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Aircraft Accident Investigation Bureau AAIB

Final Report No. 2063

by the Aircraft Accident Investigation Bureau

concerning the serious incident

to the PC-12-45-type aircraft, registration EC-JFO

on 24 October 2007

between waypoints BENOT and MILPA
at flight level FL220

followed by a diversion to Geneva-Cointrin airport,
municipality of Cointrin/GE

Ursachen

Der schwere Vorfall ist auf eine Panne im Druckkabinen-System zurückzuführen, welche nach einer Jahreskontrolle beim Hersteller aufgetreten ist.

Folgender Faktor hat zum schweren Vorfall beigetragen:

In der von der Besatzung benützten Checkliste fehlte der Prüfpunkt bezüglich Kontrolle der Kabinenhöhe während des Steigfluges.

General information on this report

This report contains the conclusions of the Aircraft Accident Investigation Bureau (AAIB) on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with art 3.1 of the 9th edition, applicable from 1 November 2001, of Annex 13 to the Convention on International Civil Aviation (ICAO) of 7 December 1944 and article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the incident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the French language.

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the serious incident, Central European Summer Time (CEST) applied as local time in Switzerland. The relation between LT, CEST and UTC is:
 $LT = CEST = UTC + 2 \text{ h.}$

Final report

Aircraft type	Pilatus PC-12-45	EC-JFO		
Operator	Norestair, S.L., Casa Llobet s/n, 2567 Biscari-Lleida, Spain			
Owner	Private			
Pilot PIC	Spanish citizen, born 1981			
Licence	Commercial pilot CPL(A) issued by the Spanish <i>Direccion General de Aviacion Civil</i> on 27 August 2003, rating PC-12, valid till 29 March 2008			
Flying time	total 2288:36 hours	during the last 90 days 57:29 hours		
	on the involved type approx. 500 hours	during the last 90 days 57:29 hours		
Copilot	Spanish citizen, born 1974			
Licence	Commercial pilot CPL(A) first issued by the Spanish <i>Direccion General de Aviacion Civil</i> on 5 September 2002, valid till 5 September 2012			
Flying time	total 1890:13 hours	during the last 90 days 33:05 hours		
	on the involved type 511:55 hours	during the last 90 days 33:05 hours		
Location	Between waypoints BENOT and MILPA			
Coordinates	---	Altitude FL220		
Date and time	24 October 2007, at 10:15 UTC			
Type of operation	Private IFR			
Flight phase	Climb			
Nature of the serious incident	Loss of cabin pressurisation			
Injuries to persons				
Injuries	Crew	Passengers	Total number of persons on board	Other
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	2	0	2	Not applicable
Total	2	0	2	0
Damage to aircraft	None			
Other damage	None			

1 Factual information

1.1 History of the flight

1.1.1 Pre-flight history

On 15 October 2007, i.e. one week before the flight involving the serious incident, the Pilatus PC-12, registration EC-JFO, with two pilots on board, left Barcelona/E airport for Buochs aerodrome, where the aircraft's annual technical inspection was to be carried out at the manufacturer's works.

1.1.2 History of the first flight

On 24 October 2007, the crew of the PC-12, having submitted an IFR flight plan and re-fuelled, took off from Buochs aerodrome at about 09:50 UTC, destination Sabadell/E aerodrome.

At about 10:15 UTC, just after waypoint BENOT, which is geographically located on the south bank of Lake Biemme along the airway UN869, when the aircraft was passing flight level FL220 in a climb to flight level FL270, as it had been cleared to do, the commander experienced tiredness which he thought to be abnormal. The crew noted that the differential pressure of the cabin indicated approximately 3 PSI, whereas it should have indicated a value close to its maximum, i.e. 5.75 PSI.

At 10:17:02 UTC, the pilot requested permission from air traffic control services to stop the climb at flight level FL230, without specifying the reason.

The crew also noted that the cabin altitude was approximately 15 000 ft and was continuing to increase at a rate of 1500 ft/min.

The PIC immediately ordered oxygen masks to be donned and, shortly afterwards, the master warning CAB PRESS was displayed on the Central Advisory and Warning System (CAWS). The red warning CAB PRESS is displayed on the central CAWS panel. Additionally, both master warnings on the instrument panel (pilot and copilot side) are illuminated and a voice callout "*warning cabin pressure*" is issued. By pressing either master warning lamp, the master warning can be cancelled. The warning on the CAWS however remains active as long as the condition is present.

