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Swiss Transportation Safety Investigation Board STSB

Final Report No. 2435

by the Swiss Transportation Safety Investigation Board (STSB)

concerning the serious incident involving the airliner Airbus A330-343 , HB-JHI ,

on 13 September 2024

approx. 50 NM west-northwest of Basel

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General information on this report

The sole purpose of an investigation of an aircraft accident or serious incident is to prevent further accidents or serious incidents from occurring. It is expressly not the purpose of the safety investigation and this report to establish blame or determine liability.[1]

Should this report be used for purposes other than those of accident prevention, this statement should be given due consideration.

The definitive version of this report is the original report in German.

All information, unless otherwise indicated, relates to the time of the serious incident.

All times in this report, unless otherwise indicated, are stated in Coordinated Universal Time (UTC). At the time of the serious incidentserious incident, Central European Time (CET) applied as Local Time (LT). The relation between LT, CET and UTC is:
LT = CET = UTC + 2 hour.

[1] Article 3.1 of the 13th edition of annex 13, effective from 28 November 2024, to the Convention on International Civil Aviation of 7 December 1944 which came into force for Switzerland on 4 April 1947, as amended on 28 November 2024 (SR *0.748.0*)

Article 24 of the Federal Act on Civil Aviation of 21 December 1948, as amended on 1 January 2025 (CAA, SR *748.0*)

Article 1, point 1 of Regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC, which came into force for Switzerland on 1 February 2012 pursuant to a decision of the Joint Committee of the Swiss Confederation and the European Union (EU) and based on the agreement of 21 June 1999 on air transport between Switzerland and the EU (Air Transport Agreement)

Article 2, paragraph 1 of the Ordinance of 17 December 2014 on the Safety Investigation of Transportation Incidents, as amended on 1 January 2025 (OSITI, SR *742.161*)

Summary

Overview

Operator	Swiss International Air Lines Ltd., Malzgasse 15, 4052 Basel
Owner	Swiss International Air Lines Ltd., Malzgasse 15, 4052 Basel
Manufacturer	Airbus S.A.S., Toulouse, France
Aircraft type	A330-343
Country of registration	Switzerland
Registration	HB-JHI
Location	Luxeuil-les-Bains region, France, in the Flight Information Region (FIR) Reims Control, at flight level (FL) 220
Date and time	13 September 2024, 16:20 UTC
Type of operation	Commercial
Flight rules	Instrument Flight Rules (IFR)
Point of departure	Zurich Airport (LSZH)
Destination	Newark Liberty International Airport (KEWR), USA
Flight phase	Take-off and climb
Type of serious incident	Emergency descent due to loss of cabin pressure

Investigation

The serious incident occurred on 13 September 2024 at 16:20 UTC, and the report was received by the STSB at 17:21 UTC. The French safety investigation authority delegated the investigation to Switzerland and appointed a representative to participate in the investigation. The STSB opened an investigation on the same day.

The following information was available for the investigation:

- Radar recordings;
- Records from the flight data recorder (FDR) and the quick access recorder (QAR)[2] ;
- Recordings from the cockpit voice recorder (CVR) in the cockpit;
- Information from crew members;
- On-site investigation results.

This final report will be published by the STSB.

Synopsis

On 13 September 2024, the Airbus A330-343 airliner, registered as HB-JHI, took off from Zurich (LSZH) for a scheduled flight to Newark (KEWR) with flight number LX18. On board were two pilots, ten cabin crew members and 205 passengers.

[2] The QAR is a device similar to a flight data recorder that records essential parameters used by the airline to monitor flight operations and for maintenance purposes.

During the climb, the flight crew received the ECAM[3] message CAB ALT at flight level (FL) 220, followed by the ECAM warning CAB PR EXCESS CAB ALT. Although both outflow valves were indicated as fully closed, the cabin pressure system was unable to build up sufficient cabin differential pressure.

The cockpit crew donned their oxygen masks and initiated an emergency descent. They also manually activated the oxygen masks in the cabin for passengers and cabin crew and decided to return to Zurich, where the aircraft landed without incident.

The passengers and crew were able to leave the aircraft in the normal manner. No one was injured.

Causes

The serious incident, in which the cabin pressure exceeded 10,000 ft during the commercial aircraft's climb and the cockpit crew had to initiate an emergency descent, was caused by a defective skin check valve, which prevented the cabin pressure system from building up sufficient cabin differential pressure.

A service bulletin published by the aircraft manufacturer in 2016 recommending the earliest possible replacement of the skin check valve with a modified skin check valve had not been implemented, which was causal for the serious incident.

Safety recommendations and safety advice

This final report provides one safety recommendation and one safety advice.

[3] ECAM: *Electronic Centralised Aircraft Monitor*

1 Factual information

1.1 Flight preparations and history of flight

1.1.1 Pre-flight history

On the afternoon of 13 September 2024, ground staff and the flight crew prepared the airliner Airbus A330-343, registered as HB-JHI, for flight LX18 from Zurich (LSZH) to Newark (KEWR). Preparations proceeded normally. As usual, the yellow air hoses of the preconditioned air unit (PCU) were connected to the aircraft to supply the aircraft cabin with fresh air (see chapter 1.6.2). When the aircraft was ready to push back from the gate, the hoses were disconnected from the aircraft.

