



Summary Report

A summary investigation, in accordance with article 45 of the Ordinance on the Safety Investigation of Transport Incidents (OSITI), was carried out with regards to the following serious incident. This report was prepared to ensure that lessons can be learned from the incident in question.

Aircraft	Avro 146-RJ100	HB-IYR		
Operator	Swiss Global Air Lines AG, Malzgasse 15, 4052 Basel			
Owner	Swiss International Air Lines Ltd., Malzgasse 15, 4052 Basel			
Pilot	Swiss citizen, born 1982			
Licence	EASA (European Aviation Safety Agency) Airline Transport Pilot Licence Aeroplane (ATPL(A)), issued by the Federal Office of Civil Aviation (FOCA)			
Flying hours	Total	3,419 h	During the last 90 days	91 h
	On the incident type	3,171 h	During the last 90 days	91 h
Co-pilot	German citizen, born 1990			
Licence	EASA Commercial Pilot Licence Aeroplane CPL(A), issued by FOCA			
Flying hours	Total	820 h	During the last 90 days	73 h
	On the incident type	550 h	During the last 90 days	73 h
Location	approx. 8 NM south of runway 28 in Zurich			
Coordinates	---	Altitude	approx. FL 080	
Date and time	24 th October 2016, 19:28 UTC			
Type of operation	Scheduled flight			
Flight rules	Instrument Flight Rules (IFR)			
Flight phase	Approach to runway 28 in Zurich			
Type of serious incident	Oil fume smell in the cockpit, use of oxygen masks			
Point of departure	Birmingham airport (EGBB)			
Destination	Zurich Airport (LSZH)			
Injuries to persons	Crew	Passengers	Third parties	
Minor	0	0	0	
None	4	66	n/a	
Damage to aircraft	Not damaged			
Third-party damage	None			

Course of events

On 24th October 2016, the scheduled flights from Zurich to Birmingham and back were carried out by the commercial transport aircraft Avro 146-RJ100 'Jumbolino', registered as HB-IYR, under the IATA flight numbers LX424 and LX425. The flight from Zurich to Birmingham took place without incident.

In Birmingham, at 17:40 UTC, the scheduled pushback of the aircraft for the return flight to Zurich took place with the auxiliary power unit (APU) running. Two pilots, two cabin crew members and 66 passengers were on board. After the start-up of the four engines, the flight crew activated the APU's bleed air and the two air conditioning packs (PACKs) in order to ventilate the cabin (see short description of the pressure ventilation system and defroster).

Whilst taxiing to the take-off runway, the cabin crew manager (*maître de cabine*) entered the cockpit to inform the flight crew that the cabin was ready for take-off. In the course of this, he and the flight crew noticed a distinct oil fume smell in the cockpit. The flight crew subsequently checked whether a change from APU bleed air to ENG bleed air would clear the fume smell. As this was the case, they decided to deactivate the APU and take off without cabin ventilation.

At 17:48 UTC, the aircraft took off in Birmingham. At an altitude of 1,500 ft above ground, the engine power was reduced from take-off to climb and the ENG bleed air and both air conditioning packs were activated. As expected by the flight crew, the build-up of a smell failed to occur, meaning the climb and cruise flight could proceed without incident.

The descent towards Zurich took place with the defroster activated. At an approximate altitude of Flight Level (FL) 80, the defroster was switched off. About one minute later, the flight crew once again detected a distinct oil fume smell and subsequently put on their oxygen masks. At 19:29:06 UTC, they sent an urgency message (Pan, pan), informed air traffic control about the use of oxygen masks and requested approach priority.

The approach to runway 28 took place using radar vectoring and the flight crew made no further adjustments to the aircraft's pneumatic system. Nothing out of the ordinary could be detected in the cabin, meaning that from the perspective of the passengers and the cabin crew, the approach proceeded as normal. The aircraft landed on runway 28 at 19:36 UTC.