At 10:20:48 UTC, the crew informed ATC on the 128.900 MHz frequency that they were having a cabin pressurisation problem and requested radar vectors for Zurich airport. The air traffic controller issued a heading of 080°. The crew confirmed the heading and immediately requested an emergency descent. The descent was made with the aid of the autopilot at a rate of descent of approximately 2500 ft/min and the emergency CAB PRESS checklist was applied.

The controller cleared them to descend to flight level FL160 and asked them if they wanted a diversion to Zurich airport or to Geneva airport. The crew then opted for Geneva. A new heading, along with flight level FL150, was then allocated to them. The crew repeated the instructions and in the process asked for clearance to descend below flight level FL150. The controller cleared them to continue their descent at their convenience and, after assuring himself that the crew were able to change frequency, asked them to contact Geneva Arrival on the 136.250 MHz frequency. The crew reported that they were descending to flight level FL100 and made contact on this frequency.

The Geneva airport approach controller cleared EC-JFO to descend to 7000 ft and provided radar vectors to bring the aircraft onto the runway 05 ILS. He asked the crew the usual questions in an emergency, including the number of persons on board. As they were passing flight level FL100 in descent, the crew noted that the cabin altitude corresponded to the flight altitude and decided to take off their oxygen masks.

The final phase of the flight took place without event and the aircraft landed on runway 05 at Geneva-Cointrin airport at 10:43 UTC.

1.1.3 Actions undertaken on the ground

The aircraft was directed to the northern area, where a fire-fighting services vehicle was waiting for it. They were offered a medical check, to which the commander agreed. The copilot, for his part, declined the offer.

The Transairco SA/RUAG maintenance company carried out various checks on the aircraft to determine the cause of the fault. Static tests were carried out and it was decided to replace various components of the pressurisation system. Further tests were carried out satisfactorily, enabling the aircraft to return to service six days later. A representative from the aircraft manufacturer was present.

1.1.4 History of the second flight

On 30 October, aircraft EC-JFO, with the same two pilots on board, departed Geneva at 12:35 UTC, destination Barcelona. When passing 5000 ft in a climb, the crew noted that pressurisation was not taking place and decided to return to Geneva. The landing took place without difficulty.

A further inspection of the pressurisation system revealed that the bleed air hose in the engine compartment was not properly fitted. After rectifying the assembly fault and after further tests had been carried out, it was found that the aircraft's pressurisation system was functioning and EC-JFO was returned to service.

On the same day, at 17:00 UTC, the PC-12 EC-JFO took off for San Javier/E.

1.2 Meteorological conditions

1.2.1 General

The information contained in sections 1.2.2 and 1.2.3 was supplied by Meteo-Suisse.

1.2.2 General meteorological situation

Ein Höhentief über der Adria weitete seinen Einflussbereich etwas nach Westen aus und lenkte aus Südosten feuchte und eher milde Luft zur Alpensüdseite. Auf der Alpennordseite blieb der Einfluss eines skandinavischen Hochdruckgebietes bestehen und die feuchtkalte Bisenlage hielt weiter an.

Translation:

An upper low-pressure zone over the Adriatic was extending its area of influence somewhat to the west and was conveying humid and rather mild air from the south-east to the southern side of the Alps. On the northern side of the Alps, the influence of a Scandinavian high-pressure zone persisted and the humid and cold *Bise* wind situation was continuing.

End of translation.

1.2.3 Meteorological situation at the location and time of the serious incident

On the basis of the information available, it is possible to conclude that at the time of the incident the following weather conditions prevailed in the airspace between Buochs and Geneva at FL220:

Weather	High fog ceiling at about 6000 ft AMSL
Visibility	Over 30 km
Wind	North-east wind at about 40 kt
Temperature / dewpoint	-28 °C / -39 °C
Atmospheric pressure	QNH LSGG 1014 hPa, LSZH 1017 hPa, LSZA 1016 hPa
Hazards	None detectable