1.1.2 History of flight

At 16:07 UTC, HB-JHI took off from runway 32. The take-off and climb were uneventful, and the cockpit crew did not experience any unusual pressure in their ears. During the climb, the crew contacted Reims Control, which cleared LX18 to climb to FL 300.

As the aircraft passed flight level (FL) 220, at 16:22:22 UTC, the caution message CAB ALT[4] appeared on the Electronic Centralized Aircraft Monitor (ECAM) in the cockpit. The cockpit crew read a cabin pressure altitude of 9200 ft, which was rising slowly but steadily. The crew immediately switched the cabin pressure controller (CPC) from system 1 to system 2. The two outflow valves were completely closed at this point (see section1.6.2.2 1.6.2.2). Nevertheless, the cabin pressure system was unable to build up sufficient cabin differential pressure, causing the cabin pressure altitude to continue to rise. The cockpit crew could not identify any other malfunctions and no further error messages were displayed.

The cockpit crew subsequently requested Reims Control to level off at FL 250, which was granted by the air traffic controller. At the same time, the master warning sounded in the cockpit and the warning message CAB PR EXCESS CAB ALT[5] appeared on the ECAM at 16:23:01 UTC.

The cockpit crew issued an urgency message ("PAN PAN") indicating a cabin pressure problem and donned oxygen masks. About 20 seconds later, the crew transmitted a distress call ("MAYDAY") stating that they would initiate an emergency descent.

Neither member of the cockpit crew could explain what technical problem might have occurred. They informed the cabin crew about the emergency descent and subsequently also manually activated the oxygen masks in the cabin.

During the emergency descent, which took place at a descent rate of around 5000 ft/min, the cabin pressure reached a maximum value of 10,800 ft. When the aircraft reached FL 100, the cabin pressure had also dropped back below 9000 ft and the corresponding messages on the ECAM had disappeared. The return flight to Zurich then took place. The approach to runway 16 and the overweight landing[6] were uneventful.

[4] The caution message CAB ALT appears on the ECAM when the cabin pressure altitude exceeds 8800 ft.

[5] The warning message CAB PR EXCESS CAB ALT appears on the ECAM when the cabin pressure altitude exceeds 9550 ft.

[6] An overweight landing refers to the landing of an aircraft with a mass that exceeds the maximum permissible mass in normal operation. For an Airbus A330-343, there are established procedures for safely performing an overweight landing if necessary.

The passengers and crew were able to leave the aircraft in the normal manner. No one was injured.

1.1.3 Location and time of the serious incident

Location	Luxeuil-les-Bains region, France, in the Flight Information Region (FIR) Reims Control
Date and time	13 September 2024, 16:20 UTC
Lighting conditions	Day
Coordinates	N 47°43’ 26’’ / E 006°24’ 21’’ (WGS[7] 84)

1.2 Injuries to persons

1.2.1 Injured persons

Injuries	Crew members	Passengers	Total of occupants	Other
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	12	205	217	Not applicable
Total	12	205	217	0

1.3 Aircraft damage

1.3.1 Findings on the aircraft

The aircraft was technically inspected after the serious incident. Damage was found to elements of the cabin pressure system around the low-pressure manifold and the emergency ram air inlet (see section 1.6.2.3).

The sealing sleeve and one of two screw clamps were missing at the location between the low-pressure manifold and the check valve of the emergency ram air inlet (see figure 1). The sealing sleeve was found badly damaged inside the aircraft fuselage (see figure 2). The remaining screw clamp on the side of the low-pressure distributor was loose. The second screw clamp could not be found.

[7] WGS: World Geodetic System

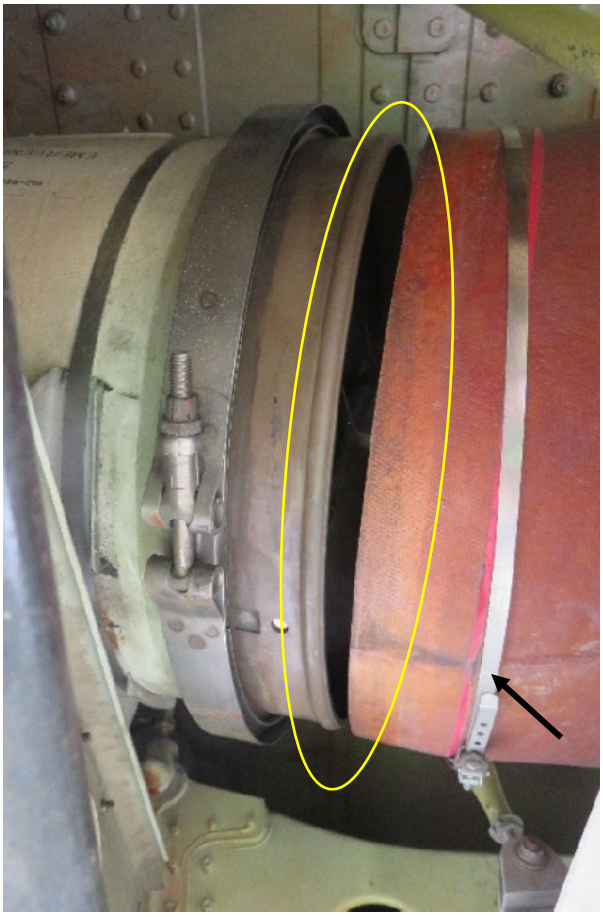

Figure 1: Position between the low-pressure manifold (right image side) and the check valve of the emergency ram air inlet (left image side) with missing sealing sleeve (circled in yellow) and the screw clamp (black arrow) still in place.

