DATA SUMMARY

LOCATION

Date and time	**Friday, 6 July 2012 at 18:48 local time[1]**
Site	**Approach to the Palma de Mallorca Airport (Spain)**

AIRCRAFT

Registration	**SE-DST**
Type and model	**British Aerospace AVRO 146 Series RJ100**
Operator	**Malmö Aviation AB**

Engines

Type and model	**Lycoming ALF507**
Serial Number	**4**

CREW

	Captain	First officer
Age	**56 years**	**27 years**
Licence	**ATPL(A)**	**CPL(A)**
Total flight hours	**9,600 h**	**3,300 h**
Flight hours on the type	**8,000 h**	**2,800 h**

INJURIES	Fatal	Serious	Minor/None
Crew			**5**
Passengers			**101**
Third persons			

DAMAGE

Aircraft	**None**
Third parties	**None**

FLIGHT DATA

Operation	**Commercial air transport – International – Passenger**
Phase of flight	**Approach**

REPORT

Date of approval	**27th January 2014**

[1] Unless otherwise specified, all times in this report are in local time. The origin and destination airports are in the same time zone. To obtain UTC, subtract 2 hours from local time.

1. FACTUAL INFORMATION

1.1. History of the flight

On Friday, 6 July 2012, a British Aerospace 146 aircraft, registration SE-DST, took off from the Malmö/Sturup (ESMS) Airport in Sweden at 15:45 en route to Palma de Mallorca (LEPA) in Spain. There were 101 passengers, 2 flight crew and 3 flight attendants onboard.

While descending into the Palma de Mallorca Airport, the first officer's upper[2] EFIS[3] display, the PFD (primary flight display), went blank (figure 1). The first officer selected the lower EFIS display, the ND (navigation display), to compact mode[4]. The first officer then noticed a smell of electrical smoke, after which the presence of smoke was confirmed. They turned off the first officer's EFIS system and donned their oxygen masks. They declared an emergency and were given landing priority. During the remainder of the descent, the smoke cleared and the crew removed their oxygen masks. Neither the smell nor the smoke entered the passenger cabin.

The landing was uneventful and the crew, assessing that the emergency situation was over, decided not to do an emergency evacuation and to continue taxiing to their parking stand. The passengers disembarked normally and there were no injuries.

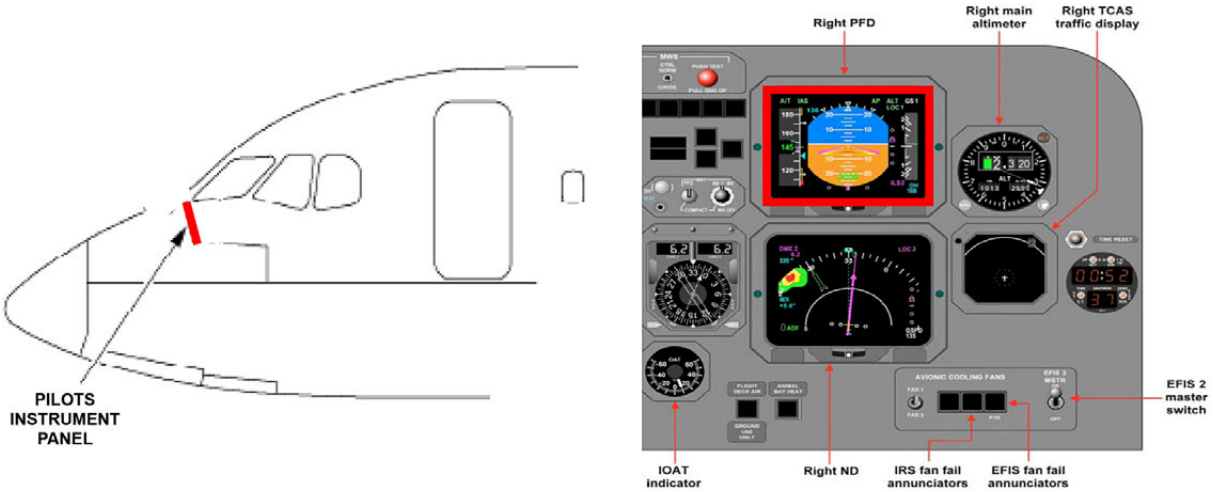

Figure 1. Instrument panel and location of the first officer's PFD

[2] On this airplane the EFIS displays are installed one atop the other, with the PFD above the ND.
[3] EFIS: Electronic Flight Information System.
[4] Compact mode shows the most relevant information from the two EFIS displays on a single screen.