1.3 Aircraft information

1.3.1 General

Registration	EC-JFO
Type	Pilatus PC-12-45
Characteristics	Single-turbine engine cantilever aircraft of metal construction, retractable landing gear with nose-wheel
Manufacturer	Pilatus Aircraft Ltd., Buochs
Serial number	549
Year of construction	2004
Engine	Pratt & Whitney PT6A-67B
Propeller	Variable pitch, Hartzell HC-E4A-3D/E10477K
Airframe operating hours	511:25 hours total since construction
Engine operating hours	511:25 hours total since construction
Propeller operating hours	511:25 hours total since construction
Maximum take-off mass	4500 kg
Recorders	Neither a cockpit voice recorder nor a flight data recorder was prescribed or installed.
Mass and centre of gravity	The take-off mass was approximately 4200 kg. At the time of the serious incident the mass was approximately 4070 kg. Both mass and centre of gravity were within the limit prescribed by the manufacturer.
Maintenance	The last scheduled maintenance, along with the annual check and the application of service bulletins, were carried out by the manufacturer on 24 October 2007 at 510:45 hours.
Technical restrictions	None

Fuel grade	JET A1 kerosene
Fuel quantity	The tanks were filled prior to take-off from Buochs. The capacity is 1538 l, for an hourly consumption of approximately 300 l. Between take-off and the serious incident, the flight duration was 25 min.
Registration certificate	Issued by the Spanish <i>Direccion General de Aviacion Civil</i> on 15 July 2005.
Airworthiness certificate	Issued by the Spanish <i>Direccion General de Aviacion Civil</i> on 8 March 2005, valid till revocation by the competent authority.

1.3.2 Checklists

The manufacturer's current valid reference checklist (issued March 30, 2001 – Revision 2 February 28, 2005), under point 4.11 CLIMB, specifies for normal procedures that the cabin pressure must be checked during the climb.

The manufacturer has also produced a short checklist, the version of which used by the crew was dated 2 October 2001. The latter does not mention checking cabin pressure during a climb. However, it does specify that for complete information it is appropriate to refer to section 4 of the PC-12's Pilot Operation Handbook (POH).

1.3.3 Pressurised cabin

The pressurised cabin is supplied with compressed air by the environmental control system – ECS. The link between the two systems is via a flexible hose which passes inside the engine cowling.

After the incident on 24 October 2007, no anomaly was found during the pressurised cabin check prescribed by the aircraft maintenance handbook.

The test of the cabin altitude switch demonstrated that the threshold at which the cabin pressure warning light should have tripped was out of tolerance and was replaced.

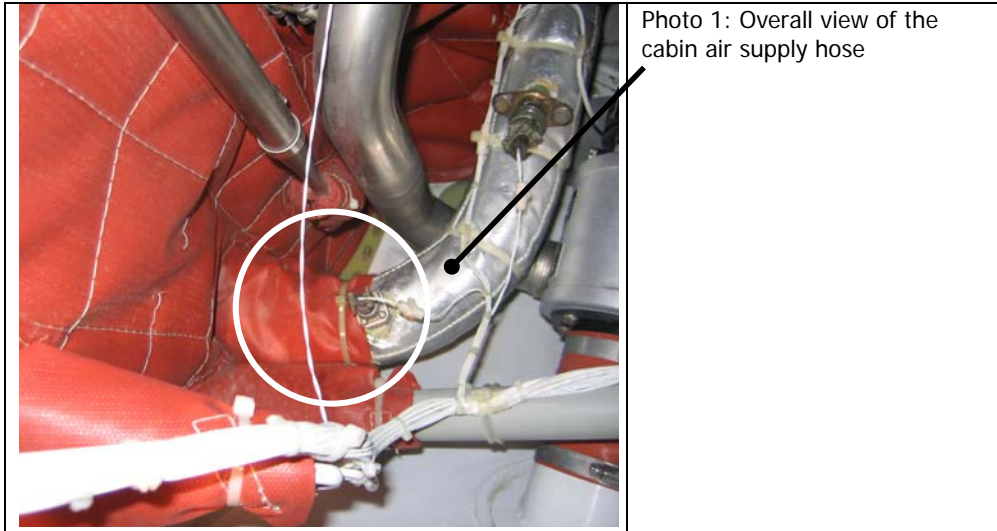
Given that the air outflow valve had been dismantled, cleaned and refitted during the last annual check on 24 October 2007, this valve was changed for preventive reasons. This valve's control unit (outflow valve controller) was also replaced as a precautionary measure.

