
Fire and smoke, Incident involving aircraft SE-DUP in the airspace above Jönköping, F county, Sweden, on 2 February 2001

Micro-summary: Fire and smoke prompts a successful diversion of this Boeing 757.

Event Date: 2001-02-02 at 0830 UTC

Investigative Body: Swedish Accident Investigation Board (AIB), Sweden

Investigative Body's Web Site: <http://www.havkom.se/>

Cautions:

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!***
 3. Reports may or may not represent reality. Many many non-scientific factors go into an investigation, including the magnitude of the event, the experience of the investigator, the political climate, relationship with the regulatory authority, technological and recovery capabilities, etc. It is recommended that the reader review all reports analytically. Even a "bad" report can be a very useful launching point for learning.
 4. Contact us before reproducing or redistributing a report from this anthology. Individual countries have very differing views on copyright! We can advise you on the steps to follow.
-

ISSN 1400-5719

Report RL 2001:42e

***Incident involving aircraft SE-DUP in
the airspace above Jönköping, F county,
Sweden, on 2 February 2001***

Dnr L-005/01

SHK investigates accidents and incidents with regard to safety. The sole objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of this activity to apportion blame or liability.

The material in this report may be reproduced free of charge provided due acknowledgement is made.

The report is also available on our Web site: www.havkom.se

Translated by Dennis Lynn Anderson

From the original Swedish at the request of the Board of Accident Investigation.

In the event of discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

2001-11-23

L-005/01

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Report RL 2001:42e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an aircraft incident that occurred on 2 February 2001 in the airspace above Jönköping, F county, Sweden, involving an aircraft with registration SE-DUP.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board herewith submits a final report on the investigation.

Olle Lundström

Monica J Wismar

Henrik Elinder

Contents

SUMMARY	5
1 FACTUAL INFORMATION	6
1.1 History of the flight	6
1.2 Injuries to persons	6
1.3 Damage to aircraft	7
1.4 Other damage	7
1.5 Personnel information	7
1.5.1 <i>Commander</i>	7
1.5.2 <i>Co-pilot</i>	7
1.5.3 <i>Cabin crew</i>	7
1.5.4 <i>The pilots' work schedule</i>	7
1.6 Aircraft information	8
1.6.1 <i>General</i>	8
1.6.2 <i>Aft galley</i>	8
1.7 Meteorological information	8
1.8 Aids to navigation	9
1.9 Communications	9
1.10 Aerodrome information	9
1.11 Flight recorders	9
1.11.1 <i>Flight Data Recorder</i>	9
1.11.2 <i>Cockpit Voice Recorder</i>	9
1.12 Incident site	9
1.13 Medical information	9
1.14 Fire	9
1.15 Survival aspects	10
1.16 Tests and research	10
1.16.1 <i>Technical investigation</i>	10
1.16.2 <i>Investigation of cannon plug</i>	10
1.17 Organizational and management information	12
1.18 Additional information	12
1.18.1 <i>Previous cases of overheating in cannon plugs</i>	12
1.18.2 <i>Measures taken by the airline</i>	12
1.18.3 <i>Aircraft evacuation</i>	12
2 ANALYSIS	13
2.1 The flight	13
2.2 The fire	13
3 CONCLUSIONS	13
3.1 Findings	13
3.2 Causes	14
4 RECOMMENDATIONS	14

