Federal Department of the Environment, transport, Energy and Communications **N° 1710**

Final Report of the Aircraft Accident Investigation Bureau

concerning the

incident with the aircraft Boeing 737-500, G-MSKB

on 12 August 1999

at Geneva-Airport

Federal Building Nord, CH-3003 Berne

Swiss Aircraft Accident Investigation Bureau

INVESTIGATION REPORT

on the incident with

the aircraft Boeing 737-500, G-MSKB
on 12 August 1999
at Geneva-Airport

This report has been prepared for the purpose of accident avoidance. The legal assessment of accident causes and circumstances is no concern of the accident investigation (art. 24 of the Swiss Aviation Law of 21.12.1948, SC 748.0).

0. GENERAL

0.1 Summary

Saturday, 7 August 1999, Flight British Airways 8412 from Birmingham to Geneva (operated by Maersk Air UK) was initiating the descent from FL370 towards the destination airport when the cabin crew recognized smoke and an acrid smell in the cabin. The commander issued a pan-pan-pan message and started a rapid descent. 12 minutes later the aircraft was landed uneventfully on runway 23 in Geneva. The 40 passengers and the crew evacuated the aircraft via the forward passenger door over the inflated slide. Nobody was injured and no damage resulted to the aircraft.

0.2 Investigation

The incident happened at 1155 local time. The Federal Office for Aircraft Accident Investigations was alerted at 1230 LT. The investigation was initiated at 1530 LT on the same day.

1. FACTUAL INFORMATION

1.1 History of the flight

Flight BA 8412 operated by Maersk Air UK departed runway 15 in Birmingham, UK at 0825 Z for a scheduled service to Geneva, Switzerland. The uneventful take-off was performed using reduced thrust. During initial climb cabin crew and passengers were kept strapped in due to some turbulence. Passing 4000 feet the purser entered the cockpit and advised the flight crew about a burning smell in the cabin without visible signs. The commander, having no indications of a potential problem in the flight deck, asked her to check the ovens. No evidence for the origin of the smell was found. The flight crew switched off galley power and placed the right hand pack switch to the „high“ position, asking the purser to report any improvement. A few minutes later the purser reported that the smell was clearing and requested to get the galley power back. The pilots restored the galley power and selected the right-hand pack to „auto“.

During cruise no further problems were reported. The commander inspected the cabin personally and did not detect any smell. At 0940 UTC the aircraft reached the calculated top of descent and the respective clearance was requested with Paris control on 118.22 MHz. Due to conflicting traffic the descent was delayed by the air traffic controller causing the copilot, who was flying pilot, to start to reduce the speed to prevent from a steep profile situation. The power levers were retarded and at once the strong acrid smell reappeared in the cabin.

While the purser opened the cockpit door to inform the flight crew, the smell was noticed by both pilots. This time smoke started to appear and spread in the cabin. The mid-section and the rear was especially affected. The reduction of the visibility was such that the cabin attendant in the rear was unable to see the front end of the relatively short cabin of the Boeing 737-500. The flight crew actioned the memory items of the smoke drill and emitted a „pan“ call on the Geneva control frequency to which they were transferred in the mean time. While they were directed for a direct approach to runway 23 in Geneva the pilots performed the reminder of the smoke drill concentrating on the air conditionning systems. As the smoke slowly dissipated, the commander briefed the purser to prepare for a normal evacuation of the aircraft using the forward airstairs. In preparation for this, the APU was started on final approach to supply power for the airstairs extension. On the ground the airport rescue services were ready for intervention. The Boeing 737 landed normally on runway 23 and left via taxiway „Charlie“ were it was stopped. While the cockpit crew performed the evacuation checklist they unintentionally shut down the APU, preventing the purser from being able to extend the airstair. In consequence the commander redirected the purser to deploy the evacuation slides. Assisted by the rescue services the passengers and crew left the aircraft calmly over the slide. Nobody was injured and the aircraft sustained no damage.

1.2 Injuries to persons

	Crew	Passengers	Others
Minor/None	6	40	---

1.3 Damage to aircraft

No damage.

1.4 Other damage

None.

1.5 Personnel information

Pilots

Commander:	British citizen, 1969	
	Total hours:	4150
	Previous 90 days:	139.3
	Total B737:	1845
First Officer:	British citizen, 1942	
	Total hours:	7150
	Previous 90 days:	190
	Total B737:	1430

Cabin attendants

Purser:	1
Cabin attendants:	3

1.6 Aircraft

Type:	Boeing 737-500	
Manufacturer:	Boeing Aircraft Company	
Characteristics:	Twin engine short to medium range passenger jet aircraft	
Year of manufacture:	1990	
Serial Number:	24928	
Certificate of airworthiness:	12 November 1996 valid till 11 November 1999	
Owner/Operator:	Maersk Air UK Ltd., Birmingham Intl. Airport, Coventry Road, Birmingham, B26 3QB, UK	
Types of Operation:	Commercial flights: IFR day and night	
Operating hours at the time of the incident:	Airframe:	20289 hrs/16367 cycles
	Left-hand engine:	Serial Number 725627 20405 hrs/16059 cycles
	Right-hand engine:	Serial Number 722254 18523 hrs/
Relevant maintenance actions:	21 July 1999 the right-hand engine was replaced while the aircraft was in a HMV. It flew first on 31 July 1999 and totalized 46:57 h until the incident. In response to a pilot discrepancy report about cabin pressure fluctuations while retarding the power for descent, the high pressure bleed valve of the right-hand engine has been changed during the Night preceding the incident.	
Mass and Center of gravity:	Mass and the center of gravity were within the limits at the time of the incident.	