1.3.4 The environmental control system – ECS

During the ground test on the turbine, after replacement of the pressurised cabin components, the ECS warning light was activated. Relay K631 (P/N 974.20.01.901), which was defective, was replaced. The subsequent test was performed successfully.

During the flight on 30 October 2007 to Barcelona, it was again impossible to pressurise the cabin and the cabin pressure warning light came on. The airflow from the ECS on the panel outlets to the cockpit was very low.

At the time of the troubleshooting for the causes of this malfunction, it was found that the cabin air supply hose (P/N 917.97.28.141 IPC 21-40-00 Page 1/3 item 50 – see Annex 1) was not properly fitted at the pressurised cabin bulkhead. The hose was then connected correctly. The tests subsequently carried out demonstrated that the system was again functioning correctly and the aircraft was brought back into service.



2 Analysis

2.1 Technical aspects

The pressurised cabin passed the pressure test. No leak was found. Apart from a relay which malfunctioned during the ground test, the environmental control system was functioning perfectly. Since the air supply hose was not properly fitted, the cabin could not be supplied with sufficient compressed air. One indication was the reduced airflow out of the panel outlets. It is possible that at the time of the annual inspection at the aircraft manufacturer's works, this hose was accidentally separated from the cabin bulkhead. The connection is covered by an insulation mat and is therefore not visible.

The pressurised cabin and ECS test, carried out separately after replacement of the components, did not reveal any malfunction. It was only when the two systems had to operate together again in flight that the malfunction occurred. It is clear that a test of the operation of the entirety of the two systems was necessary, such as the one carried out during the second check after the flight on 30 October 2007.

Given that the aircraft was equipped with neither a cockpit voice recorder (CVR) nor a flight data recorder (FDR), the information which would have been contained in this equipment was not available to facilitate the progress of the investigation.

2.2 Operational and human aspects

Although the PC-12 is an aircraft which can be operated by one pilot, the company operating this aircraft opted for operation by two pilots who implement the concept of a two-man crew. In fact, one pilot acts as pilot flying (PF) whilst the other performs the tasks of the pilot non flying (PNF).

In the case in question, application of the allocation of functions played a major role in the satisfactory handling of the serious incident. The choice of options adopted and actions taken was appropriate to the situation. Indeed, when the failure was detected, the crew immediately aborted their climb and reported this to the ATC controller. Noting the constant increase in cabin altitude, the crew initiated an emergency descent, applying the corresponding checklist. Donning of oxygen masks was ordered by the commander and their removal was authorised when flight level FL100 was reached.

Nevertheless, the crew, by applying the short checklist, clearly did not check the cabin pressure, as this point is not covered by this checklist. If it had been, they could have and should have detected the cabin pressurisation system malfunction during the initial climb phase.

The choice of Geneva as the alternate airport by the crew was appropriate, considering distance, altitude of the aircraft at the time of the fault and the available repair facilities.

3 Conclusions

3.1 Findings

- The documents supplied indicate that the pilots were in possession of appropriate licences.
- The aircraft had a valid airworthiness certificate.
- The mass and centre of gravity were within the limits prescribed by the aircraft manufacturer.
- The quantity of fuel onboard was sufficient to make this flight.
- On the day of the serious incident, the aircraft had just been undergoing maintenance, during which it had undergone the annual check at the manufacturer's works.
- The pressurisation fault was discovered during the climb phase of the flight.
- The crew made an emergency descent and diverted to Geneva.
- Initial trouble-shooting was carried out and the aircraft was brought back into service.
- Six days later, the crew detected a situation similar to that on the previous flight and decided to return to Geneva.
- A second trouble-shooting exercise found that the hose supplying air to the cabin was not correctly installed.
- The weather played no part in this serious incident.

3.2 Causes

The serious incident is due to a cabin pressurisation failure which occurred after an annual inspection at the manufacturer's works.

Factor contributing to the serious incident:

Absence from the checklist used by the crew of a point relating to checking the cabin altitude during a climb.

4 Safety recommendations and measures taken after the serious incident

4.1 Safety recommendations

None.

4.2 Measures taken after the serious incident

4.2.1 Short check list

Pilatus will examine the short check list and it will be modified if necessary. Similar to the PC-12/47E SCL the climb check will be amended by the point „Cabin pressure, monitor“.

