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Aircraft accident investigation bureau

Final Report No. 1820 by the Aircraft Accident Investigation Bureau

concerning the serious incident
to the aircraft Airbus A 321-111, HB-IOA,
operated by Swissair under flight number SWR 809
on 21 February 2000
during the flight from London-Heathrow to Zurich-Kloten

Ursache

Der schwere Vorfall ist darauf zurückzuführen, dass sich aufgrund einer bekannten Fehlfunktion eines *cabin pressure controllers* das *outflow valve* der Druckkabine öffnete und die redundante Regelanlage nicht in der Lage war, die Fehlfunktion zu korrigieren.

General remarks to this report

In accordance with Annex 13 of the International Civil Aviation Organisation agreement (ICAO Annex 13) this report has been prepared solely for the purpose of accident/incident prevention. The legal assessment of accident/incident causes and circumstances is no concern of the investigation (art. 24 of the Air Navigation Law).

The masculine form is used exclusively in this report regardless of gender for reasons of data protection.

If not otherwise stated, all times in this report are indicated in universal time coordinated (UTC). At the time of the accident, the Central European Time (CET) was valid for the area of Switzerland. This CET was equal to the local time (LT). The relation between LT, CET and UTC is: $LT = CET = UTC + 1 \text{ h}$.

The german-language version of this report is authoritative.

The Aircraft Accident Investigation Bureau (AAIB) of Switzerland would like to thank the authorities and other organizations for the given support throughout the investigation

Final Report

Aircraft	Airbus A 321-111	HB-IOA
Operator	Swiss Air Transport Co. Ltd., 8058 Zurich Airport	
Owner	Flightlease AG, 8058 Zurich Airport	

Commander	Swiss citizen, born 1961			
Licence	Airline Transport Pilot Licence (ATPL), according to JAR, issued by the Federal Office for Civil Aviation, valid till 9 August 2005			
Flying hours	total	7058	during the last 90 days	157
	on Airbus A-320 series	514	during the last 90 days	157

Co-pilot	Swiss citizen, born 1963			
Licence	Airline Transport Pilot Licence (ATPL), according to JAR, issued by the Federal Office for Civil Aviation, valid till 23 April 2005			
Flying hours	total	4300	during the last 90 days	170
	on Airbus A-320 series	841	during the last 90 days	170

Location	In the vicinity of VHF omnidirectional range KOKSI (VOR KOK), Belgium		
Coordinates	---	Altitude	FL 330
Date and time	21 February 2000, 20:01 UTC		

Type of operation	Scheduled flight
Flight phase	Cruise
Type of incident	Rapid loss of cabin pressure

Damage to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly injured or uninjured	7	121	
Damage to the aircraft	None		
Material damage to third parties	None		

History

At 19:40 UTC on 21 February 2000, aircraft HB-IOA took off from London-Heathrow on scheduled flight SWR 809 to Zurich-Kloten.

At 20:01 UTC, after a continuous climb of approximately 21 minutes duration and shortly after the aircraft had reached its cruising altitude of flight level (FL) 330, the co-pilot reported a rapid increase in cabin altitude to the commander. The commander noticed that control system 2, which regulates the cabin pressure, was indicating a malfunction. He further discovered that control system 1 did not take over the intended function and that the cabin altitude was increasing further. A little later control system 1 also failed and the outflow valve remained half open, so the air in the cabin could escape unhindered within a very short time. Inside the aircraft, because of this adiabatic expansion, distinct cooling accompanied by condensation was perceived.

When the cabin altitude had exceeded 9550 ft, the "excess cabin altitude" warning in the cockpit was triggered. The commander then decided to initiate an emergency descent immediately. Both flight crew members put on oxygen masks and the co-pilot as pilot flying initiated the descent. The commander reported to air traffic control that SWR 809 was in an emergency situation and subsequently received several clearances for a rapid descent to FL 100. During the following 6 minutes the aircraft descended to the cleared flight level at an average rate of descent of 3800 ft/min. During the descent the flight crew implemented the corresponding ECAM procedure. After the incident the flight crew indicated that throughout the entire event they had not noticed any master caution or master warning.