Figure 2: Severely damaged sealing sleeve.

On the skin check valve, located between the low-pressure manifold and the mixer unit of the cabin pressure system, one of the two flaps was open more than 90° upwards. The flap was movable and could be closed. The hinge was defective (see section 1.3.2).

1.3.2 Skin check valve

On the removed skin check valve, it was found that the hinge on one flap was broken, and the hinge pin was bent (see figure 3). Furthermore, the leaf spring on the broken hinge, which ensures that the flap closes, was also broken off. The entire hinge, the flaps, the contact surfaces and the end stops were severely damaged.

The skin check valve was a component with part number 4063-18140-01.

Figure 3 : Damaged skin check valve.

1.4 Other damage

No third-party damage occurred.

1.5 Personnel information

1.5.1 Flight crew

1.5.1.1 Commander

Person	Swiss citizen, born in 1962	
Licence	Airline Transport Pilot Licence for aeroplanes (ATPL(A)) in accordance with the European Union Aviation Safety Agency (EASA), issued by the Federal Office of Civil Aviation (FOCA)	
Flying experience	Total	14,808:21 h
	On type	2747:05 h
	During the last 90 days	214:26 h
	On Type	214:26 h

1.5.1.2 First officer

Person	Swiss citizen, born in 1990	
Licence	ATPL(A) only for multi-pilot operations (MP OPS only) in accordance with EASA, issued by the FOCA	
Flying experience	Total	5755:08 h
	On type	2351:07 h
	During the last 90 days	231:09 h
	On type	231:09 h

1.6 Aircraft information

1.6.1 General

Registration	HB-JHI
Aircraft type	A330-343
Characteristics	Twin-engine medium- and long-range aircraft with turbofan engines
Manufacturer	Airbus S.A.S., Toulouse, France
Year of manufacture	2010
Serial number	1181
Operator	Swiss International Air Lines Ltd., Malzgasse 15, 4052 Basel
Owner	Swiss International Air Lines Ltd., Malzgasse 15, 4052 Basel
Total operating hours	Aircraft 62,698:48 h (TSN[8])
Total landings	9441
Mass and centre of gravity	Both the mass and centre of gravity were within the limits specified in the Aircraft Flight Manual (AFM).

1.6.2 Cabin pressure system

1.6.2.1 General

The cabin pressure system ensures that a comfortable and safe environment in terms of air pressure and air temperature is maintained in the aircraft cabin for the crew and passengers throughout the flight.

1.6.2.2 Cabin pressure control

The cabin pressure controller (CPC), which is usually in automatic mode, regulates the cabin pressure primarily via two outflow valves, one at the front and one at the rear of the fuselage. They adjust the outflow rate of the cabin air so that the desired cabin pressure resp. correct cabin differential pressure is maintained. The pressure is regulated by bleed air from the engines, which is processed by the air conditioning packs (PACK) before entering the cabin.

On the A330 aircraft type, the cabin is usually pressurized to a maximum altitude of 7,350 ft (approximately 2,240 m). The system has integrated safety mechanisms, including alarms that alert the cockpit crew of anomalies and automatic deployment of oxygen masks for passengers in the event of a pressure drop at a cabin pressure altitude above 14,000 ft (4,270 m).

The alarms relevant to the present case are as follows:

- The CAB ALT caution message appears on the ECAM when the cabin pressure altitude exceeds 8,800 ft.
- The warning message CAB PR EXCESS CAB ALT appears on the ECAM when the cabin pressure altitude exceeds 9550 ft.

[8] TSN: *Time Since New*, operating time since manufacture

1.6.2.3 Sources of the pneumatic system

During flight, the engines are the primary source of bleed air for the PACK. On the ground, when the engines are not running, the auxiliary power unit (APU) usually supplies the PACK with bleed air (see figure 4). The PACK then supplies the mixer unit with the necessary fresh air.

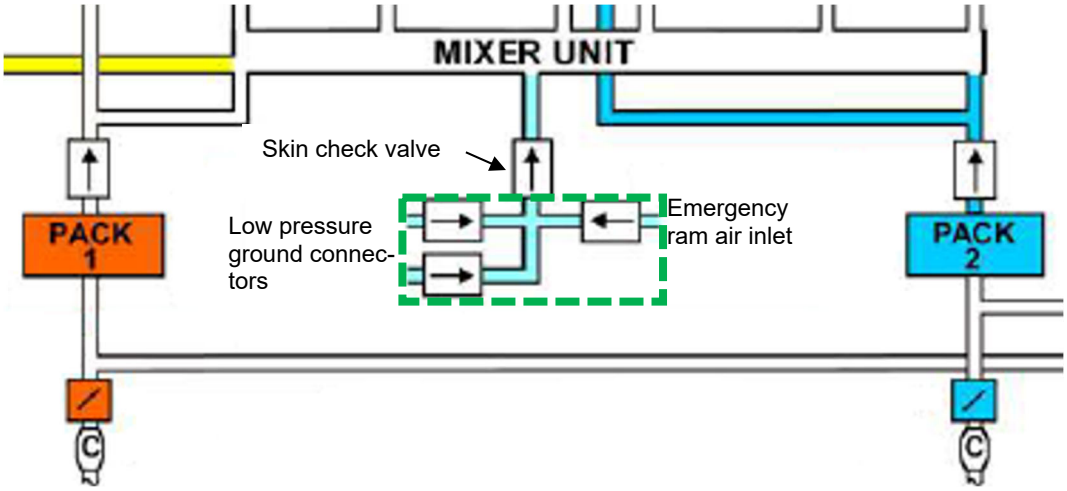

Figure 4: Schematic of the mixer unit of the cabin pressure system and the low-pressure manifold (green dotted frame). Source: Aircraft manufacturer, edited by STSB.

