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Swiss Transportation Safety investigation Board STSB

Aviation Division

Final Report No. 2240 by the Swiss Transportation Safety Investigation Board STSB

concerning the serious incident involving the Fokker F28 Mk 100 aircraft, registration HB-JVH

on 15 July 2013

approximately 15 NM south of Basel

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General information on this report

This report contains the Swiss Transportation Safety Investigation Board's (STSB) conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with Article 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation 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 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/incident prevention, due consideration shall be given to this circumstance.

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

All information, unless otherwise indicated, relates to the time of the serious incident.

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

Contents

Final Report

Synopsis

Owner	HB-JV Hotel AG, Egglirain, 8832 Wilen, Switzerland
Operator	Helevetic Airways AG, Postfach 250, 8058 Zürich, Switzerland
Manufacturer	Fokker Aircraft B.V., Amsterdam, The Netherlands
Aircraft type	F28 Mk 100, also known as Fokker 100
Country of registration	Switzerland
Registration	HB-JVH
Location	Approximately 15 NM south of Basel
Date and time	15 July 2013, 06:33 UTC

Investigation

The serious incident occurred on 15 July 2013 at 06:33 UTC. The incident was notified just before 07:00 UTC and the former Swiss Accident Investigation Board (SAIB) opened an inquiry at approximately 08:30 UTC. The SAIB informed France, which was the state involved due to the competent air traffic control unit, and the Netherlands, which was the state involved as the state where the aircraft was manufactured, of the serious incident. France appointed an authorised representative, who subsequently assisted with the investigation.

The present final report is published by the Swiss Transportation Safety Investigation Board.

Summary

On 15 July 2013 at 06:23 UTC, the Fokker F28 Mk 100, registration HB-JVH, took off from runway 28 in Zurich (LSZH) on a scheduled flight to Bristol (EGGD). While climbing, just after the oven used to heat food had been turned on, the senior cabin attendant (SCA), who was working in the galley towards the front of the aircraft, discovered smoke coming from oven no. 2. When he opened the door of the affected oven he was confronted by a cloud of smoke. He then turned this oven and all other galley equipment off.

At the same time the flight crew had noted that white smoke was entering the right side of the cockpit from the rear. The SCA was then instructed by the flight crew to pull the oven circuit breaker (CB). This interrupted the power supply to the oven and smoke generation ceased.

The flight crew then informed air traffic control that they would fly back to Zurich.

The aircraft landed on runway 16 in Zurich at 07:00 UTC. The flight crew decided to let passengers disembark normally since no further smoke was visible.

No occupants were injured. An oven on board the aircraft was damaged.

There was no other damage.

Causes

Copy of chapter 3.2.

1 Factual information

1.1 Prehistory and history of the flight

1.1.1 General

For the following description of the prehistory and history of the flight, the recordings of the radiocommunication, radar data and the statements of the crew members were used. For the entire flight the commander was pilot flying (PF) and the first officer was pilot not flying (PNF).

It was a scheduled flight under instrument flight rules (IFR).

1.1.2 Prehistory

The crew began duty in Zurich at 05:00 UTC, with the exception of one flight attendant, who had already travelled from Bern to Zurich that morning. This flight attendant began duty at 04:30 UTC.

The aviation operator provided the crew with the documentation pack necessary for the preparation of the flight. In addition to an operational flight plan (OFP), the relevant weather and flight information, this pack also contained a list of technical defects with respect to the deferred items according to the MEL[1], and an information bulletin on internal processes (flight crew briefing sheet).

1.1.3 History of the flight

On 15 July 2013 at 06:23 UTC, the Fokker F28 Mk 100 aircraft, registration HB-JVH, took off from runway 28 in Zurich (LSZH) on a scheduled flight to Bristol (EGGD). On board were 67 passengers and four crew members. The flight was conducted under flight number 2L440; the radio call sign was Helvetic four four zero.

At 06:28:59 UTC, the crew was instructed by the Swiss Radar West area control to climb to flight level (FL) 200 and call Reims Radar area control. At this time, the aircraft was climbing to FL 110, 10 NM north of the Willisau (WIL) beacon. The crew then received clearance to continue climbing to FL 220.

In this phase, the ovens used for heating food were switched on for preheating. A short time later, the senior cabin attendant (SCA), who was working in the galley towards the front of the aircraft, discovered smoke coming from oven no. 2. When he opened the door of the affected oven he was confronted by a cloud of smoke. He then turned this oven and all other galley equipment off. The SCA believed that the smell of smoke indicated an electrical defect.

