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Aircraft accident investigation bureau AAIB

Final Report No. 1940 by the Aircraft Accident Investigation Bureau

concerning the serious incident

to the SAAB 2000 aircraft, HB-IZJ

operated by Swiss International Air Lines

under callsign SWR 1042

on 15 August 2003

at Zurich Airport

Bundeshaus Nord, CH-3003 Berne

Ursachen

Der schwere Vorfall ist darauf zurück zu führen, dass im Flug ein Lichtbogenüberschlag zwischen zwei stromführenden Kabeln und der Flugzeugstruktur entstand, weil die Führung der Kabel eine Beschädigung ihrer Isolation ermöglichte.

General information on this report

This report contains the AAIB's conclusions on the circumstances and causes of the serious incident which is the subject of the investigation.

In accordance with Annex 13 of the Convention on International Civil Aviation of 7 December 1944 and article 24 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent future accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident 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 prevention, due consideration shall be given to this circumstance.

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

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the serious incident, 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

For reasons of protection of privacy, the masculine form is used in this report for all natural persons, regardless of their gender.

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Final Report

Owner	SL Pisces Ltd., Tokyo, Japan
Operator	Swiss International Air Lines, 4002 Basel
Aircraft type	SAAB 2000
Country of registration	Switzerland
Registration	HB-IZJ
Landing location	Zurich Airport, municipality of Kloten/ZH Elevation of location: 432 m AMSL 1416 ft AMSL
Date and time	15 August 2003 at approximately 16:00 UTC

Summary

Brief description

A SAAB 2000 aircraft, registration HB-IZJ, with callsign SWR 1042, took off on 15 August 2003 at 15:48 UTC from Zurich Airport on a scheduled flight to Cologne (D). During cruise, an unusual smell similar to molten plastic occured in the cockpit. The flight crew tried to determine the cause of the smell. When they did not succeed, they decided to return immediately to Zurich and requested priority for landing. The return flight and the landing in Zurich were uneventful. The 50 passengers and the four crew members were uninjured.

Investigation

The aircraft HB-IZJ landed on 15 August 2003 at 16:33 UTC after its unscheduled return to Zurich Airport. At 16:40 UTC, the Swiss Air Rescue Service (REGA) notified the Aircraft Accident Investigation Bureau (AAIB), which opened an investigation the same day.

The serious incident is attributable to the fact that during the flight arcing occurred between two live cables and the structure of the aircraft, because the cable routing made it possible for its insulation to be damaged.

1 Factual Information

1.1 Pre-flight history and history of flight

1.1.1 General

Recordings of radiocommunication, radar data and the statements of crew members were used for the following description.

For the majority of the flight, the commander was pilot flying (PF) and the copilot was pilot not flying (PNF).

1.1.2 Pre-flight history

On 7 August 2003, a crew on HB-IZJ noticed a smell which was similar to that of an electrical fire. They also noticed that circuit breaker (CB) E 28 had interrupted the power supply to some light assemblies in the passenger cabin. This had already been observed by other crews. The maintenance department then examined the aircraft and found a damaged lamp-holder in the circuit protected by CB E 28. Moreover, in the same area of the on-board power supply, a defect was assumed in a ballast supplying fluorescent tubes. These defective components were replaced and the aircraft was released for operation.

On 12 August 2003, another flight crew reported that circuit breaker E 28 had again cut off the circuit it protected. Maintenance personnel attempted to reset the circuit breaker between two flights. However, CB E 28 tripped again after a short time. Since there was no time for detailed trouble-shooting, CB E 28 was left in the open position and the rectification of the fault was deferred to a later time. The aircraft was then used again in flight operations.

1.1.3 History of flight

On 15 August 2003 at 15:48 UTC, aircraft HB-IZJ, with callsign SWR 1042, took off from runway 28 at Zurich Airport on a scheduled flight to Cologne (D). The flight path was westerly for a short time and then turned left in the direction of VHF omnidirectional radio beacon (VOR) Kloten. Shortly before reaching VOR Kloten, flight SWR 1042 could adopt an easterly heading towards Friedrichshafen and continue its climb. At 16:02 UTC, over Allgäu, the cruising altitude, flight level (FL) 220, was reached on a northerly heading.