APPENDIX

1 Extracts from Register of Licenses regarding the pilots (*to the Swedish Civil Aviation Administration only*)

Report RL 2001:42e

L-005/01

Report finalised 2001-11-23

<i>Aircraft; registration and type</i>	SE-DUP , Boeing 757-200
<i>Class/airworthiness</i>	Normal, valid certificate of airworthiness
<i>Owner/operator</i>	Nordbanken Finans AB/Britannia Airways AB
<i>Time of occurrence</i>	2001-02-02 approx. 09:30 hours in Daylight <i>Note: All times are given in Swedish standard time = UTC + 1 hour</i>
<i>Location</i>	In the airspace above Jönköping, F county, Sweden, (approx. position 5745N 01404E, 9,450 meters above sea level)
<i>Type of flight</i>	Charter
<i>Weather</i>	Actual weather for Göteborg/Landvetter airport at 09:39 hours: wind 020°/15 knots, visibility 7 km in haze, few clouds at 700 feet and broken cloud cover at 1,500 feet, temp./dewpoint -10°/-12 °C, QNH 1025 hPa.
<i>Persons on board: crew</i>	2/6
<i>passengers</i>	232
<i>Injuries to persons</i>	One cabin attendant suffered bronchial distress
<i>Damage to aircraft</i>	Slightly damaged
<i>Other damage</i>	None
<i>Commander:</i>	
<i>Age, certificate</i>	41 years old, Airline Transport Pilot's License, (Swedish D)
<i>Total flying time</i>	8,876 hours, of which 1,790 hours on the type
<i>Flying hours previous</i>	
<i>90 days</i>	135 hours, all on the type
<i>Number of landings previous</i>	
<i>90 days</i>	33
<i>Co-pilot:</i>	
<i>Age, certificate</i>	35 years old, Commercial Pilot's License with Instrument Rating (Swedish B)
<i>Total flying time</i>	3,410 hours, of which 710 hours on the type
<i>Flying hours previous</i>	
<i>90 days</i>	140 hours, all on the type
<i>Number of landings previous</i>	
<i>90 days</i>	12
<i>Cabin crewmembers:</i>	See section 1.5.3

The Board of Accident Investigation (SHK) was notified on 2 February 2001 that an aircraft with registration SE-DUP had been involved in an incident in the airspace above Jönköping, F county, Sweden at approximately 09:30 hours on that same day.

The incident has been investigated by SHK represented by Olle Lundström, Chairman, Monica J Wismar, Chief investigator flight operations and Henrik Elinder, Chief technical investigator aviation.

The investigation was followed by Kåre Jernling, Swedish Civil Aviation Administration.

Summary

The aircraft departed from Stockholm/Arlanda airport on 2 February 2001 at 08:58 hours on a charter flight to Malaga in Spain. A little more than 30 minutes after takeoff, when the aircraft was cruising at flight level (FL) 310 (approximately 9,450 meters above sea level) two cabin attendants who were in the aft galley, heard a loud bang and observed a flash of light that came from the oven and water boiler control panel on the rear cabin wall. Shortly thereafter smoke began to escape from the area surrounding the control panel. One of the cabin attendants fetched a fire extinguisher, donned protective gloves and proceeded to spray the panel.

The smoke dissipated quickly, but as the crew was unsure about just what had taken place and what possible damage had been caused to the aircraft, the commander chose to discontinue the flight and declared an emergency with the air traffic controller at Malmö Control. He requested clearance to descend as soon as possible and fly a straight-in approach to Göteborg/Landvetter airport for landing, which was granted.

The aircraft landed uneventfully on runway 03 at 09:47 hours and taxied in to parking position 24.

During the technical investigation extensive soot was found in the compartment behind the control panel for the ovens and water boilers in the aft galley. There was also soot on the exterior surface of the panel. Furthermore, the electrical cannon plug that connects the control panel to the ovens and to the water boilers, was severely burnt and sooty. The insulation material on the cannon plug had been burned and deformed. The damage confirmed that a local fire had taken place within the compartment.

SHK has established that there was no manufacturing defect within the cannon plug itself, but that the electrical system serving the ovens and water boilers in the aft galley was underdimensioned. On account of this and similar incidents, the manufacturer has introduced an obligatory modification of the system.

The incident was caused by an electrical flash-over within the electrical system supplying the ovens and the water boilers in the aft galley.

Recommendations

None.

1 FACTUAL INFORMATION

1.1 History of the flight

The aircraft departed from Stockholm/Arlanda airport on 2 February 2001 at 08:58 hours on a charter flight with flight number BLX 101 to Malaga in Spain. The takeoff and the climb to cruising level proceeded normally.