At the same time, at approximately 06:33 UTC, the flight crew had noted that white smoke was entering the right side of the cockpit from the rear. At this time the aircraft was climbing through FL 190, 15 NM south of Basel. The flight crew also believed that the smell of the smoke indicated that it was the result of an electrical fire or overheating of electrical components.

To carry out an assessment of the situation, the flight crew finished climbing to FL 220 and informed air traffic control accordingly. They called the senior cabin attendant into the cockpit and informed him of the smoke. He explained that smoke had been issuing from oven no. 2 and that he had since turned it off. He explained that no smoke had been detected in the passenger cabin. The flight attendant was then instructed by the flight crew to pull the oven circuit breaker

[1] MEL: minimum equipment list

(CB). This interrupted the power supply to the oven. The SCA then determined that the smoke was no longer being generated in the oven.

As a precautionary measure, the crew decided to abort the flight and return to Zurich. They received the appropriate clearance from Reims Radar air traffic control and initiated a 180° turn at 06:38:26 UTC. The aviation operator was then informed of this decision via radio.

Shortly thereafter, smoke again entered the cockpit for a short time, so the flight crew decided to don their oxygen masks without the associated goggles and work through the electrical smoke emergency checklist. This checklist provides for the power supply to be reduced to essential consumers (essential and emergency power only). As a result, various displays and automatic flight control were largely out of service and the commander flew without autopilot while the first officer conducted radio communications.

Helvetic four four zero then initiated a descent to FL 190.

At 06:41:33 UTC, the crew of HB-JVH resumed contact with Swiss Radar West air traffic control. The air traffic controller asked the crew if they required priority, to which the first officer replied in the affirmative.

Three minutes later, at 06:44:50 UTC, the air traffic controller instructed the flight crew to maintain their heading and continue to descend to FL 140. He also informed the flight crew that they would probably land on runway 16, which is the longest runway at Zurich Airport.

At 06:45:02 UTC, the air traffic controller instructed the crew to switch to the Zurich Arrival frequency, which they did immediately.

On the approach to runway 16, the flight crew switched on the normal power supply for the instruments again in order to make more displays available for flight control.

At 06:51:05 UTC the Zurich Arrival air traffic controller asked whether the crew wanted to evacuate the aircraft on the runway, to which they answered in the negative. At 06:57:00 UTC the air traffic controller requested Helvetic four four zero to call Zurich Tower. During the first call on the Zurich Tower frequency, the air traffic controller issued landing clearance for runway 16.

The aircraft landed on runway 16 in Zurich at 07:00 UTC and was escorted to the stand by the fire brigade. Communications between the crew and the fire brigade took place by calling through the open cockpit window. At the stand, the flight crew decided to let passengers disembark normally since no further smoke was visible.

After the passengers had disembarked the aircraft, the fire brigade examined the galley using a thermal imaging camera. No heat concentrations were observed.

Nobody on board was injured. Oven no. 2 on board the aircraft was damaged.

1.1.4 Location and time of the serious incident

Location	Approximately 15 NM south of Basel
Date and time	15 July 2013, 06:33 UTC
Lighting conditions	Daylight
Altitude	Approximately flight level 190

1.2 Injuries to persons

1.2.1 Injured persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	4	67	71	Not applicable
Total	4	67	71	0

1.2.2 Nationality of the occupants of the aircraft

The crew comprised four Swiss citizens.

There were 67 passengers of various nationalities on board.

1.3 Damage to aircraft

An oven on board the aircraft was damaged.

1.4 Other damage

There was no other damage.

1.5 Personnel information

1.5.1 Flight crew

1.5.1.1 Commander

1.5.1.1.1 General

Person	Swiss citizen, born 1976
Licence	Airline transport pilot licence aeroplane (ATPL(A)) according to the European Aviation Safety Agency (EASA), issued by the Federal Office of Civil Aviation (FOCA).

All available evidence suggests that the commander started duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.5.1.2 Flying experience

Total	6758 hours
of which on the type involved in the incident	6510 hours
during the last 90 days	134 hours
of which on the type involved in the incident	134 hours

1.5.1.3 First officer

1.5.1.1.2 General

Person	Swiss citizen, born 1984
Licence	Commercial pilot licence aeroplane (CPL(A)) according to the EASA, issued by the FOCA.

All available evidence suggests that the first officer started duty well-rested and in good health. There are no indications that fatigue played a role at the time of the serious incident.

