HUNGARIAN CIVIL AVIATION SAFETY BUREAU

FINAL REPORT

Ref: 161-2003

Type of occurrence:	incident
Location and time of the occurrence:	Gatwick Airport, United Kingdom 2nd August, 2003
Flight number (type) of aircraft involved:	Fokker F-28 Mk0070

Contents

Abbreviations

AFL	Aircraft Flight Log
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
AWG	American Wire Gage
CAA	Civil Aviation Authority
CASB	Civil Aviation Safety Bureau
CB	Circuit Braker
FAA	Federal Aviation Administration
FL	Flight Level
HASB	Hungarian Civil Aviation Safety Bureau
ILS	Instrument Landing System
LGW	London Gatwick Airport
MALÉV	MALÉV Hungarian Airlines
PFD	Primary Flight Display
WTC	Window Temperature Controller

Synopsis

After take off from Gatwick Airport in the 8th minute on FL 80 the crew heared some sizzling noise and they saw sparking behind the panel behind the captain's seat and smelled electrical smell in the cockpit. The phenomenon took a few seconds only. There was no visible smoke in the cockpit. All equipments and systems worked functionally without rebuke only the Primary Flight Display (PFD) faded away twice for one second. This has happened several times on this aircraft in case of potential fluctuation. The crew decided to stop climbing on FL 110, they returned and landed at Gatwick Airport. During this process, they proceeded normal ILS approach and landed safely. The air traffic controllers of the airport notified the fire department that escorted the aircraft from the runway to the stand. The fire-brigade looked over the whole aircraft with a heat detection camera especially the front toilet front wall, but they did not find any trace of any heat. After leaving the aircraft the passengers were transported into the terminal by buses. The local contracted technical handling agent of the airline opened the panel and they found that the wires of the connector P4222B were carbonized. The agent had no licence to do anything else. No circuit braker opened during the incident.

The incident was reported on the 2nd August, 2003, at 18:40 by the Safety Officer of MALÉV to the HASB technician on duty, who reported it further to the director of the HASB and of the CAA.

After reporting the incident the technician on duty together with the operator of the aircraft evaluated the situation and had a discussion together with the director of the HASB and the competents of MALÉV and defined the way of conducting the investigation and the possibility of making the aircraft airworthy.

Based on that the director and an investigator of the HASB, the Safety Officer of MALÉV and four technical staff, to do the maintenance works and to make the aircraft airworthy, visited the incident site and started the investigation.

The technical staff removed the P4222B connector from its place. Wires 1, 2, 12, and 13 were no longer attached to the connector because of having been burned. The heat radiated to the adjacent P4223B and P4230B connectors therefore these connectors were also partly burned without effecting the electrical connection. The burned wires belonged to the left hand windshield and the left hand sliding window heating system. The Safety Officer and the technical staff of MALÉV decided that after disconnecting the left hand windshield and the left hand sliding window heating, the aircraft could be declared airworthy. After doing all the defined maintenance work and preparing the necessary documentation the aircraft arrived in Budapest without passangers with a 25 hours delay on the 3rd August, 2003 at 21:26 local time.

When replacing the connectors in Budapest the technical staff realised some bubbles in the form of a flash of lightning in the left hand sliding window. The left hand sliding window and the other removed components involved in the incident were sent to the Type Certificate Holder for further investigation.

Presumably the main cause of the incident was the slow carbonizing at the incorrectly bound pins of the connector. Since the wires got burned and they became separated from the connector, the circuit brakers were needless to break the circuit.

Cathegory of occurrence:	INCID
Time of the occurrence:	2nd August, 2003, 16:20 local time
Location of the occurrence:	London Gatwick International Airport

Organization conducting the investigation:	Hungarian Civil Aviation Safety Bureau (HASB)
Persons nominated to investigate:	Mr. Sándor SIPOS Ms. Zsófia OLÁH

1. Factual Information

1.1. History of the flight

The HA-LME registered Fokker 70 aircraft started the MA-615 scheduled flight from London Gatwick (LGW) to Budapest on 2nd August, 2003 at 15:54 local time with 67 passangers and 5 crew on board.

About 8 minutes after take off at FL 80 the crew heard some sizzling noise from behind the panel behind the captain's seat and as they looked there, they saw sparkling behind the panel. After the sparkling they smelled a strong electrical smell in the cockpit. The crew observed three times the sparkling for 2-3 seconds within one minute and they saw the last two. There was no visible smoke in the cockpit. Then the phenomenon stopped.

