COMANDO DA AERONÁUTICA

CENTRO DE INVESTIGAÇÃO E PREVENÇÃO DE ACIDENTES AERONÁUTICOS

FINAL REPORT
IG - 016/CENIPA/2017

OCCURRENCE:	**SERIOUS INCIDENT**
AIRCRAFT:	**PR-AZG**
MODEL:	**ERJ 190-100 IGW**
DATE:	**28JAN2017**

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 by taking into account the contributing factors and hypotheses raised. The report is, therefore, a technical document that 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 into the Brazilian legal system by 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 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 28JAN2017 serious incident with the ERJ 190-100 IGW aircraft model, registration PR-AZG. The serious incident was classified as “[SCF-NP] System/Component Failure Non-Powerplant – Unintentional/explosive decompression”.

During a regular flight between the cities of Curitiba and Recife, with approximately two hours of flight, the aircraft was depressurized during the cruise phase at FL370 due to the opening of the Positive Relief Valve for a period of two minutes and three seconds.

The opening of the valve occurred with a pressure differential lower than expected, possibly caused by the formation of ice inside.

Cabin altitude reached a maximum value of 18,050 ft. There was the High Cabin Alt message and the oxygen masks automatically dropped.

The crew performed an emergency descent and switched destiny to the Deputado Luís Eduardo Magalhães Aerodrome (SBSV), Salvador - BA.

The landing was uneventful. The aircraft had no damage.

All occupants of the aircraft left unharmed.

An Accredited Representative of the *Bundesstelle für Flugunfalluntersuchung* (BFU) – Germany, (State where the components of the pressurization system were manufactured and place of examinations) was designated for participation in the investigation.

CONTENTS

GLOSSARY OF TECHNICAL TERMS AND ABBREVIATIONS

ADTS	Air Data Test Set
ANAC	Brazil's National Civil Aviation Agency
BFU	Bundesstelle für Flugunfalluntersuchung
CA	Airworthiness Certificate
CENIPA	Aeronautical Accident Investigation and Prevention Center
CMA	Aeronautical Medical Certificate
CPCS	Cabin Pressure Control-System
DECEA	Air Space Control Department
DVDR	Digital Voice and Data Recorder
IFRA	Instrument Flight Rating - Airplane
LABDATA	Flight Data Recorders Read-Out and Analysis Laboratory
NSCA	Aeronautics Command System Standard
NVM	Non-Volatile Memory
OFV	Outflow Valve
PCM	Commercial Pilot License – Airplane
PIC	Pilot in Command
PLA	Airline Pilot License – Airplane
PN	Part Number
PPR	Private Pilot License – Airplane
PSO-BR	Operational Safety Plan for Brazilian Civil Aviation
SBCT	ICAO Location Designator - Afonso Pena Aerodrome, Curitiba - PR
SBRF	ICAO Location Designator - Guararapes Aerodrome - Gilberto Freyre, Recife - PE
SBSV	ICAO Location Designator - Deputado Luís Eduardo Magalhães Aerodrome, Salvador - BA
SIC	Second in Command
SIPAER	Aeronautical Accident Investigation and Prevention System
SN	Serial Number
SV	Safety Valve
TAT	True Air Temperature or Total Air Temperature
TMA-SV	Terminal Control Area - Salvador
TPR	Aircraft Registration Category of Regular Public Transport
UTC	Universal Time Coordinated
VDC	Voltage Direct Current

1. FACTUAL INFORMATION.

Aircraft	**Model:** ERJ 190-100 IGW **Registration:** PR-AZG **Manufacturer:** EMBRAER	**Operator:** Azul *Linhas Aéreas Brasileiras* S.A
Occurrence	**Date/time:** 28JAN2017 - 1315 UTC **Location:** TMA-SV **Lat.** 12°54'31"S **Long.** 038°19'21"W **Municipality – State:** Salvador – BA	**Type(s):** "[SCF-NP] System/Component Failure Non-Powerplant" **Subtype(s):** Unintentional/explosive decompression

1.1 History of the flight.

The aircraft took off from the Afonso Pena Aerodrome (SBCT), Curitiba - PR, to the Guararapes - Gilberto Freyre Aerodrome (SBRF), Recife - PE, at about 1115 (UTC), to transport cargo and personnel, with five crewmembers. and one hundred and four passengers on board.

After about two hours of flight, when the aircraft was at FL370, the cabin altitude rose from the initial value of about 8,000 ft to 18,050 ft in approximately two minutes. There was the automatic drop of the oxygen masks.

An emergency descent procedure was performed, and the flight proceeded to land on the Deputado Luís Eduardo Magalhães Aerodrome (SBSV), which was performed without intercurrences. The aircraft had no damage.

The five crewmembers and one hundred and four passengers left unharmed.

1.2 Injuries to persons.

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	5	104-	-

1.3 Damage to the aircraft.

There was no damage to the aircraft.

1.4 Other damage.

None.

1.5 Personnel information.

1.5.1 Crew's flight experience.

Flight Hours		
	PIC	SIC
Total	12.000:00	3.000:00
Total in the last 30 days	76:00	65:00
Total in the last 24 hours	05:00	05:00
In this type of aircraft	2.000:00	1.500:00
In this type in the last 30 days	76:00	65:00
In this type in the last 24 hours	05:00	05:00

N.B.: The data relating to flown hours were obtained from the aircraft operator's records.

1.5.2 Personnel training.

The PIC took the PPR course at the Santa Cruz do Sul Aeroclub - RS, in 1990.

The SIC took the PPR course at the EJ *Escola de Aviação Civil* in Itápolis - SP, in 2009.

1.5.3 Category of licenses and validity of certificates.

The PIC had the PLA License and had a valid E179 aircraft type Rating (which included the ERJ 190-100 IGW model) and an IFRA Rating.

The SIC had the PCM License and had valid E179 aircraft type and IFRA Ratings.

1.5.4 Qualification and flight experience.

The pilots were qualified and had experience in the type of flight.

1.5.5 Validity of medical certificate.

The pilots had valid CMAs.

1.6 Aircraft information.

The aircraft, serial number 19000329, was manufactured by EMBRAER in 2009 and was registered in the TPR category.

The aircraft had a valid CA.

The technical maintenance records were updated.

The last inspection of the aircraft, the “Heavy Check” type, which consisted of a series of inspections and maintenance tasks, was carried out between 11DEC2016 and 19JAN2017, by the maintenance organization TAP *Manutenção e Engenharia Brasil* SA, in Porto Alegre - RS.

The PR-AZG aircraft had 22,783 hours flown and 18,034 cycles on the inspection date. After the maintenance action and until the flight of the occurrence, the aircraft flew 60 hours and performed 51 cycles.

Among the maintenance tasks performed in the “Heavy Check”, the Positive Relief Valve functional test was performed, using a piece of equipment called ADTS. No discrepancies were found in the tests performed.

In the aircraft's failure log system, there was no release related to the pressurization system.

Until the moment of this occurrence, the plane had a total of 22,843 flight hours and 18,085 cycles.

The aircraft was equipped with a pressurization system that allowed the air inside the cabin to remain in a suitable condition for the transport of passengers during normal operation.

This operation was done through the air bled from the compressor stages of the two engines being directed, then, to the interior of the cabin after passing through the air conditioning and ventilation systems, as shown in Figure 1.

