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## **In-flight smoke, Final Report by the Aircraft Accident Investigation Bureau concerning the serious incident to the aircraft EMB-145LU, HB-JAU on 16 November 2003 at Zurich Airport**

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**Micro-summary: Smoke on climb on this Embraer 145 resulted in a declaration of emergency and return to Zurich.**

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**Event Date: 2003-11-16 at 1959 UTC**

**Investigative Body: Aircraft Accident Investigation Bureau (AAIB), Switzerland**

**Investigative Body's Web Site: <http://www.bfu.admin.ch>**

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1. Accident reports can be and sometimes are revised. Be sure to consult the investigative agency for the latest version before basing anything significant on content (e.g., thesis, research, etc).
  2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***
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# Final Report by the Aircraft Accident Investigation Bureau

concerning the serious incident

to the aircraft EMB-145LU, HB-JAU

on 16 November 2003

at Zurich Airport

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 incident investigation (art. 24 of the Air Navigation Law). For data protection reasons the masculine form is used exclusively in this report for the naming of both sexes.

**Ursache**

Der schwere Vorfall wurde durch einen Fremdkörper in der *spray nozzle* im linken *environmental control system* (ECS) verursacht.

# Final Report

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<b>Aircraft</b>	Embraer EMB-145LU	HB-JAU
<b>Keeper</b>	Swiss International Airlines	
<b>Owner</b>	Kalidas Grundstücksgesellschaft mbH & Co. Kg.	

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**Pilots**                      PIC:        Italian citizen, born 1968  
                                      Copilot:    Swiss citizen, born 1974

**Licence**                      PIC and copilot: ATPL

<b>Flying hours</b>	<b>total (PIC)</b>	3573	<b>on EMB 145</b>	1324
	<b>total (copilot)</b>	2977	<b>on EMB 145</b>	1334

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**Location**                      Zurich Airport

**Date and time**                16 November 2003, 19:59 UTC (landing time)

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**Type of operation**            Scheduled flight / LX 818

**Flight phase**                 Climb after take-off in Zurich

**Type of incident**             Smoke (fumes) in the passenger cabin

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## Damage to persons

	<b>Crew</b>	<b>Passengers</b>	<b>Third parties</b>
<b>Fatally injured</b>	---	---	---
<b>Seriously injured</b>	---	---	---
<b>Slightly injured or uninjured</b>	4	34	
<b>Damage to the aircraft</b>	---		
<b>Damage to third parties</b>	---		

## Pre-flight history

The following entry was made in the technical log on 14 November 2003, on flight LX 816: *"Just after take off at about FL100 there was a big noise in the middle of the cabin. Find out it was from Pack#1. Pack#1 off. Flight continued at FL240"*.

Actions by the aircraft maintenance company: various visual checks were carried out. A crack was found in the hose between the recirculation fan and the environmental control system (ECS) pack. The hose was replaced. No anomalies were found during the subsequent high power check.

The following entry was made in the technical log on 16 November 2003, on flight LX 1059: *"After take off at FL120, CA (cabin attendant) complained about smoke coming out of A/C mid cabin into aisle. Found cabin temperature decreasing below 10°C. Switched temperature control in manual control to heat cabin up. No success. We switched off Pack Auto 2. Temperature control by Pack 1. Continued to ZRH at FL 250"*.

Actions by the aircraft maintenance company: *"No time to T/S (trouble shoot) due to short ground time TA (turn around). DD (deferred defect) IAW (in accordance with) MEL (minimum equipment list) 21-51-00"*.

Dispatch status for flight LX 818: "Pack#2 INOP"

## History of the flight

On 16 November 2003, at 19:42 UTC, aircraft HB-JAU took off from runway 32 in Zurich on scheduled flight LX 818 to Hanover.

Even during taxiing to runway 32, an unusual noise was heard in the passenger cabin in the vicinity of the recirculation fans. This disturbed a passenger in row 9.

Shortly after take-off, the responsible cabin attendant informed the commander that smoke was visible in the passenger cabin. Through the open cockpit door, the flight crew saw that smoke was spreading along the floor in the area between seat rows 4 and 10. Shortly afterwards in this area, traces of frost became visible and the cabin temperature began to fall. In addition, the cabin attendant then also noticed an unusual noise near row 9. No specific smell was noticed.