During the incident no circuit braker opened and all the equipments and systems seemed to function without rebuke. Only the captain experienced that the Primary Flight Display faded twice for one-one second. The cockpit window heating was on during the whole time of the incident.

The captain stopped climbing at FL 110 and after discussing it with the ATC returned to LGW. They proceeded a normal ILS approach and landed uneventfully.

The air traffic controllers of the airport notified the fire department that escorted the aircraft from the runway to the stand. After stopping the aircraft the airport fire-brigade examined the cockpit and the front toilet with a heat sensor camera. During the examination they did not find any deviation.

After leaving the aircraft the passangers were transported to the terminal by buses.

After this the local contracted technical handling agent of the airline removed the panel behind the captain's seat and discovered the carbonization of the wires attached to the P4222B connector. They had no licence to do anything else.

The crew administrated the incident on the 0347281 AFL and reported it to Budapest to ask for technical help to solve the problem.

In the presence of the investigating team the technical staff removed the connector. After the removal it could be seen that one end of the synthetic connector, where the wires 1, 2, 12, and 13 were attached, had been burned and melted. Based on burning signs of the connector it was presumable that the adjacent two connectors had been also effected, so they were removed as well. The synthetic connector of P4223B and P4230B were also melted partially, but this had no effect on the electrical connection they provided.

When removing the P4222B connector the technical staff realized that the wires 1, 2, 12, and 13, that had provided electricity for the left hand windshield and the left hand sliding window heating, could be separated from the connector without any reacting force.

After the technical staff had disconnected the left hand windshield and the left hand sliding window heating from the electrical system at the incident site, the aircraft was declared to be airworthy for a ferry-flight back to Budapest. The aircraft arrived at Budapest International Airport on the 3rd August, 2003, at 21:26 local time flown by the pilots assigned the flight the previous day, together with the technical staff and the investigating

team. After landing the aircraft was taxiing to the maintenance area to start the necessary maintenance works.

During the maintenance the plug involved in the incident, its receptacle, the adjacent connectors, the burned wires and the circuit braker of the window heating were removed from the aircraft. During the maintenance works in Budapest bubbles in the form like a flash of lightning were discovered in the surface of the left hand sliding window, so this window was also removed from the aircraft. These components were sent to the Type Certificate Holder of the aircraft, who started a detailed investigation together with the vendors to discover the causes of the incident. This was done under the observation of the representative of the independent investigating organization of the Manufacturing State. The independent investigating organization of the Manufacturing State provided copies of the reports prepared during the investigation to HASB Hungary in order to help preparing the Final Report.

1.2. Injuries to persons

Injuries	Crew	Passangers	Third party
Fatal	0	0	0
Serious	0	0	0
Small	0	0	0
None	2+3	67	0

1.3. Damage to aircraft

There was no damage to the aircraft.

During the incident the plug P4222B, the receptacle J4222A, the adjacent two plugs (P4223B and P4230B) located in the panel behind the captain's seat were burned and melted. Wires 1, 2, 12, and 13 of the burned plug, that belong to the left hand windshield and the left hand sliding window heating system, were realised to be no longer attached during the removal of the connector.

After the incident the left hand sliding window was removed from the aircraft for further investigation. After the removal bubbles in the form of a flash of a lightning were observed in the surface of the sliding window. The window was sent to the Type Certificate Holder of the aircraft for further investigation.

1.4. Other damage

No other damage was discovered except the extra costs of the Operator because of the cancelled flight and the costs related to the checks.

1.5. Personnel information

1.5.1. Captain

Age, gender:	40 years old male
Ratings of licence:	Air Transport Pilot Licence (ATPL)
Validity of licence:	31st March, 2004
Medical validity:	12th February, 2004

1.5.2. First Officer

Age, gender:	33 years old male
Ratings of licence:	Air Transport Pilot Licence (ATPL)
Validity of licence:	31st March, 2004
Medical validity:	30th January, 2004

1.6. Aircraft information

Manufacturer:	Fokker Aircraft B.V.
Type of aircraft:	Fokker F28 Mk0070
Registration:	HA-LME
Serial number:	11575
Validity of Certificate of Airworthiness:	14th October, 2003

	Flight hours	**Number of cycles**
From manufacture	15 877 hours	11 139 cycles
Since last maintenance	1183 hours	855 cycles

The aircraft was airworthy at the time of the incident.