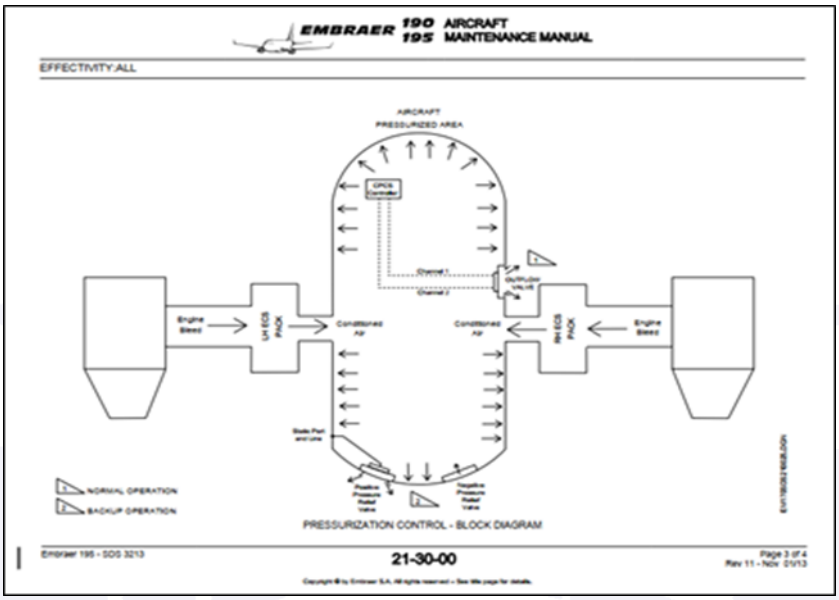

Figure 1 - Schematic diagram of the aircraft's pressurization system.
Source: EMBRAER 190/195 Aircraft Maintenance Manual.

The PR-AZG pressurization system was composed of subsystems for control and an indication of pressurization and cabin pressure relief.

The main component of the pressurization control and indication subsystem was the CPCS. In its normal mode, the CPCS controlled the pressure inside the cabin in a fully automated manner, regulating the airflow rate through the OFV. The crew could also control the pressurization system manually by adjusting the position of the OFV.

The CPCS had two independent control channels that monitored the pressure inside the cabin, providing indications in case of failure to the crewmembers.

The cabin pressure relief subsystem had the purpose of protecting the aircraft's fuselage structure in cases of overpressure and negative pressure differential. This subsystem consisted of the Positive Relief Valve, also called Safety Valve, and the Negative Relief Valve (Figure 2).

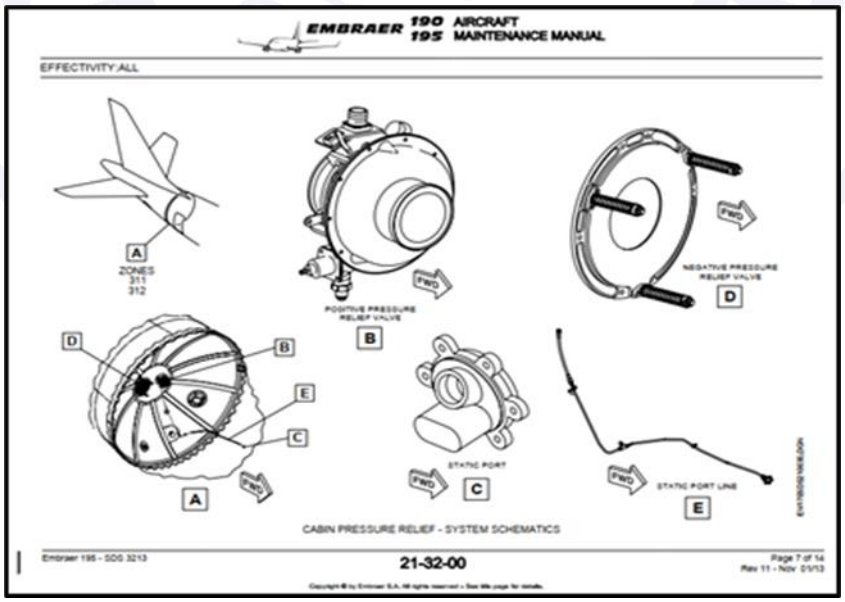

Figure 2 - Arrangement of the pressure relief subsystem components.
Source: EMBRAER 190/195 Aircraft Maintenance Manual.

The pressure relief subsystem operated pneumatically and independently of the rest of the pressurization system and did not require any crew action for its operation. The Positive Relief Valve allowed the passage of air from the interior of the aircraft to the outside when the pressure differential reached values greater than 8.66 psid (or 597 hPa). The Negative Relief Valve allowed the passage of external air to the interior of the cabin when the pressure differential was -0.15 psid (or -10 hPa).

The aircraft had a static port that supplied pressure from the outside environment to the Positive Relief Valve through aluminum tubing.

The static door had a screen against ingestion of foreign objects and a 28 VDC heating system, coming from the essential bus of the aircraft, in order to avoid blocking the entrance due to ice formation.

Figure 3 shows the schematic operation of the Positive Relief Valve and Figure 4 shows the Valve Control Unit.

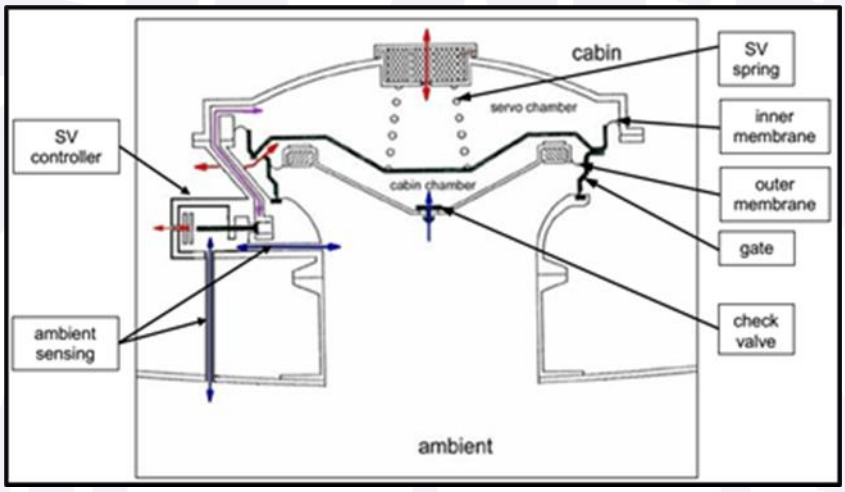

Figure 3 - Positive Relief Valve schematic diagram.

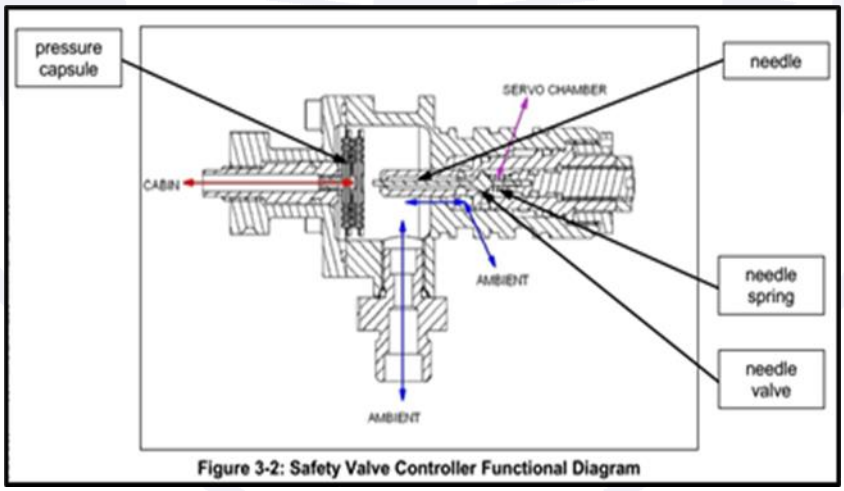

Figure 4 - Positive Relief Valve controller unit (SV Controller).