A few minutes later, the copilot noticed an unusual smell similar to that of melting plastic. Since the cause of this smell was assumed to be in the pressurisation and air conditioning system, the flight crew switched off air conditioning pack 1, which among other things supplies the cockpit with conditioned air. When the situation did not change, they switched off the windshield heating and checked whether any covers or ciruit breaker panel had a raised temperature. These measures were unable to eliminate the smell or establish its cause. For this reason, the flight crew decided to abort the flight and return to Zurich. At this time, flight SWR 1042 was approximately over Stuttgart. The flight crew subsequently informed the Frankfurt Radar air traffic control unit of their intention and requested priority for landing. After the aircraft had turned onto a heading for Zurich, passengers were informed of the impending return to Zurich for technical reasons.

Since the unusual smell was noticeable at times throughout the flight but was not very intense and no smoke was being generated, the crew refrained from donning their oxygen masks.

At 16:21:57 UTC, the flight crew made contact with Zurich arrival east sector (APE) and were then requested to fly direction VOR Trasadingen and to descend to flight level 110: *"SWR 1042 hello, direct to Trasadingen,…descend to flight level one one zero*". The flight crew confirmed this order and explained that for the time being everything was all right and that they would merely like to have priority for landing: *"Direct Trasadingen, one one zero, SWR 1042, and so far everything is all right, we'd just like priority*". This request was granted and flight SWR 1042 could continue flying towards Zurich at present speed.

A short time later, the flight crew received the request to descend to flight level 70 and was informed that a remaining flight path of approximately 35 NM to landing was expected. In this phase, HB-IZJ was being guided on a heading of 220° towards the extended centreline of runway 14.

At 16:26:55 UTC, flight SWR 1042 was cleared to descend to 5000 ft QNH and a little later the APE air traffic controller informed the crew that the fire brigade had been requested and was standing by. At this point, the aircraft was approximately 10 km north of Schaffhausen and was passing 6500 QNH in descent.

With a final heading instruction, APE gave clearance at 16:29:06 UTC for an instrument landing on runway 14: *"SWR 1042, left heading one six zero, cleared ILS one four."*

A short time later, the air traffic controller wanted to know if the aircraft would vacate the runway normally after landing or whether a special procedure was envisaged: *"SWR 1042, you will leave the runway normally, or any special procedure?"* The flight crew answered that for the time being everything was all right and that they were not requesting any special measures.

At 16:30:53 UTC, flight SWR 1042 was approximately 6 NM before the touchdown point of runway 14 and the flight crew reported that the aircraft was now established on the localiser beam and was following the glidepath of the runway 14 instrument landing system: *"SWR 1042, er…we are established, six miles".*

On request of the APE, the flight crew changed to the aerodrome control (ADC) Zurich tower frequency and reported, among other things, that they were operating normally: *"Tower, guten Tag, SWR 1042, five miles runway 14. Operations normal (…)"* They then received landing clearance at 16:31:17 UTC: *"SWR 1042, thanks for the info, surface wind three four zero degrees, six knots, runway one four you're cleared to land."*

At 16:33 UTC, aircraft HB-IZJ landed on runway 14 and was then instructed to taxi to the stand. The fire brigade accompanied the aircraft to the stand and the occupants were able to disembark the aircraft normally.

The 50 passengers and the four crew members were uninjured.

1.2 Injuries to persons

	Crew	Passengers	Third parties
Fatally injured	---	---	---
Seriously injured	---	---	---
Slightly/not injured	4	50	

1.3 Damage to aircraft

Parts of the aircraft structure as well as a cable were damaged by arcing.

1.4 Other damage

There was no damage to third parties.