Alternatively, an external pneumatic source, a preconditioned air unit (PCU), can be used via the low pressure ground connector. While the aircraft is being prepared at the gate, this connection is typically used so that the APU does not have to be operated. The ground air connection consists of two adjacent connections, each equipped with a check valve, through which external air can be fed into the low-pressure manifold. This is done via flexible air hoses attached to the passenger boarding bridges (see figure 5).

According to the aircraft manufacturer, the low-pressure manifold is not designed to absorb the entire differential pressure of the cabin in the event of a skin check valve failure.

Figure 5: Air hose of the pre-conditioned air system connected to the low pressure ground connectors. Source: Zurich Airport.

The low pressure manifold is also connected to the emergency ram air inlet. This inlet can be opened during flight if both PACKs fail or if smoke needs to be removed from the aircraft cabin.

The air is fed through the low-pressure manifold and a second check valve, known as the skin check valve, directly into the mixer unit (see figure 4 and Appendix 1). The mixer unit combines fresh air with recirculated air and feeds it to the various cabin zones, ensuring that the conditioned air is distributed throughout the entire aircraft.

1.6.2.4 Skin check valve

The skin check valve has a housing with two semicircular flaps mounted on a hinge bar (see figure 3). The flaps can only be opened in one direction and are held in the closed position by springs. The air flow from the emergency ram air inlet or from the pre-conditioned air at the bottom causes the flaps to open. This allows the air to flow through the skin check valve to the mixer unit. Conversely, the skin check valve prevents cabin air from escaping from the mixer unit into the low-pressure manifold.

According to the aircraft manufacturer, check valves are generally very robust as long as they remain in defined positions, i.e. either completely closed or completely open. Fluttering in intermediate positions can lead to wearing on the hinges or the axle or to a failure of the spring. For this reason, pre-conditioned air and air from the PACK should not be used simultaneously on the ground, as this can lead to an unstable air flow in the skin check valve (see chapter 1.17.1).

1.6.3 Maintenance

1.6.3.1 Maintenance of the skin check valve

The skin check valve had been installed since the new aircraft was delivered from the factory in 2010; at the time of the incident, the aircraft had 62,698:48 operating hours and 9,441 landings. According to the aircraft manufacturer, the skin check valve must be inspected every 24 months, which requires it to be removed. There is no operating time limit for such a skin check valve before it must be overhauled or replaced. The skin check valve on HB-JHI was last inspected on 24 November 2022.

1.6.3.2 Modification of the skin check valve

On 9 November 2016, the aircraft manufacturer published Service Bulletin No. A330-21-3179 recommending that the skin check valve with part number 4063-18140-01 be replaced with a modified *valve* with part number 24328-01[9]. This was due to a large number of reports to the aircraft manufacturer of skin check valve failures in A330 aircraft due to broken flaps and springs. Extensive tests by the aircraft manufacturer also revealed vibrations in the skin check valve flaps, particularly during normal operation. This resulted in damage to the emergency ram air inlet check valve and the low-pressure manifold with the ground connectors, which led to a drop in cabin pressure and, consequently, to the flight being aborted. The aircraft manufacturer recommends that the service bulletin be implemented as soon as possible to avoid significant operational disruptions.[10]

[9] The aircraft manufacturer published identical service bulletins No. A340-21-4160 and No. A3456-21-5054 for the Airbus A340 and A340-500/600 aircraft models.

[10] Excerpt from the service bulletin: "*This could lead to damage to the emergency ram check valve and ducting downstream to low pressure ground cart connectors, resulting in cabin depressurisation and in-flight turnback.* [...] *RECOMMENDED: Service bulletin recommended to be accomplished to prevent significant operational*

The modified skin check valve includes the following design improvements:

- Reduction of the valve opening angle from 85 degrees to a maximum of 75 degrees;
- Reinforcement of parts prone to wear: hinges, contact surfaces and end stops;
- Reduction of friction between the valves and the hinge axis by the use of a special surface coating;
- Reduction of spring force by using only one spring instead of two springs;
- Re-arrangement of the flap ribs to prevent flap flutter during normal operation.

The service bulletin had not been implemented on the HB-JHI involved in the serious incident.[11] On six of the eight A330s operated by the airline, the skin check valves, which showed signs of wear, were replaced during scheduled maintenance work.

1.6.3.3 Maintenance of the check valves in the low-pressure distributor

The two check valves at the ground air connectors and the check valve on the emergency ram air inlet have the same inspection interval and scope as the skin check valve. There is also no operating time limit for the overhaul or replacement of such check valves. The check valves were last inspected on 24 November 2022.