In summary, the Positive Relief Valve worked as follows: the cabin chamber was at the same pressure as the aircraft cabin. The pressure differential was measured on the Positive Relief Valve Control Unit (SV Controller). When this value was greater than or equal to 8.67 psid (597 hPa), the pressure capsule pressed the needle of the controller unit allowing the passage of air from the servo chamber to the external environment. and, consequently, equating the pressure value of the chamber with that of the external air.

The pressure difference between the two chambers caused the displacement of the Positive Relief Valve membrane, overcoming the force of the spring inside the servo chamber. This displacement allowed the valve to be opened through the gates and the air to escape from inside the cabin.

1.7 Meteorological information.

The weather conditions were favorable for the flight.

1.8 Aids to navigation.

Nil.

1.9 Communications.

The crewmembers declared an emergency and requested priority for landing at SBSV. All communications were uneventful.

1.10 Aerodrome information.

The serious incident occurred out of the Aerodrome.

1.11 Flight recorders.

The aircraft was equipped with a combined voice and flight data recorder, DVDR, Part Number 960-6025-001, and Serial Number (SN) 02551 from Honeywell.

Data from the recorders were extracted at the facilities of the CENIPA`s LABDATA. Figure 5, below, presents the parameters of the flight pressurization system.

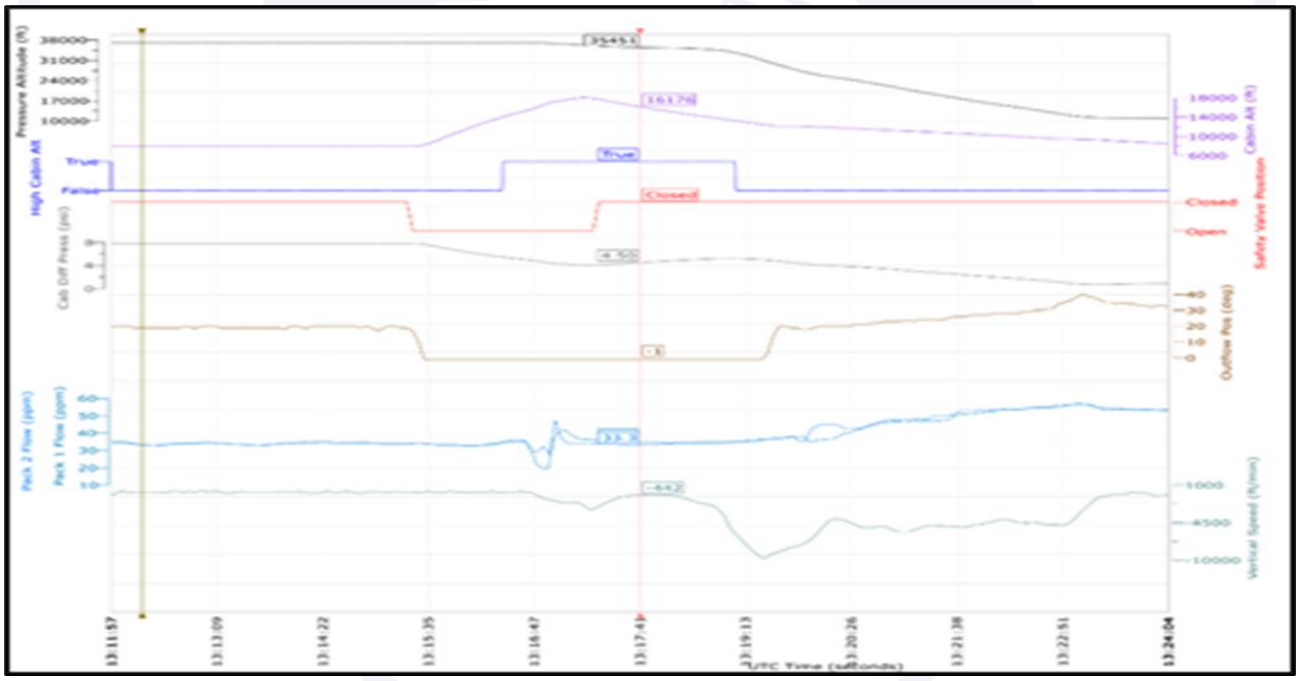

Figure 5 - Pressurization parameters extracted from flight recorders.

In Figure 5, it is possible to observe the change in position of the Positive Relief Valve (Safety Valve Position parameter, indicated by the red line) from closed to open, at 01:15:25 pm (UTC), and the pressure differential between the cabin and the external environment, which at that time it was 7.78 psid (536 hPa). The Positive Relief Valve remained open for two minutes and three seconds.

From the change in position of the Positive Relief Valve, it is possible to observe an increase in the cabin altitude and, consequently, a decrease in the cabin pressure differential and the outside air.

By the logic of the pressurization system, the OFV went to the closed position due to the increase in the cabin altitude.

About a minute after the Positive Relief Valve opened, the cabin reached 14,000 ft. There was an indication of high cabin altitude (High Cabin Alt) and the automatic drop of oxygen masks.

The crewmembers performed emergency procedures and began the descent of the aircraft shortly after the High Cabin Alt message. Even in the time interval that the Positive Relief Valve was in the open position, the cabin altitude continued to rise until reaching the maximum value of 18,050 ft.

After the Safety Valve closed, the cabin altitude began to decrease. The crew continued with the emergency descent procedure increasing the descent rate value to reaching approximately 10,000 ft/min and then varying around 4,500 ft/min.

The landing was performed at SBSV Aerodrome without major complications.

Additionally, data were extracted from the NVM of the CPCS, which helped in carrying out the exams, tests, and research conducted. The data demonstrated that there was no internal failure of the CPCS.

1.12 Wreckage and impact information.

Nil.

1.13 Medical and pathological information.

1.13.1 Medical aspects.

No evidence was found that problems of physiological nature could have affected the flight crew performance.

1.13.2 Ergonomic information.

Nil.

1.13.3 Psychological aspects.

No evidence was found that problems of physiological nature or incapacitation could have affected the flight crew's performance.

1.14 Fire.

There was no fire.

1.15 Survival aspects.

All occupants disembarked from the aircraft unharmed through the main doors.

1.16 Tests and research.

The following items were tested:

- CPCS / PN: 21609-04BA / SN: 0982775;

- OFV / PN: 21425-01 / SN: 09113088; and

- Positive Relief Valve / PN: 21615-02 / SN: 09112694.

All components were installed in the aircraft since the beginning of its operation, thus having 22,843 flight hours and 18,085 cycles each.

Bench tests were performed in the CPCS. The resistance referring to the covering of the component was out+ the predicted values. However, no failures were found in the logic tests performed.

Figure 6 - CPCS removed from the aircraft.

Electrical and leakage functional tests were carried out at the OFV, in addition to visual inspections. All tests were within the established parameters.

Figure 7 - Outflow Valve overview.