1.2. Damage to aircraft

The aircraft was not damaged during the incident. After landing, an inspection of the instrument panel revealed the following:

- The first officer's PFD showed signs of smoke around the ventilation holes at the top of the unit (figure 2).
- The isolation blankets on the PFD were not properly adjusted (figure 2).
- The units next to the PFD were not affected.
- The disassembly of the PFD revealed that:

  – When the top cover was removed, there were stains left behind by water, corrosion and arcing on several connectors at the top of the low-voltage power supply (figure 2).

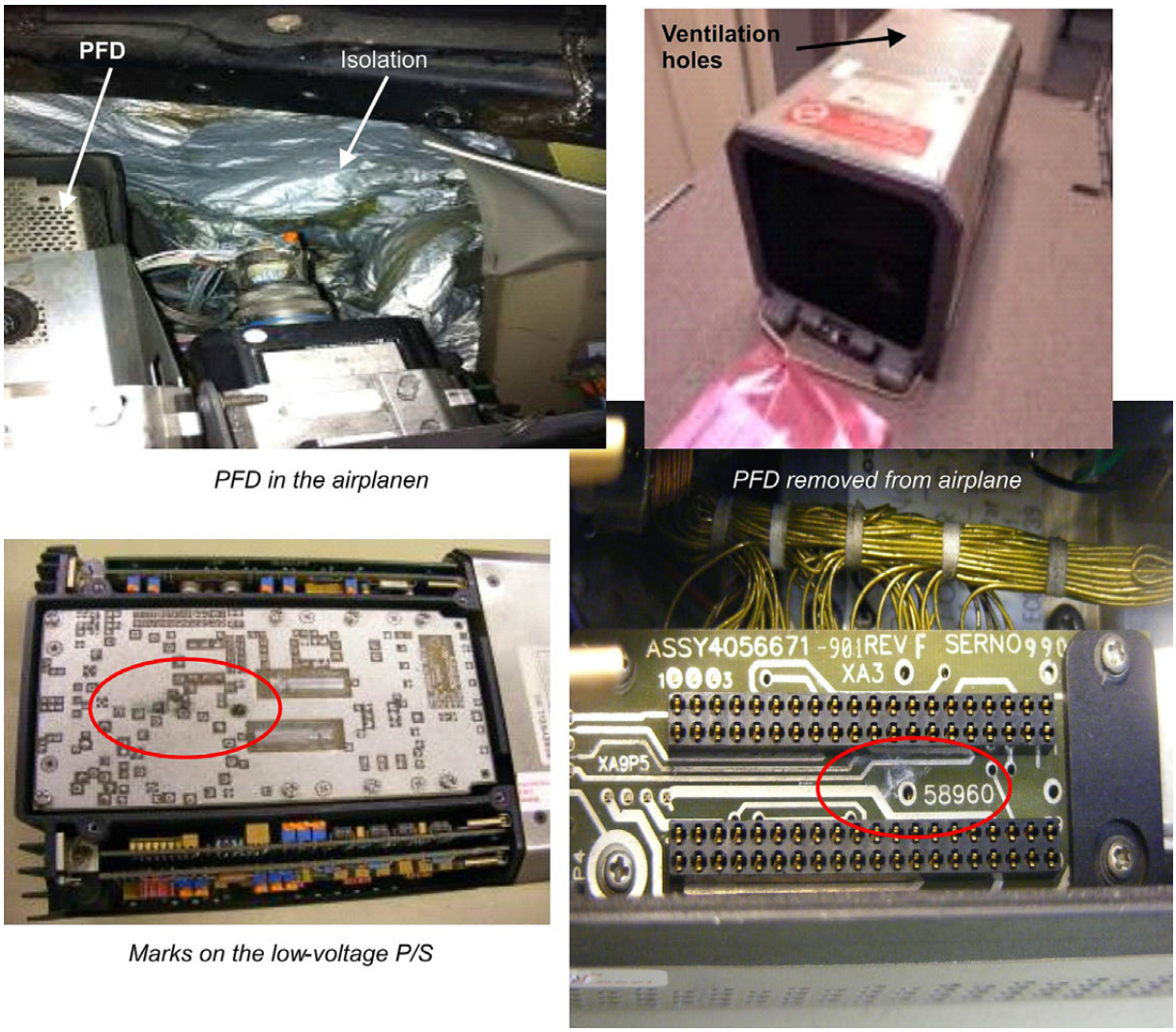

Figure 2. First officer's PFD

– There were water marks on one of the connector boards (figure 2).
– The circuit boards were removed but no corrosion was found on any of them.
– No additional water marks were found in the rest of the unit.

1.3. Personnel information

The pilot, a 56 year old Swedish national, had an ATPL (Airline Transport Pilot License) and had been with the company for 20 years. He had a total of 9,600 flight hours, 8,000 on the type. The first officer, a 27 year old Swedish national, had a CPL (Commercial Pilot License) and had been with the company for one year. He had 3,300 total flight hours, 2,800 on the type. Both had rested the day before.

The purser was 43 and had been at the company 4 years. The other flight attendants were 57 and 24 years old and had been working for Malmö Aviation for 14 and 1 years, respectively.

The entire crew, both pilots and FAs (flight attendants), had recently taken the CRM (Crew Resource Management), Dangerous Goods, Fire and Smoke and Security and Safety courses. In addition to these courses, the FAs had also had medical training. The pilots had undergone the Operator Proficiency Check, the License Proficiency Check and the corresponding Technical/Ground recurrent training.

1.4. Aircraft information

