FINAL REPORT

AIRBUS A380, REGISTRATION 9V-SKB INFLIGHT ENTERTAINMENT SMOKE INCIDENT

30 OCTOBER 2013

AIB/AAI/CAS.099

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

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The Transport Safety Investigation Bureau of Singapore

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> *"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."*

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SYNOPSIS

On 30 Oct 13 at about 2120 hours, an SIA A380 aircraft was operating a passenger flight from Singapore to Sydney Australia. After the aircraft had taken off from Singapore for Sydney and when the aircraft was climbing through FL 130, the cabin crew noticed electrical sparks and smoke emitting from an In-Flight Entertainment (IFE) screen. The cabin crew discharged a halon fire extinguisher and disconnected the electrical power to the IFE. Thereafter, the smoke or spark did not recur. There was no injury to any person. The flight proceeded to Sydney.

The occurrence was classified as an incident.

AIRCRAFT DETAILS

Aircraft type:	Airbus A380-800
Aircraft registration:	9V-SKB
Numbers and type of engines:	4 x Rolls-Royce Trent 800
Type of flight:	Scheduled passenger flight
Date and time of occurrence:	13 October 2013, 2120 hours Singapore time
Phase of flight:	Climb

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1 FACTUAL INFORMATION

All times used in this report are Singapore times. Singapore time is eight hours ahead of Coordinated Universal Time (UTC).

1.1 History of Flight

1.1.1 On 30 October 2013 at about 2120 hours, an A380 aircraft departed Singapore Changi Airport for Sydney, Australia.

1.1.2 While the aircraft was climbing through FL 130 to its cruising altitude, a Leading Stewardess (LSS) who was around the galley in front of seat row 54 noticed a wisp of smoke from the area around seat 55D. She went over to the seat to investigate.

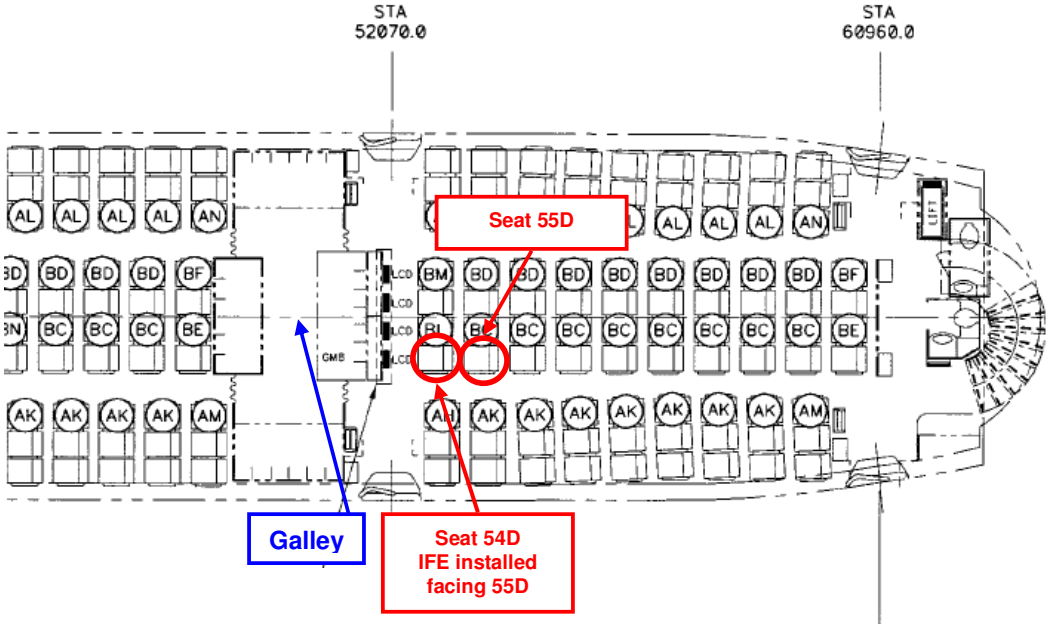

Figure 1: Seat location

1.1.3 When she reached seat 55D, she saw that the passenger at the seat was not looking at the In-Flight Entertainment (IFE) screen (which was installed on the rear face of the seat in front, i.e. seat 54D) but was doing something else and did not appear to notice anything amiss. She also saw sparks coming from behind the IFE screen and a puff of thicker smoke coming from the screen.