Initially, a visual inspection was performed on the Positive Relief Valve, as shown in Figures 8 and 9, below:

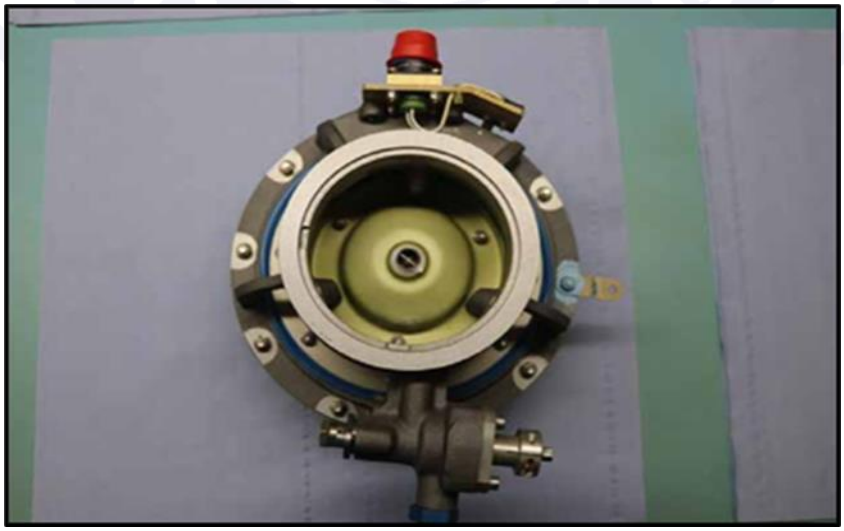

Figure 8 - Positive Relief Valve viewed towards the external, non-pressurized section of the aircraft.

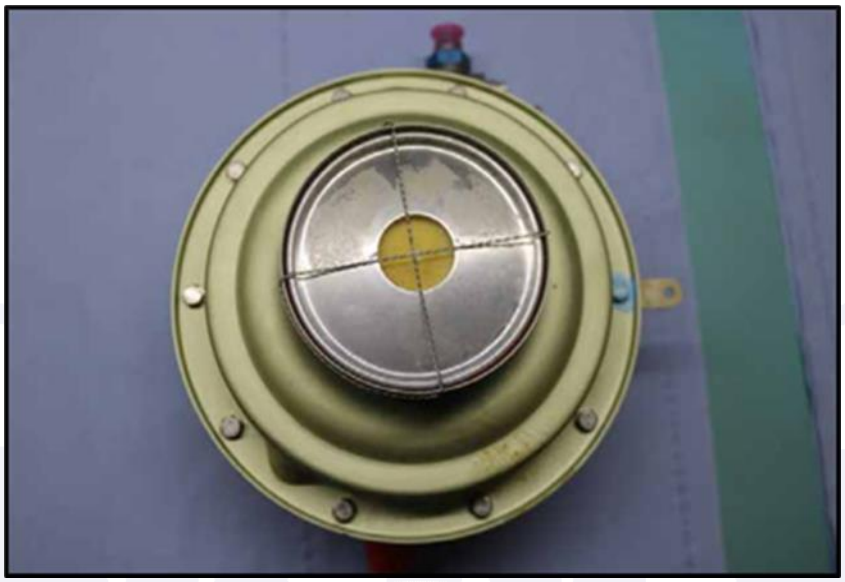

Figure 9 - Positive Relief Valve viewed towards the internal, pressurized, section of the aircraft.

No discrepancies were found in the initial inspection.

Before disassembling the Positive Relief Valve, a computed tomography scan was performed in order to verify the existence of any internal condition that could have contributed to its opening.

Figures 10, 11, and 12, below, show the results of the computed tomography.

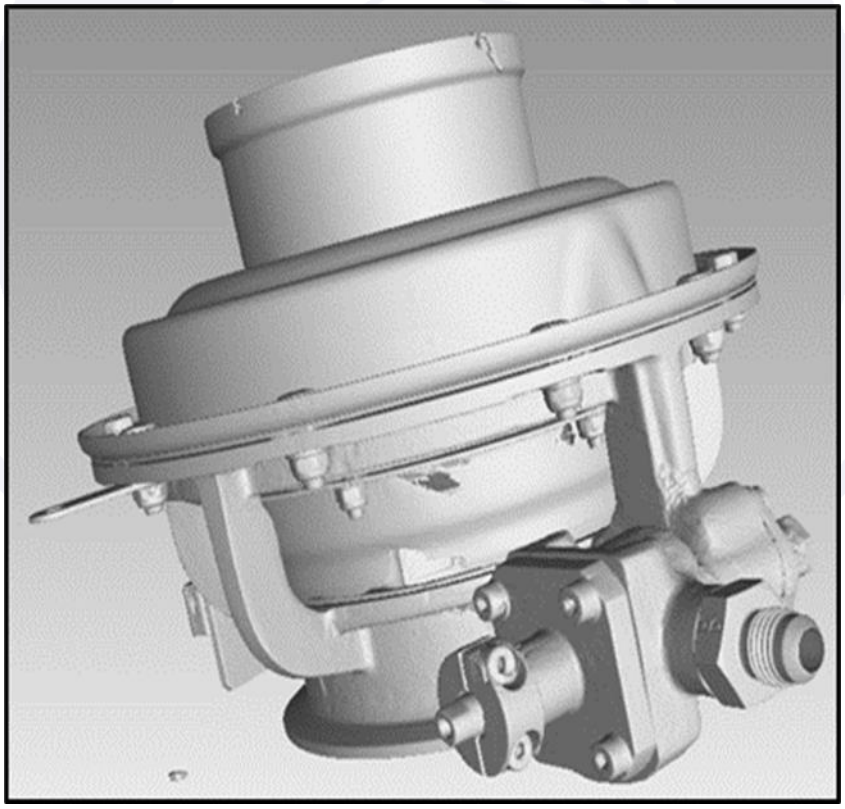

Figure 10 - Computed tomography of the Positive Relief Valve. Perspective view.

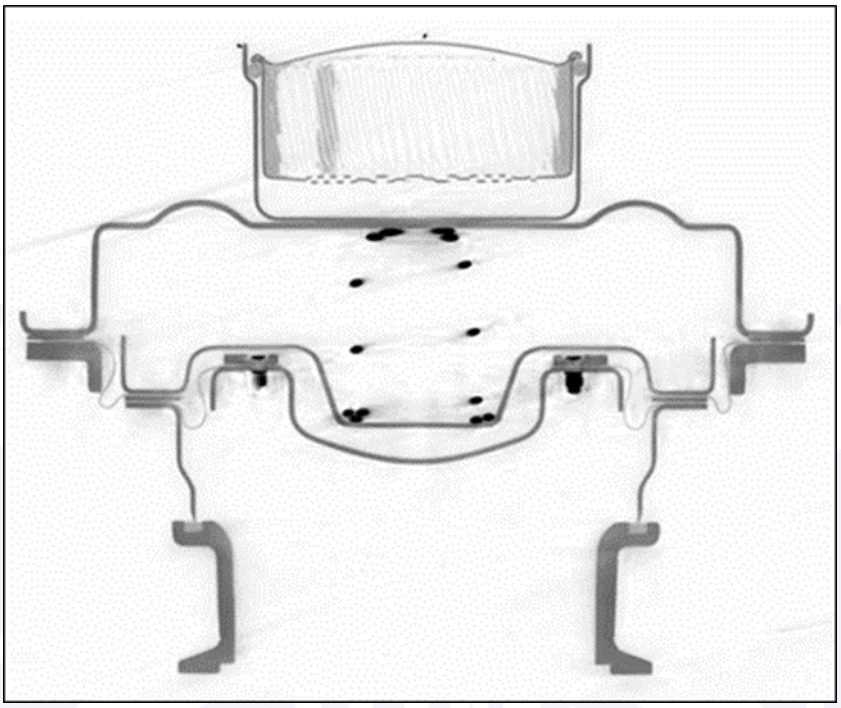

Figure 11 - Computed tomography of the Positive Relief Valve. Cross-section view.