A little more than 30 minutes after takeoff, when the aircraft was at flight level (FL) 310 (approximately 9,450 meters above sea level), a sudden disturbance in pitch was experienced. The pilots believed this to be caused by the aircraft transiting the wingtip vortices from another aircraft.

Simultaneously, two cabin attendants who were in the aft galley, heard a loud bang and observed a flash of light that came from the oven and water boiler control panel on the rear cabin wall. Shortly thereafter smoke began to escape from the area around the control panel. One of the cabin attendants contacted the purser and the commander simultaneously via the flight interphone and informed them about what had occurred. Another cabin attendant fetched a fire extinguisher, donned protective gloves and proceeded to spray the panel.

The smoke dissipated quickly, but as the crew was unsure about just what had taken place and what possible damage had occurred to the aircraft, the commander chose to discontinue the flight and declared an emergency with the air traffic controller at Malmö Control. He requested clearance to descend as soon as possible and to fly a straight-in approach to Göteborg/Landvetter airport for landing, which was granted.

During the remainder of the flight the commander was kept informed about the situation in the aft galley. Because of the fact that the smoke generation had ceased, he chose to apply only the flight diversion checklist. He informed the passengers of the incident and that his intentions were to land at Landvetter. None of the passengers exhibited any apprehension at that time.

The air traffic controller conducted a green alert (warning alarm) and diverted other air traffic into holding patterns so that BLX 101's approach could be accomplished without delay.

The aircraft was landed without problems on runway 03 at 09:47 hours and taxied in to parking position number 24. After the aircraft was parked, the flight crew thought that it took a long time for the ground personnel to connect the ground power and to dock a stairway in order to enable the passengers to disembark.

After the passengers had left the aircraft they were attended to by personnel in the terminal building. They were able to continue to their destination later in the day on another aircraft from the same airline.

The incident occurred in the airspace above Jönköping at an approximate position of 5745N 01404E; 9,450 meters above sea level.

1.2 Injuries to persons

	<i>Crew</i>	<i>Passengers</i>	<i>Other</i>	<i>Total</i>
Fatal	–	–	–	–
Serious	–	–	–	–
Minor	1	–	–	1
None	7	232	–	239
Total	8	232	–	240

1.3 Damage to aircraft

Slightly damaged.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 Commander

The commander was 41 years old at the time and held a valid Airline Transport Pilot's License (Swedish D).

Flying hours

<i>latest</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
All types	0	135	8,876
This type	0	135	1,790

Number of landings this type previous 90 days: 33.

Flight training on type concluded 1997-04-15.

Latest OPC (operational proficiency check) carried out 2000-10-25.

1.5.2 Co-pilot

The co-pilot was 35 old at the time and held a valid Commercial Pilot's License with Instrument Rating (Swedish B).

Flying hours

<i>latest</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
All types	0	140	3,410
This type	0	140	710

Number of landings this type previous 90 days: 12.

Flight training on type concluded 1999-06-22.

Latest OPC carried out 2000-11-05.

1.5.3 Cabin crew

The cabin crew consisted of a purser and five cabin attendants. All cabin crewmembers completed their latest emergency training during the period from April 2000, up to and including January 2001.

1.5.4 The pilots' work schedule

During the week prior to the incident the pilots had the following work schedule:

	Commander		Number of Flights	Co-pilot	Number of Flights
2001-01-27	Day off	-	22.15-		
2001-01-28	Day off	-	-07.55	1	
2001-01-29	08:00-14:00	standby	Day off	-	
2001-01-30	10:00-18:00	training	Day off	-	
2001-01-31	10:30-19:30	training	Day off	-	
2001-02-01	06:00-12:00	standby	Day off	-	

1.6 Aircraft information

1.6.1 General

AIRCRAFT

<i>Manufacturer:</i>	The Boeing Company
<i>Type:</i>	Boeing 757-200
<i>Serial number:</i>	24793
<i>Year of manufacture:</i>	1990
<i>Gross weight:</i>	Max authorized 113,399 kg, max authorized landing weight 89,811 kg, actual approximately 100,000 kg at landing.
<i>Center of gravity:</i>	26,2 MACTOW
<i>Total flying time:</i>	42,951 hours
<i>Number of cycles:</i>	13,242
<i>Flying time since latest inspection:</i>	23 hours
<i>Fuel loaded before event:</i>	JP1

