):** NIL

1.1 History of the flight.

The aircraft took off from the Congonhas Aerodrome (SBSP), São Paulo - SP, to the Antônio Carlos Jobim Aerodrome (SBGL), Rio de Janeiro - RJ, to carry out a scheduled passenger transport flight with 6 crewmembers and 118 passengers on board.

During instrument approach (RNAV Y) to SBGL threshold 28, the crew performed the missed approach procedure below the Minimum Descent Altitude (MDA) and, almost simultaneously with the beginning of the go-around procedure; there were two EGPWS warnings related to proximity to the terrain (Too Low, Terrain).

After the go-around procedure, a new instrument approach was made, however, to threshold 15 of the same Aerodrome (ILS T), and the landing occurred successfully.

The aircraft was not damaged.

All occupants left unharmed.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	6	118	-

1.3 Damage to the aircraft.

None.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Hours Flown		
	Pilot	Copilot
Total	7.183:00	4.650:00
Total in the last 30 days	38:00	55:00
Total in the last 24 hours	07:00	06:00
In this type of aircraft	2.682:00	3.200:00
In this type in the last 30 days	38:00	55:00
In this type in the last 24 hours	07:00	06:00

N.B.: The Data related to the flown hours were obtained through the crewmembers information.

1.5.2 Personnel training.

The pilot took the PPR course, at the EWM Aviation School - SP, in 2001.

The copilot took the PPR course, at the Tuiuti University from Paraná – PR, in 2008.

1.5.3 Category of licenses and validity of certificates.

The pilot and the copilot had the PLA Licenses and had valid A320 and IFRA Ratings.

1.5.4 Qualification and flight experience.

The pilots were qualified and had experience in that kind of flight.

1.5.5 Validity of medical certificate.

The pilots had valid CMA.

1.6 Aircraft information.

The aircraft, serial number 4287, was manufactured by the *Airbus Industrie*, in 2010, and it was registered in the TPR category.

The aircraft had valid Certificate of Airworthiness (CA).

The last inspection of the aircraft, the "Check C" type, was carried out on 23MAR2016 at the Avianca Hangar - CGH, in São Paulo - SP, having flown 1 hour and 25 min. after the inspection.

The aircraft was classified as Category C according to its performance data, that is, its cruising speed over the threshold during the landing at the maximum certificated weight was equal to or greater than 121kt and less than 141kt.

Information about the Enhanced Ground Proximity System – EGPWS.

The aircraft was equipped with EGPWS manufactured by Honeywell International Inc. The data of the equipment installed on the aircraft were: Part Number (PN) 965-1676-002 and Serial Number (SN) EMK5-30820.

The EGPWS used data entry of the aircraft's geographic position, attitude, height, speed and deviations in the approach slope to predict potential conflicts between the estimated aircraft trajectory and the position of the terrain / obstacles ahead. The system provided information to the crew, through sound alerts and visual cues, when a hazardous situation was identified.

In addition, the EGPWS provided information for sharp deviations in the approach slope, landing gear / flap configuration for landing, side tilt and altitude Callouts.

According to the Product Specification for the Enhanced Ground Proximity Warning System (EGPWS), DWG No. 965-0976-603 and the MKV-A EGPWS Pilot's Guide manual, the system was composed of six basic alert modes that could contain other sub modes according to the configuration of the aircraft.

The basic modes of information for the EGPWS were:

Mode 1	Excessive Descent Rate;
Mode 2	Excessive Terrain Closure Rate;
Mode 3	Descent After Takeoff;
Mode 4	Unsafe Terrain Clearance;

Mode 5	Excessive Deviation Below Glideslope;
Mode 6	Excessive Bank Angle; Altitude Callouts

Next, there is a brief description of the EGPWS's protection Modes that could be related to the occurrence:

Mode 1: Excessive Descent Rate

Mode 1 of the EGPWS provided alerts in situations of excessive rate of descent, that is, when the aircraft had a significant altitude loss in a period. Mode 1 of the EGPWS was active in all flight phases and its protection envelope is shown in Figure 1:

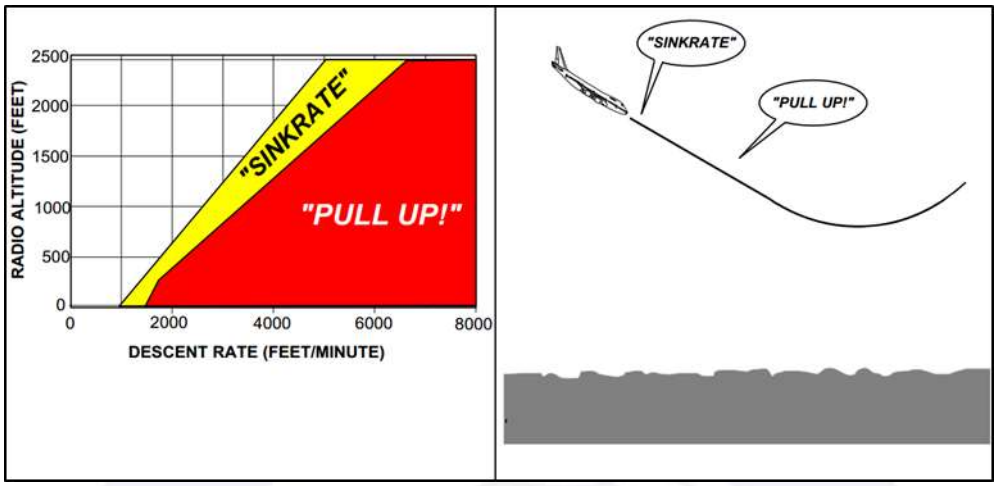

Figure 1 - EGPWS Mode 1 Envelope, taken from DWG Manual No. 965-0976-603.

Mode 2: Excessive Terrain Closure Rate

Mode 2 of the EGPWS provided alerts if the aircraft approached the ground at an excessive rate. Mode 2 of the EGPWS was divided into two sub modes (Mode 2A and Mode 2B).

Mode 2A was activated if the aircraft entered the approach envelope with the terrain and the flaps were not in the landing configuration.

If the aircraft entered the Mode 2A actuation envelope, the *Terrain, Terrain* alert would initially be generated. If the aircraft continued to penetrate the envelope, the *Pull Up!* aural warning would be repeated continuously until the warning envelope was closed.

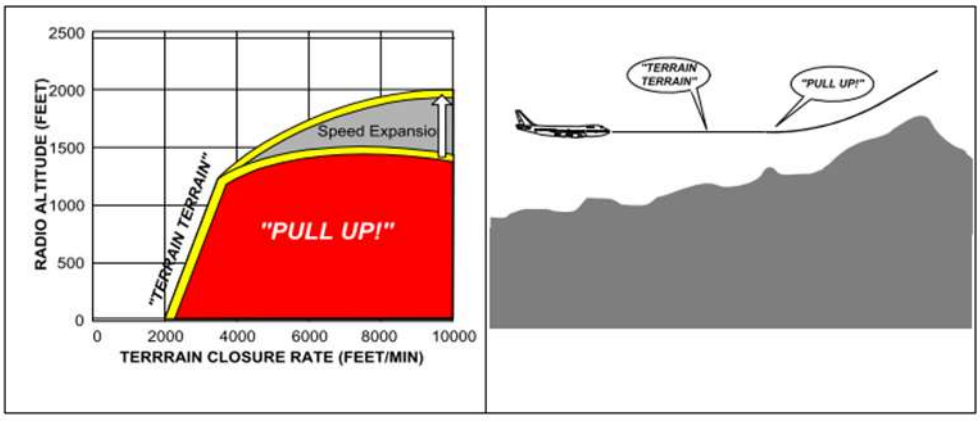

Figure 2 - EGPWS Mode 2A Envelope.

Mode 2B is designed to be "less sensitive" allowing the aircraft to perform a normal approach to landing without producing unwanted alerts. Mode 2B would be activated for four conditions:

- whenever the flaps were selected to the landing position;

- if, by performing an ILS approach, the aircraft was within ± 2 points of the center lines of the localizer and Glideslope;

- if the aircraft was within 5 miles of the runway, at 3,500 feet or below and with the "Land Recognition" function enabled and intact; and

- within 60 seconds after take-off.

If the aircraft entered the Mode 2B envelope with the landing gear or flaps outside the landing configuration, the aural warning system would initially issue the *Terrain, Terrain* alert. If the risk situation persisted, the Pull Up! warning would be issued.

When the aircraft had flaps and landing gears configured for landing, the Aural Pull Up! warning would be suppressed and only Terrain warning would be issued, regardless of the area contained in the envelope.

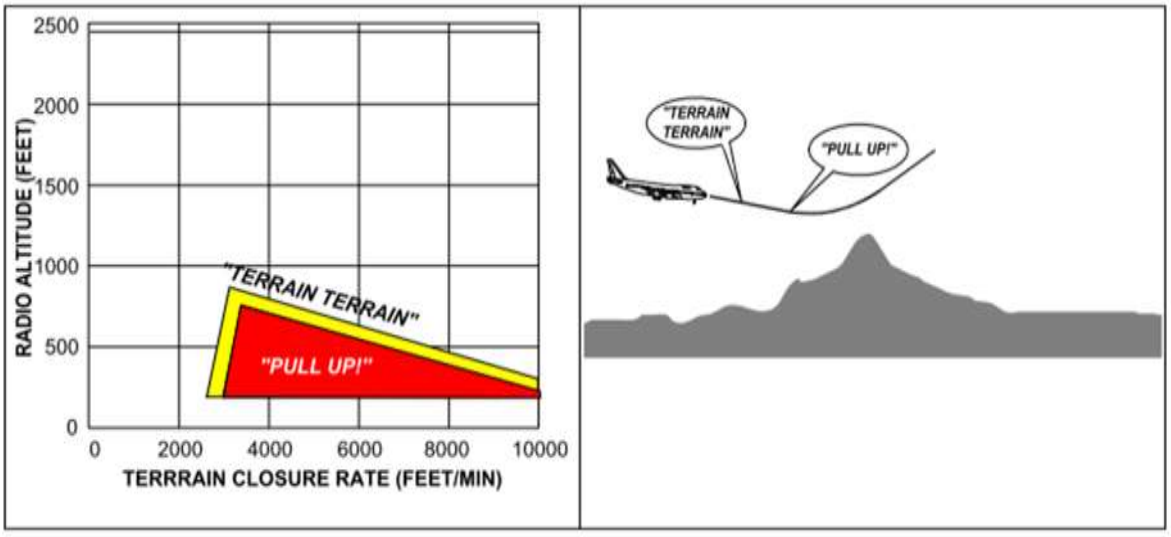

Figure 3 - EGPWS Mode 2B Envelope.

Figure 3 above illustrates the EGPWS Mode 2B envelope.

The Terrain Closure Rate parameter was calculated using the EGPWS internal logic, considering parameters of the radio altimeter, aircraft configuration, speed and approach profile.

Mode 3: Descent After Takeoff

Mode 3 Descent After Takeoff was not analyzed in this report, so its explanation was intentionally suppressed.

Mode 4: Unsafe Terrain Clearance

Mode 4 of the EGPWS provided alerts regarding insufficient terrain separation through three protection modes, based on radio altimeter parameters, aircraft speed and configuration.

Mode 4A would be active during the cruise and approach phases with aircraft landing gears not set up for landing. The warnings issued in 4A Mode were *Too Low, Terrain* and *Too Low, Gear.*

Mode 4B would also be active during the cruise and approach phases, however, when the landing gear was set up for landing. The warnings issued in 4B Mode were *Too Low, Terrain* and *Too Low, Flaps.*

Mode 4C would be active during the takeoff phase with the landing gear or flaps not configured for the landing. The warning issued in 4C Mode was *Too Low, Terrain*.

Mode 5: Excessive Deviation Below Glideslope

Mode 5 would be active on approaches with the Instrumental Landing System (ILS) configured. When the aircraft was below the standard beam of the ILS procedure, the warning issued in Mode 5 would be Glideslope.

Mode 6: Excessive Bank Angle and Altitude Callouts

Mode 6 Excessive Bank Angle and Altitude Callouts was not analyzed in this report, so its explanation was intentionally suppressed.

EGPWS also provided some additional protections. These included the Terrain Clearance Floor function, which was intended to increase the envelope in the vicinity of Aerodromes under conditions different from those observed in Mode 4 of the EGPWS.

The protective envelope of the Terrain Clearance Floor Mode was based on the height of the aircraft, given by the radio altimeter, in its position, obtained by GPS (Global Position System) and IRS (Inertial Reference System) data, and coordinates of the destination Aerodrome stored in the internal EGPWS database.