1.1.4 The LSS told the passenger to move away from the seat[1] and asked a cabin crew colleague to inform the In-Flight Supervisor (IFS). She then took the fire extinguisher in the overhead baggage compartment above seat 54D and discharged it at the IFE screen.

[1] The seats in front of and next to the passenger were not occupied.

1.1.5 The IFS arrived shortly after and the LSS briefed him of the situation. The IFS then removed electrical power to the IFE screen by toggling off a switch installed under the cushion of seat 54D. However, the LSS noticed that, for about 15 minutes thereafter, the light at the base of the screen was still flickering and the remote control handset was still lit.

1.1.6 The LSS and IFS monitored the IFE system at seat 54D throughout the remainder of the flight to Sydney. There was no recurrence of smoke or spark.

1.2. Inflight Entertainment System

1.2.1 The IFE components for each passenger seat comprise the following (see **Figure 2**):

- IFE display unit (including a screen)
- Handset (for programme selection, etc.)
- Cradle (for housing the handset)

Figure 2: IFE components at each passenger seat

1.2.2 The IFE unit for the passenger at seat 55D was installed on the rear face of the seat in front, i.e. seat 54D. Similarly, the IFE units for the passengers at seats 55EFG were installed on the rear face of the seats 54EFG. The four IFE units installed on Row 54DEFG are powered in common through the following components:

- Supply power module
- Seat electronic box
- Electrical isolation switch (under the cushion of seat 54D)

1.2.3 The IFE display unit contains a multiport jack panel that contains a USB port, an iPod connector and a set of video input connectors.

1.2.4 The IFE display unit receives electrical power from the supply power module and distributes the electrical power to the handset and cradle.

1.2.5 The electrical isolation switch located at each row of seats controls the flow of electrical power from the supply power module to the IFE display units on that row. A wire connects the switch to each of the IFE display units on the row. When the switch is toggled to the OFF position, electrical power will be isolated from the display units and the rest of the IFE components.

1.2.6 Electrical power to the IFE components can also be controlled by making the necessary selection at the main IFE control centre. When controlled through the control centre, electrical power can only be controlled by zones (i.e. several rows of seats will be affected). It is not possible to control the supply of electrical power to each individual row of seats through the main IFE control centre.

1.3 Tests and Research

1.3.1 The following items were investigated with the help of the IFE manufacturer:

- IFE display unit from seat 54D
- Handsets from seat 54D and 54E
- Cradles for handsets from seat 54D and 54E
- Multiport jacks of IFE display units from seat 54D and 54E
- Seat electronic box (SEB) for Row 54DEFG
- Supply power module (SPM) for Row 54DEFG
- Seat assembly for row 54DEFG, including the cable harnesses installed (three for connection between various IFE components)

1.3.2 The results of the investigation by the IFE manufacturer are as shown below in Table 1.

Component	Results
Handsets	No fault found
Cradles	No fault found
Multiport jacks	No fault found
Seat electronic box	No fault found
Supply power module	No fault found
IFE display unit	Signs of heat stress on an integrated circuit chip (IC500), a ferrite bead (FB1) and the underside of the printed circuit board in the area beneath IC500. The display unit failed to function when electrical power was applied.
Seat assembly for row 54DEFG including cable harnesses installed	A wire harness, connecting a switch to the SPM, which provides shut-off function to the IFE function at seat row 54DEFG, was found to be severed.

1.3.3 The IC500 chip was also examined by the chip manufacturer who determined that the failure was due to electrical overstress[2].

1.3.4 The IFE system manufacturer also conducted further tests using a fully functional IFE display unit. The results of the tests suggested that the failure of the IC500 chip could be due to an external application of overvoltage or overcurrent to one of the pins that provided USB functionality[3] at seat 55D and that the overvoltage or overcurrent condition could have also caused heat stress damage to FB1.