ENGINE

<i>Manufacturer:</i>	Rolls Royce	
<i>Model:</i>	RB211-535-E4	
<i>Number of engines:</i>	2	
<i>Engine</i>	<i>Nr 1</i>	<i>Nr 2</i>
<i>Total operating time, hours:</i>		
<i>Operating time since overhaul:</i>	3,689	182
<i>Cycles after overhaul:</i>	928	39

The aircraft had a valid certificate of airworthiness.

The aircraft landed with a landing overweight. There for a customary inspection was performed before the next flight.

1.6.2 Aft galley

The aft galley in the aircraft is manufactured by AIM Aviation LTD, a sub-contractor to the aircraft manufacturer Boeing. The galley is equipped with five electrical ovens with a rated output of 3.87 kW and two water boilers with a rated output of 5.00 kW. The electrical supply to the ovens and the water boilers is accomplished via a control panel (Intermediate Electrical Panel) placed at the rearmost portion of the starboard side of the galley. Located on the exterior of the panel are, among other things, circuit breakers for the respective oven and water boiler. Each oven and each water boiler have a 15 amperes circuit breaker per phase. The panel is supplied with electricity via one of the aircraft's A/C systems (three phase 115 V /400 Hz) and is protected by a 50 amperes circuit breaker per phase.

The electrical supply from the control panel to the ovens and the water boilers takes place via a cannon plug, designated as D4B01P, which contains 23 separate connector pins. The cannon plug is placed within a limited space behind the control panel.

1.7 Meteorological information

Actual weather for Göteborg/Landvetter airport at 09:39 hours: wind 020°/15 knots, visibility 7 km in haze, few clouds at 700 feet and broken cloud cover at 1,500 feet, temp./dewpoint -10/-12 °C, QNH 1025 hPa.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The pilots declared an emergency with Malmö Control and requested to fly direct to Göteborg. They informed the air traffic controller that they had smoke build-up on board and that they wanted to have the fire department personnel present at landing. At 09:33 hours Malmö Control transferred surveillance of the aircraft to ATS¹ Landvetter. BLX 101 received priority and was radar vectored to final approach to runway 03. The radio communication transpired normally.

1.10 Aerodrome information

Göteborg/Landvetter airport had operational status in accordance with the Swedish AIP (Aeronautical Information Publication).

1.11 Flight recorders

1.11.1 *Flight Data Recorder (FDR)*

FDR-data from the flight has been compiled. It has been determined that a detailed analysis of the information from the flight was not necessary for the investigation.

1.11.2 *Cockpit Voice Recorder (CVR)*

The CVR was not stopped after the incident and therefore the recording relative to the incident was recorded over (30 min continuous cycle).

1.12 Incident site

The incident occurred at cruising altitude, FL 310 (approximately 9,450 meters above sea level).

1.13 Medical information

Nothing indicates that the mental or physical condition of the crew had been impaired prior to or during the flight.

1.14 Fire

A brief local fire originated behind a control panel in the aft galley in connection with a flash-over within an electrical connector. Fuel to maintain the fire, which consisted of the plastic isolation in the connector, was limited. The panel was sprayed with type BCF² fire extinguishing agent. The fire had probably gone out spontaneously but the extinguishing effort performed by the cabin personnel could have accelerated the process.

¹ ATS – Air Traffic Services

² BCF - Bromine Chloride Fluoride/bromochlorodifluoromethane (Halon 1211)

1.15 Survival aspects

From the perspective of flight safety, fire and/or smoke onboard are always serious. In the case at hand the fire was transient and limited to a system that is not vital from a standpoint of flight safety. Therefore, the persons aboard were not exposed to any immediate danger.