The Terrain Clearance Floor Mode issued the *Too Low, Terrain* warning if the aircraft entered the envelope protection area shown in Figure 4:

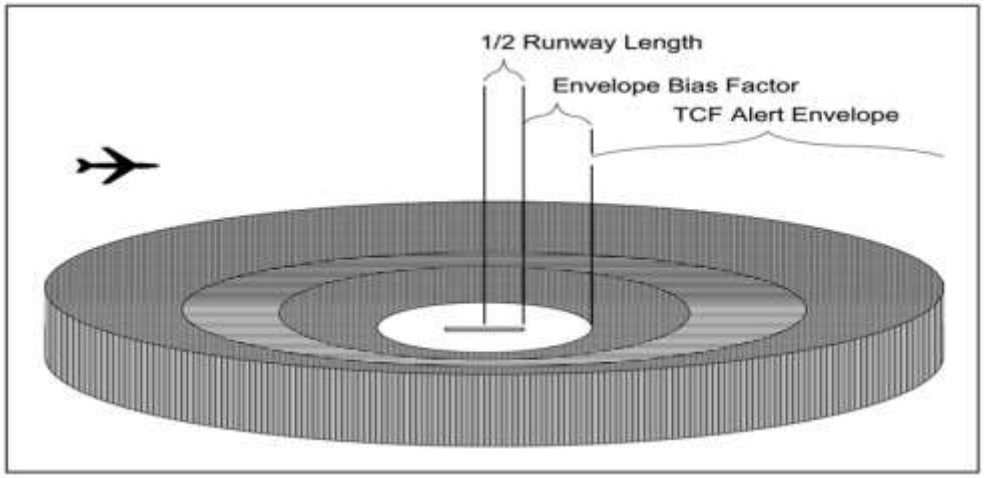

Figure 4 - Terrain Clearance Floor protection area, taken from DWG manual No. 965-0976-603.

The envelope of the Terrain Clearance Floor Mode (gray area of Figure 4) was calculated from the center of the runway at the destination Aerodrome and as a function of the Envelope Bias Factor (k) parameter. This parameter considered precision errors in the position of the aircraft obtained through GPS data. Typical values of the Envelope Bias Factor (k) parameter ranged from 0.25 to 1.0 nautical miles (NM).

Within the Bias Factor Envelope area (white area of Figure 4), the audible warning would not be issued.

1.7 Meteorological information.

SBGL's Aerodrome weather forecast (TAF), available to the crew before the flight, had the following condition for the approximate time of the landing at that location:

TAF SBGL 190230Z 1906/2012 27010KT 6000 BKN012 TN14 / 1909Z TX19 / 1917Z PROB30 1906/1912 3000 RA BR BKN007

According to this highlighted section of the original message, the forecast for the Galeão Aerodrome in the period between 0600 (UTC) on the 19th and 1200 on the 20th would be a 270° and 10kt wind, with 1,200ft ceiling. There was still a 30% probability, in this period, that the horizontal visibility would be reduced to 3.000 m, there would be rain with humid mist and the ceiling would drop to 700 ft.

In addition to the information contained in the TAF, the Significant Weather Chart (SIGWX) recorded the presence of a cold front over the entire state of Rio de Janeiro, according to Figure 5.

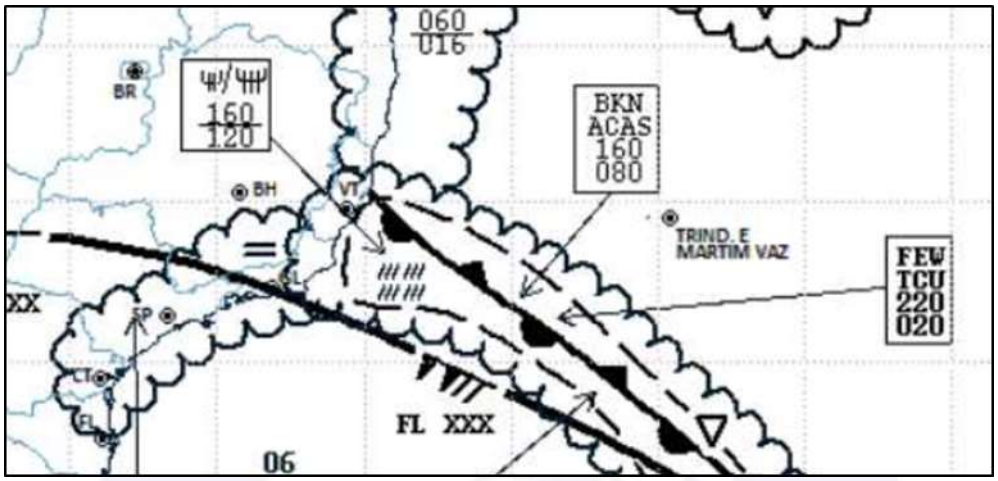

Figure 5 - SIGWX Chart presenting a cold front on Rio de Janeiro.

The Meteorological Aerodrome Report (METAR) at 1100 (UTC) and the Selected Special Aeronautical Weather Report (SPECI) at 1117 (UTC) contained the following information respectively:

METAR SBGL 191100Z 27007KT 2500 -DZ BR BKN007 OVC015 17/15 Q1026

SPECI SBGL 191117Z 28008KT 2500 -DZ BR BKN003 OVC010 16/15 Q1027

According to the 1100 (UTC) METAR, the Galeão had prevailing wind of 270º with 7kt, visibility of 2,500m, light drizzle with humid mist and ceiling of 700ft. However, the SPECI message published 17 minutes later updated the previous information, modifying the wind to 280º with 8kt, maintaining the same visibility of 2,500m and the same light drizzle with humid mist, however reducing the ceiling to 300ft.

1.8 Aids to navigation.

According to NOTAM D1060 / 17, the NOA NDB (215 KHz) would be inoperative between days 26JUN2017 and 14AUG2017.

According to NOTAM D1185 / 2017, ILS ILM of the SBGL runway 28, would be inoperative between days 18JUL2017 and 18AUG2017.

Runway 28 was being used for landings and runway 33 for takeoffs.

In addition to ILS for runway 28 (which was inoperative on the day of the occurrence), thresholds 10 and 15 also had such navigation aids for precision approach.

The procedure in use in SBGL was the RNAV Y of runway 28, in view of the unavailability of ILS to this threshold, as reported in NOTAM.

In order to carry out the procedure, the crew used the Jeppesen Chart 12-3 of SBGL (Figure 6), of 02DEC2016 and effected in 08DEC2016, which was the last published version of that instrument approach chart.

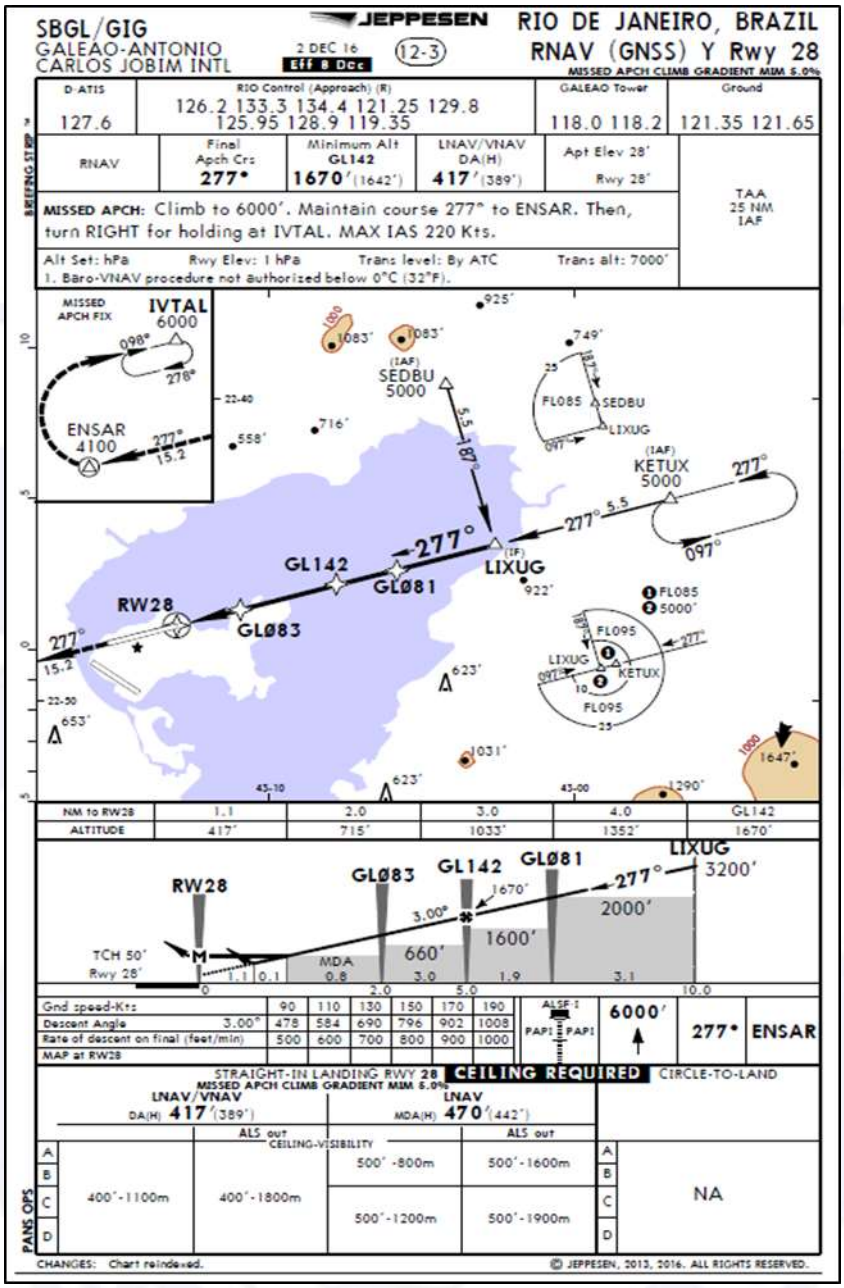

Figure 6 - Jeppesen chart used by the crew.

1.9 Communications.

According to transcripts of the communication audios, it was verified that the crew maintained radio contact with all air traffic control agencies and that there was no technical abnormality of communication equipment during the flight.

In order to support the analysis of the sequence of events that preceded the serious incident, the Investigation Team highlighted some points that may help in understanding the dynamics of the aeronautical occurrence. For the record of the schedules described in this field, the Universal Time Coordinated (UTC) was used as reference.

At 10h48min30s, the Rio de Janeiro Approach Control (APP-RJ), in the initial contact with PR-AVC, authorized the descent "via arrival" EPGIP 1A and reported that the procedure in use at Galeão was the RNAV Y of the runway 28.

At 10h48min46s, the same control restricted the descent of the aircraft to the FL090 and, thereafter, began to command some descent limits and speed reductions, in order to correctly position the aircraft in the sequencing for approach in SBGL.

From 11h:04min:42s, the controller started a RADAR vectoring for PR-AVC, commanding a left turn (heading 090°), a gradual descent from FL090 to 7,000ft and reducing the speed to 170kt.

From 11h09min01s, the aircraft was allowed to retake navigation, curving to the right on the bow of LIXUG (Intermediate Fix - IF procedure RNAV Y RWY 28), descending to 5,000ft and reducing to approach speed.

However, at 11h:11min:17s, the APP initiated a new RADAR vectoring, due to the go-around procedure of the third aircraft that had not been able to land on the Galeão. According to this new vectoring, the PR-AVC should fly in the heading 320º and descend to 3,500ft.

At 11h:13min:34s, the control authorized that aircraft to retake navigation, again, on the bow of LIXUG and also authorized the RNAV Y procedure.

However, at 11h:14min:12s, the controller reported that, from that moment, the Galeão Tower (TWR-GL) would be closing the Aerodrome for landings, due to a fourth aircraft that had performed a go-around procedure for not being able to see the runway.

Therefore, the APP requested that the PR-AVC start a holding pattern on the LIXUG position, with curves to the right, considering the heading 240º in the approach leg and maintaining 3,500ft.

At 11h:14min:52s an aircraft questioned the APP-RJ regarding the possibility of landing operation on runway 15, but the controller informed that it would not be possible, due to the wind that was in the direction of 300° and the intensity varying between 6 and 9 kt.

At 11h16min27s, the control explained to the PR-AVC, which was already waiting on LIXUG that the go-around procedures at Galeão were, exclusively, due to the restrictions of ceiling, not visibility.

Considering that, according to the recent rule change defined by the DECEA, through AIC 11/17 of 22JUN2017, the ceiling should no longer be a meteorological indicator for determining the IFR operation in Brazilian Aerodromes, the controller questioned, therefore, whether the PR-AVC crew intended to attempt the procedure.

At 11h:16min:43s, the crew requested time to assess the situation, and then the control reported that the meteorological conditions observed at Galeão were of 2,500m visibility with a 300ft ceiling.

At 11h:17min:45s, APP-RJ transmitted the following information:

> "Oceanair 6284 (PR-AVC call code), the traffic that preceded it, a BE40 (Cessna Beechjet), managed to land."

Soon after (at 11h:17min:45s) the crew decided:

"Affirmative sir, 6284 will then try to approach"

At 11h:17min:45s, the control again authorized the execution of the procedure and requested that the aircraft reported when it was stabilized in the final approach.