1.5.1.1.3 Flying experience

Total	460 hours
of which on the type involved in the incident	138 hours
during the last 90 days	137 hours
of which on the type involved in the incident	137 hours

1.5.2 Cabin crew

1.5.2.1 Senior cabin attendant

Person	Swiss citizen, born 1988

1.5.2.2 Flight attendant

Person	Swiss citizen, born 1990

1.6 Aircraft information

1.6.1 General information

Registration	HB-JVH
Aircraft type	F28 Mk 100, also known as Fokker 100
Characteristics	Twin-jet commercial aircraft, constructed as a cantilever low-wing aircraft of full metal construction with retractable landing gear in nosewheel configuration.
Manufacturer	Fokker Aircraft B.V., Amsterdam, The Netherlands
Year of manufacture	1993
Serial number	11 324
Owner	HB-JV Hotel AG, Egglirain, 8832 Wilen, Switzerland
Operator	Helvetic Airways AG, Postfach 250, 8058 Zurich, Switzerland
Mass and centre of gravity	The mass was below the maximum permitted landing mass and was, together with the centre of gravity, within the per-

	missible limits according to the aircraft flight manual.
Technical limitations	The following points were listed in the deferred items list according to the MEL: *"Centre wing tank SOV fuelling only in manual mode, centre tank switch in shut."*

1.6.2 Selected systems and aircraft equipment

1.6.2.1 Oven installation

The affected oven[2], which was manufactured by Rumbold, was incorporated into the galley towards the front of the aircraft. The following figure illustrates the position from the left front entrance door.

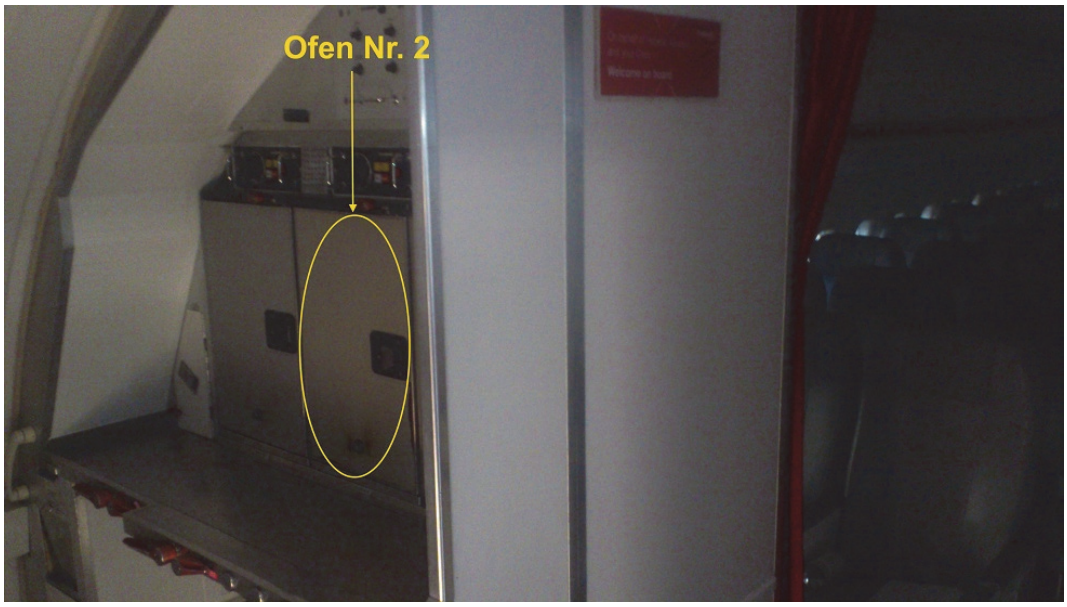

Figure 1: Looking towards the cabin.

The oven has a maximum power of 3850 watts and is connected via a 15 amp three-phase circuit breaker.

[2] category No. 67255-3; serial No. 122977

1.6.2.2 On-board ventilation system

The Fokker F28 Mk 100's on-board ventilation system is ensured via two cooling packs. Figure 2 provides an overview of the air supply on board this aircraft.