One of the cabin attendants suffered bronchial distress from smoke inhalation and was taken to hospital for control.

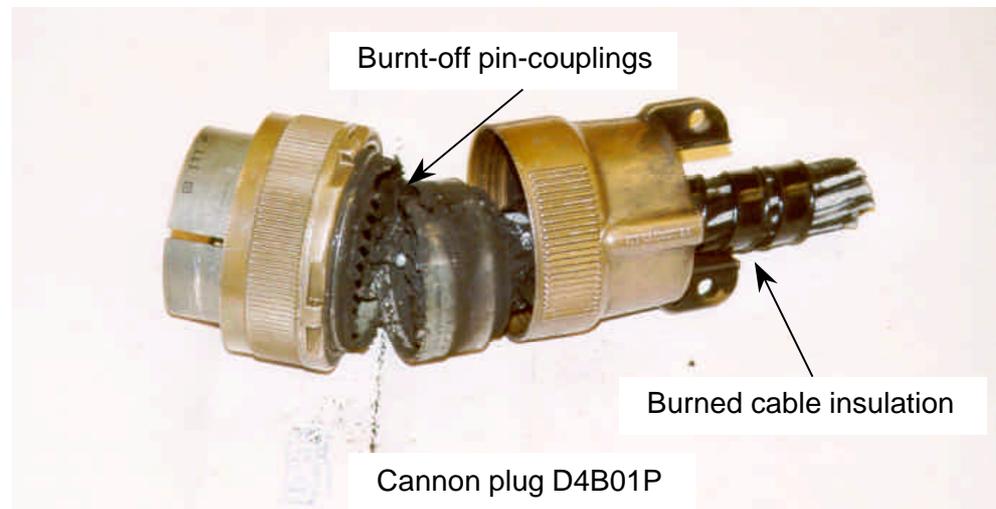
1.16 Tests and research

1.16.1 *Technical investigation*

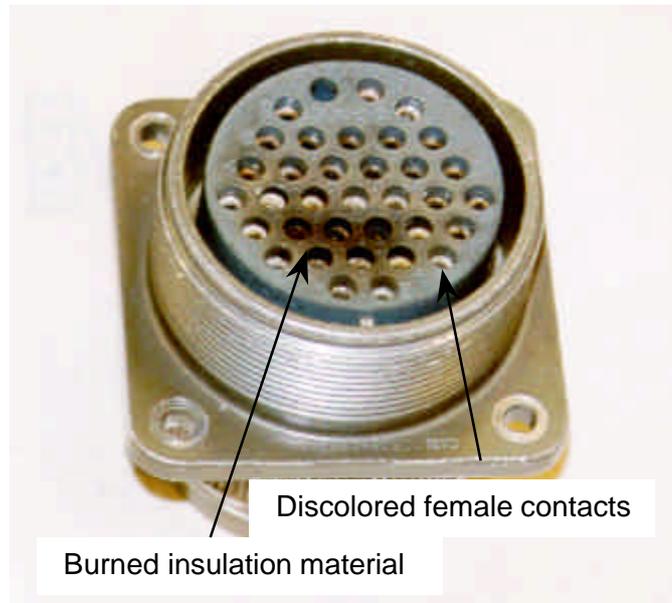
During the technical investigation that was conducted after the incident, extensive soot was found in the compartment behind the control panel for the ovens and water boilers in the aft galley. There was also soot on the exterior surface of the panel. Furthermore, the electrical cannon plug that connects the control panel to the ovens and to the water boilers was severely burnt and sooty. The insulation material on the cannon plug had been burned and deformed. The damage confirmed that a local fire had taken place within the compartment. All of the oven and water boiler circuit breakers had tripped.