At 11h:20min04s, the aircraft reported that it was stabilized on the final approach and the controller asked the crew to contact the TWR-GL.

At 11h:20min24s, the initial contact of the aircraft with the Tower was made. During this contact, the tower controller authorized further approach and asked the crew to inform them when they saw the runway, complementing that the aircraft preceding it reported the sighting at 400ft.

At 11h:23min:02s, the PR-AVC crew reported that they were initiating the go-around procedure.

1.10 Aerodrome information.

The Aerodrome was public, run by the RIO Galeão concessionary and capable of operating under visual flight rules (VFR) and by instruments (IFR), in daytime and nighttime periods.

The airport had two runways, one made of concrete and one of asphalt.

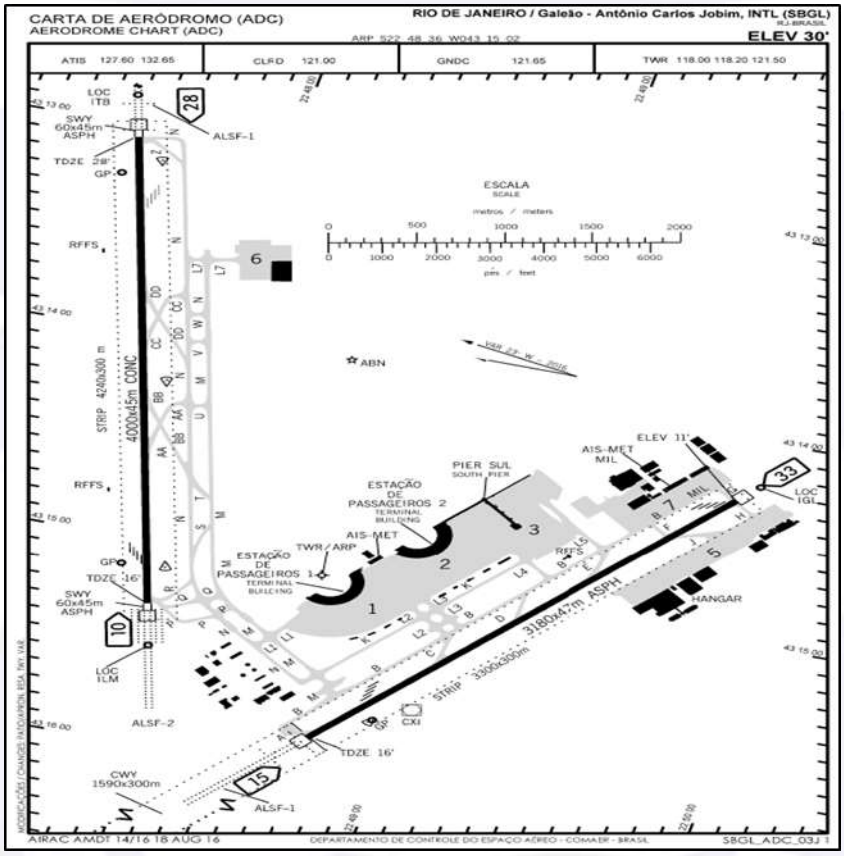

Figure 7 - SBGL Aerodrome chart.

The asphalt runway (thresholds 15/33) was 3180m long, 47m wide, elevation approximately 30ft, had PAPI for both thresholds and Approach Lighting System (ALS) for threshold 15.

The concrete runway (thresholds 10/28) was 4,000m long, 45m wide and elevation approximately 30ft and had PAPI and ALS for both thresholds, as shown in Figure 7.

1.11 Flight recorders.

The aircraft was equipped with a Digital Flight Data Recorder (DFDR) - HONEYWELL P / N 980-4700-042, S / N SSFDR-17989, capable of storing the last 100 hours of flight data.

The aircraft was equipped with a voice recorder - Cockpit Voice Recorder (CVR) - HONEYWELL P / N 980-6022-001, S / N CVR120-12585, with storage capacity for the last 2 hours of flight.

However, both flight data and voice data were overwritten because the notification to the CENIPA occurred 29 days after the event and the recorders were not separated.

The aircraft was equipped with a QAR (Quick Access Recorder) card with a storage capacity of 512mb, capturing the same information of the DFDR, limited to 1.200 flight parameters. The information contained in this card has been preserved and much of the

event analysis was based on the content recorded on this recording device. Figure 8 shows the parameters recorded by QAR close to the EGPWS warning message:

Horário Local	Fase de Voo	Distância NM THR 28 (NM)	Altitude Barométrica (ft)	Altitude Radar Altímetro (ft)	Ângulo de Trajetória	Velocidade Vertical (ft/min)	Mensagem EGPWS
11:22:29	FINAL	3,18	663,03	691	-3,43	-720	
11:22:30	FINAL	3,15	651,03	669	-3,34	-720	
11:22:31	FINAL	3,12	639,03	669	-3,34	-720	
11:22:32	FINAL	3,09	635,03	643	-3,16	-240	
11:22:33	FINAL	3,06	623,03	643	-2,99	-720	
11:22:34	FINAL	3,03	607,03	620	-2,99	-960	
11:22:35	FINAL	2,99	599,03	620	-3,16	-480	
11:22:36	FINAL	2,96	587,03	599	-3,16	-720	
11:22:37	FINAL	2,93	571,03	599	-3,25	-960	
11:22:38	FINAL	2,90	559,03	567	-3,34	-720	
11:22:39	FINAL	2,86	543,03	567	-3,6	-960	
11:22:40	FINAL	2,83	531,03	537	-3,87	-720	
11:22:41	FINAL	2,80	515,03	537	-4,13	-960	
11:22:42	FINAL	2,76	499,03	504	-4,22	-960	
11:22:43	FINAL	2,73	487,03	504	-4,31	-720	
11:22:44	FINAL	2,70	471,03	477	-4,31	-960	
11:22:45	FINAL	2,67	455,03	477	-4,48	-960	
11:22:46	FINAL	2,63	435,03	459	-4,57	-1200	
11:22:47	FINAL	2,60	419,03	459	-4,75	-960	
11:22:48	FINAL	2,57	403,03	425	-4,83	-960	
11:22:49	FINAL	2,54	383,03	425	-5,01	-1200	
11:22:50	FINAL	2,50	371,03	389	-4,83	-720	
11:22:51	FINAL	2,47	355,03	389	-4,48	-960	
11:22:52	FINAL	2,44	339,03	355	-4,39	-960	
11:22:53	FINAL	2,41	319,03	355	-4,39	-1200	
11:22:54	FINAL	2,37	307,03	317	-4,13	-720	
11:22:55	FINAL	2,34	295,03	317	-3,43	-720	
11:22:56	GO AROUND	2,27	291,03	162	-2,2	-240	
11:22:57	GO AROUND	2,24	291,03	162	-0,62	0	T_LOW__TER
11:22:58	GO AROUND	2,21	295,03	291	1,14	240	T_LOW__TER
11:22:59	GO AROUND	2,17	311,03	291	3,25	960	

Figure 8 - Data recorded by QAR.

1.12 Wreckage and impact information.

Nil.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

Not investigated.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

Both pilots involved in the occurrence had an employment relationship with the airline and were in operational progression to assume new functions in command.

The commander had approximately ten years of work in the company. He was the commander and instructor of the Airbus 320 aircraft for en-route flights and flight simulators. He was preparing to become an A330 aircraft commander, on international flights.

According to the colleagues of profession perception, he was considered a commander of easy interaction, being described like a friendly and communicative person, which facilitated the interaction in cabin.

Due to his duties at the company, he was working on the evaluation of pilots in operational progression for A320 family aircraft, as it was the case of the copilot at the time of the occurrence.

According to the data obtained by the Investigation Team, these pilots had already carried out several operations together and, not rarely, carried out flight schedules similar to those planned for the day of the occurrence.

Both were familiar with that air operation, and it was the fourth time that the copilot had completed the schedule that month, which had been executed the day before. There were no reports of conflicts between them, as well as, according to reports, neither of them had experienced critical situations in flights performed on previous occasions.

The copilot was described as a communicative and outgoing person, dedicated to his studies and his career. According to the commander, he was a proactive professional in flight and had the necessary skills to take on the role of commander.

On the flight that originated the occurrence, landing operations were only taking place on runway 28, due to weather conditions. This runway was not the one usually used by the crew. Pilots were also informed that the ceiling was at 300ft, below the minimums indicated in the instrument approach procedure in use.

That day, due to these weather restrictions, other aircraft had already performed go-around procedures, claiming difficulties in sighting the runway.

According to the DECEA legislation in force, at the time of the occurrence, the crew was responsible for deciding whether to proceed to the landing with a ceiling below the minimums prevised in the charts. The pilots of the occurrence had the autonomy of the company to alternate the destination Aerodrome, for the sake of flight safety, if necessary.

During the waiting period, while the crew decided whether to attempt the approach procedure, they were informed that a smaller aircraft had been able to land. In response, the crew promptly communicated their intention to continue the instrument approach.

At the moment the pilots decided on the descent procedure, the commander informed the copilot that they would perform the "dive and drive" procedure, as performed at Santos Dumont Airport (SBRJ). According to the information obtained, this approach technique was used with the intention of making possible the visual contact with the runway as fast as possible.

The "dive and drive" was a familiar procedure for both the commander and the copilot, since both were commonly scheduled for flights to the SBRJ, where this technique was utilized because of the specificities of the locality. However, none of the pilots had performed this technique on SBGL.

Although the initial descent briefing did not previse the dive and drive procedure, there was no question from the copilot about this decision.

According to the interviewees, at the time of the occurrence, this technique was already in disuse in the company, except for operations carried out in SBRJ.

According to the data obtained, the copilot sought to maintain his attention both in the commander's behavior in the cabin and in the external environment, seeking to visualize the runway.

The crew reported that, at about 800ft, they made eye contact with the runway. However, they did not remember having seen the indications of the Precision Approach Path Indicator (PAPI).

As it was reported, after seeing the runway, both crewmembers were concerned about maintaining eye contact with the external environment. At one point, the copilot

verbalized that the aircraft was low, and then the commander made a new adjustment in relation to the descent rate.

At that time, according to data recorded in QAR, the aircraft crossed 600ft and the commander extended the descent ratio from 800 to 1,000ft / min.

There was no intervention by the copilot in relation to this change, and the flight continued under those circumstances. According to his account, he had not observed that the rate of descent had been increased, rather than reduced, at that time.

When the aircraft reached approximately the indicated altitude of 295ft, the missed approach procedure was initiated.

During the go-around procedure, there was the activation of the EGPWS alarm, indicating the proximity to the terrain.

According to the perception of the pilots, there was no apparent reason for the alarm, as they did not see any obstacle that could compromise the safety of the flight during this procedure.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

Nil.

1.16 Tests and research.

Nil.

1.17 Organizational and management information.

The aircraft involved in the incident belonged to the Oceanair Airlines (Avianca) and had been used for scheduled public passenger transport, in the stretch between SBSP and SBGL.

This flight was routine to the activities of the company and the pilots had been previously communicated of the schedule, according to the existing practices in that organizational context.

The procedures for air operations were formally established through the company's General Operations Manual (MGO). At the time of the occurrence, the 27th revision of the document, approved in January 2017, was in force.

Although this document addressed the procedures foreseen for IFR flight, considering the meteorological minimums for landings and departures, changes in aeronautical legislation regarding ceiling restrictions had not been incorporated into the scope of the Manual yet.

In this way, the Operations Directory of the Airline issued the Operations Directive Nº 028/17; aiming to guide the crews on the operational standards to be adopted in case of a ceiling below the minimums presented in the approach charts.

However, among the members of the organization, there was a discrepancy of understanding about this content, as well as some lack of knowledge about the publication of this information.

In addition, among the professionals of the organization, there was no consensus regarding the use of the technique "dive and drive". In some cases, there was a lack of knowledge about this technique.

For the professionals who had been in the company for a longer time, there was the understanding that it was a disused procedure and incompatible with the level of automation available on the aircraft.

There were also those who considered it a procedure restricted to the locality of SBRJ and, for some, it was a possible procedure to be executed, when appropriate, even in other contexts.

According to the reports obtained from the interviewees, although there were systematized organizational processes to keep information updated, communication in the organization was partially hampered by the excess of communication channels.

The most relevant information was not centralized in a single point and, according to the perception of some, this fact favored the devaluation of some announcements.

There were also difficulties in communication between the Operational Safety Directorate and the Operations Directory, which, according to the interviewees' perception, could hinder the internal management of some situations.

In the present case, there were divergent reports about the event within the organization, which fomented complaints of lack of communication among the professionals of different Boards.

After initiating the investigation process of this serious incident, the adopted organizational actions involved a recycling in the training of the pilots involved in the occurrence, as well as the temporary suspension of the operational progression of both.

Although such actions were presented as a preventive measure, the collective perception that persisted in the organization, was that punitive measures had been adopted as a result of the event.