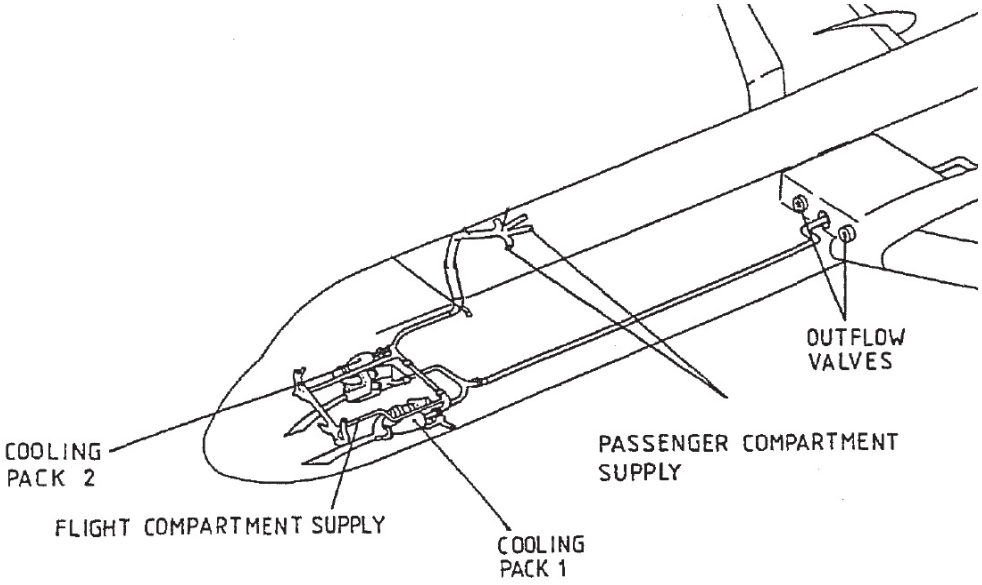

Figure 2: Diagram of the Fokker F28 Mk 100's on-board ventilation system

The exhaust air from the cabin exits via the outflow valves. The exhaust air from the galley enters the avionics cooling exhaust duct independently of the cabin exhaust air and is fed overboard together with the avionics exhaust.

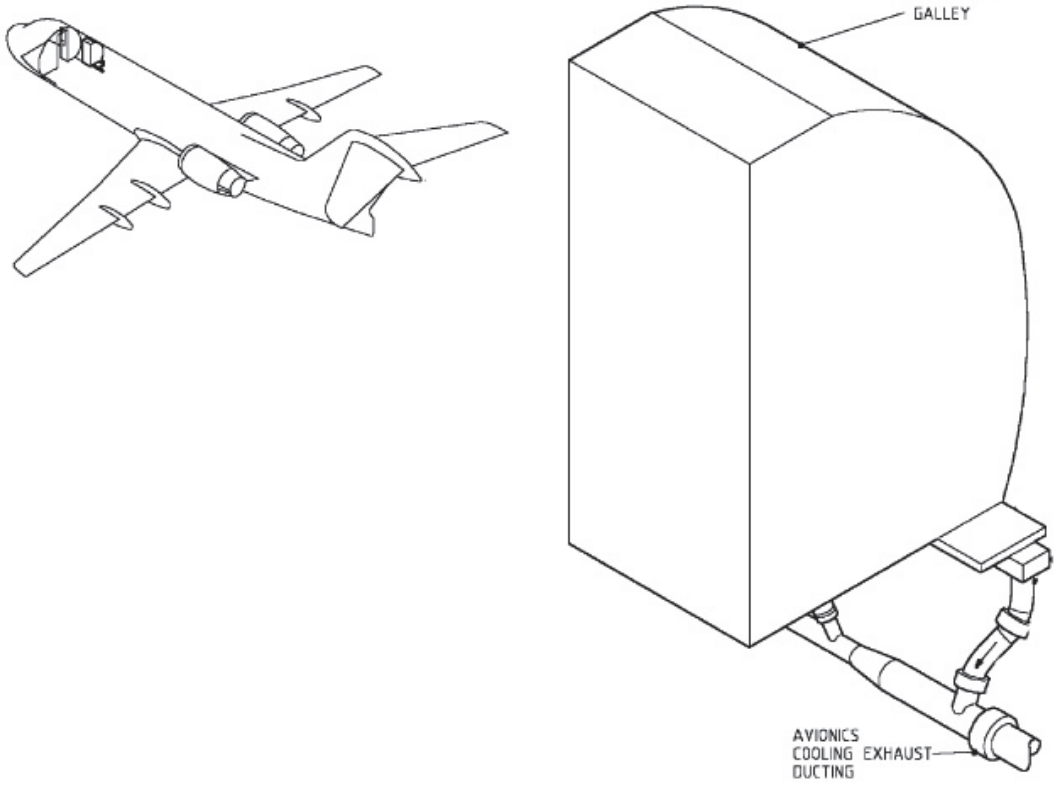

Figure 3: Detailed view of the galley ventilation.