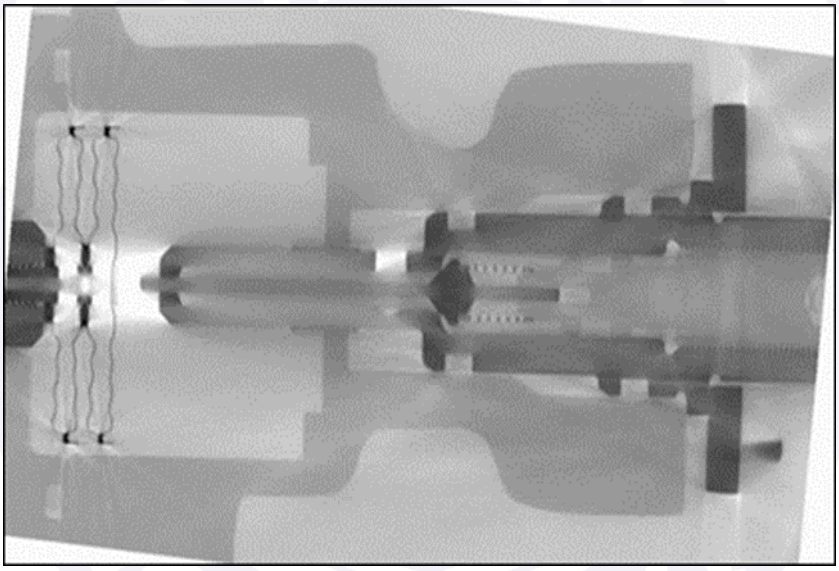

Figure 12 - Computed tomography of the Positive Relief Valve needle.

The CT scan did not reveal any foreign objects or conditions that could cause the valve to open in flight.

Then, a functional test was performed on the Positive Relief Valve, which consisted of visual inspection and electrical, pressurization, and sealing tests.

The following conditions were verified in the visual inspection:

- general condition: not approved in the corrosion criterion;

- air filter: not approved in the cleaning criteria;

- control valve pressure doors: not approved in the cleaning criterion and for the presence of dust; and

- sealing ring: not approved in the criterion regarding the presence of dust.

No failures were found in the pressurization and sealing tests.

After functional testing, the Positive Relief Valve Control Unit was dismantled and inspected.

The parameters of spring resistance force and needle leakage of the Control Unit were in accordance with the values established in the manuals. No defects or mechanical irregularities were found inside the unit. It was only verified the presence of small points of contamination in the region indicated in Figures 13 and 14, below:

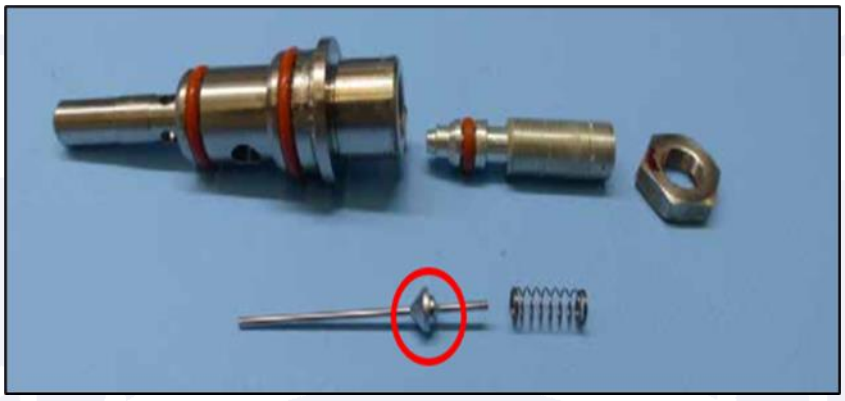

Figure 13 - Disassembly of the Needle of the Controller Unit. Highlighted, where signs of contamination were found.

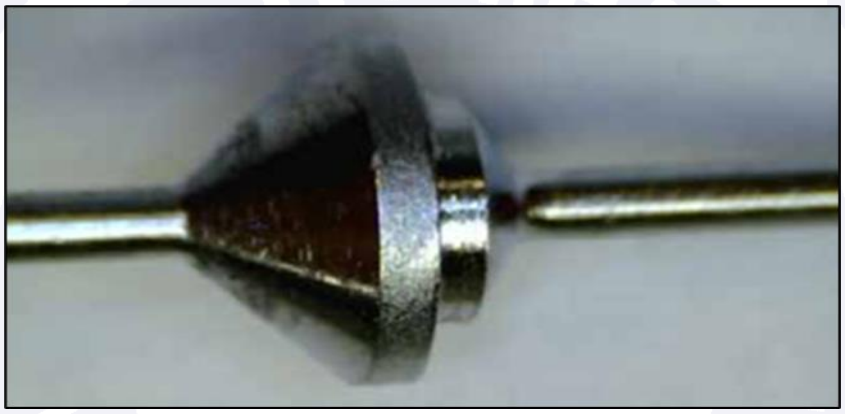

Figure 14 - Small points of contamination inside the Control Unit.

The Control Unit's pressure capsule was also dismantled and examined. The wall inside the capsule was contaminated by residues of solid material, as shown in Figures 15, 16, and 17, below:

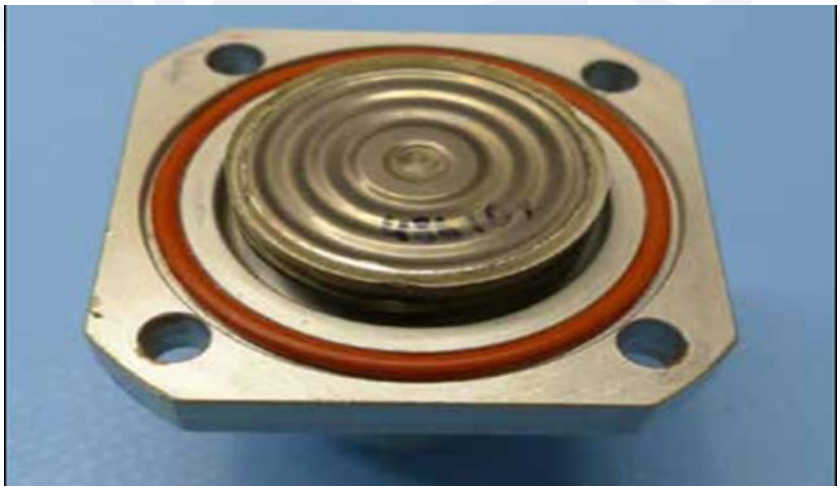

Figure 15 - General view of the pressure capsule.