The loading of the aircraft was within the given limits.

The aircraft was loaded with JET A-1 fuel.

The last maintenance of the aircraft (1C Check) was finished on the 6th March, 2003.

1.7. Meteorological information

The incident occurred daytime, in good visual conditions. The runway was dry. The meteorological information had no effect on the incident, so details are ignored.

1.8. Aids to navigation

There were no effects of navigational aids to the incident.

1.9. Communication

There were no technical failures concerning communication. There was radar and radio contact between the ATC and the aircraft.

1.10. Aerodrome information

There were no effects of aerodrome parameters to the incident. The runway used by the pilot was appropriate for landing.

1.11. Flight recorders

The flight recorders of the aircraft were operating. The data of the incident flight was downloaded and evaluated by the FOQA program. These data are not relevant to the incident.

1.12. Wreckage and impact information

There was no impact or wreckage concerning the incident.

1.13. Medical and pathological information

There were no injuries related to the incident. There are no information on the condition of the flight crew before and during the flight.

1.14. Fire

No fire occurred in the incident except the sparkling reported by the crew and the carbonisation of the connectors.

1.15. Survival aspects

No life threatening situation occurred in the incident.

1.16. Test and research

1.16.1. The visual examination of the removed components

All the connectors involved in the incident and the left hand sliding window were sent by the Operator to the Type Certificate Holder for investigation. The first examination was conducted visually without opening the components on the 18th September, 2003 in the

presence of the Dutch Transport Safety Board. The following was determined during the examination:

„(…) the electrical connector. The pins 1 and 12 were missing. These pins are subjected to the load of the sliding window heating current. (…) [Based on the Wiring Manual it can be seen that] both wires are spliced together before and after the connector. Possible cause for the overheat can be:
1. A too high current (only possible if the circuit breaker is out of specification and a failure in the sliding window heating system allowing a too high current).
2. A pushed back pin or socket.
The pins 1 and 12 are missing. (…) there is still something present in one of the socket holes (…).

(…) the window. The seal of the window (…) is partly open. This may be caused by overheating or by some other (mechanical) reason.

(…) the wire leads inside of the window. These leads have black spots on it. This is a possible indication for an overheat.

(…) bubbles in the window. These bubbles seem to be located on the inside of the outer windowpane. These kind of bubbles are also a possible indication for an overheat.

During investigation of other window occurrences the sequence was a breach of the sealing resulting in moisture ingress between the windowpanes. The moisture ingress resulted in a local overheat. (…)"

1.16.2. Further investigation of the left hand sliding window

On the 10th May, 2004 the Dutch Transport Safety Board gave the following information about the investigation: „Window damaged by overheat. No sealing problems found. This means that the overheat most likely occurred due to a factor from outside the window. The window Temperature Controller was tested, but the test did not reveal any complaints. The connector that was damaged (burned) specifications have been reviewed. The contact rating of the connector is 13 amps. The maximum current is 30 amps (protected by a CB). The window heating current is spliced. This indicates that the connector should be alble to withstand 26 amps, but the CB is 30 amps."

1.16.3. More detailed investigation conducted by Fokker Services and the Vendors

The report was issued on the 4th June, 2004 by Fokker Services.

1.16.3.1. Investigation of the left hand sliding window

The left hand sliding window was examined in the presence of the Vendor (GKN Aerospace Transparency Systems LTD), engineers of Fokker Services and the investigator of the Dutch Transport Safety Board. The Vendor issued a report on the examination. They stated the following:

„<<In summary, the windscreen appears to have experienced an applied voltage for a duration longer than normal control would allow. This applied voltage for an extended time period, necessary for only an order of minutes under flight conditions, has lead to a considerable increase in heating film temperature has caused the outer stretched acrylic ply to start to shrink back. This shrinkage would set up large strain forces within the thin heating film and lead to a film failure. This initial film failure location is liable to be in the same region as the area of greatest heating intensity, which would experience the fastest and greatest shrink back. This apprears to be the case in this example. Once a film failure has been initiated the film would rupture quickly over a longer length until the resistance of the film increased to the level in which all electrical heating has ceased. During this rupture, visible 'arcing' with the window may be seen for a very small dureation. It is therefore, in the opinion of GKN TS, probable that the windscreen overheat is a secondary failure and occurred as a result of a primary failure elsewhere in the system. Key areas are:

- Electrical circuit wiring and connections that may have lead to the burn.
- Sensor controller, including the scenario of an 'electrical short' in the sensor circuitry.
- Power breakers and the power circuits to both windows.