1.7 Meteorological information

1.7.1 Weather at the time of the serious incident

The weather at Zurich Airport (LSZH) at the time of the serious incident was as follows:

Weather/clouds	Showers in the vicinity, slightly cloudy with cumulonimbus clouds at 3500 ft AAE[12], scattered clouds at 4000 ft AAE, broken clouds at 7000 ft AAE
Visibility	More than 10 km
Wind	230° / 3 kt
Temperature/dew point	10 °C
Air pressure (QNH)	1023 hPa (pressure reduced to sea level, calculated using the values of the ICAO[13] standard atmosphere)
Hazards	None

1.7.2 Astronomical information

Sun position	Azimuth: 262°	Altitude: 12°
Lighting conditions	Day	

disruptions. [...] Accomplishment of this service bulletin is recommended at the earliest opportunity where manpower and facilities are available."

[11] The flight operations company stated that the modification had been rejected in 2017 due to what it considered to be the high reliability of the original skin check valve and the costs associated with replacing the valve.

[12] AAE: *Above Aerodrome Elevation*

[13] ICAO: *International Civil Aviation Organisation*

1.8 Navigation aids

Not affected

1.9 Communications

Radio communication between the pilots and air traffic control was conducted properly and without difficulty.

1.10 Aerodrome information

Not affected

1.11 Flight recorders

1.11.1 Flight data recorder

The data from the flight data recorder (FDR) and the quick access recorder (QAR) could be read and evaluated (see Appendix 2).

The following key data can be identified from these recordings:

- After take-off, the two outflow valves moved continuously towards the closed position and reached the fully closed position during climb at approximately 12,000 ft AMSL and a cabin pressure altitude of approximately 3,000 ft.
- The cabin pressure then increased at an average rate of approximately 750 ft/min.
- The ECAM issued the CAB ALT caution message at a cabin pressure altitude of approximately 9,000 ft.
- The warning message CAB PR EXCESS CAB ALT appeared at a cabin pressure altitude of just under 9600 ft.
- The flight altitude was at a maximum of 25,200 ft AMSL when the cockpit crew initiated the emergency descent.
- The cabin pressure altitude reached a maximum value of 10,800 ft (3,291 m) approximately 1½ minutes later.
- The emergency descent to FL 100 took place within 3 minutes with an average descent rate of around 5000 ft/min.

1.11.2 Cockpit voice recorder

The cockpit voice recorder (CVR) was retrieved and analysed.

1.12 Wreckage and impact information

Not affected

1.13 Medical and pathological information

There are no indications of health impairments or fatigue on the part of the pilots.

1.14 Fire

Not affected

1.15 Survical aspects

Not affected

1.16 Tests and research

Not affected

1.17 Organisational and management information

1.17.1 Airline

The relevant procedures for the crew were documented in the flight operations company's operating manuals.

The relevant procedures and information for the serious incident under investigation from the Flight Crew Operating Manual (FCOM), the Flight Crew Techniques Manual (FCTM) and the Quick Reference Handbook (QRH) are listed below. With regard to exceeding the maximum cabin pressure altitude, these are as follows:

- When the CAB ALT warning appears, it is recommended that the cabin pressure controller (CPC) be manually switched to the other CPC.
- Operations Engineering Bulletin (OEB) exists for the CAB PR EXCESS CAB ALT warning. According to this, the CAB PR EXCESS CAB ALT ECAM procedure must always be carried out, even if the maximum cabin pressure altitude is not indicated on the cockpit instruments.
- If the aircraft is at an altitude above FL 160 when the CAB PR EXCESS CAB ALT warning message appears, the cockpit crew should first execute the memory items for an emergency descent and only then the ECAM procedure displayed.
- According to the ECAM procedure CAB PR EXCESS CAB ALT, the cockpit crew must, among other things, put on oxygen masks, initiate an emergency descent and manually deploy the masks for the passengers if the cabin pressure altitude exceeds 14,000 ft.
- It is also specified that the passenger masks may also be deployed manually if it is obvious that the cabin pressure will exceed 14,000 ft.

The following information applies to the use of the preconditioned air unit (PCA):

- The flight crew must not use air from the air conditioning pack (PACK) and the preconditioned air unit (PCA) at the same time to avoid adverse effects on the air conditioning system.

1.18 Additional information

Not affected

1.19 Useful or effective investigation technique

Not affected

2 Analysis

2.1 Technical aspects

2.1.1 General

The flight data recorder data was recorded without gaps and could be read. The safety systems functioned properly and the recorded data was plausible. However, the recorded data did not reveal which system or component was responsible for the pressure drop in the cabin.

2.1.2 Cabin pressure

Due to the defective skin check valve, which remained in the open position (see chapter 1.3.2 and 1.6.2.4), the cabin pressure could not build up as planned during the HB-JHI's climb. The two outflow valves, which normally remain in a slightly open position during flight to regulate the cabin pressure, moved continuously towards the closed position and were already completely closed at an altitude of approximately 12,000 ft AMSL.

However, cabin air continued to escape via the mixer unit and through the open skin check valve (see chapter 2.1.3) into the low-pressure manifold. No pressure could build up here either, as the damaged sleeve between the low-pressure manifold and the check valve of the emergency ram air inlet was missing and air was escaping there (see chapter 2.1.4). As a result, the cabin pressure continued to rise at an increased rate of around 750 ft/min until it exceeded the limit values, and the cockpit crew initiated the emergency descent. The defect in the skin check valve was therefore the causal factor for the serious incident.