Aircraft SE-DST, a British Aerospace Avro 146 Series RJ100, was manufactured in 1994. It was part of Malmö Aviation's fleet of Avro 146 series RJ85-95 and RJ100-112 airplanes. This operator had a valid and in force air operator's license issued by the Swedish aviation authority for the public transport of passengers.

The aircraft had a valid airworthiness certificate at the time of the incident.

1.4.1. *Information about the first officer's PFD (R/H PFD)*

The right PFD screen had been reinstalled on 12 June 2012 (three weeks before the incident) with a total of 31,013 total aircraft hours after it went blank and had stopped working for 10 minutes. It was made by HONEYWELL and had P/N 4466192-901 and S/N 99031007.

A year earlier, in May 2011, this same unit had been replaced twice, the first time after it went blank and the second due to a malfunction.

1.5. Meteorological information

As per the crew's statement, there was mist at the time of the incident. There were no significant weather conditions during the landing at Palma de Mallorca.

1.6. Communications and radar trace

The aircraft was in radio contact with the Palma ACC when the smoke appeared in the cockpit. At 18:44:59, the ACC had cleared the aircraft to descend to FL90 and fly the LUNIK1P arrival. A minute and six seconds later, at 18:46:05, the ACC tried to raise the aircraft to stop the descent but received no reply. The controller called repeatedly until finally, at 18:46:46 (point 1 in figure 3), the aircraft made contact with ATC to declare an emergency. This message was very poor in quality, however, and the only intelligible words were MAYDAY MAYDAY MAYDAY. The rest of the message, including the callsign, was garbled (table 1).

The ACC continued calling the aircraft, which at 18:47:40 (point 2 in figure 3) managed to issue a clear message and declare an emergency due to smoke in the cockpit. There were no further problems with the clarity of the transmissions.