1.18 Operational information.

This was a scheduled passenger transport flight originating from SBSP and having SBGL as destination.

The aircraft was carrying six crewmembers (two pilots and four commissioners) and 118 passengers. It was supplied with 6,400kg of fuel, having a total weight of 58,519kg (the PMD for the SBSP conditions was 69,200kg and the Maximum Landing Weight was 62,500kg) and there were no dangerous loads on board.

The supply already contemplated an extra amount of fuel of 22 minutes, due to the prediction of adverse meteorological conditions en route, according to Figure 9.

```
XTR FUEL **WEATHER**
QNH 1013-OAT 12C-RWY 17R-CONF 3-WIND 0-PERF WT 69200KG
RMK RMK ATT POSSIBLE MODERATE ENROUTE TURBULENCE

          FUEL  TIME  DIST ARRIVE   ELEV
DES SBGL 001941 00/40 0220  1105Z  00028FT   TRK CGHGIG1UP
ALT SBGR 002200 00/44 0283  1149Z  02461FT   COMP M061
HLD      001200 00/30
CON      000149 00/04
REQ      005490 01/58
XTR      000710 00/22
TOT      006200 02/20
TAXI     000200
BLK      006400 02/20

SBSP PUKR1A UGPOP UZ42 ESORU EPGI1A SBGL
```

Figure 9 - Flight planning, contemplating extra fuel, due to meteorology. (our emphasis)

The flight occurred without abnormalities until the beginning of the approach at the Galeão.

The runway used in SBGL was number 28. However, due to intermittent breakdowns in the ILM Locator, identified on 18JUL2017, the ILS ILM (RWY 28) was temporarily removed from operation and this information was recorded in NOTAM D1185 / 2017.

In this context, the instrument approach procedure for the Galeão was the RNAV Y of runway 28.

This allowed aircraft capable of performing LNAV / VNAV navigation (lateral and vertical navigation) to reach a DA (decision altitude) of 417ft and those aircraft that could only perform LNAV (lateral navigation) reached an MDA (minimum descent altitude) of 470ft.

The Rio de Janeiro Approach Control (APP-RJ) had to perform some vectors for the PR-AVC, in order to reposition it in the sequence of approximations for the Galeão, which was being influenced by the aircraft's go-around procedures that were not being able to land, due to the low altitude of the cloud layer.

The ceiling estimated by the Control Tower was of 300ft.

After positioning the PR-AVC in traffic sequencing, the APP-RJ authorized the crew to resume navigation, flying on the heading of LIXUG (Intermediate Fix). However, even before the aircraft reached the authorized position, the control started a new RADAR vector, due to the go-around procedure of a third aircraft that could not establish visual references for landing.

When the desired spacing with the RADAR vector was achieved, the controller once again authorized the PR-AVC crew to resume navigation, flying on the heading of LIXUG and, from that position, to begin the approach procedure.

However, as the aircraft moved towards the position LIXUG, a fourth traffic started the go-around procedure as a result of the ceiling conditions at the Galeão.

As a consequence of this fourth go-around procedure, the TWR-GL decided to close the landing field, since the estimated ceiling (300ft) was below the limits prevised in the procedure in use: 400ft for LNAV / VNAV and 500ft for LNAV, according to Figure 9.

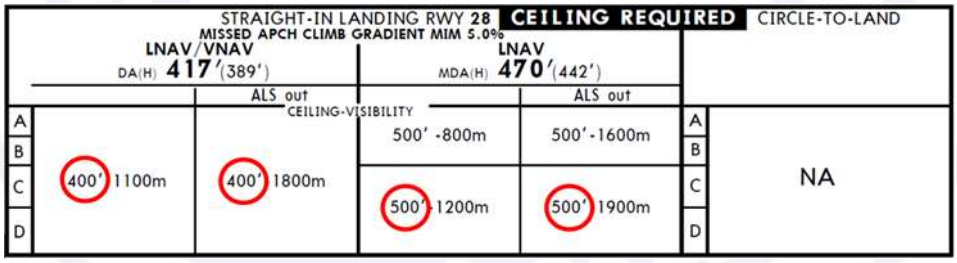

Figure 10 - Detail of the Jeppesen chart, presenting the required ceiling limits for LNAV / VNAV type approaches or only LNAV (with or without ALS).

The TWR-GL decision was communicated to APP-RJ, which retransmitted it to the PR-AVC's crew, which was instructed to perform a wait on the LIXUG position, remaining at 3,500ft with right turns.

While the aircraft performed the designated holding pattern, the controller rectified the misinformation that the field was closed.

The APP explained to the PR-AVC crew that the aircraft, which had preceded it, had performed a go-around procedure due to the ceiling restrictions at the Galeão. However, the ceiling limit should no longer be a parameter to be used by the Brazilian air traffic control organizations, to restrict the attempt to perform an instrument approach procedure.

This new rule appeared in the AIC 11/17 issued by the Airspace Control Department on 22JUN2017.

In this context, the controller questioned whether the PR-AVC crew intended to perform the RNV Y RWY 28 procedure, considering the Tower's estimate of a 2,500m visibility with a 300ft ceiling in the SBGL.

Initially, the crew asked for the control some time before making the decision. However, while the pilots decided if they were going to try the procedure, the APP-RJ informed them that the aircraft, which preceded them, had just landed.

Immediately after receiving this information, the pilots decided that they would try the procedure.

The Air Company operating the PR-AVC had issued, through its Operations Department, on 14JUN2017, the Operational Directive (DOP) No. 028/17, to be carried out on 23JUN2017, dealing with AIC 11/17 of the DECEA.

The DOP No. 028/17 (Figure 11) presented in full the text of the AIC 11/17 that would come into effect from the 22JUN2017 on but the company's Operations Directorate established the following reservation in the document:

> It is established that to perform / start the IFR approach / landing procedure, the ceiling and visibility minima in the charts are maintained for the time being.

DOP Nº 028/17	DIRETRIZ DE OPERAÇÕES DOP	Avianca Diretoria de Operações
EMITIDO EM: 14 / 06 / 2017		
APLICABILIDADE: A32F/A-330	ASSUNTO: AIC 11/17	
DATA DE EFETIVAÇÃO: 23 / 06 / 2017	EMAIL:fsa32f@avianca.com.br	
STATUS: Efetivo	VALIDADE: Indeterminado	
PARA: Pilotos e DOV	CÓPIA: N/A	

Caros colegas,
Informamos que a partir do dia 22 de junho de 2017 entra em vigor a "*Aeronautical Information Circular*" (AIC) 11/17 que trata da **MODIFICAÇÃO DO USO DOS VALORES DE TETO COMO INDICADOR METEOROLÓGICO PARA DETERMINAÇÃO DE OPERAÇÃO DE AERÓDROMO**, o texto da AIC 11/17 está reproduzido abaixo na íntegra. Fonte: http://publicacoes.decea.gov.br.

Fica estabelecido que para efetuar/iniciar o procedimento de aproximação/pouso IFR, mantém-se os mínimos de teto e visibilidade por ora constando nas cartas.

Período de vigência: de 22 JUN 2017 a PERM.

Figure 11 - Extract from DOP No. 028/17, containing the determination that maintained, within the company, the limits established in the IFR approach charts (our emphasis).

In addition to the determination contained in the DOP No. 028/17, the company's General Operations Manual (MGO), in force at the time of the event, had the following determination:

> **6.3 Meteorological minimums for landings and takeoffs (Rev. 26 - 23JUN2014)**
>
> (...)
>
> **6.3.2 IFR - RBAC 121.651**
>
> (...)
>
> The pilot may only continue an approach after passing the final approach fix or, where no such fix exists, begin the final approach segment of an instrument approach procedure, if the latest meteorological information issued by the Aeronautics Command Organization or other Organization recognized by it, confirms visibility, **ceiling** and RVR equal to or greater than those provided in the IFR descent procedure being performed.

The MGO was in Revision 27 (10JAN2017), though the aforementioned Section was included in Revision 26, dated 23JUN2014, and did not undergo modifications in the update that was in force.

The crew reported that, shortly before starting the approach, the commander informed the copilot that he would perform an approach using the “dive and drive” technique, as performed in the SBRJ (Figure 12).

According to this technique, the crew should maintain a descent rate higher than that shown on the instrument approach chart (dive), in order to seek the establishment of visual references at a point prior to that identified as the missing approach point - Missed Approach Point (MAPT), being limited in the descent by the Stepdown Fixes and the MDA.

By establishing visual references, the crew would adjust the trajectory to a landing profile (drive).

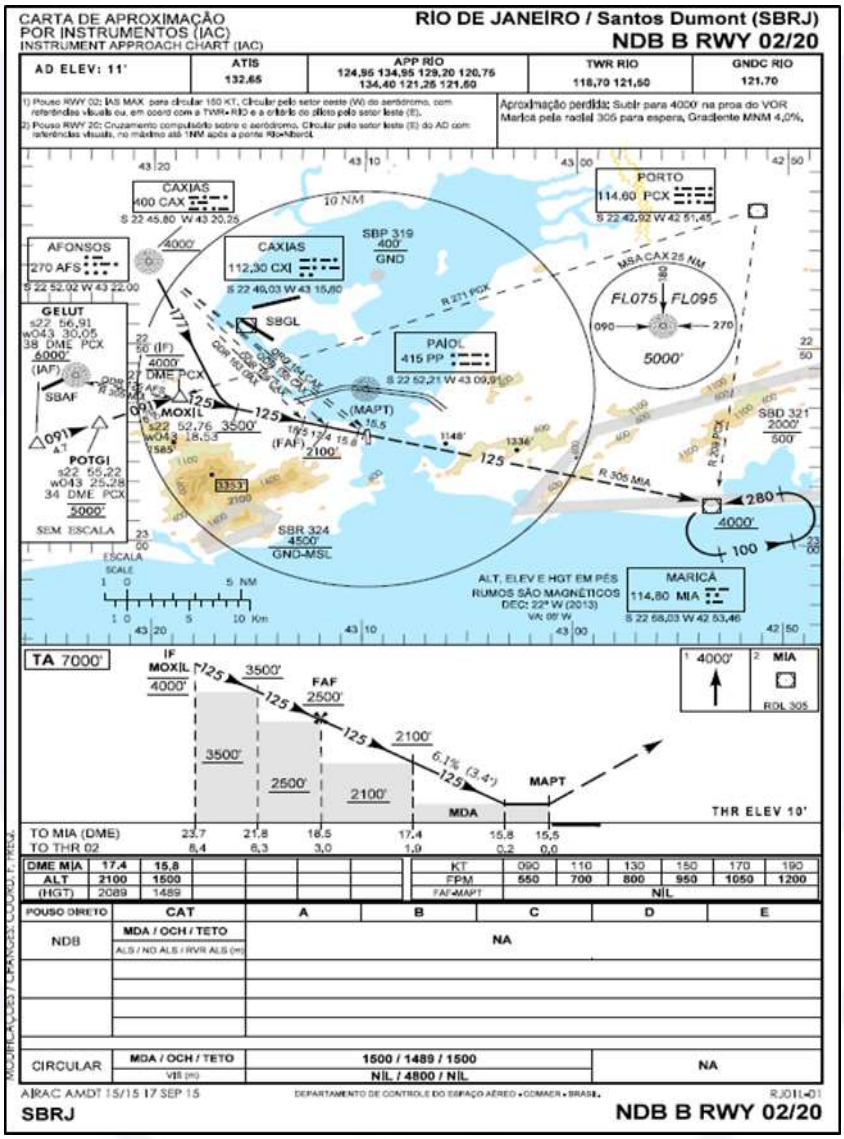

Figure 12 - SBRJ Instrument Approach Chart NDB B RWY 02/20.

For the execution of the RNAV Y RWY 28 procedure, the crew of that aircraft, A319-115, would be able to perform the complete LNAV / VNAV or only LNAV type approach.

However, according to the company's Flight Crew Operating Manual (FCOM), a specific mode of aircraft guidance, as shown in Figure 13, should be selected for each approach type.

CROSS-REFERENCE TABLE

Ident.: PRO-NOR-SOP-18-A-00014489.0004001 / 29 MAY 13
Applicable to: MSN 3030-3642, 4491-7656, 7995-8064

This table provides Guidance Modes that may be used depending on the Approach Types.

	Guidance Modes per Approach Types				
	LOC G/S	FINAL APP	LOC FPA	NAV FPA	TRK FPA
ILS / MLS / GLS	*Refer to APPR using LOC G/S*	N/A	N/A	N/A	N/A
LOC ONLY ILS G/S OUT	N/A	N/A	*Refer to APPR using FPA Guidance*	N/A	N/A
LOC B/C	N/A	N/A	N/A	N/A	*Refer to APPR using FPA Guidance*
RNAV(GNSS) with LNAV/VNAV minima	N/A	*Refer to APPR using FINAL APP*	N/A	Not Authorized	Not Authorized
RNAV(GNSS) with LNAV minima	N/A	*Refer to APPR using FINAL APP*(1)	N/A	*Refer to APPR using FPA Guidance*	Not Authorized
RNAV(GNSS) with LPV minima	N/A	Not Authorized	N/A	Not Authorized	Not Authorized

(1) *The FINAL APP is the recommended guidance mode for this type of approach.*

For Visual Approach, *Refer to Visual Approach*
For Circling Approach, *Refer to Circling Approach*

Figure 13 - Table contained in the FCOM, indicating the way of guiding the aircraft according to the type of approach (our emphasis).