1.7 Meteorological information

From the top of descent to landing the aircraft was in VMC/Day conditions. The weather was of no significance for the incident.

1.8 Aids to navigation

Not significant.

1.9 Communications

The radio communications with the air traffic services of Geneva developed in a controlled and calm manner. After the crew issued the „pan“ call at FL370 the flight received immediate priority and was directed for a direct approach to runway 23. The radio recording reveals some unreadable phrases by the crew that are probably scrambled by the breathing noise while wearing oxygen masks.

1.10 Aerodrome information

The aerodrome fire fighting and rescue organization was timely ready to assist the landing aircraft.

1.11 Flight Recorders

Flight Data Recorder: Installed and working properly. Data used to analyze the descent profile.

Voice Recorder: Installed and working properly.

1.12 Wreckage and crash impact information

1.13 Medical Observations

1.14 Fire

Despite the presence of a smoke-like air contamination no actual fire occurred.

1.15 Survivability

1.16 Tests and research

Due to the fact that descriptions of smells are not commonly classified and vary greatly from person to person it is difficult to determine the nature and the source of cabin air contamination. The physical search of the entire aircraft for any traces of fire did not show any evidence. The investigation had therefore to proceed with the systematic operation of all aircraft systems that could have been the source for the smoke-like substance. Taking the history of the flight and related information into consideration the search was focussed on the air conditioning system. Previous experience with other incidents have indicated that even small amounts of engine oil that penetrate the air conditioning system can form strong smells and reduction of the visibility. Depending on the temperature to which the oil is heated up to the resulting smell and smoke can vary greatly in nature and intensity. However the oil is not carbonized and therefore not burned.

By the systematic elimination of components that could have been the source of the problem, it was finally established that the air conditioning system was contaminated by the 9th stage high pressure bleed air manifold of the right-hand engine. This theory was supported by the fact that the contamination started at power reduction which is the moment when the high pressure bleed supply cuts in to sustain the bleed air pressure at low power. The boroscopic inspection of the 9th stage bleed air manifold revealed small black traces of burned oil in the tube connecting the engine housing to the manifold on the right-hand side. The change of the right-hand engine cleared the problem finally.

2. ANALYSIS

2.1 Operational Aspect

Strong smells and smoke in an aircraft are the nightmare of every flight crew. It is difficult to assess the nature and the source of the contamination and as a consequence the choice of the applicable measures are mostly random or based on secondary symptoms. Priority on landing the aircraft as soon as possible is certainly an appropriate action because the exposure time to the unknown time to the unknown hazard is reduced. In consideration of the seriousness of the presence of smoke it might be advisable to issue a „mayday“ call to get immediate attention instead of the less known „pan-pan“. It is remarkable how the crew of BA8412 duly assisted by air traffic Control managed to descend from 37'000 feet and land the B737 within 16 minutes. The aircraft was stabilized on ILS final approach from 6'000 feet while maintaining the appropriate speed schedule. The communication between cockpit and cabin was adequate and prevented from anyone panicking. The plan to evacuate the aircraft via the airstairs was reasonable, however the outcome shows that aircraft drills and situational decisions easily lead to unforeseen constraints. As in this case, where there was no electrical power available to extend the airstairs after the execution of the evacuation drills despite the fact that the commander remembered to start the APU prior to the landing. While the fire and rescue services approached the aircraft they were puzzled by the opening and re-closure of the passenger exit caused by the need to re-arm the evacuation slides. The usual lack of a direct link between the fire-chief and the aircraft commander often leads to confusion and misunderstanding. A unique worldwide radio frequency would allow a quick and unambiguous communication between the rescue forces and the cockpit crew.

2.2 Technical Aspect

Air contamination by leaking engine parts is inherent to all systems that use engine or APU bleed air as pneumatic supply. The operational consequences of such contaminated air may however be very serious. While discrepancies in pressure or temperature of the bleed air are sensed and commonly operate a shut-off valve, there is no such device, like an optical sensor, looking for the presence of foreign particles in the air stream.

Not only could the contamination of the cabin air be avoided but also the troubleshooting would be much assisted. The installation of a small retaining filter in the air recirculation ducting could additionally allow a chemical analysis of particles that were present and therefore investigations could be based on data rather than on assumptions.

1. CONCLUSIONS

3.1 Findings

- The crew held valid licences.
- The aircraft was properly certified for navigation.
- The right-hand engine was installed on 21 July and flying since 31 July.
- During the night before the incident the right-hand high pressure bleed valve has been changed for troubleshooting.
- Oil penetrated the right-hand 9th stage high pressure bleed air manifold and injected a smoke-like aerosol in the passenger cabin via the air conditioning system.
- Cockpit and cabin crew acted successfully along their procedures.
- Air traffic control assisted the flight optimally.
- The airport fire and rescue services provided timely and adequate help.

3.2 Cause

The incident was caused by engine oil, penetrating the air conditioning system through the right-hand high pressure bleed air port, that evaporated and formed a smoke-like aerosol in the passenger cabin.

4. RECOMMENDATION

With the hindsight of the numerous accidents and incidents with cockpit/cabin smoke, it is strongly recommended to implement a system enabling the crew to detect airconditioning smoke. This system should be installed on all aircraft using engine and/or APU bleed air as pneumatic supply for airconditioning and pressurization.

Berne, 7 November 2000 Swiss Aircraft Accidents Investigation Bureau