1.16.2 *Investigation of canon plug*

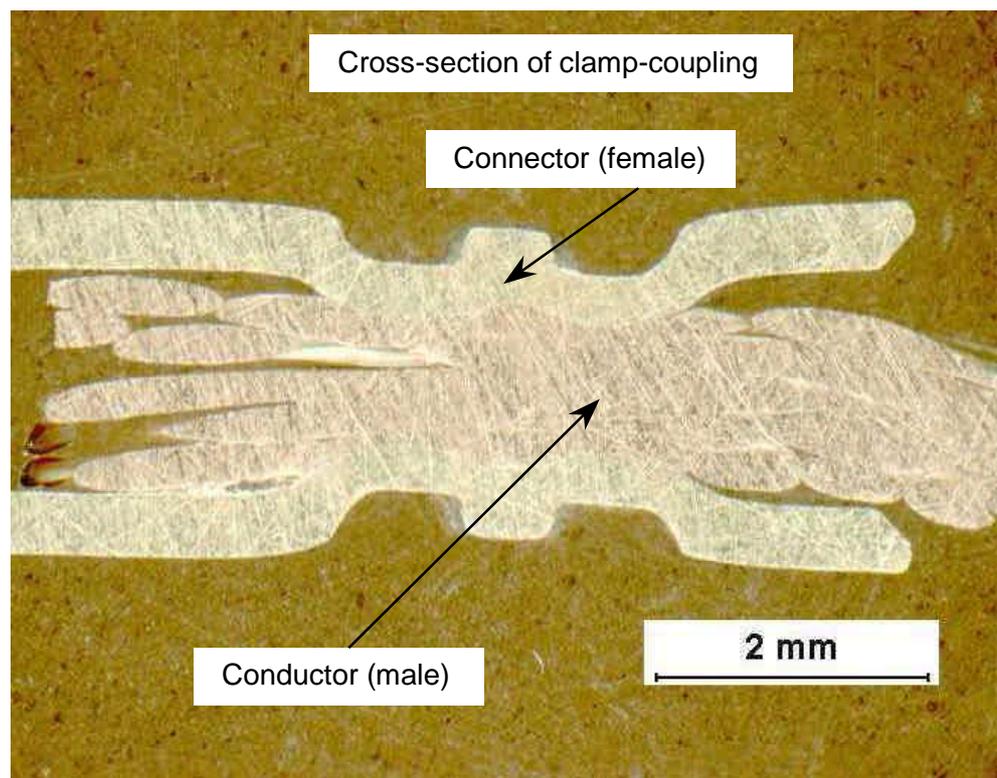
The burned cannon plug has been examined at a technical materials laboratory. The investigation showed that all but one of the electrical conductors within the connector were burned-off adjacent to the pin-clamp couplings. The internal area was completely burned-out and the heat generation had been so high that the copper in the electrical cables had melted.



The investigation also showed that several of the contact pins were discolored due to the overheating and that the insulating material between the pins in the cannon plug had been affected by high temperature and had also been discolored. This all points to the fact that the source of heat generation was not external in connection with the fire but took place within the electrical pin couplings during an extended period of time.



Metallurgical examination of the burned pin-clamp couplings indicates that they were manufactured correctly and that there was no presence of contamination on the contact surfaces.



1.17 Organizational and management information

Britannia Airways AB is an airline with headquarters in Upplands Väsby, Sweden. The company holds an operator's license (AOC³) according to JAR-OPS⁴ 1 and pursues scheduled and non-scheduled traffic with the aircraft types Boeing 737-800, Boeing 757-200 and Boeing 767-300.

1.18 Additional information

1.18.1 *Previous cases of overheating in cannon plugs*

Similar cases involving overheating and fire within the type of cannon plug mentioned above have occurred on the company's Boeing 757:

- The 16th of August 1999 on aircraft SE-DUO
- The 24th of August 1999 on aircraft SE-DUN

The airline reported these occurrences to Boeing and to AIM Aviation LTD. In September of 1999 AIM Aviation LTD issued an optional modification of the system (Service Bulletin SB 443) involving the exchange of the cannon plug in question for two other electrical connectors. The reason for the modification was stated to be the hindrance of overheating of the cannon plug and its associated electrical cables. The British Civil Aviation Administration, CAA, having also received reports of similar incidents from other operators, has made it mandatory through a Civil Aviation Directive that SB-443 shall be carried-out on all affected aircraft.