1.5 Personnel information

1.5.1 Commander

Person	Swiss citizen, born 1959
Licence	Air transport pilot licence aeroplane (ATPL(A)), first issued by the Federal Office for Civil Aviation (FOCA) on 31.3.1993
Ratings	Type rating SAAB 2000 as pilot in command
	Class rating for single engine piston (SEP)
	International radiotelephony for visual and instrument flight rules RTI (VFR/IFR)
	Night flying NIT
Instrument flying ratings	Instrument flight rules aircraft (IFR(A))
	Instrument approaches Cat. III on SAAB 2000, last extended on 13.4.2003, valid till 25.5.2004
Last proficiency check	13 April 2003, licence proficiency check
Medical fitness certificate	Class 1, without restrictions
Last medical examination	8 April 2003
Flying experience	6737 hours total
on the type involved in the incident	2487 hours
during the last 90 days	87 hours
of which on the type involved in the incident	87 hours

1.5.2 Copilot

Person	Swiss citizen, born 1977
Licence	Commercial pilot licence aeroplane, (CPL(A)), according to joint aviation requirements (JAR), first issued by the Federal Office for Civil Aviation (FOCA) on 1.6.1999
Ratings	Type rating SAAB 2000 as copilot Class rating for single engine piston (SEP) International radiotelephony for visual and instrument flight rules RTI (VFR/IFR) Night flying NIT
Instrument flying ratings	Instrument flight rules aircraft (IFR(A)) Instrument approaches Cat. III on SAAB 2000, valid till 20.11.2003
Last proficiency check	1 April 2003, operator proficiency check
Medical fitness certificate	Class 1, without restrictions
Last medical examination	15 April 2003
Flying experience	2400 hours total
on the type involved in the incident	2242 hours
during the last 90 days	101 hours
of which on the type involved in the incident	101 hours

1.5.3 Flight attendants

Person 1	French citizen, born 1972
Person 2	German citizen, born 1979

1.6 Aircraft information

1.6.1 Aircraft HB-IZJ

Aircraft type	SAAB 2000
Characteristics	Two-engined turboprop regional transport aircraft, constructed as cantilevered low-wing aircraft, completely metal construction with retractable landing gear in nosewheel configuration. The passenger cabin was designed for 50 passengers and a two-person flight crew and a two-person cabin crew were specified.
Wingspan	24.76 m
Length	27.28 m
Height	7.73 m

Max. permitted take-off mass	22 999 kg
Manufacturer	SAAB Aircraft AB, Linköping, Sweden
Registration	HB-IZJ
Serial number	015
Year of construction	1995
Owner	SL Pisces Ltd., Tokyo, Japan
Operator	Swiss International Air Lines Ltd., Postfach, 4002 Basel
Registration certificate	dated 1.7.2002, issued by the FOCA, valid until removal from the aircraft register
Airworthiness certificate	dated 26.4.1995, issued by the FOCA, valid until revoked
Certification	VFR by day VFR by night IFR Category I IFR Category II IFR Category IIIa B-RNAV[1] (RNP 5[2])
Fuel	According to the flight plan, take-off fuel was 2400 kg. Among other things, this included a trip fuel of 1100 kg. The remaining 1300 kg would have allowed the aircraft to fly to the alternative aerodrome at Dusseldorf plus 35 minutes holding, without having to use the final reserve of 380 kg.
Mass and centre of gravity	The aircraft's mass on take-off from Zurich was 21 567 kg. Throughout the flight, the mass and centre of gravity were within the permitted limits.

1.6.2 Information on the forward galley

1.6.2.1 General

The Swiss International Air Lines type SAAB 2000 aircraft are equipped with two galleys. The forward galley is installed on the left side of the aircraft between the main entry door and the cockpit. It is used to store beverage and smaller items of equipment for the on-board catering service.

[1] B-RNAV – basic area navigation: a navigation method which allows an aircraft to be guided on any flight path as long as the aircraft is within the range of ground-based navigation aids respectively the on-board systems are able to provide sufficiently accurate positioning on a continuous basis.

[2] RNP – required navigation performance: RNP 5 means that the aircraft must be located for at least 95% of the flight time within a radius of 5 NM of a required position.

1.6.2.2 Construction

The forward galley is primarily constructed from a lightweight composite material (composite honeycomb). It consists of various compartments and drawers plus a work surface, mounted on a baseplate. The base plate is provided with rails and a tilt mechanism which make it possible to pull the entire galley out of the aircraft's structure. This is essential not only for maintaining the galley but also provides access to an area of the aircraft in which electronic equipment is installed. This avionics compartment located behind the galley is sealed by a door.