[2] Electrical overstress is a localised temperature increase in the IC chip resulting in melting or vaporising of certain portion or the entire IC chip, ultimately causing it to fail.

[3] The functionality allows passengers to connect their personal electronic device to the IFE system located at their seat via the USB port located on the multiport jack at their seat. However, according to the LSS, when she arrived at the seat location to when the smoke and sparks were emitted, the passenger was not using the IFE system at her seat location and there were no devices plugged into the external USB port. Visual inspection performed by maintenance personnel after the aircraft landed did not reveal any anomalies of the external USB port.

2 ANALYSIS

2.1 Observations

2.1.1 The overvoltage or overcurrent condition resulted in heat being generated, which damaged the IC500 chip as well as the PCB board and surrounding electronic components on the board. The sparks and a puff of smoke that the LSS saw were probably due to the failing components.

2.1.2 The investigation team was unable to determine the exact cause of the overvoltage or overcurrent condition. Nevertheless, the investigation team wishes to address the following aspects:

(a) Continual supply of electrical power
(b) Crew response to isolate electrical power to display unit

2.2 Continual supply of electrical power

2.2.1 According to the LSS, after she had discharged the fire extinguishing agent at the IFE display unit, the IFS toggled off the electrical isolation switch for seat row 54DEFG. However, she noticed that the light at the bottom of the display unit was flickering and the handset at seat 55D was lit for 15 minutes even after the electrical power supply was supposed to have been removed.

2.2.2 The investigation performed by the IFE system manufacturer revealed that the wire harness connecting the electrical isolation switch to the display unit was severed. Despite the switch being toggled off, the electrical power supply cut off command could not reach the display unit because the wire harness had been severed.

2.2.3 This resulted in the display unit continuing to receive electrical power supply from the supply power module and continuing to distribute electrical power. This would explain why the lamp below the display unit was flickering[4] and the handset was lit.

2.2.4 It could not be ascertained how the wire harness was severed. One possibility is that it was damaged during the installation of the seat assembly for row 54DEFG when the aircraft manufacturer was preparing the aircraft for delivery to the operator. During the installation, the wire harness could have been pinched between part of the seat assembly and the floor panel and the pressure exerted on it could have caused it to be severed.

2.2.5 The maintenance manual for the IFE system is produced by the IFE system manufacturer. Despite the electrical isolation switch

[4] The flickering was possibly due to damaged electrical circuits.

being a safety feature, there is no instruction for maintenance personnel to perform a functional check, by toggling the switch to ensure electrical power supply is removed, after any maintenance action that may affect this feature. Had such an instruction been available in the maintenance manual, the damaged wire harness could have been detected.

2.3 Crew response to isolate electrical power to display unit

2.3.1 According to the operator, all its cabin crews are trained to isolate power to the IFE system installed at each row of seats by toggling the electrical isolation switch, and all its senior cabin crew members who are responsible for operating the IFE system are also trained to toggle a master switch that removes electrical power and shuts down the entire IFE system[5].

2.3.2 In this incident, the master toggle switch for the IFE system was not toggle off as the cabin crew did not appreciate the need for such action. It seems that while they found it odd that the lamp below the display unit was flickering and the handset was still lit even though the electrical isolation switch for seat row 54DEFG had been toggled off, it did not occur to them that the electrical power had not actually been isolated. It would be desirable for cabin crews to be better trained in this regard.

[5] Apparently, cabin crew members are not trained to remove electrical power for the IFE system in a zonal manner (as described in paragraph 1.2.6).

3 SAFETY ACTION

During the course of the investigation and through discussions with the investigation team, the following safety action was initiated by the operator.

3.1 The operator has reviewed its cabin crew training in handling IFE system related emergency. The training has been enhanced to incorporate the need to check and verify that electrical power has been removed from the affected IFE system. The operator is introducing three additional steps that could and shall be taken progressively to remove electrical power to the affected IFS system. The operator will incorporate the training enhancement in its safety procedures manual.

4 SAFETY RECOMMENDATION

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

4.1 It is recommended that the manufacturer of the In-Flight Entertainment System review its installation manual to require a functional check for each electrical isolation switch after installation in the aircraft. [TSIB Recommendation RA-2016-001]