Since the cabin altitude had reached 14,000 ft in the meantime, the oxygen masks in the passenger cabin were released and the passengers were requested by an automatic announcement to put them on.

When HB-IOA reached FL 100, the flight crew took off their oxygen masks and the commander informed the passengers. Since none of the passengers exhibited any adverse health effects and since there was sufficient fuel to continue the flight to Zurich at a lower altitude, the commander decided not to perform a diversion landing and to continue the flight to the destination. The flight crew ascertained that the cabin could be pressurised manually. Since icing conditions prevailed at FL 100 on the remaining segment of the flight to Zurich, a climb to FL 140 was carried out and the cabin pressure was controlled manually. As a precaution, the flight crew asked for a doctor to be present on landing to care for passengers, if necessary. This was not needed.

The landing in Zurich-Kloten took place at 21:01 UTC.

No other aircraft was affected by this emergency descent.

Findings

- The responsible persons of Swissair did not notify the Aircraft Accident Investigation Bureau (AAIB) of the serious incident. The AAIB learned of the event in an indirect manner and subsequently initiated an investigation.
- The responsible persons of Swissair were not aware of the regulations on notification of serious incidents as published in the aeronautical information publication (AIP). The airline's operation manual was not complete in this regard.
- As the incident had not been notified as per regulations, the flight data recordings available were incomplete.
- Investigation of the incident was handed over by the Belgian authorities (*Ministère des Communications et de l'infrastructure, Cellule d'Enquêtes d'Accidents et d'Incidents d'Aviation*) to the Swiss AAIB.
- According to the flight data recordings, five seconds after the "excess cabin altitude" warning the master warning was triggered which was acknowledged manually by the crew six seconds later. One second later the master caution was triggered.
- A321 aircraft are equipped with two cabin pressure controller (CPC). Each CPC is able to regulate cabin pressure independently and in the process is monitored by the second, redundant controller. The control and monitoring functions are swapped cyclically on every flight. The switching logic provides for the second CPC to take over the control functions in case of a malfunction on the active CPC. In addition, however, certain conditions must be fulfilled. Thus, for example, the units installed in aircraft HB-IOA at the time of the incident, would be able to take over pressure regulation only if the rate of climb in cabin altitude was less than 2000 ft/min.
- Two cabin pressure controllers of the same modification standard (STD-8) were installed on aircraft HB-IOA.
- On flight SR 809, before the incident, the CPC 2 was active and the CPC 1 was monitoring the functions of CPC 2.
- In 1998 the Nord-Micro company, which manufactured the CPC, issued service bulletin (SB) VB 15702-21-006, the purpose of which, like that of the basic SB A320-21-1116 of the aircraft manufacturer, was a modification of all CPCs to STD-10. This upgrade was necessary because several cases had occurred in which CPCs with modification status STD-8 had permitted an uncontrolled opening of the outflow valve under certain conditions, thereby causing a rapid loss of pressure in the passenger cabin. Moreover, the controller's software was changed so that in the event of failure of the active CPC the redundant CPC is able to take over the function even if high rates of climb or descent are encountered. Once a test phase with the new update had been completed by several other airlines, from 26 October 1999 SR Technics also began to modify the stored CPCs to STD-10. From 25 January 2000 onwards, all CPCs installed in aircraft were successively replaced. As initially only a few modified CPCs were available, in a first stage only one CPC modified to STD-10 standard was installed in an aircraft and, for a transitional period, it was used together with a CPC of an older modification standard. From mid-2001 only CPCs with modification standard STD-10 or higher were in use in all aircraft.