1.7 Meteorological information

1.7.1 General meteorological situation

Switzerland lay on the edge of an area of high pressure centred over the south-west of the British Isles.

1.7.2 Weather at the time of the serious incident

The sky over Switzerland and neighbouring countries was largely cloudless. The wind was weak in the air layer below 15,000 ft above mean sea level (AMSL). At 06:00 UTC the zero degree isotherm was at approximately 11,900 ft AMSL (3600 m AMSL).

1.7.3 Astronomical information

Position of the sun	Azimuth: 85°	Elevation: 25°
Lighting conditions	Daylight	

1.7.4 Aerodrome meteorological reports

In the period from 06:20 UTC up to the time of the serious incident, the following aerodrome meteorological report (METAR) was valid for Zurich Airport:

METAR LSZH 150620Z 33003KT 300V010 CAVOK 19/12 Q1023 NOSIG=

This means:

On 15 July 2013, shortly before the 06:20 UTC issue time of the aerodrome meteorological report, the following weather conditions were observed at Zurich Airport:

Wind	330 degrees at 3 kt, variable between 300 and 010 degrees
Meteorological visibility	10 km or greater
Cloud	No clouds below the highest minimum sector altitude, which in Zurich is 8600 ft AMSL.
Temperature	19 °C
Dewpoint	12 °C
Atmospheric pressure (QNH)	1023 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere.
Landing weather forecast	No significant change expected

1.8 Aids to navigation

The crew used the appropriate instrument landing system for the approach and landing on runway 16 at Zurich airport. Both the on-board systems and the equipment on the ground worked perfectly.

1.9 Communications

Radio communications between the flight crew and the air traffic control units involved took place correctly and without difficulties.

Communications between the crew and the fire brigade took place by calling through the open cockpit window.

1.10 Aerodrome information

1.10.1 General

Zurich Airport is in north-east Switzerland.

The reference elevation of the airport is 1416 ft AMSL and the reference temperature is 24.0 °C.

1.10.2 Runway equipment

The Zurich Airport runways have the following dimensions:

Runway	Dimensions	Elevation of runway thresholds
16/34	3700 x 60 m	1390/1388 ft AMSL
14/32	3300 x 60 m	1402/1402 ft AMSL
10/28	2500 x 60 m	1391/1416 ft AMSL

At the time of the serious incident there were 3700 m of runway available for a landing on runway 16.

1.10.3 Rescue and fire-fighting services

Zurich Airport was equipped with Category 10 fire-fighting resources. The airport's professional fire brigade was on permanent standby duty during flight operations and escorted the aircraft to the stand after landing.

According to the aeronautical information publication (AIP) for Switzerland, Section LSZH AD 2.6, the 123.100 MHz frequency is available for direct communication between the flight crew and the director of operations of the airport fire brigade.

1.11 Flight recorders

1.11.1 Flight data recorder

Type	FA2100
Manufacturer	L3 Communications
Part number	2100-4042-00
Serial number	00256
Recording medium	Solid state memory

It was possible to read and use the data.

1.11.2 Cockpit voice recorder

Type	A100A
Manufacturer	Fairchild
Part number	93-A100-83
Serial number	55107
Number of parameters	4 channels
Recording medium	Magnetic tape
Duration of recording	30 minutes

The reading of the cockpit voice recorder (CVR) was carried out in the presence of an SAIB employee with the French safety investigation authority. The record-

ings were of good quality. Due to the limited recording time of 30 minutes, the phase in which smoke generation occurred had been overwritten.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

None of the occupants of the commercial aircraft complained of health problems as a result of the smoke.

1.14 Fire

During the flight, smoke developed in oven no. 2. Fire did not break out.

1.15 Survival aspects

1.15.1 Exposure to smoke

The flight crew members and flight attendants working in the galley were exposed to smoke. The flight crew donned their oxygen masks, which protected them adequately. The passengers were not exposed to the influence of smoke.

1.15.2 Aircraft evacuation

All the occupants disembarked the aircraft via the passenger stairs because no smoke had been generated for some time at this point.

1.16 Tests and research

1.16.1 Analysis of the deposits in the oven

The remains of a transparent plastic film and smoke residue were found in the oven. The latter were examined using scanning electron microscopy. This indicated that the residues were in the form of a variety of different small particles and were composed exclusively of carbon (C) and oxygen (O). It was therefore a case of organic particles rather than inorganic deposits. The smallest particles had a high aluminium content; this may have been intrinsic material from the oven components.