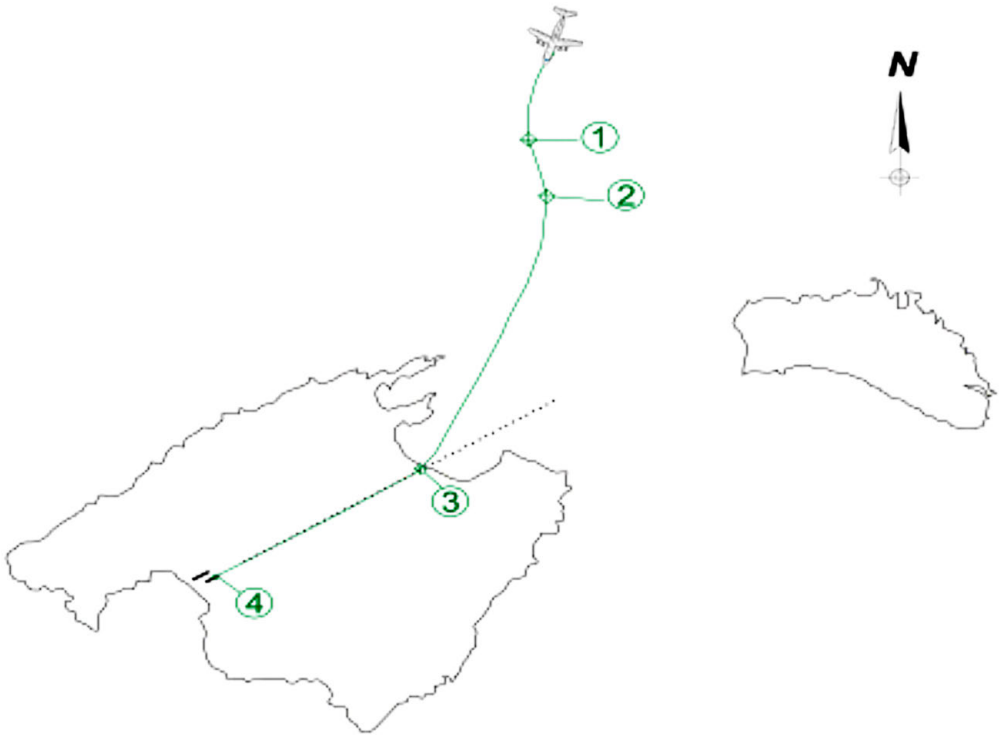

Figure 3. Flight path of the aircraft following the emergency

Table 1. Communications with ATC to declare the emergency

Local time	Station	Message
18:44:59	ACC	SCW792[5] descend FL90 fly LUNIK1P arrival
18:46:05	ACC	SCW792 Palma
18:46:11	ACC	SCW792 Palma
18:46:21	ACC	SCW792 Palma
18:46:27	ACC	SCW792 Palma
18:46:38	ACC	SCW792 Palma Do you read me?
18:46:44	SCW792[6]	(unintelligible)
18:46:46 (1)	SCW792[6]	(unintelligible) MAYDAY MAYDAY MAYDAY (unintelligible)
18:46:54	ACC	SCW792 Palma
18:47:00	ACC	SCW792 Palma
18:47:05	SCW792	SCW792 with you
18:47:08	ACC	I was calling you six times 792. Stop descent at FL130
18:47:15	SCW792	Ok... (unintelligible)... 24 left
18:47:18	ACC	SCW792 Stop descent at FL130, do you read me?
18:47:24	SCW792	(unintelligible)
18:47:31	ACC	SCW792 Stop descent at FL130
18:47:40 (2)	SCW792	Stop descend FL130 MAYDAY MAYDAY MAYDAY smoke on board

At 18:52:03 the crew reported that the smoke had cleared, but continued to request priority for landing and stairs on arrival.

At 18:53:42 they intercepted the 24L localizer (point 3 in figure 3).

At 18:53:53 they were transferred to the TWR.

At 18:55:31 the crew informed the TWR of their intention to exit the runway and taxi to their parking stand and of the need for stairs to disembark the passengers.

At 19:00 (point 4 in figure 3) the aircraft landed normally on runway 24L. It left the runway via taxiway H-7 and while taxiing to its assigned parking stand (154), the crew reported that they did not need assistance from the firefighters.

[5] Callsign of aircraft SE-DST
[6] Due to the poor quality of the transmission, it is highly likely that it was made by aircraft SCW972.

1.7. Flight recorders

The flight recordings were not saved and were taped over after the incident. The operator did not have a procedure for preserving this type of information after an incident.

1.8. Survival aspects

After the aircraft had declared MAYDAY on the ACC frequency, the ACC notified the tower, which in turn notified the operations coordination center at the Palma de Mallorca Airport so that the relevant protocols could be activated.

At 18:52 a Red Alert was declared at the Palma de Mallorca Airport, which triggered the Emergency Plan. All of the services specified in the plan were alerted and mobilized.