With the FINAL APP mode engaged, the aircraft would enter the managed / managed condition, and its automatism would take care of lateral and vertical navigation in the flight director (the first “managed” refers to lateral navigation and the second “managed” refers to vertical navigation).

On the other hand, there would still be the possibility of guiding modes, in which the automation of the aircraft would take care of the lateral navigation, in the flight director, but the pilot should select some specific parameter for vertical navigation. In this case, the aircraft would be in a managed selected condition (the managed referring to the lateral navigation and the selected referring to the vertical navigation).

According to the company's FCOM, for LNAV / VNAV type approaches, the aircraft should be operated exclusively in FINAL APP mode, and no other guiding option is allowed.

In the case of an LNAV-type approach, the same cross-reference table (Figure 13), recommended the use of the Final APP mode, but also allowed the selection of the Flight Path Angle (NAV-FPA).

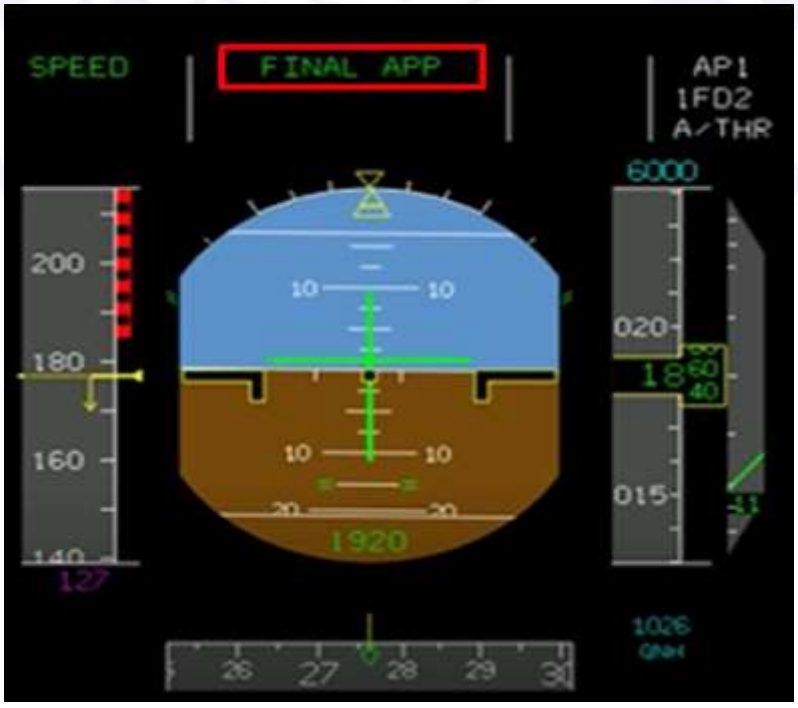

Figure 14 - Highlight in red for the “FINAL APP" mode engaged in the pilot's PFD.

According to what was reported, the commander had established at the approach briefing that the procedure would be performed in FINAL APP mode. In this case, with the autopilot connected, the aircraft automatism would be responsible for maintaining the slope and the final approach axis, according to the parameters provided in the RNAV Y RWY 28 procedure of the SBGL until the DA of 417ft, which should have been inserted in Flight Management and Guidance Computer (FMGC).

According to data collected from QAR, it was observed that the approach was initiated in FINAL APP mode, as agreed in briefing, but, after passing the Final Approach Fix (FAF - position GL142 of the procedure), the commander selected the Vertical Speed (V/S) guiding mode and entered a descent rate of 1.400ft / min.

Thus, the aircraft changed from the managed / managed condition to the managed / selected condition, and the crew would have to comply with the constraints imposed by the LNAV profile approach, including the descent limitation to the 470ft MDA, as shown in Figure 15.

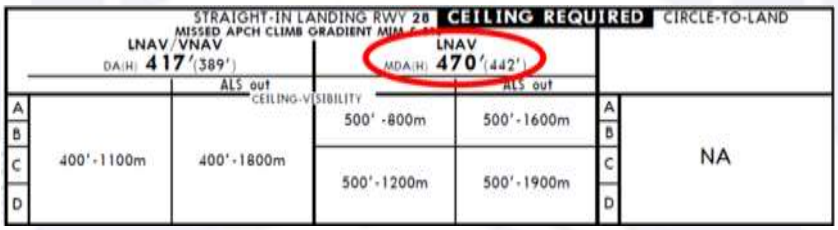

Figure 15 - Detail of the Jeppesen chart, presenting the MDA of 470ft for LNAV approximation.

The profile of the procedure used by the crew established some Stepdown Fixes, marked by positions GL081 (2,000ft), GL142 (1,600ft), GL083 (660ft) and MDA itself (470ft), as shown in Figure 16:

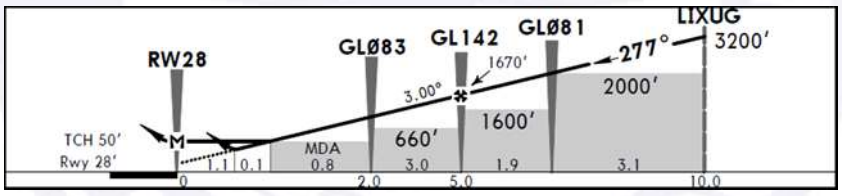

Figure 16 - Profile view of the SBP Jeppesen RNAV Y RWY 28 chart, containing the Minor Segment Altitudes (Stepdown Fixes).

When selecting the Vertical Speed (V/S) mode, after passing the FAF, the crew assumed the responsibility of meeting the GL083 and the MDA altitude restrictions.

However, due to the rate of descent applied, the MDA was exceeded at approximately 2.67 NM from threshold 28, that is, even before position GL083.

The aircraft was equipped with an aural warning system, which among other messages, relayed information to pilots such as: Hundred above, when the aircraft was 100ft above the minimum altitude of the procedure, and Minimum when the aircraft reached a minimum altitude of the scheduled procedure by the crew at FMGC.

Regardless of the altitude entered in the FMGC and its respective aural warnings, the aircraft continued to descend to the altitude of 295ft (adjusted with the predicted QNH of 1026 hPa) at a distance of 2.34 NM from threshold 28 (even before position GL083), when the commander began a go-around procedure.

During the go-around procedure, due to the inertia, the aircraft reached 291ft of barometric altitude. The height recorded in the QAR, based on information from the radio altimeter, was 162ft, (information shown in Figure 8, recorded at 11h:22min:56s).

Approximately one second after commencing the go-around procedure, the aircraft successively issued two EGPWS warnings of Too Low, Terrain.

According to the pilots, the go-around procedure was not performed according to the evasive maneuver procedure for EGPWS warnings.

After the go-around, the aircraft was instructed to perform the ILS T procedure for runway 15 of SBGL and, following this procedure, the landing happened with no abnormalities.

The crew reported the incident to the company's Safety sector, in compliance with the guidance contained in the Safety Disclosure (DSO) No. 04/2017, which had a list of events that should be reported to Safety Sector of that Airline, among others, which, those related to EGPWS Warning, according to Figure 17.

QUAIS EVENTOS SÃO DE COMUNICAÇÃO OBRIGATÓRIA AO *SAFETY*?

EVENTOS DE COMUNICAÇÃO IMEDIATA POR TELEFONE	
Alarme de fogo ou superaquecimento (falso ou não)	Colisão com Equipamentos / Veículos / Aeronaves
Fogo, fumaça, explosão em solo ou em voo	Perda de Controle em Voo ou no Solo
Corte ou Falha de Motor em Voo (voluntário ou involuntário)	Danos a Para-brisas / Janela / Porta
Despressurização	Emergência de Combustível
Birdstrike / Ingestion / Vestígios de Ave	Perda de Componente em Voo ou no Solo
Incursão / Excursão de Pista / Pouso antes da pista	Pouso sem Trem
Pouso em Local Não Previsto	Estouro de Pneu
Jetblast	O envio do relato via Portal AQD também é obrigatório em até 48 horas após o evento.

EVENTOS DE COMUNICAÇÃO VIA AQD EM ATÉ 24 HORAS	
TCAS RA	Hard Landing
EGPWS Warning	Eventos de Tráfego Aéreo
Windshear Warning	Vazamento de Combustível e outros Fluidos
Fenômenos meteorológicos (lightning strike, gelo, granizo)	Abertura inadvertida de Escorregadeira
Vazamento / Embarque incorreto de Artigo Perigoso	

Figure 17 - Extract from DSO 04/2017, listing the mandatory communication events by the crew (our emphasis).

Although the alarm in the event falls within the category EGPWS Cautions (Figure 18), the crew, nevertheless, considered it pertinent to communicate the Safety Directorate about the event, even though it was not a mandatory notification by the company.

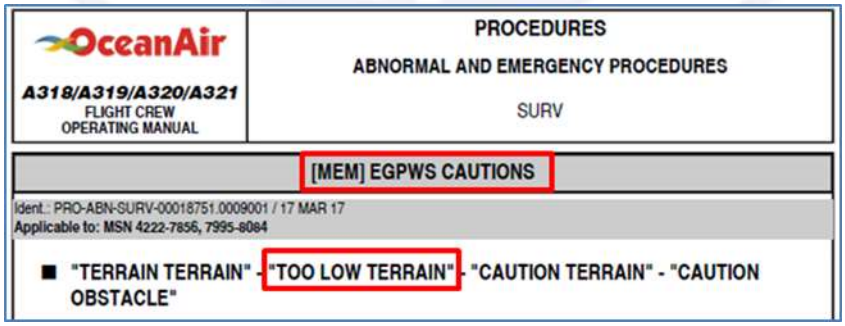

Figure 18 - Detail of the FCOM section of the company that presents the Too Low, Terrain alarm as a message of the EGPWS Caution type.

Pilots were instructed by the Safety Directorate to complete a Self-Report so that, through this tool (defined in the company's Flight Monitoring and Analysis Program), they could clarify the occurrence and reasons for the possible extrapolation of some parameters established in the current operational publications.

Such a measure would aim to minimize the request for additional clarifications at the time that flight was analyzed by the Flight Operational Quality Assurance Program (FOQA) and operational deviations were detected.

However, during the telephone communication made by the pilots to the Airline Safety Directorate, it was not noticed that the event was an incident.

At the time the flight data was analyzed (through the company's FOQA Program), it was found that the event was more critical than previously thought. From then on, the CENIPA was notified.

Based on the information, the aeronautical occurrence was classified as a serious incident and the investigations were initiated.

The interval between the event and its notification to the Brazilian investigative authority did not allow the use of data from flight data and voice recorders, since they had already been overwritten, due to the continued operation of the aircraft.

1.19 Additional information.

Item 6.3.2 of the General Operations Manual referred to Section 121.651 of the Brazilian Civil Aviation Regulation 121 (RBAC 121). However, the text of RBAC 121 had been updated, which had not been included in the current MGO of the airline.

The item referenced in the MGO contained the following text:

> **6.3.2 IFR - RBAC 121.651**
>
> (...)
>
> The pilot may only continue an approach after passing the final approach fix or, where no such FIX exists, begin the final approach segment of an instrument approach procedure, if the latest meteorological information issued by the Aeronautics Command Organization or other Organization recognized by it confirms **visibility, ceiling and RVR** equal to or greater than those predicted in the IFR descent procedure being performed. (our emphasis)

However, Amendment No. 03, dated 04JUL2014, of Section 121.651 of RBAC 121, modified the text as follows:

> **121.651 - Meteorological minimums for landings and takeoffs. All certificate holders**
>
> (b) (...) no pilot may continue an approach after passing the final approach fix or, where no such FIX exists, begin the final approach segment of an instrument approach procedure, unless the latest meteorological information issued by the Aeronautics Command Organization or other Organization recognized by it, confirms **visibility** equal to or greater than that provided for in the IFR descent procedures being performed (our emphasis).

The MGO of the company provided in the item 6.8 the procedures related to the stabilized approach, as follows:

> **6.8 Stabilized Approaches**
>
> The purpose of the approach shall be to stabilize the descent approach trajectory of the final approach, in VAPP and landing configuration, at 1000 ft. AGL **when the Aerodrome is operating IFR** or at 500 ft. AGL when the Aerodrome is operating VFR.
>
> For an approach to be considered stabilized, the following requirements must be met simultaneously:

• the aircraft is in the correct lateral trajectory and **glide slope**;

• the aircraft is in the desired landing configuration;

• the aircraft speed is not greater than VAPP + 20kt and not less than VAPP - 5kt;

• the power adjustment is stabilized to maintain the VAPP during the final approach path;

• the pitch should be between -2.5 and +10 degrees;

. the rate of descent is not greater than 1000 ft./min. If an approach requires a descent rate of more than 1000 ft./min, then a special briefing should be made earlier;

• all briefings and checklists have been performed;

• in ILS approach, at most half a dot of Glideslope and Localizer offset;

• **in RNAV approaches, maximum 0.1NM of lateral deviation and ½ dot of V/DEV deviation;**

• in RNP AR approaches, at most 1 dot lateral deviation of L / DEV and 1/2 dot of V / DEV deviation.