Comparing the obtained Fourier-transform infrared spectra with the reference spectra database revealed that the light-brown bead-like deposits on the inside of the oven and the heating elements was a plastic from the polyethylene terephthalate (PET) family.

The transparent, film-like fragments from oven no. 2 were of the same material.

The smoke deposits on the inside of the oven door were mono-methyl terephthalate. This is the constituent monomer used to produce PET. In this case it was presumably a decomposition product produced during the thermal decomposition of PET.

PET, like paper, is composed of three elements (carbon, oxygen and hydrogen) and essentially contains no toxic substances.

Due to the manufacturing process, PET contains very small traces of antimony (III) oxide and acetaldehyde. In the case of complete combustion of PET, carbon dioxide and water are produced and almost no toxic residues are left.

In the case of incomplete combustion or thermal decomposition, fumes are produced which contain soot, carbon monoxide and other hydrocarbons. These can be harmful to health.

1.16.2 Reconstruction of the smoke generation

A laboratory experiment made it possible to reconstruct the smoke generation. First oven no. 2 was put into operation in the state in which it was removed from the aircraft with the accompanying tray rack. This arrangement generated dense smoke inside the oven above a temperature of approximately 190 °C; this smoke was able to escape the closed oven door.

The oven and tray rack were then cleaned, the contaminated heating element replaced with a brand new element and the oven operated again in the same way. No smoke generation was observed during this second test.

1.16.3 Inspection of the electrical components

When inspecting the electrical components of the oven it was found that all three thermostats functioned appropriately in both mechanical and electrical terms.

The functional inspection of the heating element, which features six individual heating sub-elements, indicated in the case of continuity measurements performed with an ohmmeter that all heating elements were conductive and functional. There was also no defect in relation to insulation (heating element to earth conductor / housing).

1.17 Organisational and management information

1.17.1 Helvetic Airways

1.17.1.1 General

The Swiss aircraft operator Helvetic Airways, which is based in Zurich, was established in 2003 and operates seven aircraft, including six Fokker F28 Mk 100s and an Airbus A319-112.

Maintenance is carried out at its own maintenance department at Zurich Airport.

1.17.1.2 Emergency checklists

For the Fokker 100 aircraft, Helvetic Airways distinguishes between various emergency checklists for combating smoke as follows:

- *Air conditioning smoke*
- *Cabin equipment smoke*
- *Electrical smoke*
- *Smoke FWD (AFT) cargo*[3]

The flight crew proceeded to combat smoke generation according to the electrical smoke emergency checklist.

1.17.1.3 Use of ovens

Two different types of oven are used in the galley on the Fokker F28 Mk 100 aircraft type operated by Helvetic Airways. One variant has a cover plate at the rear wall in front of the heating element. The other version does not feature such a cover plate; this construction therefore has an unprotected heating element facing the inside of the oven. The oven which generated smoke during the serious incident had an unprotected heating element (see. Figures 4 to 7).

[3] The aircraft manufacturer calls this checklist „cargo compartment smoke" and publishes an additional checklist called „toilet smoke". According to the manufacturer the „toilet smoke" checklist is applicable for the aircraft HB-JVH but not the „cargo compartment smoke" checklist.

Figure 4: Oven with un-protected heating element

Figure 5: Oven with protected heating element

Figure 6: Tray rack without rear wall

Figure 7: Tray rack with rear wall

The cabin crew stated that in their opinion the cover plate for the heating element of oven no. 2 on the HB-JVH aircraft had been missing for *"a long time"*.

The companies that deliver the food for the passengers and crew are familiar with two different tray racks in which the food is delivered. Some tray racks feature a rear wall and some do not. In the case of the flight involved in the incident, a tray rack without a rear wall was delivered. The catering companies do not know which types of tray rack to deliver for which type of oven, or which types of oven are used in which aircraft.