Immediately after reaching the parking position and opening the doors of the aircraft, a cockpit air sample was taken and analysed by the fire service. After the passengers had left the aircraft in the normal way, the levels of oxygen and carbon dioxide in the blood of the crew members were also measured on location. The results of all of the tests were normal.

Short description of the pressure ventilation system and defroster

The pressure ventilation system supplies the cockpit and cabin with conditioned air. This is taken as APU bleed air or as ENG bleed air and is processed by two air conditioning packs (PACKs). The two PACKs are located at the rear of the aircraft (see illustration 1).

PACK 1 is supplied by the APU or the left-hand engines, PACK 2 is supplied by the APU or the right-hand engines. Under normal circumstances, PACK 1 supplies the cabin and cockpit, whilst PACK 2 only supplies the cabin.

The same hot bleed air from the engines (in red on illustration 1) that also feeds the two air conditioning packs can prevent the formation of ice on the leading edges of the wings and of the horizontal stabiliser. The activation or deactivation of the defroster thereby also changes the condition of the bleed air which is supplied to the packs.

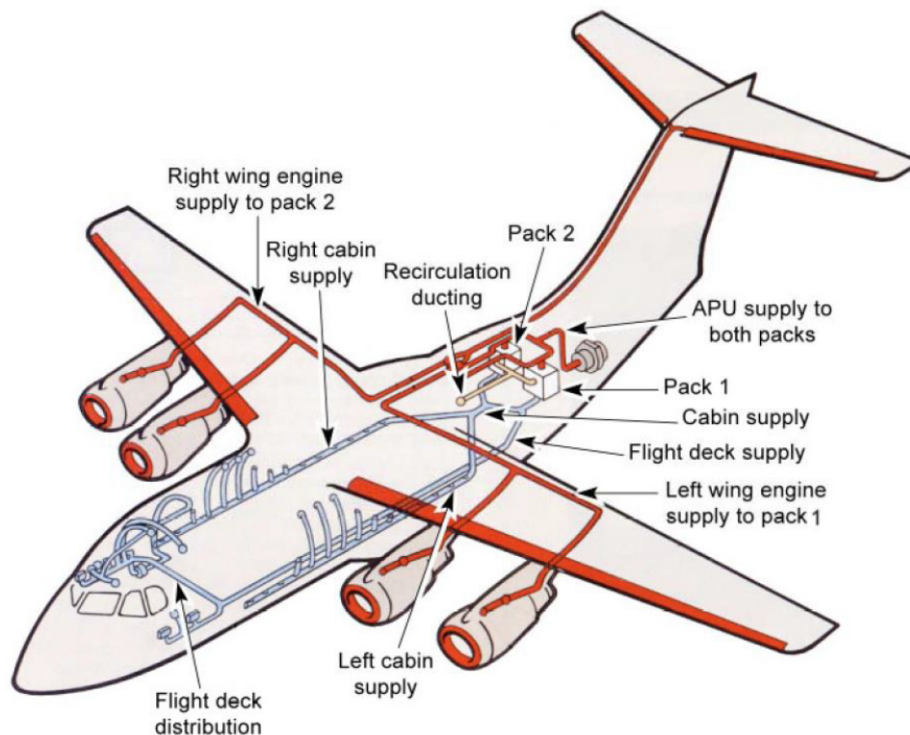


Illustration 1: Bleed air system (source: flight crew operation manual (FCOM) of Swiss)

Findings after the serious incident

The maintenance company carried out all inspections of different components as stipulated for cases such as this. The four engines and the APU were also examined using a borescope. No hard findings which could have explained the oil fume smell were produced by any of these inspections; as part of these inspections a hydraulic oil leak was in fact found and repaired, however, it was not assessed to be the root cause.