1.6.2.3 Lighting

A lamp is fitted above the work surface in the forward galley.

1.7 Meteorological information

1.7.1 General

All meteorological data were provided by MeteoSwiss.

1.7.2 General weather situation

"Die Schweiz liegt im Bereich einer Kaltfront mit feucht-labiler Luft, die kaum mehr nach Südosten vorankommt."

Switzerland lies in the area of a cold front with humid/unstable air which is advancing very slowly to the south-east.

1.7.3 Weather conditions at Zurich airport

1.7.3.1 Weather at the time of the serious incident

Cloud	*3 – 4/8 CB[3], base approx. 6000 ft AMSL* *5 – 7/8, base approx. 14,000 ft AMSL*
Weather	*Thunderstorms*
Meteorological visibility	*7 km improving to over 10 km*
Wind	*North wind at 2-3 kt, gusting to 6 kt*
Air temperature	*22 °C*
Dew point	*17 °C*
Atmospheric pressure	*QNH 1016 hPa*
Hazards	*Local thunderstorms*

1.7.3.2 Aerodrome weather reports

In the period from 15:50 UTC until after the serious incident, the following METAR (meteorological aerodrome reports) applied:

151550Z 34002KT 9999 TS FEW045CB SCT130 BKN250 23/17 Q1016 BECMG NSW

151620Z 35005KT 9999 FEW045CB SCT130 BKN250 22/18 Q1016 RETS NOSIG

[3] CB: abbreviation of cumulonimbus, kind of cloud with big vertical extension. Precipitation in the form of rain, hail or snow can fall from a CB and it is often associated with thunderstorms.

In clear text, this means: On 15 August 2003 shortly before the issue time of the 15:50 UTC aerodrome weather report, the following weather conditions were observed on Zurich aerodrome:

Wind	direction 340°, speed 2 kt
Meteorological visibility	10 km or more
Weather phenomena	Thunderstorms
Cloud	1 – 2/8 CB, base at 4500 ft AAL
	3-4/8, base at 13 000 ft AAL
	5-7/8, base at 25 000 ft AAL
Temperature	23 °C
Dew point	17 °C
Atmospheric pressure	1016 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Land weather forecast	Latest two hours after the weather observation, no further significant weather phenomena are to be expected.

Similar conditions apply to the second METAR: On 15 August 2003 shortly before the issue time of the 16:20 UTC aerodrome weather report, the following weather conditions were observed on Zurich aerodrome:

Wind	direction 350°, speed 5 kt
Meteorological visibility	10 km or more
Cloud	1 – 2/8 CB, base at 4500 ft AAL
	3-4/8, base at 13 000 ft AAL
	5-7/8, base at 25 000 ft AAL
Temperature	22 °C
Dew point	18 °C
Atmospheric pressure	1016 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Additional information	Recent thunderstorms
Land weather forecast	In the two hours after the weather observation, no further substantial changes are expected.

1.7.3.3 Aviation hazards

In the period from 14:15 UTC to 18:15 UTC the following aviation weather warning (AIRMET[4]) applied:

[4] An AIRMET report is issued by the Zurich Kloten aviation weather centre for flights with propeller and turboprop aircraft as a warning of the following aviation hazards: occasional or local thunderstorms, moderate icing, moderate turbulence and moderate mountain waves. Their validity extends up to 4 hours. The altitude range extends from the ground up to FL 240 and horizontal extent will be defined. This report will only be issued if the respective weather phenomena are not already part of the GAMET report.

SWITZERLAND FIR/UIR TS OBS AND FCST AREA ALONG JURA/LSZH/EAST NC

In clear text, this information means:

Applicable region	Flight information region – FIR[5]) and upper flight information region (UIR[6]) of Switzerland
Weather phenomena	Thunderstorms were observed and are forecast
Region	In an area along the Jura towards Zurich Airport respectively east
Change in intensity	No change

1.7.4 Astronomical information

Position of the sun	
Azimuth	*260°*
Elevation	*28°*

1.8 Aids to navigation

Runways 14 and 16 at Zurich Airport are equipped with a Category IIIB instrument landing system (ILS).