Five NM before aircraft SE-DST reached the threshold, the TWR halted all take-off on runway 24R. After landing at 19:00, the firefighters that were waiting for the aircraft drove alongside it to accompany it to parking. The parking assigned to it had been modified during the emergency to one that was at the end of the runway. The stairs, buses and Civil Guard had not arrived by the time the airplane reached this parking stand, meaning the passengers had to wait a few minutes until they could deplane.

At 19:05 the bus arrived and the passengers disembarked normally. The passengers were accompanied by a doctor and a nurse in the bus to the terminal. Only one passenger needed medical attention due to a slight anxiety attack. The medical service later returned to the airplane to attend to a FA who had become anxious after arguing with a passenger.

Taxiing was momentarily stopped on taxiway I-12 while it was occupied by firefighting, signalman and handling vehicles.

At 19:20 the rescue and firefighting service completed its check of the aircraft and reported that the situation was under control, and the emergency was terminated.

1.9. Tests and research

1.9.1. *Crew statements*

The crew stated that there was mist when the incident occurred. After the first officer's PFD went blank, they placed the EFIS switch in compact mode. The first officer then noticed an electrical burning smell, followed by the appearance of smoke, which both pilots saw. After this they completely deenergized the first officer's EFIS system.

They donned their oxygen masks and focused on the navigation. The first officer unsuccessfully tried to declare an emergency to ATC. At the same time ATC was instructing them to maintain a flight level above their initial clearance. Since the first officer was unable to contact ATC, communications were transferred to the captain, the pilot flying, who declared an emergency due to smoke in the cockpit and requested priority. He was able to communicate with ATC without any problems.

During the emergency the purser called the cockpit to report that the cabin was clear. On receiving no response, she went into the cockpit as per procedure. When she entered she unexpectedly found smoke, the smell of electrical fire and the pilots wearing their oxygen masks. The first officer handled the interactions with the cabin attendants for the remainder of the flight. The first officer briefed the purser on the emergency at about the same time as they were intercepting the ILS.

After completely deenergizing the first officer's EFIS system, the smoke started to clear such that when the purser returned to report cabin clear for the second time, they informed her that the smoke had cleared and that the landing would be normal.

All passenger briefing was handled by the purser.

During the approach they requested stairs to disembark the passengers. After landing without any problems, they proceeded to their parking stand. While they waited for the buses to arrive, the captain was able to speak to the passengers and explain that the situation was under control, that they were waiting for the stairs so they could disembark and that they would deploy the slides if necessary.

The crew reported problems reading the displays due to the smoke and to the glare from the mist outside.

1.9.2. *History of problems with the PFD and isolation blankets*

The history of problems involving EFIS screens on aircraft SE-DST showed that similar problems had occurred prior to this incident:

- 6 July 2012 (incident): R/H PFD went blank and smoke appeared.
- 12 June 2012: R/H PFD went blank and stopped working for 10 minutes. A new PFD was installed.
- 24 July 2011: R/H PFD flickered and sometimes stayed blank. The fault could not be reproduced and no defects were found in the unit.
- 20 June 2011: R/H PFD flickered and sometimes stayed blank. During the inspection the isolation blankets were found to have fallen over. The blankets were installed again.
- 5 June 2011: R/H PFD went blank. Tests did not reveal any problems.

- 29 May 2011: installation of R/H PFD due to a break in the PFD.
- 13 May 2011: R/H PFD went blank. After flying in compact mode and reconnecting the PFD, it worked properly.
- 11 May 2011: installation of R/H PFD after it went blank.

In addition to the above, the operator also had records of the following similar problems in its fleet:

- 24 July 2010: R/H PFD display went out of focus followed by a burning smell and the screen going blank.
- 6 July 2010: smoke from the R/H PFD.
- 7 March 2004: R/H PFD went blank and gave off a burning smell.
- 25 August 2002: short circuit in the R/H PFD.

1.9.3. *Instructions for maintaining the PFD and the isolation blankets*

The instructions for installing and removing the EFIS screens included in the Aircraft Maintenance Manual (AMM 34-27-11)[7] did not include any steps involving the isolation blankets.