After a renewed inspection of the air quality using an aerotracer¹, oil fume particles could be detected in the air as soon as the bleed air from engine 2 was used. It should be noted that the bleed air from engine 2² feeds the left-hand air conditioning pack, which is primarily responsible for the air supply in the cockpit (see illustration 1). As there was also evidence of fume particles after the incident on 1st October 2016 under the same conditions (see previous incidents), the maintenance company decided to change engine 2.

As the aircraft type AVRO 146-RJ100 is being retired by the aviation company, engine 2 was taken into storage and the company did not carry out more in-depth inspections of the engine. Therefore, it cannot be stated with any certainty whether engine 2 was the root cause of the abnormal smell. On subsequent flights with this specific aircraft no other such odour developments were perceptible.

¹ An aerotracer is a device designed to detect contaminated air. Amongst other things, the manufacturer's information states that, "The aerotracer allows within short time to detect and identify volatile compounds used in and for the aircraft, like hydraulic fluids or lubrication oils, and is sensitive enough to rate odour concentrations into a sensing scale."

² The engines are numbered from left to right in the direction of the flight. As such, engines 1 and 4 are identified as the outer engines and engines 2 and 3 are identified as the inner engines.

Previous incidents

The flight crews of HB-IYR had already complained about an abnormal smell in the cockpit on 1st and 21st October 2016.

On 1st October 2016, on approach to Zurich Airport (LSZH), the flight crew noticed an abnormal smell which lasted for approximately one minute and that they compared to the smell of old socks. In addition, they described the air quality throughout the entire flight from Paris (LFPG) to Zurich as unusual and unpleasant.

The inspections carried out by the maintenance company included an air quality inspection using an aerotracer, which showed evidence of oil fume particles in the supply of bleed air from engine 2. A preliminary inspection of engine 2 showed an oil leak on bearing number 9. However, after opening the bearing housing, engine specialists could not confirm this. Subsequently a compressor wash of engine 2 was carried out. Then tests with all possible air and air conditioning configurations were carried out, once again using an aerotracer. All of these tests showed no anomalies. Before the aircraft was returned to operation, an additional inspection flight took place; this was also uneventful.

On 21st October 2016, after take-off in Dresden (EDDC), the flight crew switched the air conditioning from APU bleed air to ENG bleed air and immediately noticed a strong smell in the cockpit for approximately three minutes which they compared to the smell of old socks. After switching to fresh air mode³ the situation returned to normal. No abnormal odour was detected in the cabin. The landing in Zurich (LSZH) took place without incident.

The inspections by the maintenance company included the following, which proved inconclusive:

- Inspection of all air and air conditioning configurations possible using an aerotracer
- Borescope inspection of engines 1 and 2, and the APU
- Search for external leaks

Furthermore, PACK 1 was replaced as its air cycle machine fell outside of the tolerance with regards to torque. In addition, as a preventative measure, the cockpit and cabin filters were changed.

The inspections for both incidents displayed no clear findings that the smell could have been traced back to. Furthermore, neither was an urgency message sent, nor were the oxygen masks used by the flight crews. In both cases STSB therefore decided not to carry out an investigation.

Analysis and conclusions

The use of oxygen masks by the flight crew was safety-conscious. The sending of an urgency message requesting priority landing was appropriate for the situation.

The cause for the development of the smell in the cockpit could not be ascertained with certainty. During two inspections using an aerotracer, however, evidence emerged that the development of the smell could have been caused by the bleed air from engine 2. Changing this engine was therefore logical and justified. Subsequently, no other comparable cases occurred with this aircraft.

Bern, 12 December 2017

Swiss Transportation Safety Investigation Board

³The air conditioning system has two modes, FRESH and RECIRC, which can be chosen on the overhead panel. In FRESH mode, the PACK valves are set to full flow and all of the air for the cockpit and cabin comes from the selected bleed air source which has been chosen for the corresponding PACK. This is in contrast to RECIRC mode, which is selected in standard operation, in which the PACK valves are set to reduced flow and the cabin air is fed back into the PACKs by a recirculation valve and mixed with the circulated air.