1.9 Communication

Radio communication between the crew and the air traffic controllers of the various ATC units took place within the normal framework.

1.10 Aerodrome information

1.10.1 General

Zurich Airport is located in north-east Switzerland. In 2003, a traffic volume of about 269 000 movements were handled.

At the time of the serious incident, an extensive building programme was in progress, centred on the dock midfield located within the triangle of runways.

The dimensions of Zurich airport runways are as follows:

Runway	Dimensions	Elevation of runway threshold
16/34	3700 x 60 m	1390/1386 ft AMSL
14/32	3300 x 60 m	1402/1402 ft AMSL
10/28	2500 x 60 m	1391/1416 ft AMSL

The threshold of runway 14 is offset by 150 m. For this reason, at the time of the serious incident 3150 m of runway length was available for a landing on runway 14.

[5] The altitude range of the FIR Switzerland extends from the ground to flight level 195, corresponding to 5940 m/asl. The horizontal extent comprises the entire territory of the Swiss state.

[6] The UIR Switzerland lies above the FIR Switzerland and has the same horizontal extent.

The reference altitude of the airport is 1416 ft AMSL and the reference temperature is specified as 24.0 °C.

1.10.2 Runway equipment

Zurich airport is characterised by a system of three runways, two of which (16 and 28) intersect at the airport reference point. The approach corridors of two other runways (16 and 14) intersect approximately 850 metres north-west of the threshold of runway 14. Runways 16 and 14 are equipped with a Category III instrument landing system (ILS) and are therefore suitable for precision approaches. Runway 28 permits non precision approaches based on VOR/DME Kloten (KLO).

At the time of the serious incident, the approach sectors of runways 14, 16 and 28 were equipped with a minimum safe altitude warning (MSAW) system. This system triggers a visual and acoustic alarm in air traffic control if aircraft violate defined minimum altitudes.

1.10.3 Rescue and fire-fighting services

Zurich Airport was equipped with Category 9 fire-fighting resources. The airport's professional fire brigade is on permanent stand-by during flight operations.

1.11 Flight recorders

The aircraft was equipped with a digital cockpit voice recorder (CVR) and a digital flight data recorder (DFDR). Both recorders could be read out.

The electrical sparkover caused arcing. As a result of this, neither the smoke sensors responded nor were any other warnings triggered in the cockpit or recorded by the DFDR.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

There is no indication that the mental or physical capabilities of the crew were in any way impaired at the time of the serious incident.

1.14 Fire

According to the regulations of the International Civil Aviation Organisation (ICAO), this section describes the outbreak of fire, e.g. in the event of an aircraft crash. In the present case, arcing occurred during the flight between an onboard power cable and the aircraft structure. No actual fire occurred as a result up to the time the aircraft landed.

1.15 Survival aspects

Since the arcing did not develop into an actual fire up to the time the aircraft landed and neither excessive smoke nor toxic effects of the resulting gases occurred, control of the aircraft was not affected. There are no indications that the passengers were exposed to toxic gases or smoke. After landing, the aircraft taxied under its own power to the stand and the occupants were able to disembark normally. The airport fire brigade had been called and were standing by in case they had to intervene.

1.16 Tests and research

1.16.1 Examination of the forward galley

After the landing, it was found that the power supply cables for the working light in the forward galley were squashed between the structure of the galley and the frame of the door to the avionics compartment. The insulation of the cables had been damaged and arcing was able to occur between the cables and the metal structure of the aircraft.

1.16.2 Fleet inspection

After the power supply cable, which had been damaged by arcing, had been discovered in aircraft HB-IZJ, the entire SAAB 2000 fleet was subjected to an inspection. At the time of the serious incident, Swiss International Air Lines had 22 SAAB 2000 aircraft in service. Damage comparable to that on aircraft HB-IZJ was found in four aircraft on the corresponding power supply cable.

1.16.3 Relationship with the circuit breaker E 28

Analysis of the electrical schematic diagrams showed that the tripping of circuit breaker E 28, which had already interrupted the power supply to some light assemblies in the passenger cabin for some days, was not related to the arcing on the power supply cable of the working light in the forward galley.