Unusual approach procedures or abnormal conditions that result in deviations from the stabilized approach elements mentioned above require a special briefing.

If the approach is not stabilized at 1000 feet when the Aerodrome is operating IFR or 500 feet when the Aerodrome is operating VFR, a **GO-AROUND PROCEDURE MUST BE EXECUTED.**

If the commander observes that the approach is not stabilized and that he may reach the limits established above, being stabilization unlikely to occur, he must anticipate the go-around procedure, not being necessary to reach the limits to start the procedure. (our emphasis)

Section 6.10 of the MGO presented a table with the maximum descent ratios to be applied at low altitude defined by the company, as follows:

6.10 Maximum Descent Ratio at Low Altitude

In order to prevent CFIT (Controlled Flight Into Terrain), the maximum descent rate to be used should be as shown below, according to the height of the aircraft on the ground (AGL):

HEIGHT (AGL) MAXIMUM RATE OF DESCENT

5000 ft.	5000 ft./min
4000 ft.	4000 ft./min
3000 ft.	3000 ft./min
2000 ft.	2000 ft./min
1000 ft.	**1000 ft./min**

Unlike the Jeppesen chart (used by the crew), the DECEA chart, referring to the RNAV Y NWY 28 procedure of Galeão, did not include the indication of the fix GL083, despite presenting the restriction of descent in the predicted position, marked by the distance of 2 NM of threshold 28, as shown in Figure 19.

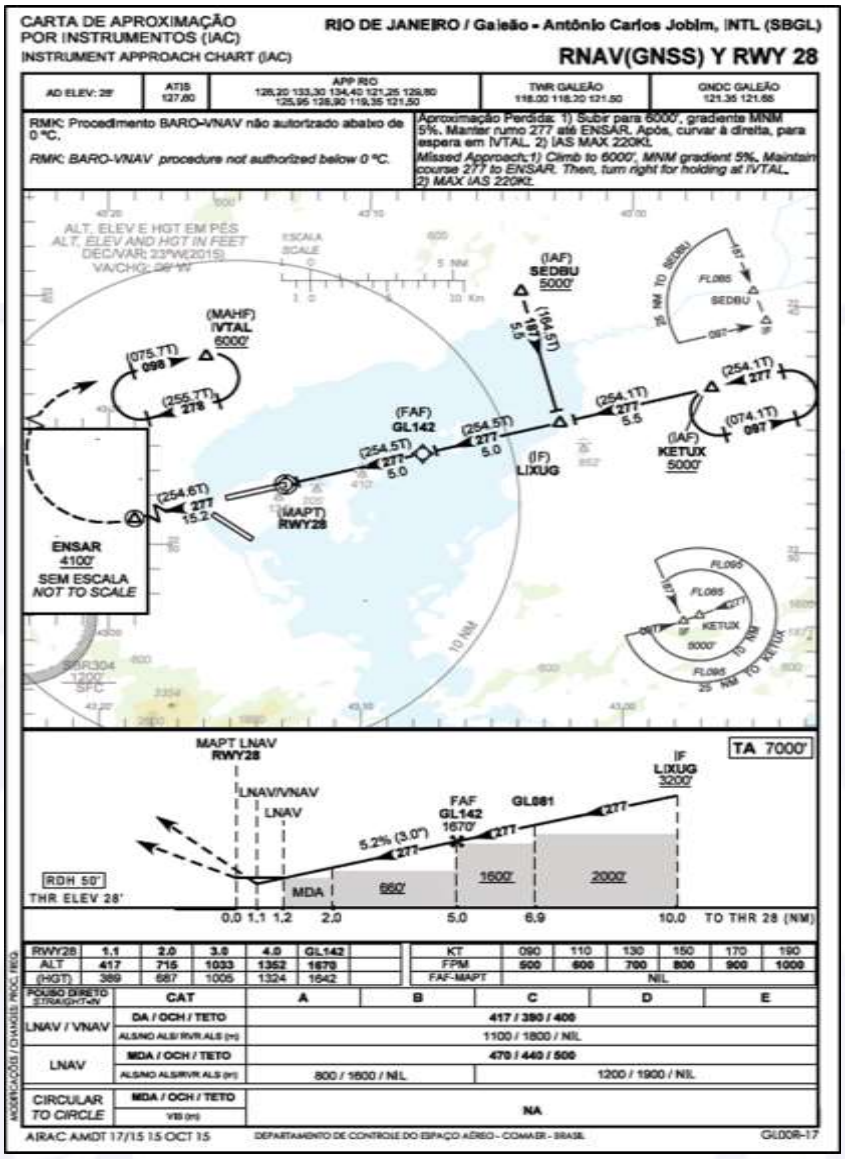

Figure 19 - DECEA chart without indication of the fix GL083 between FAF and MDA.

In the Airplane's FCOM Abnormal and Emergency Procedures Section, there were predictions of actions to be taken by pilots in case of warning of Too Low, Terrain at EGPWS, as shown in Figure 20.

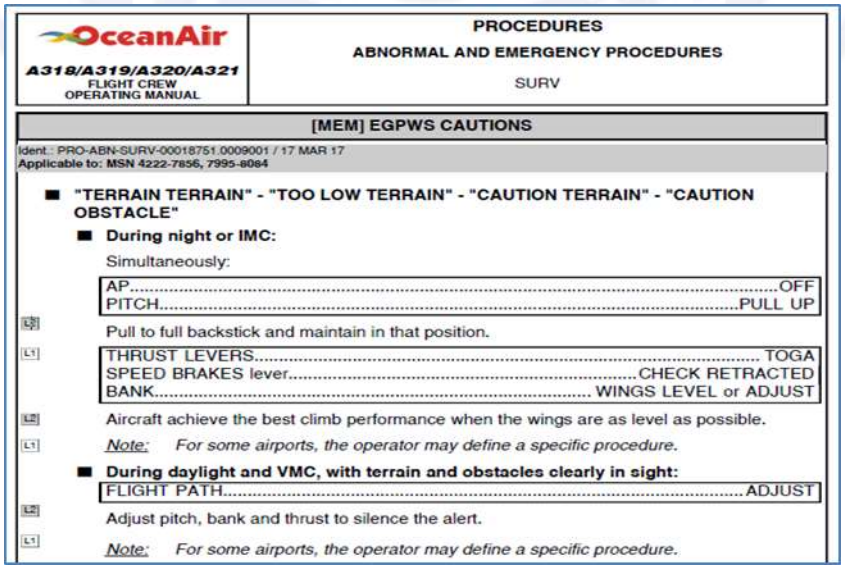

Figure 20 - Procedure provided in FCOM for warning of Too Low, Terrain in EGPWS.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

The PR-AVC aircraft's flight ran smoothly from its take-off from Congonhas to the beginning of the landing approach at Galeão.

It was known by the crew that SBGL operated under instrument conditions and that turbulence was predicted on the route according to available information.

In this scenario, the aircraft was fueled, taking into account a further 22 minutes of flight to compensate for the possibility of deviations or eventual waits. This additional fuel quantity complied with the operating weight limits of the aircraft for both landing and take-off.

On 18JUL2017, the previous day of the serious incident, LOC-ILM, which marked the ILS procedure for SBGL threshold 28, presented intermittent breakdowns that culminated in the operation removal of the aid and in the issuance of a NOTAM informing about the temporary unavailability of that locator.

So, considering that the prevailing wind at Galeão in the morning of 19JUL2017 favored the landing operation on runway 28 and that the ILS procedure for that threshold was unavailable, the procedure adopted was the RNAV Y RWY 28.

According to the pilots, a complete approach briefing was carried out, considering the execution of the RNAV procedure in the FINAL APP mode, which would allow the aircraft automatism to perform lateral and vertical navigation (LNAV / VNAV) up to 417ft DA.

In this way, the pilots configured the aircraft so that it fulfilled the slope and approach axis profiles prevised in the chart for LNAV / VNAV type operation.

In this case, the autopilot would comply with all Stepdown Fixes and the aural warning system would inform the crew when the aircraft was in the DA ("Minimum" warning) and 100ft above this altitude ("Hundred above" warning), that should have been inserted in the FMGC.

Before authorizing the commencement of the procedure for the PR-AVC crew, APP-RJ had to command a series of vectors and holdings, in order to provide traffic separations, since some aircraft were not able to land on Galeão (due to meteorology) and controllers needed to safely reposition all aircraft within the terminal.

In Brazil, instrument approach charts included ceiling limits and visibility (some localities also had a Runway Visual Range (RVR) limit for performing the procedure. If the meteorological condition had a ceiling or visibility below the limit of the chart, the Aerodrome would be closed for landing operations. This rule was valid until 21JUN2017.

From 22JUN2017 on, AIC 11/17 issued by the DECEA, which modified the use of ceiling values as a meteorological indicator to determine Aerodrome operation, became effective. In other words, Aerodromes in Brazil would no longer be closed by limitations of ceiling, but only by horizontal visibility.

According to the DECEA document itself, the air navigation procedures (SID and IAC) would remain with the required ceiling information until they undergo periodic scheduled revisions.

In addition, the DECEA regulations, which have the prevision where the ceiling is presented as a requirement for an IFR operation of an Aerodrome, should be updated by the end of 2017.

At the moments that preceded the serious incident, the ceiling estimated in Galeão was 300ft and the limit presented in the RNAV Y RWY 28 procedure was 400ft for LNAV / VNAV approximations and 500ft for LNAV approaches only.

At the time of the fourth go-around procedure of different aircraft, due to the ceiling conditions, the Galeão Tower decided to temporarily suspend landing operations at that Aerodrome since the estimated ceiling (300ft) was lower than that required by the RNAV Y RWY 28 procedure.

However, in less than three minutes, the tower realized that it should not have suspended operations because of the ceiling restriction only, since it would be contrary to AIC 11/17, which had been in force for less than a month.

Thus, APP-RJ retransmitted the tower's rectification, stating that aircraft wishing to try the IFR procedure could do so, since the weather condition that prevented previous landings was related to the ceiling and not visibility.

On this occasion, the controller reported that the estimated ceiling in SBGL was 300ft and the visibility of 2,500m.

When the APP-RJ questioned whether PR-AVC would attempt to perform the procedure in that scenario, the pilots asked for some time to decide. However, in the meantime, the controller informed them that an aircraft had just landed.

Upon receiving this information, the crew transmitted the following message:

"Affirmative sir, 6284 will **then** try to approach"

When considering this context, it is possible that the information reported by the air traffic controller has influenced the pilots' decision, leading them to choose, possibly in an impulsive way, by the attempt to approach.

This hypothesis is reinforced by the phraseology used, in which the use of the word "then" can be considered an indication that, at that moment, the successful landing of the other aircraft consisted of one of the decision factors.

In deciding to try the procedure, the pilots no longer complied with the DOP 28/17 of the airline, which provided that, within the company, the ceiling limits still laid down in the current charters should be respected.

However, despite this guideline on the part of the company, some pilots of that airline, as identified during the investigation process did not know such information.

In fact, the information appeared rather discreetly in Operations Directive 28/17 (Figure 11), although it was an information of paramount importance to pilots, since it established a safety determination by the company that was more restrictive than the regulation itself defined by the DECEA (AIC 11/17).

The way in which the information was addressed in the aforementioned Directive, connected with the amount of information conveyed in the communication channels available to the pilots, may have favored a low assimilation of this determination.

In this context, the lack of knowledge about this restriction may also have contributed to the decision of initiating the approach in the attempt to land on runway 28.

The decision of the pilots was also in disagreement with the one that was in item 6.3.2 of the General Manual of Operations, in force, in that airline. This MGO item referred to section 121.651 of RBAC 121, which defined that the pilot could only initiate the final approach of an IFR procedure if the last meteorological information issued by a COMAER body confirmed that the visibility, the ceiling and the RVR were greater than or equal to those prevised in the respective descent procedure.

Since this was the text contained in the MGO, pilots should comply with the rule defined by the company.

When the controller submitted the decision to proceed with the approach to that crew, probably influenced a decision-making that, according to the airline's procedures, it would not be up to the pilots.

It should be noted that the restrictions contained in the MGO were based on an amendment to the RBAC 121, which had already been modified by the Civil Aviation Authority (ANAC).

According to section 121.651 of RBAC 121, in force at the time of the incident (Amendment No. 3), the only meteorological information that would restrict the start of the final approach of an IFR procedure would be the visibility, which should be equal to or greater than to that previsted in the respective descent procedure.