The commander decided to return immediately to Zurich. He requested a priority landing on runway 14. He then informed the passengers about the incident and the further procedure. The smoke gradually dissipated during the descent.

Flight LX 818 landed safely at 19:59 UTC on runway 14. Since the smoke had completely dissipated after the landing, the commander decided to taxi the aircraft to the gate and allow passengers to disembark normally.

## Findings

- Aircraft HB-JAU had a history with regard to the air conditioning system.
- ECS Pack#2 remained switched off for flight LX 818.
- Even during taxiing to runway 32, an unusual noise was heard in the passenger cabin in the vicinity of the recirculation fans.
- After take-off, smoke (fumes) was visible near seat row 9. This remained close to the floor and spread fore and aft.
- After a short time, frost was visible at the point where the smoke (fumes) was emerging. The cabin temperature began to fall.
- No unusual smell was noticed, nor was there any irritation to the eyes.
- The pilots did not don their masks.
- The commander decided to return to Zurich. The recirculation fans were switched off. ECS Pack#1 remained switched on.
- The smoke (fumes) gradually dissipated during the descent.
- ECS Pack#1 was switched off after the landing.
- The fault did not trigger an EICAS warning.
- The CMC did not indicate any fault. A download produced: "DIGITAL CABIN TEMP CONTROLLER FAIL".
- The cabin temperature controller was replaced. In view of the history, the dual temperature control valve and the other parts of ECS Pack#1 were also replaced.
- During a system test of ECS Packs#1 and #2 with engines running (high power test), a very loud noise was heard in the area of seat row 8. The cabin floor was opened in this area (Annex 1 figure 2) and it was found that the hose leading from recirculation fan #1 to ECS Pack#1 had separated near the cabin entry point (Annex 1 figure 1). The hose was reconnected.
- The spray nozzle, which carries water away from the water collector to the ram air duct, was examined to see if it was clear. In the process, a foreign body was found in the spray nozzle. This was a small piece of solder residue, which had presumably found its way from the condenser via the water collector into the spray nozzle and in the process had blocked it.

## Analysis

### Technical aspects

During flights LX 816 on 14 November and LX 1059 on 16 November, similar complaints to those on flight LX 818 had already been made about the air conditioning system.

The crew of flight LX 1059 reported that the cabin temperature normalised once Pack#2 had been switched off. However, it cannot be excluded that the cabin temperature normalised as a result of the low engine power when cruising and later during the descent and that the correlation with switching off Pack#2 was coincidental. The crew's perceptions and the fact that no actions were taken on the ground meant that aircraft was released for flight LX 818 by MEL with the dispatch status "Pack#2 INOP".

The appearance of smoke in the vicinity of the cabin floor, in the middle of the passenger cabin, was reported in two cases. This may have been fumes rather than smoke. In one case, frost was also observed at the egress point.

The occurrence of fumes and frost can be explained as follows (cf. Annex 2): as a result of the blocked spray nozzle, the water which had accumulated in the water collector could no longer be carried away. This now reached the turbine, where ice crystals were then formed. These in turn blocked the condenser and high pressure was created in the direction of the recirculation fan. The non-return valve fitted at the outlet of the recirculation fan prevented pressure from being released and the hose failed near the cabin entry point. The ice crystals now reached the cabin, formed the fumes in question and led to the drop in the cabin temperature. The situation normalised itself again at low engine power.

The decision of the maintenance company not to further investigate the fault discovered during flight LX 1059 and instead to release the aircraft for flight LX 818 with dispatch status Pack#2 inoperative was inappropriate, especially as a virtually identical fault had already been reported two days before.

### Operational aspects

The decision by the crew of LX 818 to return to Zurich and request a priority landing was appropriate, in view of the situation.

## Cause

The serious incident was caused by a foreign body in the spray nozzle in the left environmental control system (ECS).