However this primary failure does not appear to be easily determined.>>

In addition to the above presented summary it is important to note that measurements revealed that both temperature sensors were still operative, and the resistance of the temperature sensors was within specification. Since the Window Temperature Controller (WTC) monitors the validity of both temperature sensors, it can be concluded that a failure in the sensor wiring is unlikely."

1.16.3.2. Window Temperature Controller (WTC) testing

The unit had been removed from the aircraft and sent back to the Type Certificate Holder's Component Maintenance Department. It was tested according to the Component Maintenance Manual. There was no abnormality found during the tests.

1.16.3.3. Circuit Braker testing

„(…) The CB was subjected to a 200% (60 ampere) load and the CB opened in 11 seconds. This is within the limits for the subject CB (…). The test was repeated with a 400% (120 ampere load). This time the CB opened in 2,25 seconds. This value is within the specifictation for this CB."

1.16.3.4. Burned connector investigation

„Plug P4222B was visually inspected. Pins 1 and 12 were no longer attached to the plug. The location of these pins was severly affected by overheat. Pins 2 and 13, adjacent to pin 1 and 12, were also affected by heat. Pins 2 and 13 were discolored, the plating material disappeared from these pins.

Receptacle J4222A was also visually inspected. The damage on the receptacle was very similar to the damage of the connector. Remains of a pin were still visible in contact 1. The contacts 1 and 12 were removed and opened for further investigation.

After removal of the contacts 1 and 12, the contacts were split in two. The socket which was located in position 1 still had the remains of a pin inside. The pin was stuck in the

socket and could not be removed by hand. This indicates that some of the material was probably partly molten during the overheat. Furthermore it is clearly visible that a significant part of the front end of socket 12 disappeared."

1.16.3.5. Aircraft installation

The wires connected to sockets 1 and 12 of the burned connector are size AWG 16. The wires are spliced together in a splice from where a wire size AWG 12 takes the current further. The circuit is protected by a 30 ampere circuit breaker. This value is chosen to protect the wiring. FAA Advisory Circular 43.13 prescribes a 30 ampere circuit breaker for wire size AWG 12. This indicates that a normally functioning circuit breaker would be able to protect the wiring.

The burned connectors are connected between the previously described wires and the left hand WTC. The burning of the connectors indicates that there must have been some kind of electrical irregulatiry in the left hand windshield temperature control circuit.

The sliding window heating system is protected by a separate circuit breaker.

1.16.3.6. Analysis of the Type Certificate Holder

„Overheating of the left hand sliding window was not caused by a window related or WTC related problem. No abnormalities were noted on the incident aircraft and the aircraft operates currently after replacement of the investigated parts. Overheating of pins 1 and 12 of the connector by itself does not explain overheating of the left hand sliding window.

The link between the overheating of the left hand windshield heating system and the left hand sliding window heating system is carbonizing of the connector. Carbon is a conductor. Conductive paths between pins 1, 12 and the closest neighbouring pins 2 and 13 may have been created. Pin 2 is connected to the left hand wind shield power (which is greater than 285 volt) and pin 13 is connected to the left hand sliding window power. Carbonizing of the connector can be an explanation for the presence of an inadvertent high voltage on the sliding window heating power connection without interruption by the window temperature control logic. This may result in overheating of the sliding window.

The investigation of sockets 1 and 12 of connector J4222A revealed that the front end of socket 1 was gone while socket 12 was still in a pretty good condition. This leads to the conclusion that the current did not divide equally over both contacts. An imbalance in current flow can only be explained by a difference in resistance of both pin/socket connections. Assuming that the contact resistance on one of these contacts is higher, most of the current will flow over the connection with the lowest resistance. Normally the current that runs through these connections is 23,5 ampere. The current is not flowing continuously because the heating is periodically switched on and off depending on the window temperature. When one of the contacts is severly affected by poor resistance than the majority of the windshield current may run through only one contact. The rating of this contact in the connector is limited to approximately 13 ampere. Currents higher than 13 ampere may result in overheating of the connector."

1.17. Organizational and management information

The relevant organizations or managements of the Operator and the State of Manufacture and the Type Certificate Holder cooperated with the Hungarian investigating team according to the international regulations.