According to the manufacturer, installing the isolation blankets is a simple process that requires no tools, which is why the Aircraft Maintenance Manual did not include any specific instructions, nor were any inspections scheduled specifically for the isolation blankets.

Problems had occurred in the past with the fastening of the isolation blankets, which prompted the manufacturer, BAe Systems, to issue service bulletin SB 25-433-61091A[8] on 8 July 2002 to minimize problems with the isolation blankets located above the EFIS displays. This service bulletin had had three revisions (2009, 2010 and 2011). At the time of the incident the third revision (2011) was in effect, but since it was not obligatory, the company had not implemented it on its fleet of aircraft.

1.9.4. *Inspection of the fleet by the operator*

After the incident, the operator carried out an inspection of every airplane in its fleet and found that approximately 50% had some type of discrepancy involving the installation of the isolation blankets on the EFIS displays.

[7] AMM 34-27-11: UNIT- EFIS DISPLAY MAINTENANCE PRACTICES.
[8] TITLE: Equipment/Furnishings- to introduce stud fastening of soundproofing above EFIS display units (LH and RH) in the flight deck to improve EFIS reliability.

1.9.5. *Inspection of the masks*

The operator conducted functional tests in the aircraft with the masks (Zodiac full face mask P/N MF10-04-02) used by the pilots during the incident in an effort to reproduce and identify the source of the communications problems that occurred when the emergency was first reported. The results of the tests showed that all communications, both external and with the passenger cabin, were received normally.

1.9.6. *Actions taken by the manufacturer after the incident*

After the incident, the manufacturer issued the fourth revision to service bulletin SB 25-433-61091A on 15 March 2013 with the following modifications:

- It expanded the applicability of the service bulletin to all aircraft in the BAe 146 100, 200, 300 and AVRO 146-RJ70, RJ85, RJ100 fleets.
- It added a silicone sealant to the fastener to keep water that may condense in this area from dripping.

The manufacturer continued to designate this service bulletin's applicability as optional, as it had with the previous revisions, though it was sent to the operators via an All Operators Message. The use of fire retardant materials in the construction of the unit, the continued airworthiness of the aircraft after the fault, crew training to handle smoke and fire conditions and the redundant nature of this system were used by the manufacturer in justifying its decision to adopt no further measures, such as an airworthiness directive.

In addition to the revised SB, the manufacturer modified the maintenance instructions for installing and removing the EFIS displays, AMM 34.27.11, to include a check of the condition of the isolation blankets after the EFIS displays are installed or removed[9].

1.9.7. *Actions taken by the operator after the incident*

After the incident, the operator took the following steps to improve and enhance its operations and maintenance:

- It implemented SB 25-433-61091A fleet wide.
- It started tracking and identifying recurring events to prevent future incidents.
- It introduced periodic checks to verify the proper position of the isolation blankets.
- It encouraged the use of emergency checklists.

[9] «Caution: after installation of EFIS Display Unit or following the lowering of the main instrument panel, verify the correct installation of the insulation blankets».

- It started saving recorder information from events that were subject to investigation.
- It provided simulator training on fire and smoke scenarios.

2. ANALYSIS

2.1. Aspects involving the PFD unit

The presence of marks from smoke, water, corrosion and arcing on the PFD after it was removed confirmed that the smoke and electrical fire smell had been caused by a short circuit in this unit due to the presence of water in it. The not properly adjustment of the isolation blankets must have allowed the water that condenses on these blankets to drip on the equipment.

The problem was limited to the PFD and did not affect nearby equipment.

While the operator had had problems before with the operation of the PFD, these issues had not allowed it to establish a connection with the isolation blankets, since the problem was not in the equipment itself but rather in an external component. The sole exception had taken place a year earlier, when the blankets were found to have fallen over following a similar event. The manufacturer had, however, traced the problems in the EFIS to the isolation blankets and had issued a service bulletin ten years earlier. The improvements specified by the manufacturer to keep the blankets from detaching had not been implemented by the operator as the bulletin was optional. The information in this bulletin would have allowed the operator to identify the source of these problems that were repeatedly affecting the PFD. After the incident the operator took actions to identify and track recurring events to avoid situations like the one in this case. It also took actions to implement the safety bulletin in its entire fleet.