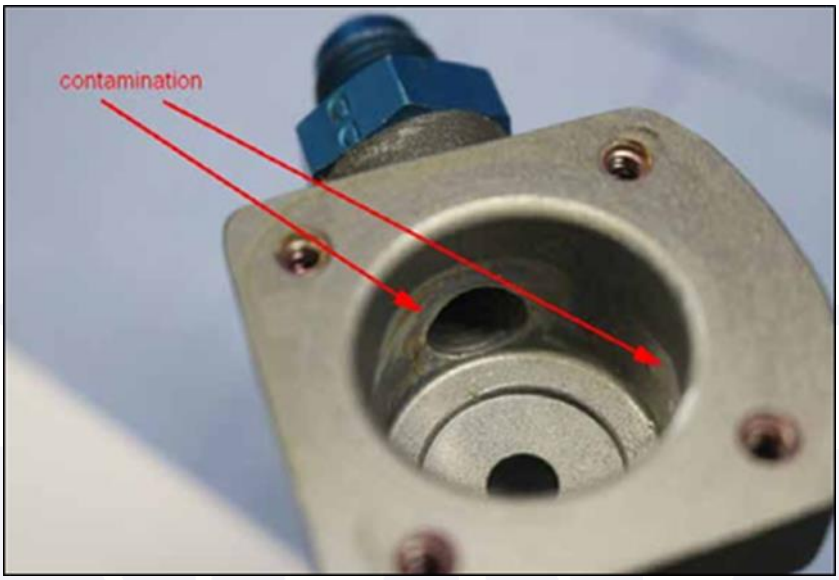

Figure 16 - Points of contamination inside the pressure capsule (View 1 of 2).

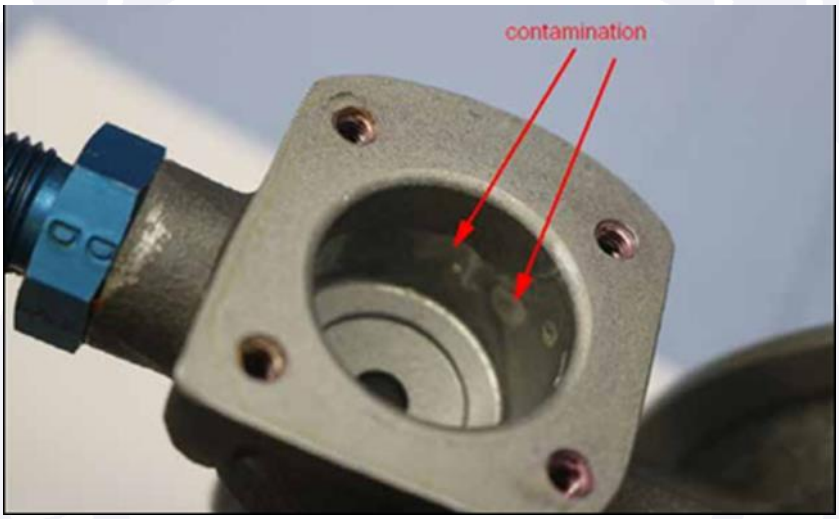

Figure 17 - Points of contamination inside the pressure capsule (View 2 of 2).

Finally, a simulation of the opening of the Positive Relief Valve was performed under the flight conditions of the event, according to the parameters shown below:

- aircraft leakage area: 0.000918 m² (the cubic leakage flow varies according to the pressure differential);

- inlet flow set to 85%: 80 lb/min;

- stable initial cruising conditions: 35,000 ft and cabin altitude of 8,000 ft;

- valve opening simulation: input ramp of 3s; and

- additional leak area with Positive Relief Valve fully open. 0.00568 m² (varies depending on the pressure differential).

The simulation result is shown in Figure 18. The red line represents the data extracted from the CPC`s NVM and the blue line the simulation data using the simulation parameters.

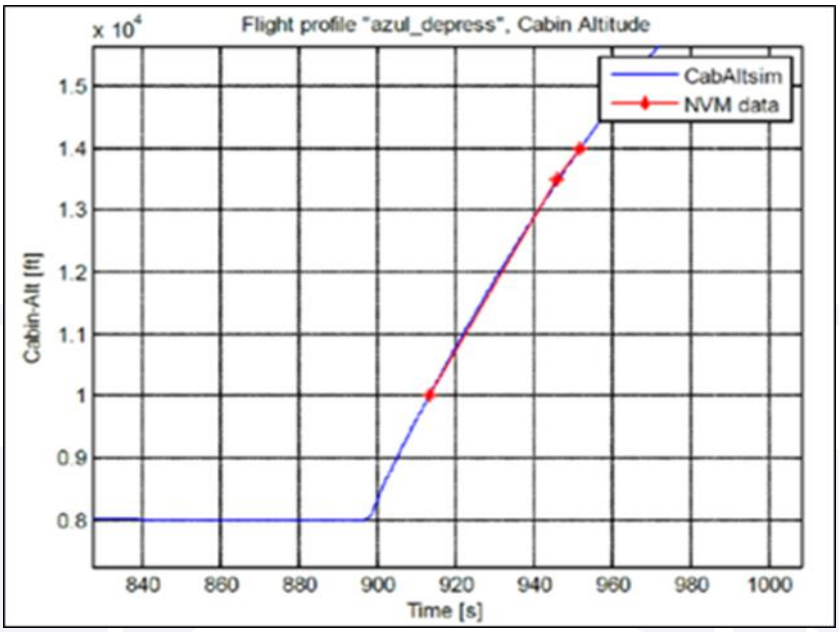

Figure 18 - Simulation of depressurization with the opening of the Positive Relief Valve performed by the component manufacturer.

Additionally, a test was performed on another aircraft to measure the temperature of the Positive Relief Valve during flight.

A total of five temperature gauges called I-buttons were installed on the valve, as shown in Figure 19.

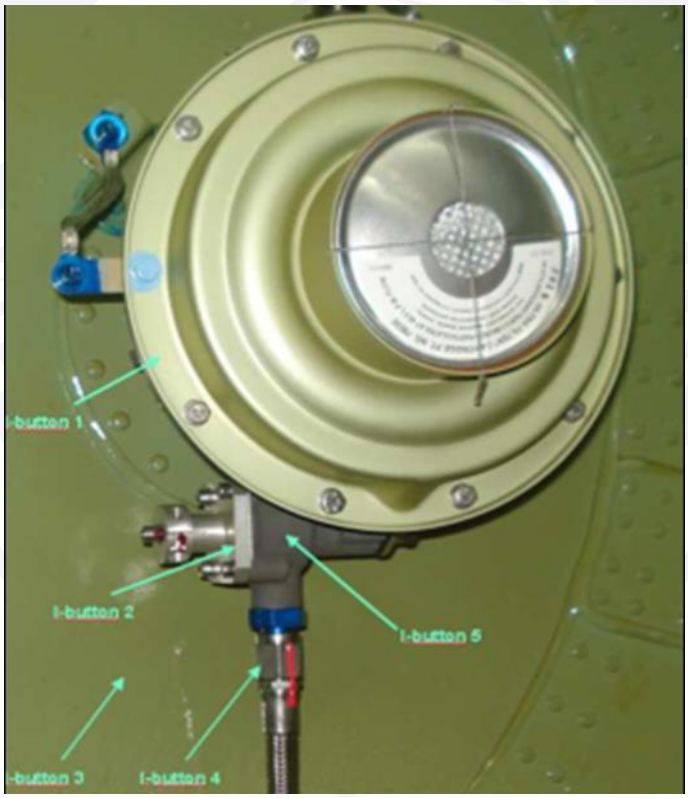

Figure 19 - I-buttons installation locations on a Positive Relief Valve.

In-flight tests with the I-buttons installed in the Positive Relief Valve showed that values below 0°C were reached after one hour of flight at negative temperatures measured by the TAT sensor.