Thus, the information conflict between what was referenced in the MGO, the updated text of section 121.651 of RBAC 121 (Amendment No. 3) and what was disclosed through DOP No. 028/17 might have confused the pilots about the permission to start the procedure.

During the approach briefing, the crew had agreed to perform the LNAV / VNAV procedure in the FINAL APP mode. However, according to what was reported by the pilots to the Investigation Team, during the wait that preceded the beginning of the procedure, the commander informed the copilot that he would make the approach in the same way that he performed at Santos Dumont Airport, using the "dive and drive" technique.

The commander was referring to the technique commonly used by some pilots in performing the SBRJ NDB B RWY 02/20 procedure.

Analyzing, specifically, the NDB B RWY 02/20 procedure of the Santos Dumont Airport (Figure 12), it is possible to identify that the slope presented suggested the maintenance of a descent gradient of 6.1% for the establishment of a 3,4º angle in the final approach.

However, in this case, there was no altitude restriction between the 2,100ft Stepdown Fix and the Missed Approach Point (MAPT), but the MDA.

Thus, there would be no impediment for a crew to "dip" from the 2,100ft Stepdown Fix to the MDA (in this case 1,500ft) on a steeper slope than the one recommended by the chart (3,4º), since the crew did not exceed the descent rate limits established by the operator on the MGO.

Because it is a "circle" approach procedure (non-direct approach), where the runway differs by a further 30º from the final approach of the instrument procedure and, therefore, the crew should perform a specific trajectory with the visual references to complete the landing, it was justifiable for some pilots to seek contact with these visual references as soon as possible, provided they did not exceed any downward restriction imposed by the chart.

As already mentioned, the pilots had previously established, in briefing, that they would carry out the procedure in the FINAL APP mode. However, shortly after passing over the final approach FIX (FAF) of the procedure, the commander selected the Vertical Speed (V/S) mode, which caused the aircraft to exit the managed/managed FINAL APP condition and operate in the managed/selected condition (in this case, with V/S connected).

When commanding the Vertical Speed mode, the commander became responsible for maintaining the aircraft slope (vertical navigation), manually controlling the desired descent rate for that approach.

The use of V/S mode was not contemplated in the company's FCOM as one of the guidelines allowed in the execution of RNAV procedures. According to the cross-reference table shown in Figure 13, the guidance modes authorized using LNAV navigation were only the FINAL APP (recommended) or NAV FPA.

For purposes of illustration, Figure 21 represents the information contained in aircraft PFDs, based on data obtained from QAR, demonstrating a flight moment when the V/S mode is connected with a descent rate of 1,400 ft. / min selected by the crew.

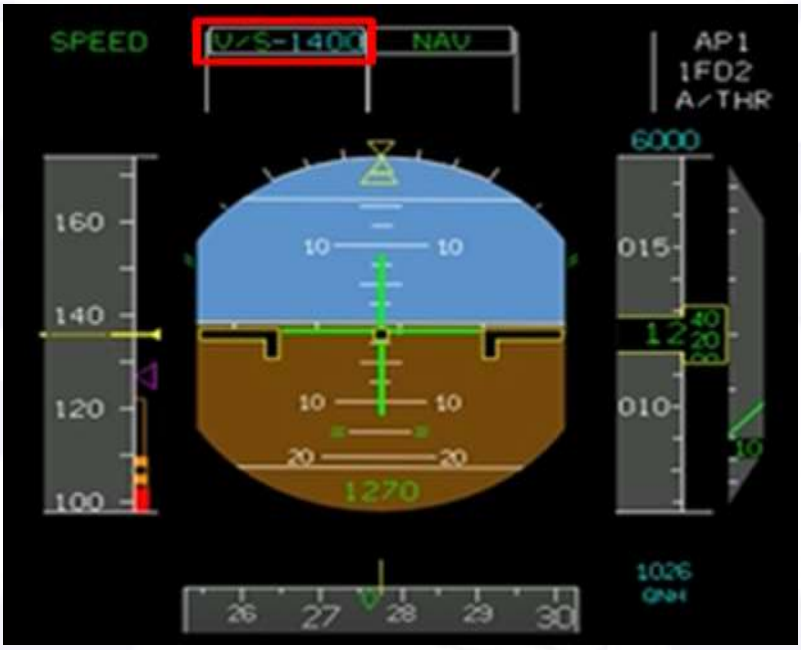

Figure 21 - Representation of the PFD with a red marking (our emphasis), highlighting the V/S (Vertical Speed) mode connected with a selected ratio of 1.400ft./min.

When modifying the approach strategy, the crew also modified the type of procedure, which became different from the one that had been combined in a briefing, and that had already been configured in the aircraft.

With the V/S mode connected, the aircraft would no longer comply with the LNAV / VNAV approach profile to perform only the LNAV profile. Consequently, the decision altitude (DA) of 417ft would be replaced by the minimum descent altitude (MDA) of 470ft, and the crew would be responsible for meeting the intermediate descent restrictions provided in the chart (Stepdown Fixes), generating a work overload.

According to information obtained by the Investigation Team, the commander's intention when manually commanding a descent rate using the V/S mode would be to perform the dive and drive technique, in order to achieve visual conditions in a position prior to that expected, if it kept a constant rate of descent.

However, considering the reality of the SBGL RNAV Y RWY 28 procedure, the use of the dive and drive technique would not bring any operational gain to that crew, since, firstly, the "dive" from the FAF would be restricted to altitude of 660ft in Stepdown Fix GL083.

Second, when deciding to reduce the automatism of vertical navigation, the crew consequently proceeded to perform a LNAV-only procedure. Therefore, the lowest point of the procedure was no longer a 417ft DA and became a 470ft MDA.

Thirdly, the crew caused an overload of work, by taking command of the rate of descent and compliance with the respective restrictions, whereas the same pilots could monitor the approach if the aircraft was in the managed/managed condition. Therefore,

such circumstances led to a greater demand for attention and demanded high levels of situational awareness. This scenario of overloading was aggravated by the lack of a detailed briefing.

Finally, because it was a direct approach, in which the runway would be aligned with the final approach, there would be no need to establish a specific trajectory (drive) to the runway alignment.

Despite these considerations, it is possible that the familiarization of the pilot in command with that technique, commonly applied by him in another context of operation, has led to the mistaken decision to apply it for landing in SBGL.

This decision denoted an inaccurate assessment of the risks in that scenario, contrary to established standards and, consequently, reducing the safety margins of that flight.

In addition to the above, the approach profile based on the QAR data indicated that that crew no longer met some parameters related to the stabilized approach.

Considering that the operation was IFR, according to item 6.8 of the company's MGO, in case the aircraft was not compliant with up to 1,000ft AGL, a go-around procedure should be initiated. However, among the parameters that were not followed by the crew, it was observed in the analysis of QAR data that:

- there was a descent rate greater than 1000ft / min; and

- there was a vertical deviation (V/DEV) greater than ½ dot during the RNAV approach.

In this context, the crew should have immediately initiated a go-around procedure. However, the aircraft continued up to 295ft of barometric altitude. Thus, the decision to perform a go-around procedure, although correct, was late, since the safety limits established in the approach chart had already been exceeded.

It should be noted that the failure to comply with the procedures envisaged denoted a low level of situational awareness on the part of the crew. This condition could be evidenced by the behavior of the cabin crew, since, even with the signal from the copilot that the aircraft was low, the commander increased the rate of descent without any intervention by the copilot in this action.

According to the data collected, the copilot had not observed that the rate of descent had been increased, rather than reduced, at that time. This inattention may have been induced by his involvement in the search for external references to the landing.

Such flaws in relation to the interaction of the crew, contributed to the occurrence in question, as they favored the continuation of the flight below the established minimum limits.

According to the crew, at about 800ft, visual conditions were established and, from this altitude, the descent occurred with references with the ground. When they crossed approximately 300ft, the visual references were lost and, therefore, the go-around procedure was initiated.

Throughout the investigation, it was not possible to obtain data to corroborate this information of the crew.

However, the technique mentioned did not correspond to the procedures foreseen in the company manuals and the parameters of stabilized approach should be followed even if the flight was occurring under visual rules, which was not the case.

Immediately after the start of the go-around procedure, the EGPWS issued two consecutive warnings “Too Low, Terrain”.

The Too Low Terrain message was not related to the EGPWS basic mode envelopes. This warning message would be associated with the advanced protection mode, Terrain Clearance Floor.

The Terrain Clearance Floor mode was intended to increase the envelope of the basic EGPWS modes near airports. The envelope in this way (gray area of Figure 4) was calculated from the center of the runway of the destination Aerodrome and the function of the parameter Envelope Bias Factor (k).

Within the Envelope Bias Factor area (white area of Figure 4), the audible warning would no longer be issued, since in this area, the aircraft would be close to landing and EGPWS warnings could deviate pilot’s attention from the landing procedures.

According to the Emergency Section of the FCOM, highlighted in figure 20, the following rules should have been adopted immediately (memory items), when that kind of warning sounded (Too Low, Terrain), being the aircraft in instrument conditions (IMC):

- disconnect the autopilot;

- pitch up the aircraft;

- fully pull the sidestick back and keep that position;

- thrust levers in TOGA;

- check if the speed brakes lever is retracted; and

- level the wings or adjust bank.

Considering the meteorological conditions observed at the Aerodrome, combined with the fact that, according to the crew, the go-around procedure was initiated due to the loss of visual references, it is clear that, at the time of the EGPWS warning, the aircraft was in IMC.

According to what has been found, the crew reported that they did not carry out the procedures mentioned, because they interpreted it as an EGPWS caution type message and the above procedure should be used just in case of a warning message. In that context, according to the crew, the evasive maneuver should only be performed in the case of a Pull Up warning!

However, this interpretation was misleading in the light of two aspects:

1) the emergency procedure in FCOM makes clear that the maneuver should be performed in the case of EGPWS CAUTIONS and also explained the TOO LOW TERRAIN alarm, as highlighted in Figure 20; and

2) in the condition that the aircraft was, the EGPWS operated in the Terrain Clearance Floor Mode, consequently the Pull Up! warning was inhibited.

Taking into account that the go-around procedure was initiated prior to the EGPWS warning, the consequences of non-execution of the evasive maneuver provided in FCOM were not more severe.

On the other hand, the misunderstanding of the crew could have catastrophic consequences if, in another scenario, they waited for the Pull Up! warning to react according to the emergency procedure described in the manual.

As mentioned, in the scenario where the aircraft was, the Pull Up! warning would be inhibited and, if the crew waited for this alarm to react, the plane would collide against the ground, as the warning would not occur.

This fact indicated that there were gaps in the crew's knowledge of aircraft systems, since even after the event; there was no identification of the gravity of the situation.

Based on the understanding that the aurals aircraft's alarms consist of important resources for maintaining the alert level of the crews, these flaws in the knowledge of the alarms contributed to a low level of situational awareness of the crew on that flight.

Figure 22 shows the approach profile previsedby the SBGL RNAV Y RWY 28 chart in contrast to the slope employed by the crew.

It is possible to identify in this Figure: a blue dotted line, representing the slope of the aircraft, if the FINAL APP mode was engaged; a red line, representing the slope performed by the crew; a green line representing the radio altimeter indication (RALT); the point at which the V/S mode was selected; the segment altitude constraints imposed by each Stepdown Fix and a relief reference, considering a cut of the topography on the approach axis, represented by a brown line.

The vertical axis of Figure 22 represents the altitude in feet and the horizontal axis represents the distance from threshold 28 in nautical miles.

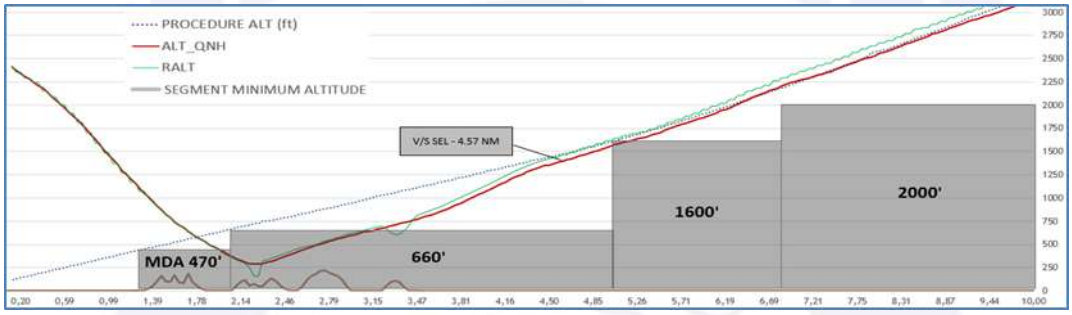

Figure 22 - Graphical representation of a constant slope previsedfor an aircraft complying with the restrictions of the SBGL RNAV Y RWY 28 procedure, in contrast with the slope performed by the PR-AVC aircraft crew.