2.1.3 Skin check valve

A severely damaged and non-functional skin check valve was found in the aircraft. The first signs of damage are likely to have been present for some time. However, it is probable that this skin check valve was still functional and closed during the last flight before the serious incident, enabling the cabin pressure system to build up sufficient cabin pressure.

When the aircraft was supplied with air at the gate by means of a preconditioned air unit (PCA), the skin check valve opened. However, after the air hoses were disconnected, the skin check valve remained open due to a defective flap hinge and a broken spring, which went unnoticed. A defective or open skin check valve is not visible from the outside due to the closed check valves of the two ground connectors. An open skin check valve can only be detected by pressing one of these check valves by hand. However, there was no procedure for such a check.

Similar incidents involving defective skin check valves had been known to the aircraft manufacturer for some time. For this reason, the manufacturer published in 2016 service bulletins for all aircraft models equipped with this component, recommending that the skin check valve be replaced with a modified skin check valve. The service bulletins point out that a defective skin check valve can lead to damage of the emergency ram check valve and ducting downstream to low pressure ground cart connector, resulting in cabin depressurization and in-flight turn back. For this reason, the aircraft manufacturer recommends that the service bulletins be implemented as soon as possible to avoid significant operational disruptions (see chapter 1.6.3.2).

The service bulletin had not been carried out on the HB-JHI. This decision is incomprehensible from a safety perspective, as failure to carry out this service bulletin can also affect flight safety (see chapter 2.2, last paragraph) and the skin

check valve had to be removed and reinstalled every 24 months for inspection anyway, i.e. at least three times on the HB-JHI. The skin check valve could have been replaced by a modified skin check valve on one of these occasions without significant additional effort.

2.1.4 Sealing sleeve on the low-pressure distributor

The sealing sleeve at the connection between the low-pressure manifold to the check valve of the emergency ram air inlet was found to be severely damaged inside the aircraft. Furthermore, one screw clamp was loose and the second was missing and could not be found inside the aircraft. The torn sealing sleeve can be attributed to the defective skin check valve, as the sealing sleeve was no longer able to withstand the air pressure. The service bulletin refers to this possible damage (see chapter 1.6.3.2). The escaping air meant that the cabin pressure could no longer be maintained.

It could not be determined why one screw clamp was loose and the second clamp was completely missing. It is presumed that the necessary work was not completely carried out during the last maintenance work on the low-pressure manifold.

2.2 Human and operational aspects

Until the CAB ALT warning appeared on the ECAM, it was hardly noticeable to the cockpit crew from the cockpit displays that the cabin pressure was not rising as usual. Due to the moderate rate of climb of the cabin pressure altitude of 750 ft/min, there were no physical symptoms, such as unusual pressure equalisation in the ears. Such a slow loss of pressure is also known as subtle decompression [14]. It is therefore understandable that the cockpit crew was surprised by the CAB ALT warning message and the subsequent CAB PR EXCESS CAB ALT warning message and was unable to explain the technical problem based on the system displays available to them.

The subsequent reaction to interrupt the climb and initiate an emergency descent shortly afterwards was in accordance with the applicable regulations and was carried out promptly and correctly. As a result, the cabin pressure did not exceed 10,800 ft.

Past incidents and accidents[15] have shown that it can sometimes be difficult for cockpit crews to detect a slow loss of pressure (subtle decompression), especially during the initial climb.

[14] Subtle decompression occurs slowly over time and is therefore difficult to detect until instruments or altitude warning systems indicate a problem.

[15] See, for example, the accident involving a Boeing B737-300 on 14 August 2005 in Greece, Helios Airways 522, registration number 5B-DBY, final report of the Hellenic Air Accident Investigation & Aviation Safety Board, or the serious incident involving an Airbus A330 on 5 February 2021 in Australia, Qantas Airways, with registration number VH-EBK, final report of the Australian Transport Safety Bureau.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- [IFR/VFR] .
- At the time of the serious incident, both the mass and centre of gravity of the aircraft were within the limits specified in *the* Aircraft Flight Manual (AFM).
- The skin check valve between the low-pressure manifold and the mixer unit was severely damaged and no longer functional.
- The skin check valve is not visible from the outside, which is why the defect went undetected.
- The sealing sleeve at the transition from the low-pressure manifold to the check valve of the emergency ram air inlet was unable to withstand the air pressure due to the defective skin check valve and was severely damaged.
- This caused cabin pressure air to escape and the cabin pressure to rise slowly but uncontrollably.
- A service bulletin published by the aircraft manufacturer in 2016 recommending the earliest possible replacement of the skin check valve with a modified skin check valve had not been implemented at the time of the serious incident.

3.1.2 Flight Crew

- The pilots held the licences required for the flight.
- There are no indications of any health impairments affecting the pilots during the serious incident.