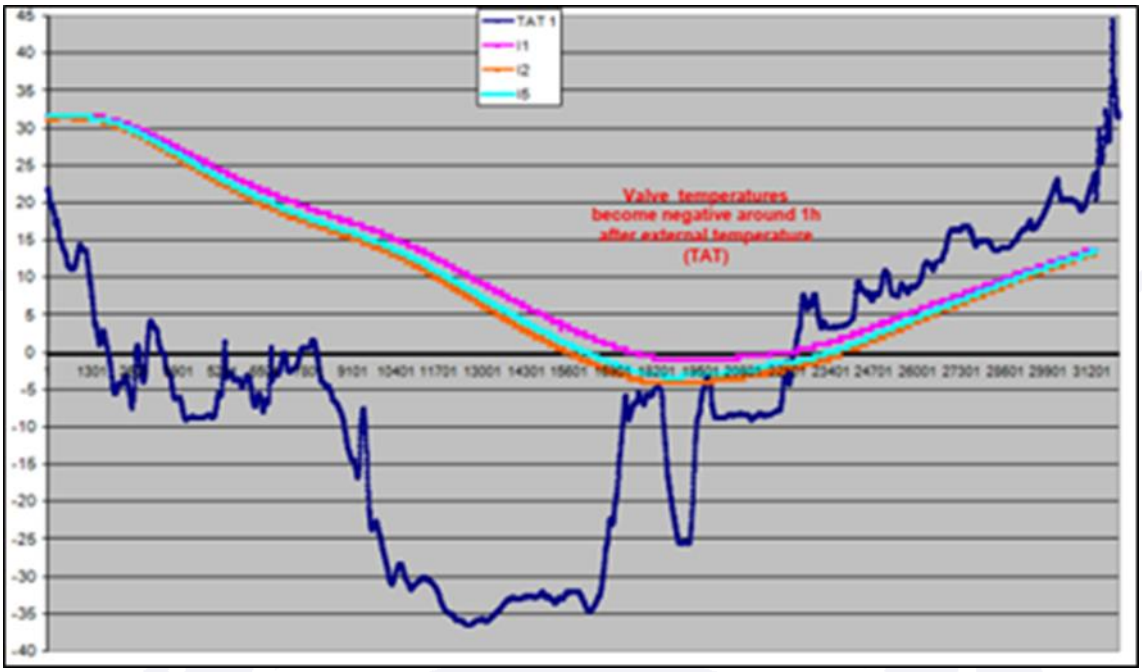

Figure 20 - Comparison between the measurement of the Positive Relief Valve temperature sensors and the external temperature.

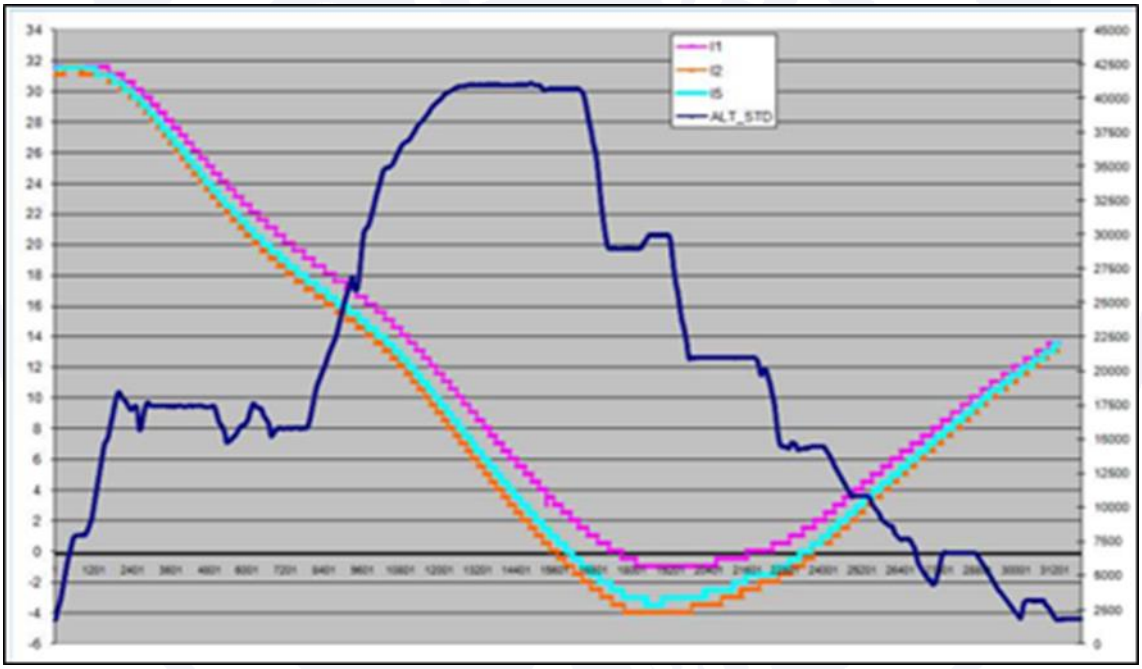

Figure 21 - Comparison between the measurement of the Positive Relief Valve's temperature sensors and the altitude of the aircraft.

1.17 Organizational and management information.

Nil.

1.18 Operational information.

The loss of aircraft pressurization generated the message Cabin Altitude Hi. For this failure message, the procedures shown in Figure 22 were expected to be performed.

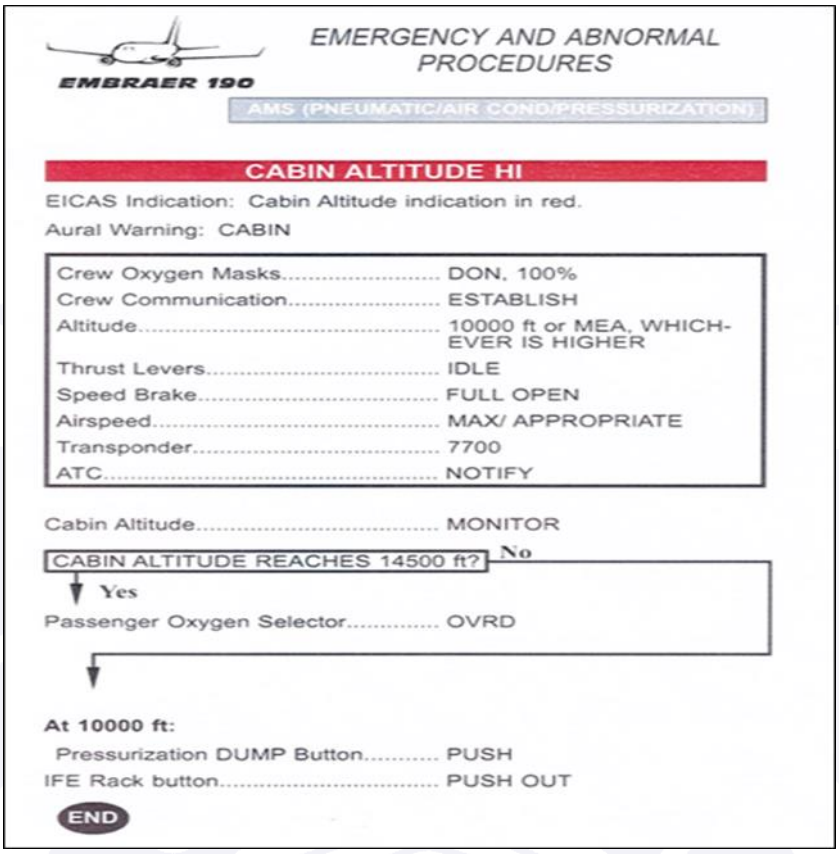

Figure 22 - Checklist related to the Cabin Altitude Hi failure. Source: Aircraft Flight Manual Revision 12.