Subsequent to this, AIM Aviation LTD has issued a obligatory modification of the system (SB-448) which involves exchanging the two electrical connectors of SB-443 for an electrical coupling block to which the conductor's respective cable terminals are screwed separately.

1.18.2 *Measures taken by the airline*

After the first two cases of overheated electrical connectors, the airline introduced a routine to periodically measure the temperature of the cannon plug through the process of simultaneously turning all ovens and water boilers on to full effect. After the third incident all use of the ovens was forbidden until all aircraft had been modified according to SB-448. Subsequent to this modification being carried out, no further disturbances of this type have occurred.

1.18.3 *Aircraft evacuation*

After the aircraft had landed nothing unusual was observed externally and the smoke generation in the cabin had ceased. The landing time was during a period of relatively heavy traffic at the airport and the aircraft was directed to parking position 24. Problems arose with getting the external ground power to function. The pilots did not want to start the aircraft's internal power engine (APU⁵), which is placed in the tail section behind the aft galley, taking into consideration the earlier smoke generation. Therefore one of the aircraft engines was allowed to run at idle power until the external ground power was connected. Also, a delay of approximately 25 minutes was incurred before the ground personnel were able to dock a functioning stairway and the passengers could depart the aircraft. This created some uneasiness amongst the passengers.

³ AOC – Air Operator Certificate

⁴ JAR-OPS - Joint Aviation Requirements - Operations

⁵ APU - Auxiliary Power Unit

2 ANALYSIS

2.1 The flight

From the perspective of flight safety, the presence of smoke and fire on board during flight is always serious. The extent of the fire and its potential effect on the flight was initially unknown to the pilots. It was therefore correct on the part of the commander to discontinue the flight and land at the nearest suitable airport. In the opinion of SHK, the crew also performed other measures in connection with the incident and landing in an effective and correct manner.

2.2 The fire

When the incident occurred, all of the ovens and water boilers that received their electrical power supply through the cannon plug in question, were most likely in use at full power rating.

No manufacturing defect of the cannon plug that could explain the flash-over has been identified. The technical investigation of the cannon plug showed however that internal overheating had taken place in the connector over an extended period of time. The rubber material between the contact pins in the male portion had “aged” so that its insulating ability had been impaired.

All the evidence therefore indicates that the electrical short was initiated by a flash-over between two contact pins. The electrical arc and heat that was hereby generated caused further shorting between other contact pins in the cannon plug. Finally an electrical arc was produced that short circuited all the electrified pins simultaneously, thereby creating an explosion and local fire within the cannon plug, resulting in the smoke generation.

This occurrence and the previous incidents that took place involving the overheating and fire in the same type cannon plug indicate that the cannon plug was under dimensioned. The design of the cannon plug was such that the cooling ability of the surrounding air was not sufficient to dissipate the heat that was generated on the surface of the conductor pins when all ovens and water boilers were turned on to full rated effect.

The final modification that the manufacturer has introduced with regards to the cannon plug, and that has obviously solved the problem, entails larger contact surfaces and better cooling. As this modification is obligatory, SHK finds no reason to issue any recommendation.

In connection with the electrical short, a momentary high power surge was probably created within the aircraft’s high-voltage system before the circuit breakers on the control panel tripped, which could have caused a variation in the voltage. Since the autopilot was engaged, it is possible that this variation was of such magnitude that it affected the autopilot and caused the pitch disturbance that the pilots noticed, at about the same time that the electrical shorting occurred.

3 CONCLUSIONS

3.1 Findings

- a) The crew was qualified to perform the flight.
- b) The aircraft had a valid certificate of airworthiness.
- c) No manufacturing defect was found in the cannon plug.
- d) The electrical system for the ovens and water boilers in the aircraft’s aft galley was under dimensioned.

e) The manufacturer has issued an obligatory modification of the system.

3.2 Causes

The incident was caused by an electric flash-over within the electrical system supplying the ovens and water boilers in the aft galley.

4 RECOMMENDATIONS

None.