



Final Report by the Aircraft Accident Investigation Bureau

concerning the serious incident

to the Saab 2000 aircraft, HB-IZJ
operated under flight number LX 1018

on 17 September 2003

over Lake Constance

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 regardless of gender.

Ursache

Der schwere Vorfall wurde verursacht durch das Eindringen von kontaminierter Luft des linken Triebwerkes ins Flugzeuginnere durch das Druckbelüftungssystem.

Final Report

Aircraft	Saab 2000	HB-IZJ		
Operator	Swiss International Air Lines, P.O. Box, 4002 Basle			
Owner	SL Pisces Ltd. Japan, Othmarstrasse 8, 8008 Zurich			
Pilots	Commander:	Swiss citizen, born 1959		
	Copilot:	Swiss citizen, born 1972		
Licences	ATPL CH and ATPL CH/JAR			
Flight Experience (Commander)	Total	6757	In the previous 90 days	77
	On incident type	1612	In the previous 90 days	77
Flight Experience (Copilot)	Total	3076	In the previous 90 days	251
	On incident type	2673	In the previous 90 days	251
Place	Airway position BODAN			
Coordinates	47 35.2N / 009 27.1E	Altitude	FL 140	
Date and Time	17 September 2003, 12:35 h (Local time = UTC + 2 h)			
Type of flight	Scheduled flight / LX 1018			
Phase of flight	Climb			
Type of incident	Indefinable smell in the aircraft			
Injuries to persons		Crew	Passengers	Others
	Fatal	---	---	---
	Serious	---	---	---
	Minor or none	4	50	
Damage to aircraft	None			
Other damage	None			

Summary

The airport authority Zurich informed the Swiss Aircraft Accident Investigation Bureau about the serious incident. An investigation was open on the same day.

The digital flight data recorder (DFDR) and the cockpit voice recorder (CVR) were removed from the aircraft and the data were evaluated.

1 Factual information

Pre-flight history

The aircraft history showed the following entries in connection with indefinable smell and visible traces of oil:

Oil smell	dated	08.03.2002
LH engine oil	dated	26.03.2002
Funny smell	dated	10.06.2003
Paint smell	dated	14.06.2003
Electrical smell	dated	07.08.2003
Smell of melted plastic	dated	15.08.2003

The last mentioned occurrence was caused by a chafed insulation of an electrical cable in the forward galley. The damage was repaired and the aircraft was released for air service.

History of flight

Swiss commercial flight LX 1018 from Zurich (LSZH) to Dusseldorf (EDDL), scheduled departure 10:05 UTC, took off at 10:21:37 UTC from runway 28 in Zurich via published departure route Bodan. The commander was pilot flying (PF), the copilot was pilot not flying (PNF). During the climb at around flight level - FL 140, approximately 10 minutes after take-off, the copilot perceived an unusual smell in the cockpit. He described the smell as follows: "as if hot oil in a pan would evaporate at high heat". His impression was later confirmed by the commander and one of the flight attendants working in the forward section of the cabin. There was neither smoke nor fume visible, the visibility was not spoiled.

The climb was initially continued according to flightplan. A troubleshooting action was initialised. The airconditioning packs and both bleed air systems were switched off/on individually in order to locate the possible source of smell. This switching had the effect that the smell shifted from the cockpit to the cabin and back. The smell varied in intensity and provoked lightly burning eyes to the copilot and the flight attendant working in the forward section of the cabin. There was no irritation of the respiratory tract. That was the reason why the oxygen masks were not used. The smell was perceptible in the cockpit and until the middle of the cabin. The commander and then the copilot went to the cabin to determine the source of smell. The copilot deliberately checked the left side of the cabin where the avionics compartment is located. He ascertained some kind of acidulous smell (like vomit). This was confirmed by the flight attendant.

The troubleshooting activity lasted for about 10 minutes. In the meantime the aircraft was overhead Stuttgart at FL 260. As the source of smell could not be determined, the flight crew decided to abandon the flight. After analysing the situation the decision was taken to return to Zurich. Air traffic control was informed about the problem. At 10:51:46 UTC the flight crew received permission from air traffic control to initiate a left turn and return to Zurich via airway position SULZ. No emergency was declared. The passengers were informed that the flight could not be continued due to a technical problem and the best solution was to return to Zurich.

During this phase of flight, according the CVR recordings, the commander expressed his concern several times about the consequences of his decision he had to expect after the landing.