Figure 1 – Damage behind the forward galley: the insulation of the cables is damaged. The heat marks on the cables and the aircraft structure show that arcing has occurred.

1.17 Organisational and management information

1.17.1 Swiss International Air Lines

Swiss International Air Lines was founded in 2002 and ran scheduled and charter flights. At the time of the serious incident, Swiss International Air Lines operated more than 80 aircraft of the following types: SAAB 2000, Embraer 145, Avro 146 RJ 85/100, Airbus A319/20/21, Airbus A330 and Airbus A340.

1.18 Additional information

None

1.19 Useful or effective investigation techniques

None

2 Analysis

2.1 Technical aspects

2.1.1 General information on the aircraft

Apart from circuit breaker E 28, which was secured in the open position, no restrictions on aircraft HB-IZJ existed during flight SWR 1042. The tripping of circuit breaker E 28 on earlier flights was not related to the arcing event on the power supply cable of the working light in the forward galley.

2.1.2 Cause of the arcing

The forward galley is located in front of an area containing electronic equipment (avionics compartment). To allow access to the avionics compartment, the galley is mounted on rails and can be pulled out with little effort. The cables for lighting the work surface must therefore possess a degree of flexibility and must be of sufficient length to allow the galley to be moved. In the present case, when the galley was pushed back these cables were presumably squashed between its structure and the frame of the door to the avionics compartment. In the process, the insulation was damaged and arcing was able to occur between the cables and the metal structure of the aircraft. The resulting high temperatures then caused part of the plastic insulation of the cables to melt and evaporate; this could be perceived as the smell of a fire.

2.2 Human and operational aspects

After the flight crew had unsuccessfully sought possible causes of the smell of fire for a few minutes, they decided to abort the flight, request priority from air traffic control and carry out a landing in Zurich immediately. Retrospectively, this decision proved to be justified, as fire could have broken out as a result of the arcing.

Since the intensity of the unusual smell at no point adversely affected the flight crew or passengers, it was reasonable to refrain from donning oxygen masks.

3 Conclusions

3.1 Findings

3.1.1 Technical aspects

- The SAAB 2000 aircraft, registration HB-IZJ, exhibited no technical restrictions which had an effect on the origin of the serious incident.
- The tripping of circuit breaker E 28 on earlier flights was not related to the arcing on the power supply cable of the working light in the forward galley.
- The mass and centre of gravity of the aircraft were within the prescribed limits.
- Two cables and parts of the aircraft structure in the area of the forward galley exhibited traces of arcing.

3.1.2 Crew

- The crew were in possession of the necessary licences.
- There is no indication that the state of health or capabilities of the crew were in any way impaired.

3.1.3 Flight history

- During cruise, a smell similar to that of melting plastic occurred.
- The flight crew attempted to determine the cause of the unusual smell.
- When the cause of the smell of fire could not be found, the flight crew decided to return to Zurich.
- The flight crew of HB-IZJ requested priority handling by air traffic control.
- The flight back to Zurich and the landing on runway 14 were uneventful.
- After the flight, the occupants of the aircraft were able to disembark the aircraft normally.

3.1.4 General conditions

- The weather conditions had no effect on the origin and course of the incident.

3.2 Causes

The serious incident is attributable to the fact that during the flight arcing occurred between two live cables and the structure of the aircraft, because the cable routing made it possible for its insulation to be damaged.

4 Safety recommendations and measures taken since the serious incident

4.1 Safety recommendations

None

4.2 Measures taken since the serious incident

4.2.1 Fleet inspection

In view of the damaged cables which were discovered on aircraft HB-IZJ, all Swiss International Air Lines SAAB 2000 type aircraft were checked. On four out of 22 aircraft damage in the same location as on aircraft HB-IZJ was found on the corresponding power supply cable. This damage was repaired and the cable routing was improved.

4.2.2 Manufacturer's service bulletin

As a result of the serious incident, on 18 December 2003 the manufacturer issued service bulletin (SB) 2000-25-092, which was sent to all operators of the SAAB 2000 aircraft type. The content of this service bulletin included a check and, if necessary, repair of the cabling in the area of the forward galley. The cable routing and protection were also improved.

Berne, 16 March 2007 Aircraft Accident Investigation Bureau