According to the place of occurrance the British investigating organization should have instituted an investigation. Since they had shown no intention on taking part in the investigation or on delegating the investigation to any other State, the investigation organization of the State of Operator conducted the investigation with the assistance of the State of Manufacture and the Type Certificate Holder.

No further information is relevant in the investigation, therefore further analysis is not necessary.

1.18. Additional information

The burned P4222B and J4222A connectors have not been replaced since the manufacture of the aircraft untill this incident.

There was no significant request for correction in the Final Report from the parties who received the draft version. The remarks received were taken into consideration.

1.19. Useful or effective investigation techniques

None.

2. Analysis

Based on the provided data, information, documentation and the interviews with the crew and the maintenance staff the incident occurred can be analysed as follows:

The wires in contact 1 and 12 connected to the connector P4222B are connected by a socket. According to the investigation the Type Certificate Holder of the Aircraft has come to the conclusion that the overheat that had started at the connection of the wires caused the carbonization of the synthetic part of the connector. The overheat was caused by the resistance difference of the connection provided by the pins and the sockets. The lower resistance connector led a bigger current than originally planned during the operation. As the carbonizing area was growing reached the pins in position 2 and 13. Because of carbon being a good conductor a short circuit was created in the circuit of the system of these pins. Wire 1, 2 and 12 were connected to the heating system of the windshield in front of the captain. Wire 13 was providing electricity to the left hand sliding window heating system.

The short circuit might have caused the high voltage in wire 13 which caused the damage in the heating film of the left hand sliding window. Because of the high voltage the film had been overheated and where its resistance was smaller first it started to shrink back and

then to rupture. That was the reason why small bubbles were created in the form of a lightning in the left hand sliding window.

The fluctuation of the voltage of the electrical systems of the aircraft can explain the two fades of the PFD.

3. Conclusions

Based on the above listed conclusions, the cathegory of the occurrence is: incident.

The incident was caused by the overheat of the connection of wire 12 in connector P4222B in the panel behind the captain's seat. Heat appears when one of the connections in the connector is incorrect, and almost all the other connection points are occupied, and a wire runs through the connector spliced in two. If the current is not equally shared between the two wires and connecting points, the heat is quickly rising in the wire that leads higher current. That was the reason why the synthetic part of the connector had become so carbonized that it provided a short circuit with the adjacent three connections. It is almost impossible to tell for how long this carbonization took. Because of the high voltage caused by the short circuit the heating film of the left hand sliding window was damaged. The overheat had an effect on the plug of the connector P4222B, J4222A and on the adjacent connectors P4223B and P4230B. The incident had no effect on the connections of these two connectors.

The incidents seems to be a sole case. Upto now the investigation team was not receiving any report on similar cases on other Fokker F-70 aircrafts. The aircraft has been in operation since the replacement of the connectors and the other parts involved in the investigation and no such case has been reported. The connector had not been replaced before, so it was operating well till the incident occured. Based on the results of the investigation and the safety recommendations of the Type Certificate Holder the investigation team states that the circuit involved in this incident is undersized.

The Captain and the First Officer were ready and able to make the flight. They had made the right decision, immediately turned back and landed at Gatwick.

The aircraft was airworthy and despite of the failure ready for flight.

4. Safety recommendations

4.1. Immediate preventing actions

The Type Certificate Holder started the research and improvement of replacing the present two wires with three in the future related to the sliding window involved in the incident based on the results of the investigation.

In addition the Type Certificate Holder examines all the wires in the electrical systems of the aircraft that are spliced and 20 or more ampere current is running through them.

4.2. Safety recommendations

The Operator should introduce the incident to the pilots and the technical staff with educational intention.

The Type Certificate Holder should inform all operators about the results of this investigation and the necessary changes on the aircraft related to this incident in a Service Bulletin. (The Type Certificate Holder issued SBF100-30-027 on the 9th May, 2005 and it is approved by EASA. The reference number is: EASA.A.AD01024.)

5. Appendix

1. Photo: The panel behind the captain's seat
2. Photo: The three adjacent connectors removed
3. Photo: The location of the burned connector
4. Photo: The ends of the wires 1 and 12
5. Photo: Bubbles in the sliding window
6. Wiring Manual 1
7. Wiring Manual 2
8. Pilot in Command Report
9. DIR 0106119-2
10. DIR 0106120-1
11. AFL 0347281
12. AFL 0347282
13. AFL 0347283

The investigation of the above incident is closed in Budapest, on 3rd October, 2005.

László Mészáros
Director