Of all the events involving the problem with the isolation blankets, the most serious was the one that took place on aircraft SE-DST, since the only consequence in the other events was the loss of the information shown on the PFD. This equipment is not essential, there is a back-up unit and it can be transferred to the ND in compact mode with or without EFIS information, meaning that its inoperability does not pose a risk to flight safety. The aircraft remained airworthy during the incident. The presence of smoke is one for which crews are trained, and there are emergency procedures for handling this situation. In this regard, the manufacturer's analysis determined that the gravity, in terms of flight safety, and the recurrence of such an event are not sufficient to warrant taking any actions in addition to those already taken. As a result, no safety recommendation is issued in this regard.

The change made after the incident to the Maintenance Manual procedure for installing or removing the EFIS units included a check of the isolation blankets, which is considered to be an adequate measure.

Both the manufacturer and the operator took sufficient and adequate steps in light of the gravity and occurrence of events such as the one involved in this case, and thus no safety recommendation is issued in this regard.

2.2. Aspects involving the emergency

Investigators were unable to analyze the handling of the emergency beyond the information provided by the crew in their statements since the information contained in the flight recorders was not preserved after the incident. The operator has taken measures to ensure that the information from the recorders is available in future events.

The crew's actions once the smoke appeared were instantaneous insofar as the donning of the oxygen masks and the emergency declaration using the word MAYDAY are concerned. Their statements were consistent with ATC's timeline for the event. The calls from the ACC that the crew did not respond to must have coincided with the appearance of the problem with the display, the smoke in the cockpit and the donning of the oxygen masks, which required the crew's full attention. The crew, more specifically the first officer in this case, must have attempted to declare the emergency during the initial message sent at 18:46:46, but this transmission was very noisy when it was received by ATC. The message was not heard on the frequency and thus the controller was unable to identify that the emergency message had been sent by this aircraft. The communications tests made with the aircraft and the masks were satisfactory, meaning that the source of the communications problem during the emergency could not be identified. When the captain took over the communications, the messages were received normally by ATC.

The act of fully deenergizing the EFIS system resulted in the gradual clearing of the smoke, which allowed the crew to remove their masks.

ATC gave landing priority to the aircraft and the decision to stop all activity on the runway parallel to the landing runway is regarded as a proper preventive measure to take that would have facilitated a go-around had this maneuver been necessary. The activation of the emergency plan and the mobilization of the airport's services complied with the requirements specified in said Emergency Plan. The only negative was the delay in the arrival of the busses and stairs to disembark the passengers, and this was probably due to changing the assigned parking stand during the emergency. In any event, the crew could have activated the slides had an evacuation been necessary.

The communications from the crew to ATC were adequate in terms of informing that the smoke had cleared and their intention to taxi to their parking stand. The situation seemed to be under control and the smoke had dissipated, meaning it was not necessary to stop the aircraft on the runway or taxiway, nor evacuating using the slides had been appropriate.

After the incident, the operator took steps, also considered appropriate, to train its crews on fire and smoke scenarios.

3. CONCLUSIONS

3.1. Findings

- The crew was qualified and the aircraft was equipped for the flight.
- The first officer's PFD unit showed signs of water, corrosion and arcing.
- The adjacent units did not show signs of overheating or fire.
- The problem only affected the first officer's PFD.
- The isolation blankets on the first officer's PFD screen had shifted from their position.
- The problem involving the isolation blankets had occurred before and was known by the manufacturer.
- The Service Bulletin that improved the fastening of the panels was not obligatory and had not been implemented on the aircraft.
- The first officer had problems communicating with ATC while wearing the oxygen mask.
- The functional tests of the masks did not reveal any problems.
- The crew declared an emergency using the term "MAYDAY".
- The crew decided not to evacuate and to taxi to the parking stand.
- The airport's emergency services were activated in keeping with a red alert situation.
- ATC gave priority to the aircraft after it declared an emergency.
- The manufacturer and operator made improvements in various areas after the incident.

3.2. Causes

The incident onboard aircraft SE-DST was likely caused by the presence of water in the first officer's PFD unit due to the improper placement of an isolation blanket that allowed condensed water to drip onto the unit.