The smell ceased occasionally, however, it's intensity increased again below FL 150 until landing.

During the approach the copilot complained again about eye burn and light headache. Approach and landing (approx. 11:14 UTC) were uneventful and no steps for a possible evacuation after landing were taken. After an announcement by the commander the passengers de-boarded the aircraft. From take-off to landing the flight lasted about 52 minutes.

Measures taken after the serious incident

Following examinations and test have been accomplished by the maintenance provider and were in part documented on work orders:

- Inspected L/H engine visual of oil leaks negative
- Inspected R/H engine visual of oil leaks negative
- Inspected area around pack intake no contamination found
- Inspected engine intakes for signs of oil negative
- Removed double seats row 11 and 12, removed also floor cover to get access to the plenum chamber and the airduct from the cabin air supply system found inside the plenum chamber isolation partly missing and or in bad condition, but isolation dry and no traces of oil. It just smelled like old isolation
- Engine run performed with different bleed settings no smell
- Inspected APU visual overfilled with oil
- Found evidence of birdstrike on L/H engine blood on propeller and smell
- Found evidence of birdstrike on R/H engine blood and feathers
- Checked L/H and R/H pilot footwarmer electrical heaters no findings
- During engine run checked left and right pack for normal operation satisfactory, no smell

- Cockpit, cabin and toilet extinguishers checked for leaks negative
- IAPS (integrated avionic processor system) opened and checked for smell negative
- Avionics rack opened and checked for smell negative
- L/H ACM panel opened ducting and ACM checked negative
- APU intake checked for possible birdstrike negative
- Lower LP bleedtube drains checked for remains non found
- Checked engine compressor for oil contamination during boroscope negative
- On both engines compressor and hot section inspected (boroscope) no signs of oil, bird remains or other damage
- Both engines leak run satisfactory
- Engine full power run performed on both engines with different bleed power settings (for 15 minutes) satisfactory, no smell
- Flight test performed oil smell confirmed on left engine during descend with powerlever in flight idle (right pack off)
- LH engine to be replaced done
- 2nd flight test performed Crew and maintenance reported no oil smell or oil presence. Only a light musty smell just after take-off. This smell cleared after several minutes and did not reappear
- Aircraft return to normal revenue service

The engine was disassembled. Thereby it was noticed that the seal-coating of the 10th stage compressor vane ring assembly showed scratches and was partly missing (due to break outs). It is not known to the investigation if any further examination was made regarding the bearing seals.

Particulars concerning the engine

The concerned engine is an Allison propeller turbine type AE2100A. Bleed air for the cabin pressurization system is taken from the 14th stage of the high pressure compressor at low engine power and from the 9th stage of the high pressure compressor at high engine power. The 14th stage is automatically engaged through the high stage valve. The bleed air pick-off for the 14th stage is located in the diffuser case, near the fuel nozzles.

The bearings of the main shaft are lubricated and cooled by the oil system. The individual bearings are sealed by carbon seals which are tightened by compressor air during engine operation.

The high pressure compressor of this engine is identical with the Rolls Royce AE3007A engine which is, among others, installed on Embraer 145 aircraft. The engine manufacturer made the following statement on his shop report:

“Missing coating (due to break outs) on XPT-268 coated vane rings is a known issue on 3007 engines (Embraer 145 engine), in which similar parts were installed. The Rolls Royce recommendation for 3007 engines was the reintroduction of aluminium-graphite seal material coated vane rings on affected engines, per SB AE3007A-72-187. For 2100A engines, mounted on the Saab 2000 involved in the incident, this recommendation is not existing.”

Until the completion of the investigation, the manufacturer could not provide any statement about the reason for the break outs respectively the peeling off of the seal coating on the inner vane rings.

Weather

The general weather situation over Switzerland was influenced by high pressure. Dry air reached the alps from the north.

The following data refer to the area of the serious incident:

Clouds:	1 – 3/8 cirrus, base approx. 25 000 ft/AMSL
Weather:	light haze
Visibility:	5 – 6 km
Wind:	northeast at 5 kt, gusts max. 10 kt
Temperature:	+ 20 °C
Dew point:	+ 11 °C
Atmospheric press:	QNH 1025 hPa
Danger:	none
Sun position:	azimuth 167°, elevation 44°

Weather report (METAR) from Zurich:

LSZH 17.9.2003 10:50 METAR 040/7KT 010V070 6000 NSC 19/13 Q1025 NOSIG

LSZH 17.9.2003 11:20 METAR 060/8KT CAVOK 21/11 Q1024 NOSIG

2 Analysis

2.1 Technical aspects

There was no evidence that the aircraft HB-IZJ was not in airworthy condition until the occurrence of the serious incident.