## Measures by the operator

In order to prevent a recurrence of the incident, two periodic checks were introduced by the operator:

1. A check to ensure that the spray nozzles are clear every 500 flying hours (1A check).
2. Cleaning of the spray nozzles every 2000 flying hours (4A check).

The introduction of these checks was coordinated with Embraer, the manufacturer of the aircraft. Embraer were also informed of all investigations carried out on the aircraft.

Berne, 9 June 2005

Aircraft Accident Investigation Bureau

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Annex 1



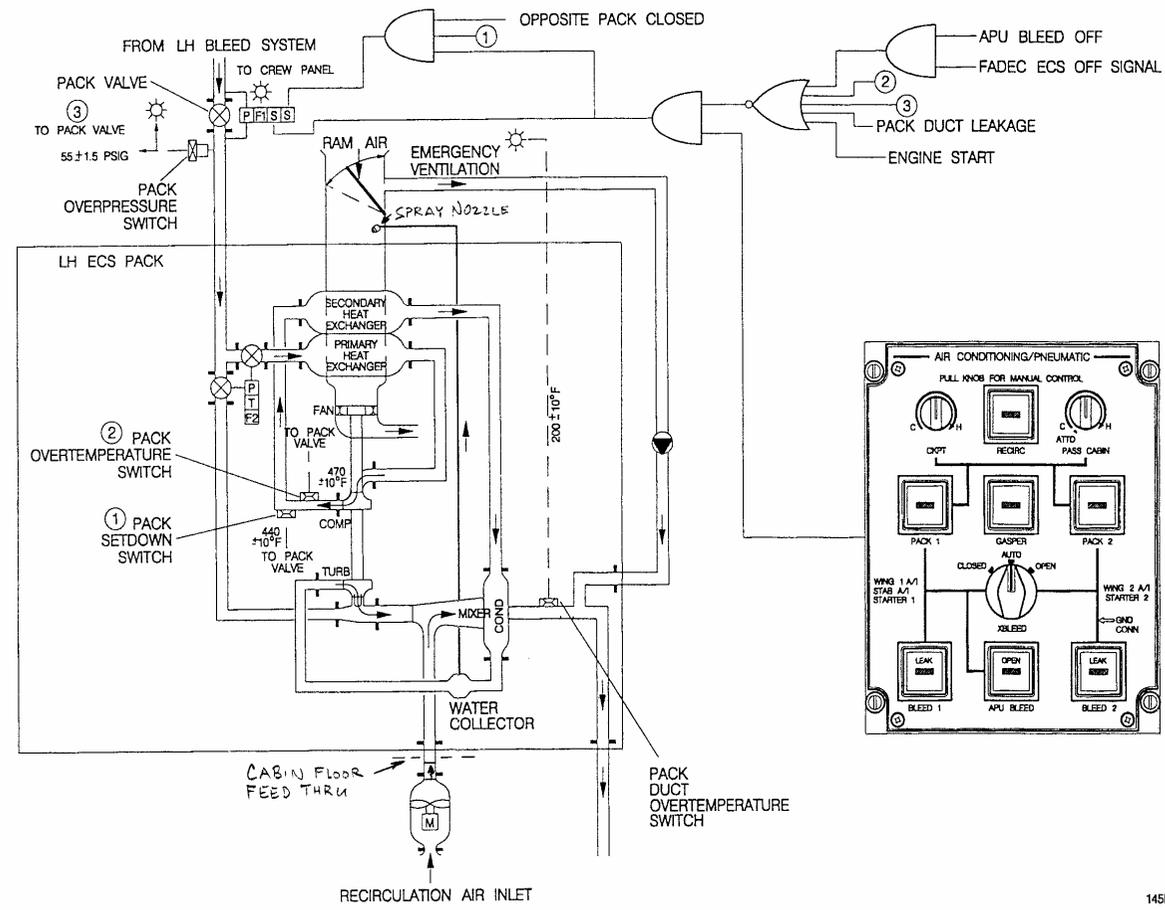
Figure 1



Figure 2

Annex 2

EMB 145 Aircraft Maintenance Manual (PART 1)  
COOLING PACK SYSTEM - SCHEMATIC DIAGRAM , S eet 1



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