3.1.3 History of the of the serious incident

- The aircraft took off at 16:07 UTC from runway 32 at Zurich Airport.
- As the aircraft passed flight level *(*FL) 220, the CAB ALT warning appeared on the ECAM.
- The cockpit crew manually switched the cabin pressure controller (CPC) from system 1 to system 2. Both outflow valves were completely closed at this point.
- The cockpit crew could not detect any other malfunctions and no further error messages were displayed.
- The cockpit crew requested a transition to level flight at FL 250 from air traffic control. At the same time*,* the master warning sounded in the cockpit and the warning message CABIN PR EXCESS ALT appeared on the ECAM.
- The crew issued an urgency call ("PAN-PAN") and donned their oxygen masks.
- Shortly afterwards, the crew transmitted a distress call ("MAYDAY"), initiated an emergency descent and manually activated the oxygen masks in the cabin.
- When the aircraft reached FL 100, the corresponding warning messages had disappeared.
- The return flight to Zurich and the overweight landing on runway 16 were uneventful.
- The passengers and crew were able to leave the aircraft in the normal manner. No one was injured.

3.1.4 General

- The weather had no influence on the serious incident.

3.2 Cause

In order to achieve its objective of prevention, a safety investigation authority shall express its opinion on risks and hazards that have been identified during the investigated incident and which should be avoided in the future. In this sense, the terms and formulations used below are to be understood exclusively from the perspective of prevention. The identification of causes and contributory factors does not, therefore, in any way imply assignment of blame or the determination of administrative, civil or criminal liability.

The serious incident, in which the cabin pressure exceeded 10,000 ft during the commercial aircraft's climb and the cockpit crew had to initiate an emergency descent, was caused by a defective skin check valve, which prevented the cabin pressure system from building up sufficient cabin differential pressure.

A service bulletin published by the aircraft manufacturer in 2016 recommending the earliest possible replacement of the skin check valve with a modified skin check valve had not been implemented, which was causal for the serious incident.

4 Safety recommendations, safety advice and measures taken since the serious incident

4.1 Safety recommendations

In accordance with international[16] and national[17] legal bases, all safety recommendations are addressed to the supervisory authority of the competent state. In Switzerland, this is the Federal Office of Civil Aviation (FOCA) or the supranational European Union Aviation Safety Agency (EASA). The competent supervisory authority must decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, organisation and individual is invited to strive to improve aviation safety in the spirit of the safety recommendations expressed.

The STSB shall publish the answers of the relevant federal office or foreign supervisory authorities at http://www.sust.admin.ch to provide an overview of the current implementation status of the relevant safety recommendation.

4.1.1 Skin check valve

4.1.1.1 Safety deficit

During the climb of an airliner Airbus A330-343, cabin pressure did not build up sufficiently, whereupon a corresponding warning message appeared in the cockpit after the cabin altitude exceeded 9550 ft and the pilots initiated an emergency descent. The reason for the insufficient pressure build-up was a defective check valve, known as a skin check valve, located between the mixer unit and the low-pressure manifold. This caused compressed air to escape from the cabin into the low-pressure manifold and out of the aircraft via a damaged sealing sleeve on the emergency ram air inlet.

Past incidents and accidents have shown that it can sometimes be difficult for cockpit crews to detect such a slow pressure drop (subtle decompression), especially during the initial climb. This can quickly lead to a dangerous situation.

On 9 November 2016, the aircraft manufacturer published Service Bulletin No. A330-21-3179 recommending that the skin check valve with part number 4063-18140-01 with a modified valve with part number 24328-01 to prevent a similar failure of the skin check valve with subsequent pressure drop in the cabin. The flight operations company decided not to implement the service bulletin. For the Airbus A340 and A340-500/-600 aircraft models, which are equipped with an identical skin check valve, the aircraft manufacturer published the corresponding Service Bulletins No. A340-21-4160 and No. A3456-21-5054.

4.1.1.2 Safety recommendation No. 605

The European Union Aviation Safety Agency *(EASA)* should publish an Airworthiness Directive (AD) based on Service Bulletins No. A330-21-3179, No. A340-21-4160 and No. A3456-21-5054.

[16] Annex 13 of the International Civil Aviation Organization (ICAO) and article 17 of Regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC.

[17] Article 48 of the Swiss Ordinance on the Safety Investigation of Transport Incidents (OSITI) of 17 December 2014, as at 1 January 2025 (OSITI, SR 742.161).

4.2 Safety advice

The STSB may publish general relevant information in the form of safety advice[18] if a safety recommendation in accordance with Regulation (EU) No. 996/2010 does not appear to be appropriate, is not formally possible, or if the less prescriptive form of safety advice is likely to have a greater effect.

4.2.1 Skin check valve

4.2.1.1 Safety deficit

During the climb of an airliner Airbus A330-343, cabin pressure did not build up sufficiently, whereupon a corresponding warning message appeared in the cockpit after the cabin altitude exceeded 9550 ft and the pilots initiated an emergency descent. The reason for the insufficient pressure build-up was a defective check valve, known as a skin check valve, located between the mixer unit and the low-pressure manifold. This caused compressed air to escape from the cabin into the low-pressure manifold and out of the aircraft via a damaged sealing sleeve on the emergency ram air inlet.

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4.2.1.2 Safety advicev No. 69

Target group: All flight operations companies with aircraft affected by Service Bulletin No. A330-21-3179, No. A340-21-4160 or No. A3456-21-5054

Flight operations companies operating aircraft affected by Service Bulletins No. A330-21-3179, A340-21-4160 or No. A3456-21-5054 should include all relevant operational scenarios in the corresponding risk analysis when deciding on the implementation of the service bulletin. In this case, this particularly concerns the dangerous situation that can arise in the event of an undetected failure of the skin check valve and an associated slow pressure drop (subtle decompression), especially during the initial climb.