2.1.1 Pick-off of air pressure at increased engine power

When the engine is not running there is no compressor air to tighten the carbon seals. In this situation small amounts of oil may get into the high pressure compressor if the carbon seals are not tight.

After engine start this oil will then be heated up by the airflow through the compressor. When increasing engine power the temperature in the compressor will rise. It may last several minutes until the oil gets into the hot section of the compressor where it evaporates. At increased power the bleed air is picked-off at the 9th compressor stage and the high stage valve of the 14th stage closes automatically.

With high probability evaporated oil reached the cockpit and the passenger cabin via the bleed air respectively the air conditioning system.

2.1.2 Pick-off of air pressure at idle/low engine power

As the air pressure at the 9th stage of the compressor is not enough for the operation of the cabin pressurization at idle/low power, bleed air is exclusively picked-up at the 14th stage. This pick-off is situated close to the fuel nozzles.

The seal-coating of the 10th stage inner vane ring assembly of the engine involved was partly broken out. Deposits of this coating settled on the fuel nozzles which led to a disturbed vorticity of the kerosene. This, in turn, resulted in an incomplete combustion of the fuel. Thereby particles found their way to the cockpit and the passenger cabin via the 14th stage bleed air pick-off and the air conditioning system.

2.2 Human and operational aspects

2.2.1 General

The experience from other incidences/accidents in connection with smoke and fire shows, that malfunctions were perceivable long before a hazardous incident, this in terms of smell, noise, heat radiation of equipment and panels, popping of circuit breakers, etc. As smell often appears sporadically respectively at variable intensity and is also difficult to describe, a target-oriented troubleshooting is time consuming and therefore cost-intensive.

Notifications by crew members or passengers about not identifiable smells have to be taken serious. The search for the cause has to be carried out consequently. Trouble shooting during flights with passengers on board is not advisable. The fleet management should, in close cooperation with technical specialists, get to the bottom of such a malfunction before releasing the aircraft for scheduled service. Safety relevant decisions have priority, operational and economical aspects have to be subordinated.

Normally crews get quickly used to work in an environment with unidentified odours. When working according to a checklist which asks for donning the oxygen mask in a specific case, it should be used, however, latest when irritation of an organ appears. Irritation partly existed during the flight involved in the incident.

After the left engine had been changed no further problems associated with undefined odours occurred.

2.2.2 Commander

The decision of the crew to abandon the flight was appropriate.

On 15 August 2003 the commander was en route with the same aircraft. Due to noticed smell (like melted plastic) he then decided to abandon the flight and to return to Zurich. According to the CVR recordings of flight LX1018 the commander assessed the smell as "equal" to the one he experienced during the incident which happened a month ago. At that time, the reason for the smell was found in a chafed electrical wire in the galley area. This shows the difficulty to distinguish between individual odours, to prescribe them precisely and to assign them to a particular source.

From an interview with the crew and from the recordings of the CVR one can conclude that it wasn't easy for the commander to take the decision to return. He expressed his discomfort that one would possibly not believe him and that he would make a fool of himself. According CVR the commander made respective remarks during the descent and up to the landing. The apprehension of losing his face due to aborting a flight again contains the risk of increased stress.

3 Conclusions

3.1 Findings

- All crew members held licences.
- During the three month prior to the serious incident the aircraft was several times complained about conspicuous odours.
- After the change of the left engine no further complaints about conspicuous odours were made.
- The reported smell during climb was most probably caused by oil leaking out of a bearing of the left engine.
- The reported smell during descent was most probably caused by incomplete combustion of kerosene.
- The decision to abort the flight was appropriated.
- It shows, that a precise assignment of individual odours to there source was difficult.
- Intervention by the fire brigade was not necessary.
- Crew and passengers didn't suffer.

3.2 Cause

The serious incident was caused by penetration of contaminated air from the left engine into the aircraft via the pressurization system.

Bern, 13 October 2005

Aircraft Accident Investigation Bureau

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Annex 1