1.17.1.4 Guidelines on preventing fire

The following directive to prevent fire in the cabin can be found in the manual for the cabin crew of Helvetic Airways:

„The best way to fight a fire is to avoid it. In order to do so:

- *check the lavatories regularly every 20 minutes*
- *use the ovens only with an oven rack*
- *check the contents of an oven before you switch it on*
- *never put anything else than food into the ovens*
- *switch off all electric items (ex. oven, coffee maker, etc.) during takeoff and landing*
- *have an eye on the passengers and what they do*
- *never cover a ventilation grill with a paper towel*
- *never smoke when first aid oxygen is in use."*

1.17.1.5 Guidelines on combating smoke in an oven

The following directive on combating fire in an oven can be found in the manual for the cabin crew of Helvetic Airways:

„In order to fight an oven fire successfully:

- *close the oven door (if it is not done already)*
- *switch electrical power off*
- *pull circuit breakers*
- *check the temperature of the associated door and door handle with the back of the hand, cold door may indicate a still contained fire*
- *open the oven door for about 5 cm but stay well back, whereby protecting yourself with the oven door*
- *if the fire is still active, direct a small amount of halon into the oven, close the door and wait for a couple of minutes*
- *recheck with back of the hand and cool from the outside with a wet cover*
- *keep the electrical power off until the aircraft has landed safely and the unit has been checked by an aircraft mechanic*
- *keep the Commander (CMD) informed about your actions and the evolution of the fire."*

1.17.1.6 Guidelines as how to proceed by fire and smoke on board

In the operator's OM A it is stated that whenever fire or smoke is detected on board, in any case an emergency situation must be declared. The flight crew only requested priority by the air traffic control when smoke development was detected.

1.18 Additional information

The cabin crew stated that smoke had already been emitted from oven no. 2 a few days prior to the serious incident, while the aircraft was still on the ground. No entry was made in the aircraft's technical log.

According to the manufacturer he has been informed by the operator in a letter dated 7 March 2013 that on bard the aircraft HB-JVH oven No. 2 has produced strong smell like burned plastic.

During the investigations on the affected oven at an independent maintenance company, the maintenance company staff pointed out that smoke generation is relatively common in the case of ovens, but that few cases produce smoke in the cockpit and that cases are rarely reported.

1.19 Useful or effective investigation techniques

None.

2 Analysis

2.1 Technical aspects

As tests indicated, smoke generation occurred because remnants of a plastic film in the oven came into contact with the heating element. This was possible because this oven type has no rear cover plate to protect the heating element. The tray rack placed in the oven did not have a rear wall. When the oven was turned on, the heating element heated up causing the plastic film to melt and carbonise.

It was possible to exclude the possibility of any other source of smoke.

The smoke spread forward along the structure of the aircraft from the galley and entered the cockpit through gaps and openings between the aircraft's outer skin and the cockpit panelling. The design of the on-board ventilation system prevents smoke spreading further through this system.

2.2 Human and operational aspects

2.2.1 Conditions for smoke generation

As the investigation indicated, neither the cabin crew nor the companies that supplied the food were aware that there were two different oven types on the Fokker 100 aircraft type at Helvetic Airways. In contrast to other ovens, oven no. 2, which was used on HB-JVH, had no rear cover plate, and should therefore have been operated with a special tray rack featuring a rear wall. The cabin crew was of the opinion that the rear cover plate had been missing for *"a long time"*. This indicates that they were not familiar with this distinction.

The inspection of the oven before operation was not complete: neither the rear cover plate to protect the heating element nor the appropriate tray rack were present and obviously a film was still located in the oven. This was not discovered and the inappropriate rack may not have been recognised as a safety risk due to lack of knowledge about the different types of ovens.

The regulations of the aviation operator in relation to inspection of the oven are general in nature and do not indicate that specific attention be paid to unprotected heating elements before the oven is put into operation.

2.2.2 Procedure after smoke generation

The cooperation between the flight crew and cabin crew was good and though the action to combat the smoke was successful, it was only partially appropriate. Opening an oven door after the onset of smoke generation inside the oven is dangerous. It can lead to a large amount of smoke being emitted and an oven fire being supplied with oxygen. The principles stipulated by the aviation operator for combating fire specified actions that would have been effective in this case, but these were not followed.

The decision of the flight crew to return to Zurich was useful as a precautionary measure. Landing in Basel would have taken a similarly long time due to the required reduction of altitude and the preparation for a landing at another aerodrome.

The support of the flight crew by air traffic control units was helpful.

The use of the electrical smoke emergency checklist is understandable due to the smell of a short circuit or electrical defect and smoke generation. It is also logical from the perspective of the flight crew, because the smoke did not enter the cockpit via the ventilation ducts. Only later was it possible to determine that the smoke stemmed solely from the oven and that the cabin equipment smoke

emergency checklist would therefore have been more appropriate. The measures according to this checklist interrupt only the power supply to the galley. The aircraft control and displays in the cockpit would not have been restricted.