Figure 22 clearly illustrates the points where the aircraft trajectory exceeded the GL083 and MDA constraints. It is possible to identify that the MDA was exceeded in a position previous to the one in which, there would be the limitation imposed by GL083.

Another well-illustrated information in Figure 22 is the influence of the relief on the radio altimeter information.

At the lowest point of the trajectory, the position of the Too Low, Terrain alarm, the presence of elevations in the terrain resulted in a lower indication of altitude when compared to the barometric altitude. In any case, the radio altimeter information reflected the actual condition of the aircraft's proximity to the relief.

Although it did not contribute to the event, the Investigation Team noted that there was a slight difference between the Jeppesen chart (used by the crew) and the respective DECEA chart, regarding the indication of the Stepdown Fixes of RNAV Y RWY 28 of SBGL.

As seen in Figure 16, in the profile view of the Jeppesen chart, each altitude limiting point in the final approach was referenced by a fix, namely: GL081, restricting descent to 2,000ft; GL142 (FAF), restricting up to 1,600ft; and GL083 restricting to 660ft.

However, comparing with the respective DECEA chart (Figure 19), it was observed that point GL083 was not explicitly presented in the procedure.

Thus, it is possible to infer that the Jeppesen chart favored the pilot with a better situational awareness than the one from the DECEA, since that chart clearly presented the specific fix that marked an important descent restriction (GL083). Such a restriction was

presented in the DECEA chart simply referenced by the distance (2 NM) relative to the threshold 28.

Regarding the involvement of Air Traffic Control, some aspects were identified during the investigation of this serious incident.

The first observed point refers to the closure of the field, due to restrictions related to the ceiling.

At the time the Air Traffic Control determined that the field would be closed, as some aircraft had performed go-around procedures because of the ceiling, it failed to comply with AIC 11/17, published by the DECEA itself, 27 days before the incident in question.

Because it was a very recent aeronautical publication, it is possible that pilots and controllers were still familiarizing themselves with the new orientation of not using the estimated ceiling as a meteorological indicator to determine the IFR operation in Brazilian Aerodromes.

In any case, the mistake of closing the field, due to the ceiling was noticed and corrected quickly (about 3 minutes) by the Air Traffic Control.

A second point, which could lead to a doctrinal study by the DECEA, refers to the criteria used to select runways for landing and take-off at Galeão.

In the moments prior to the incident, the weather conditions of the ceiling were not propitious for the sighting of runway 28, fulfilling the altitude restrictions of the procedure RNAV, although the prevailing wind favor the landing in that threshold.

According to the METAR of 1100 (UTC), the prevailing wind was 270º with 7kt. The SPECI of 1117 (UTC) had a wind of 280º with 8kt and the METAR of 1200 (UTC) registered a wind of 280º with 7kt.

At about 1115 (UTC), when TWR-GL mistakenly interrupted landing operations on runway 28, an aircraft questioned APP-RJ about the possibility of landing on runway 15. However, the request was denied under the claim that the wind would be in the direction of 300° and with the intensity varying between 6 and 9kt, generating a tail wind component for landing on that requested threshold.

By decomposing the wind (300º), informed by the controller, in relation to the approach axis of runway 15 requested by the aircraft (148º), taking into account the highest observed intensity of that wind (9kt), it was concluded that there would be a right lateral component of 4kt and a longitudinal tail component of 5kt.

In fact, the wind condition provided a head component for runways 28 and 33. However, the approach procedures available for these two thresholds were of non-precision and their respective minimum descent altitudes predicted values greater than 400ft.

Consequently, performing the instrument approach procedures available for thresholds 28 and 33 would hardly allow an aircraft to reach landing conditions, considering that the estimated Aerodrome ceiling was about 300ft.

In this scenario, where several go-around procedures were observed because of the ceiling (5 in total), and considering the existence of two thresholds with ILS operation capacity (thresholds 15 and 10), it would be pertinent to establish a risk management procedure by the Airspace Control Service, which would consider the influence of the tailwind component during landing, counteracting the advantage in performing a precision procedure that would theoretically allow aircraft to overcome the meteorological constraint of the cloud cover base layer.

When considering the organizational aspect, from the point of view of the aircraft's operating company, it was verified that the context of the occurrence indicated points in which there was lack of standardization by the crew, characterized mainly by the decision to carry out a procedure that was against the Operations Directive (DOP 028/17), in addition to the execution of a destabilized approach and below the established minimum limits.

Whether, due to lack of knowledge or misinterpretation that fostered non-compliance with the procedures, the decisions adopted may have been favored by the vulnerabilities that exist in the context of the organization.

Thus, at the time of the occurrence, the Investigation Team identified the following latent conditions present in the organization: the excess communication channels existing in the airline; the lack of prioritization of messages of greater operational relevance; as well as the possible difficulties in communication between the different sectors. Such conditions may have promoted weaknesses in the proper assimilation of procedures and crew standardization.

Another point, in which an organizational fragility was verified, was that when the company was informed by telephone about the event, the Safety Department of the company did not realize that the occurrence could be a (serious) aeronautical incident and, therefore, did not take some measures that would include the separation of the CVR and DFDR for analysis.

Failure to analyze data from voice and flight recorders may have hampered further research.

3. CONCLUSIONS.

3.1 Facts.

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

b) the pilots had valid A320 aircraft and IFRA Ratings;

c) the pilots were qualified and had experience in that kind of flight;

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

e) the aircraft was within the limits of weight and balance;

f) the airframe and engine logbook records were updated;

g) meteorology recorded the presence of a cold front over Rio de Janeiro;

h) the Galeão Aerodrome operated under instrument flight conditions;

i) the SBGL threshold 28 was being used for landing and threshold 33 for take-off;

j) the ILS of runway 28 was inoperative;

k) the instrument approach procedure in use at the Galeão was the RNAV Y RWY 28;

l) the estimated Aerodrome ceiling was of 300ft;

m) the DA of the RNAV Y RWY 28 procedure was of 417ft and the MDA was of 470ft;

n) four aircraft performed go-around procedure before PR-AVC, when attempting to approach runway 28;

o) TWR-GL briefly closed the airfield for landing, due to weather;

p) the Aerodrome was reopened when it was found that the meteorological restrictions were only in function of the ceiling, which no longer constituted an indicator for operation restriction, according to the AIC 11/17 of 22JUN2017;

q) the airline, operator of the aircraft, had issued an Operations Directive stating that, to initiate an instrument procedure, the ceiling and visibility restrictions still prevised in the charts would be maintained;

r) item 6.3.2 of the company's MGO provided that the pilot could only commence the final approach segment of an instrument approach procedure if the last meteorological information issued by an Aeronautics Command body or by a body recognized by it confirms visibility, ceiling and RVR equal to or greater than those provided in the IFR descent procedure being performed;

s) item 6.3.2 of the company's MGO referred to section 121.651 of RBAC 121, but the text was outdated;

t) the PR-AVC crew initiated the approach of the SBGL RNAV Y RWY 28 with the FINAL APP mode connected;

u) after passing the FAF, the V/S mode has been selected;

v) the company's FCOM did not foresee the execution of RNAV procedure with the selected V/S mode;

w) the 660ft restriction was exceeded at a point prior to the limit established by the fix GL083;

x) the fix GL083 was not included in the DECEA SBGL RNAV Y RWY 28 approach chart, although there was altitude restriction at that point;

y) the approach profile used by the crew did not comply with all stabilized approach parameters defined by the airline;

z) the crew started the go-around procedure at approximately 295ft with the QNH setting of 1026 hPa;

aa) the descent inertia of the aircraft allowed it to reach the altitude of 291ft;

bb) at the lowest point of the trajectory, the radio altimeter registered a height of 162ft in relation to the terrain;

cc) the EGPWS issued two alerts "Too Low, Terrain" immediately after the crew started the go-around procedure;

dd) the procedure for the Too Low, Terrain alarm was not executed;

ee) after the go-around procedure and repositioning, the crew performed the ILS T RWY 15 procedure of the SBGL;

ff) the landing occurred without abnormalities on runway 15 of SBGL;

gg) the incident was reported to the CENIPA 29 days after the occurrence;

hh) CVR and DFDR data were overwritten, due to the continued operation of the aircraft after the event;

ii) the QAR data were used by the Investigation Team;

jj) the aircraft was not damaged; and

kk) all aircraft occupants were unharmed.

3.2 Contributing factors.

- **Control skills – a contributor.**

The use of the Vertical Speed guiding mode associated with the application of an excessive descent rate contributed to the destabilization of the approach.

- **Attention – a contributor.**

During the landing procedure, pilots did not observe relevant aspects that would indicate the destabilized approach. In addition, the copilot did not pay attention to the fact that the commander had increased the rate of descent instead of reducing it after reporting that the aircraft was too low.

This inattention on the part of the crew contributed to the occurrence, as it made possible the descent of the aircraft beyond the expected parameters.

- **Attitude – a contributor.**

Failure to comply with the procedures established in the Aerodrome approach chart contributed to the occurrence of the serious incident, as it added greater risk and greater complexity to that air operation.

- **Crew Resource Management – a contributor.**

Although it was not possible to analyze the data of the voice recorder of the aircraft, it was evident a deficiency in the coordination of the cabin by not observing several operating procedures, such as: stabilized approach parameters, procedures for EGPWS warning of Too Low, Terrain, compliance with DOP 28/17, among others cited in the report.

- **Team dynamics – a contributor.**

The interaction of the pilots during the approach and landing moments was compromised, in view of the absence of a detailed briefing on the technique used in the approach to the landing and the work overload to which they underwent by choosing a procedure divergent from the predicted, thus favoring the continuation of the flight below the established minimum limits.

- **Piloting judgment – a contributor.**

The evaluation of performing a dive and drive approach, based on the final approach of the SBGL RNAV Y RWY 28 procedure, proved to be inadequate, as it did not bring operational advantage to that crew, yet it did not comply with parameters and restrictions of safety.

- **Perception – a contributor.**

The lack of precision regarding the perception of the parameters of the aircraft during the final approach resulted in the surpassing of restrictions imposed on the chart profile, indicating a lowering of the level of situational awareness presented by the crew.

- **Decision-making process – a contributor.**

The decision to proceed with the landing approach, as well as the technique chosen to carry out this procedure, showed a precipitous and imprecise assessment of the risks involved in that type of operation.

- **Organizational processes – undetermined.**

The excess of existing communication channels in the airline, the lack of prioritization of messages of greater operational relevance, as well as the possible difficulties in communication between the different sectors may have led to the emergence of a scenario unfavorable to the proper assimilation of operational procedures and standardization of the crew.

- **Support systems – undetermined.**

The discrete form, such as the procedure for air operations, in case of a ceiling below the minimums presented in the approach charts, was dealt with in DOP 28/17, may have contributed to a low assimilation of the crew on the guidelines defined by the airline.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident. In addition to safety recommendations arising from accident and incident investigations, safety recommendations may result from diverse sources, including safety studies.

In consonance with the Law n°7565/1986, recommendations are made solely for the benefit of the air activity operational safety, and shall be treated as established in the NSCA 3-13 "Protocols for the Investigation of Civil Aviation Aeronautical Occurrences conducted by the Brazilian State".

Recommendations issued at the publication of this report:

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

IG-105/CENIPA/2017 - 01 **Issued on 01/29/2019**

Act together with Oceanair Airlines (Avianca), in order to the company clearly define an Operational Directive, establishing the positioning of the airline regarding the use of the "dive and drive" technique by its crew.

IG-105/CENIPA/2017 - 02 **Issued on 01/29/2019**

Act together with Oceanair Airlines (Avianca), so that the company reinforces the disclosure of the procedure, established within the company, regarding the execution of an IFR approach when the reported ceiling and/or visibility are lower than those presented in the respective charts.

IG-105/CENIPA/2017 - 03 **Issued on 01/29/2019**

Act together with Oceanair Airlines (Avianca) to provide a theoretical instruction on EGPWS for all technical crewmembers of the company.

To the Airspace Control Department (DECEA):

IG-105/CENIPA/2017 - 04 **Issued on 01/29/2019**

Evaluate the pertinence of including the indication of the fix GL083 in the instrument approach chart RNAV Y RWY 28 of SBGL, with the purpose of increasing the situational awareness of the pilots, regarding the vertical limits of the approach.

IG-105/CENIPA/2017 - 05 **Issued on 01/29/2019**

Evaluate the pertinence of including the nominal indication of Stepdown Fixes in the approach charts of non-precision procedures, whenever there is a designation nomenclature established for the respective point.

IG-105/CENIPA/2017 - 06 **Issued on 01/29/2019**

Re-evaluate the established criteria for runway selection in SBGL, considering the lessons learned in this Investigation.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

The technical crew involved in the incident underwent simulator requalification training, aiming to cover all types of approach and automatism of the aircraft, as well as training in route with the same objective.

The company's MGO was updated (Revision 28), including, among other modifications, the revision of the section identified in this RF, that was in disagreement with RBAC 121.

The Mandatory Communication Occurrences form to the Avianca Safety Directorate has been updated.

On January 29th, 2019.