1.19 Additional information.

The aircraft manufacturer reported that, in addition to this occurrence, there was only one more event of opening the Positive Relief Valve and depressurization of the aircraft in flight.

Also, according to information from the manufacturer, the aircraft fleet of this model accumulated more than 32 million flight hours. Therefore, the measured failure rate would be approximately 6.2x10-8 occurrences per flight hour, lower than the predicted rate for events of this nature whose severity rating would be greater.

1.20 Useful or effective investigation techniques.

Nil.

2. ANALYSIS.

It was a regular passenger transport flight between SBCT and SBRF.

After approximately two hours of flight time, when the aircraft was cruising at FL370, the cabin altitude went from 8,000 ft to 18,050 ft in two minutes and three seconds, during which time the flight recorder data registered the Positive Relief Valve in the open position.

The opening of the Positive Relief Valve caused pressurized air to escape from the aircraft, thus raising the cabin altitude. The CPCS detected this increase in the cabin altitude and commanded the total closure of the OFV.

Despite the OFV being completely closed, the compressed air inlet from the engines was not able to supply the loss of pressurization caused by the opening of the Positive Relief Valve.

The logical behavior of the CPCS allows to rule out any contribution of this component to the sequence of events of the depressurization of the aircraft, despite the resistance related to the coverage of the component outside the predicted values found in the bench tests.

The examinations performed at the OFV were within the established parameters, also allowing to rule out any contribution of this component to the depressurization of the aircraft.

The Positive Relief Valve had the function of protecting the aircraft structure from pressure differentials above the values calculated in the project, which were 8.66 psid (597 hPa).

At the time of opening the Positive Relief Valve, the pressure differential between the cabin and the outside environment was 7.78 psid (536 hPa). Therefore, there was a premature opening of the valve.

Flight tests carried out on another aircraft, with temperature sensors installed in the Positive Relief Valve, showed that values below 0°C were reached after one hour of flight at cruise temperatures and attitudes typical of this aircraft model.

Thus, it is possible that the conditions for humidity condensation and ice formation inside the valve were also present in this event.

The tests carried out at the Positive Relief Valve, PN: 21615-02 and SN: 09112694, showed signs of contamination by residues of solid material in the pressure capsule of the Control Unit, without the identification of any foreign body in the valve, corroborating the hypothesis of that there was ice formation in flight, when the conditions were right and, when these were no longer present, the ice melted.

Based on the evidence of solid material found in the Positive Relief Valve Control Unit, three failure modes were identified in which ice formation would result in an opening with a lower pressure differential than anticipated:

- ice formation inside the control valve chamber causing displacement of the pressure capsule;

- ice formation between the pressure capsule and the needle of the Control Unit, resulting in the reduction of the space between the two parts; and

- ice formation inside the pressure capsule, resulting in its deformation.

The failure modes are shown highlighted in Figure 23 represented by codes 02.02, 02.03, and 02.04, respectively.

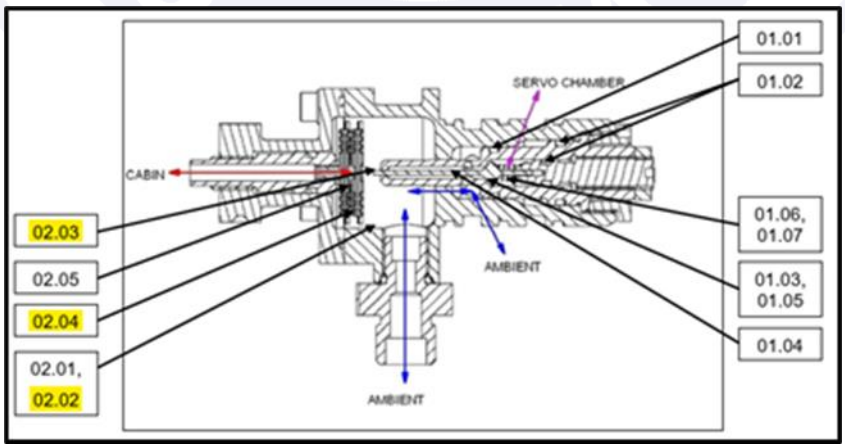

Figure 23 - Positive Relief Valve Control Unit failure modes raised by the component manufacturer.

In addition to these three failure modes mentioned, another nine related to the controller of the Positive Relief Valve and another twelve related to the valve's servo chamber were raised.

Among the three modes, the first two were considered most likely and the third was considered unlikely due to the absence of signs of deformation in the pressure capsule.

In all these situations, there would be a displacement of the Control Unit`s needle, allowing the passage of air between the external environment and the servo chamber and, consequently, the premature opening of the Positive Relief Valve.

It was not possible to establish the origin of the accumulation of water inside the valve that would allow the formation of ice for an opening of the valve in a pressure differential below the expected.

It was possible the formation of ice by the process of solidification of the accumulated humidity inside. However, under normal conditions, the volume of water was not sufficient to cause the Positive Relief Valve to open at a differential below the specified. The accumulation of water was drained through the aircraft's pipelines when the aircraft was out of icing conditions.

There were no indications of maintenance actions that could have contributed to the event, given that the aircraft flew 60 hours between the “Heavy Check” inspection, in which functional tests were carried out on the valve, and the flight of the event.

After the opening of the Positive Relief Valve, the appropriate action for the crewmembers was the emergency descent, which was performed as soon as the High Cabin Alt message was displayed.

The crew declared an emergency and requested priority for landing. The descent and landing on SBSV Aerodrome were uneventful.

3. CONCLUSIONS.

3.1 Facts.

a) the pilots had valid CMAs;

b) the pilots had valid E179 and IFRA aircraft Ratings;

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

d) the aircraft had a valid CA;

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

f) the technical maintenance records were updated;

g) the weather conditions were favorable for the flight;

h) the Positive Relief Valve was opened with a pressure differential of 7.78 psid (536 hPa);

i) the Positive Relief Valve remained open for two minutes and three seconds;

j) cabin altitude has reached 18,050 ft;

k) there was the High Cabin Alt message;

l) there was an automatic fall of the oxygen masks;

m) an emergency descent was performed;

n) the crewmembers declared an emergency and requested landing priority;

o) the landing in SBSV was performed without intercurrences;

p) there were signs of contamination in the Controlling Unit of the Positive Relief Valve;

q) flight tests on another aircraft showed that values below 0°C were reached on the Positive Relief Valve after one hour of flight in negative temperatures;

r) the aircraft was not damaged; and

s) all occupants left unharmed.

3.2 Contributing factors.

- **Design – undetermined.**

It was not possible to determine the source of the accumulation of water inside the valve, which would lead to an icing process in the Positive Relief Valve. Such a condition would trigger the opening of the valve with a lower pressure differential than expected with the consequent depressurization of the aircraft.

4. SAFETY RECOMMENDATION.

A proposal of an accident investigation authority based on information derived from an investigation made intending to prevent 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 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".

None.

5. CORRECTIVE OR PREVENTATIVE ACTION ALREADY TAKEN.

None.

On May 27th, 2022.