As various past cases demonstrate, using the smell of smoke to identify the source of smoke is often misleading. In the present case, the crew assumed that the smoke was due to an electrical failure. However, the smoke was actually due to the carbonisation of a plastic film. The smoke was also not emitted from the on-board ventilation; instead it entered the cockpit via a path that could not be determined. Experience shows that smoke and fire are easiest to deal with if the source can be localised precisely and if the source is both isolated and accessible. In this case, it was only the investigation that determined that all three conditions were present. The crew, however, had to assume an unknown source and therefore logically decided to abort the flight and an make an unscheduled landing.

The approach, landing and taxiing off the runway occurred uneventfully. The aircraft was escorted by the fire brigade. It should be noted that the crew were not offered the intended frequency on which they could have communicated with the fire brigade directly. Communication had to be made by calling through the open window of the aircraft cockpit, which can be associated with communication problems and often with risks under time-critical conditions.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The aircraft was licensed for transport according to instrument flight rules.
- Both the mass and centre of gravity of the aircraft were within the permitted limits according to the aircraft flight manual (AFM).

3.1.2 Crew

- The crew were in possession of the necessary licences for the flight.
- There are no indications of the crew suffering any health problems during the flight.

3.1.3 History of the flight

- At 06:28:59 UTC, Helvetic four four zero was cleared to climb to FL 200 and transferred to Reims air traffic control.
- At approximately the same time the senior cabin attendant switched on the ovens to heat the food.
- Shortly thereafter, smoke was emitted from oven no. 2.
- As the senior cabin attendant opened the oven door a cloud of smoke was emitted.
- The senior cabin attendant first turned off the affected oven and then all other galley equipment.
- At the same time the flight crew noted that white smoke was entering the cockpit.
- The flight crew called the senior cabin attendant into the cockpit and told him to pull the oven circuit breaker.
- The flight crew then decided to return to Zurich.
- Smoke continued to enter the cockpit for a short time, whereupon the crew donned their oxygen masks.
- The flight crew then worked through the electrical smoke emergency checklist.
- The electrical smoke emergency checklist reduces the electricity consumers, so the flight crew then temporarily flew without autopilot and with limited instrument displays.
- The landing in Zurich took place at 07:00 UTC.

3.1.4 General conditions

- Helvetic Airways operated two different oven types on their Fokker F28 Mk 100 aircraft. One oven type had a rear cover plate to protect the heating element; the other had an exposed heating element that required the use of an appropriate tray rack.

- In the present case, the oven had an exposed heating element and the appropriate tray rack was not used.
- The regulations of the aviation operator in relation to inspection of the oven are general in nature and no distinction is made between the two oven types.
- The weather conditions had no influence on the serious incident.

3.2 Causes

The serious incident is attributable to smoke generation during the flight. This was due to the fact that an exposed heating element came into contact with a plastic film in an oven.

The following factors were identified as the direct cause:

- A plastic film was mistakenly left in the oven.
- The oven was switched on with an inappropriate tray rack without a rear panel.

The following factor was identified as the systemic cause:

- The persons concerned were not aware that two oven types requiring different tray racks were in use.

Although the following factor did not directly cause the serious incident, in the context of the investigation it was identified as a risk factor:

- The principles for combating smoke generation or a fire in the oven were not followed.
- The flight crew and the fire brigade were only able to communicate by calling because they were not on a common radio frequency.

4 Safety recommendations, safety notes and measures taken since the serious incident

4.1 Safety recommendations

None.

4.2 Measures taken since the serious incident

The aviation operator raised the awareness of cabin crews using a new instruction regarding the importance of inspecting ovens before use. According to the statement of the internal maintenance company, this instruction to cabin crews has been successfully implemented. The present case was also reprocessed with the crews as part of the annual refresher.

In addition the operator has released a new directive which norms a periodically cleaning and a subsequent functional test regarding smoke development of the tray tracks and the ovens.

Following the serious incident the Federal Office of Civil Aviation (FOCA) has assigned the operator to check why the crew did not act according to the OM A procedures and whether the respective guidelines in the OM A must be either revised or the crews must be retrained.

Payerne, 21 August 2015 Investigation Services STSB

This final report was approved by the Board of the Swiss Transportation Safety Investigation Board STSB (Art. 10 lit. h of the Ordinance on the Safety Investigation of Transportation Incidents of 17 December 2014).

Berne, 13. August 2015