- The flight data recordings prove that immediately after the outflow valve had begun to open the cabin rate of climb was more than 6000 ft/min. The opening of the outflow valve increased by 24% within 12 seconds.
- After the incident a defective cabin pressure sensor was found.
- After the incident, Nord-Micro was able to read out the non-volatile memories of the CPCs. It showed that a comparable malfunction had already occurred, some months before the serious incident.
- At the time of the incident, with regard to the possible rapid opening of the outflow valve due to a CPC malfunction, a special temporary procedure was in force for emergencies and abnormal situations. These temporary emergency and abnormal procedures laid down the following, among other things:
 - *If outflow valve is moving towards open and cabin rate is above 1500 ft/min:*
 - *If at least one CPC controlling (SYS 1 or SYS 2 green)*
 - *DITCHING* *ON*
 - *AS soon as outflow valve is closed:*
 - *ONE PACK* *OFF*
 - *CABIN PRESS MODE SEL* *MAN*
 - *DITCHING* *OFF*
 - *V/S CTL* *AS RQRD*
 - *BOTH PACKS* *ON*
 - (...)
 - *If both CPC failed (CAB PR SYS 1 + 2 FAULT)*
 - *CPC 1 and 2 CB* *RESET*
- After the flight, the flight crew reported that events had unfolded so quickly that there had been no time to implement the temporary emergency and abnormal procedures.
- An extended high-pressure area stretched from the Azores to central Europe. A very weak occlusion extended from the Norwegian coast to northern France. The following weather prevailed along the route: there was light cloud over southern England and the Channel; the main cloud base was at about 25 000 AMSL. Several strata of dense cloud lay over northern France and Belgium. Over northern Switzerland cloud was 3-4/8 with a base at 11 000 ft AMSL and 5-7/8 with a base at 26 000 ft AMSL. Wind speeds at altitudes between FL 100 and FL 390 were 20 to 30 knots, generally from a north-westerly direction.

Analysis

During the climb at 20:01 UTC the active cabin pressure controller (CPC) 2 failed, causing the cabin outflow valve to open. This CPC malfunction was very probably caused by a defective cabin pressure sensor. As the non-volatile memory of the CPC 2 showed, the same fault had already occurred a few months earlier. Since the non-volatile memory can be read out by the manufacturer only, this defect was not discovered.

The opening of the outflow valve led to a rapid loss of cabin pressure; the rate of climb, expressed as pressure change versus time, exceeded 2000 ft/min. With this, the limit for a take-over of the control function by the CPC 1 with modification status STD-8 was exceeded, so this control system also reacted with an error code and did not apply a corrective signal to the outflow valve.

It had been known for some time that CPCs with modification standard STD-8 had problems in taking over the function of the other CPC if the failure was associated with high rates of climb. A corresponding modification of the controllers was therefore in progress. Modification standard STD-10 no longer exhibited this characteristic. Since the airline did not have enough CPCs with modification standard STD-10, only one CPC STD-10 could be installed per aircraft until the year 2001.

According to the flight crew's statement, the failure of both systems occurred so quickly that there had not been time to follow the temporary emergency and abnormal procedures. Since the responsible persons from the airline did not report the serious incident, the cockpit voice recorder in particular could not be secured in time, making an accurate reconstruction of the actual chronological conditions impossible.

It must remain open whether application of the aircraft manufacturer's temporary emergency and abnormal procedures by the crew could have alleviated the situation more quickly than was allowed by the emergency descent.

Both pilots put on their oxygen masks immediately and carried out an emergency descent to FL 100. This reaction was appropriate. As the recordings of the flight recorder indicate, the master warning and master caution did function. The fact that the flight crew could no longer recall these warnings after the flight is not unusual and is explicable by the high workload during the emergency situation.

Since in the crew's estimation neither the passengers nor they themselves had suffered any adverse health effects after the emergency descent and it was possible to control the cabin pressure manually, they continued their flight to Zurich. With regard to the weather situation and the available fuel, this decision appears understandable.

Cause

The serious incident is attributable to the fact that because of a known malfunction of a cabin pressure controller, the outflow valve of the pressurised cabin opened and the redundant controller was not able to correct the malfunction.

Berne, 24 April 2006

Aircraft Accident Investigation Bureau

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