[18] Article 56 of the Swiss Ordinance on the Safety Investigation of Transport Incidents (OSITI) of 17 December 2014, as at 1 January 2025 (OSITI, SR 742.161)

4.1 Measures taken since the serious incident

The measures taken, of which the STSB is aware, are mentioned below without further comment.

As of 3 November 2025, the flight operations company noted the following:

"After the incident, Maintenance Program Task Card 215500-02-1 was issued ahead of schedule with priority given to the longest installation time for the skin check valve.

Excerpt from OIR CO-0KUA:

As immediate preventive measure, the Maintenance Program Taskcard (TC) 215500-04-1 got modified with an additional step to check the condition of the sleeve connecting emergency ram air inlet and manifold, additionally the torque of the clamps in September 2024.

Based on the TSI review of the skin check valves, an early performance of TC 215500-02-1 and 215500-04-1 was initiated on the oldest valves during A-Check in ZRH. The inspections on aircraft HB-JHH, HB-JHK and HB-JMG. HBJHJ were performed until November 2024.

To highlight critical aspects of the maintenance processes and ensure that employees develop a greater awareness of standards and potential safety risks, the SWR CAMO Engineering department will produce an MRO newsletter for the external maintenance organisations highlighting this error and its consequences.

In addition, the SWR CAMO Engineering will monitor the population development of the post-mod skin check valve provided by the component pool and re-evaluate the situation in case of a trend change or specific findings. »

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014.

Bern, 6 January 2026 Swiss Transportation Safety Investigation Board

Appendix 1: Ground air connection and emergency air intake

AIRBUS	IPC - SWR - A330	REV DATE: Jul 01/2024
	Tail Number - MSN - FSN: HB-JHI - 01181 - 209	
	FIG. 21-55-03-02B - CONNECTION INSTL-GROUND,FR39-40.3 Zone(s) 191 (Oct 01/21)	

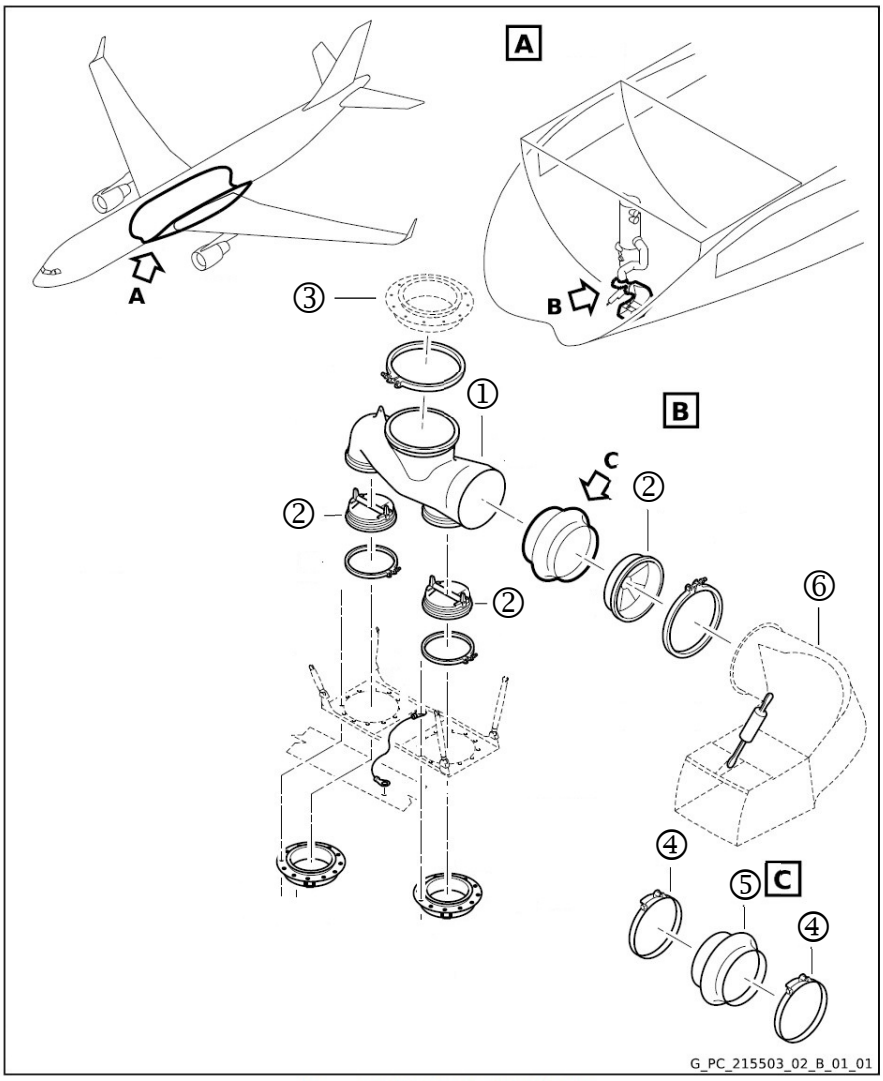

Figure 21-55-03-02B (SHEET 1)
**** ON A/C FSN ALL**

Key:

① *Manifold* assembly
② *Check valve*
③ *Skin check valve*
④ *Clamp*
⑤ *Sleeve*
⑥ *Emergency ram air inlet*

Appendix 2: Evaluation of the flight data recorder (FDR)