4.2.2 Maintenance manual

The maintenance manuals will be amended as follows:

12-A-05-00-01-00A-010A, Task No. 21-20/221

ECS and bleed air ducts, pipelines, associated clamps and equipment in the engine compartment	Examine
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12-A-21-40-02-00A-920A-A, Water Separator, Removal/Installation

New task 2.9

Check all ECS clamps for correct installation and tightness

Payerne, 12 January 2010

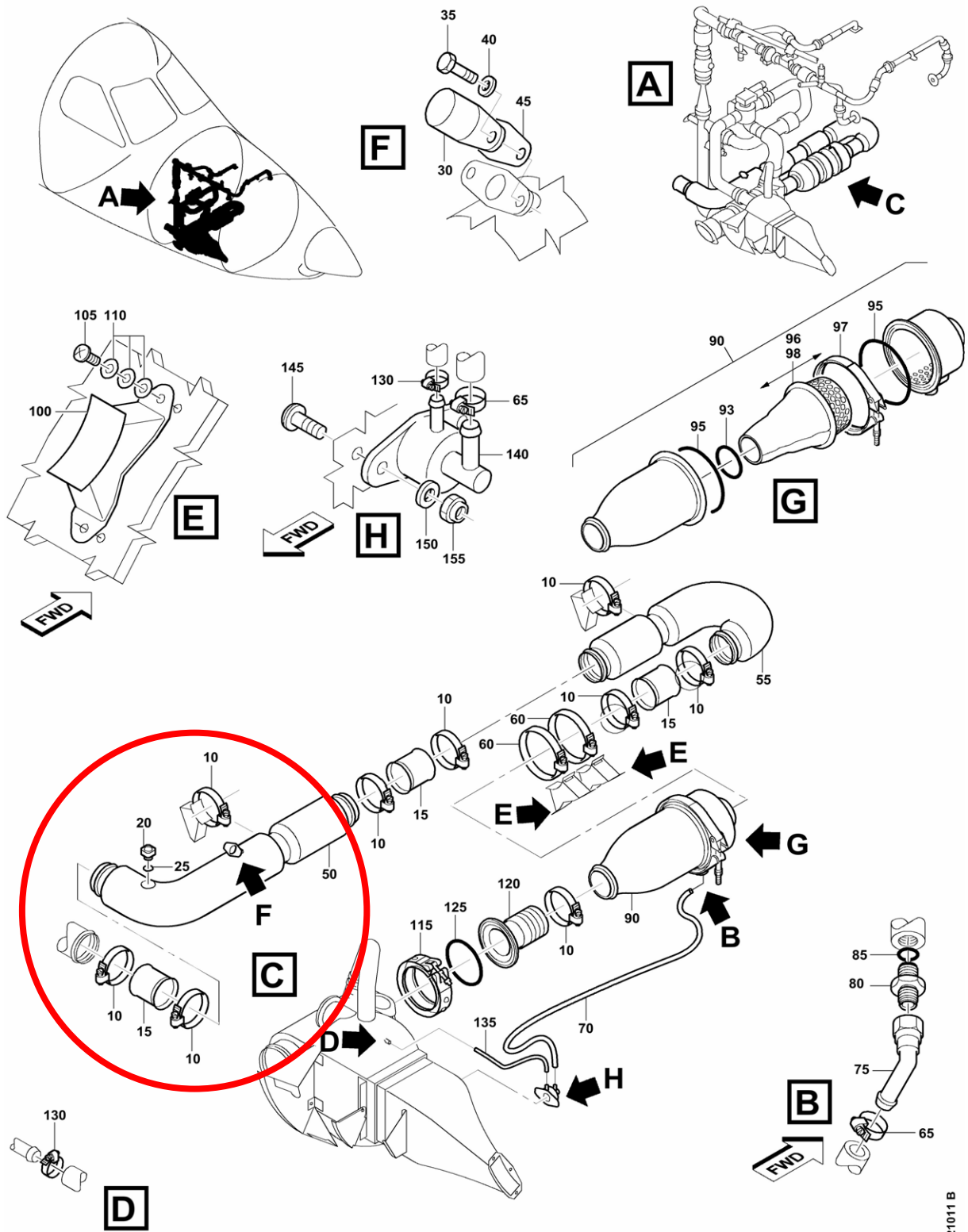
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Annex 1 – Extract from IPC 21-40-00 Environmental Control System – ECS



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