

Final Report

BOEING B777-300ER, REGISTRATION 9V-SWQ IN-FLIGHT ENTERTAINMENT SMOKE INCIDENT

27 MARCH 2023

TIB/AAI/CAS.221

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

12 March 2024

The Transport Safety Investigation Bureau of Singapore

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GLOSSARY OF ABBREVIATIONS

FS	: Flight Steward
IFE	: In-flight Entertainment
IFM	: In-flight Manager
LS	: Leading Steward
MPJ	: Multiport Jack
SEB	: Seat Electronics Box
SPM	: Seat Power Module

SYNOPSIS

On 27 March 2023 at about 1115 hrs Local Time, when a B777-300ER was on descent to Los Angeles International Airport in the USA, a passenger reported to the cabin crew that smoke was emitting from an In-Flight Entertainment (IFE) panel. The cabin crew immediately switched off the seat power supply to the affected IFE panel and then discharged two fire extinguishers at the IFE panel until no further smoke was seen. A cabin crew member was stationed at the affected seat to monitor the IFE panel.

When the aircraft had just touched down on the runway, smoke and fire were seen again at the IFE panel and the cabin crew member stationed at the seat discharged another fire extinguisher. The aircraft exited the runway normally and taxied to the parking bay without further incident.

No one was injured in the occurrence.

The Transport Safety Investigation Bureau classified this occurrence as an incident.

AIRCRAFT DETAILS

Aircraft type	:	Boeing B777-300ER
Operator	:	Singapore Airlines
Aircraft registration	:	9V-SWQ
Numbers and type of engines	:	2 x GE90-115B
Date and time of incident	:	27 March 2023, 1115 hrs Local Time
Location of occurrence	:	During descent to Los Angeles International Airport
Type of flight	:	Scheduled
Persons on board	:	234

1 FACTUAL INFORMATION

All times used in this report are Los Angeles Local Time unless otherwise stated. Los Angeles Local Time is seven hours behind Coordinated Universal Time.

1.1 History of the flight

1.1.1 On the evening of 27 March 2023, a Boeing B777-300ER aircraft was enroute from Narita International Airport, Japan, to Los Angeles International Airport, USA. The flight was scheduled to land in Los Angeles at 1250 hrs.

1.1.2 During descent to Los Angeles, a passenger from Seat 48K reported to the Leading Steward (LS) seated at Door 4L that the In-Flight Entertainment (IFE) panel at the back of Seat 47K (i.e. the IFE panel in front of Seat 48K) was emitting smoke. The LS went over to Seat 48K and saw that smoke was emitting from the USB port of the IFE multiport jack¹ (MPJ). Another Flight Steward (FS) who was present then proceeded to switch off the seat power module (SPM) maintenance switch under Seat 47H to turn off the power supply to the seatback IFE equipment for seats at rows 47 (i.e. H/J/K).

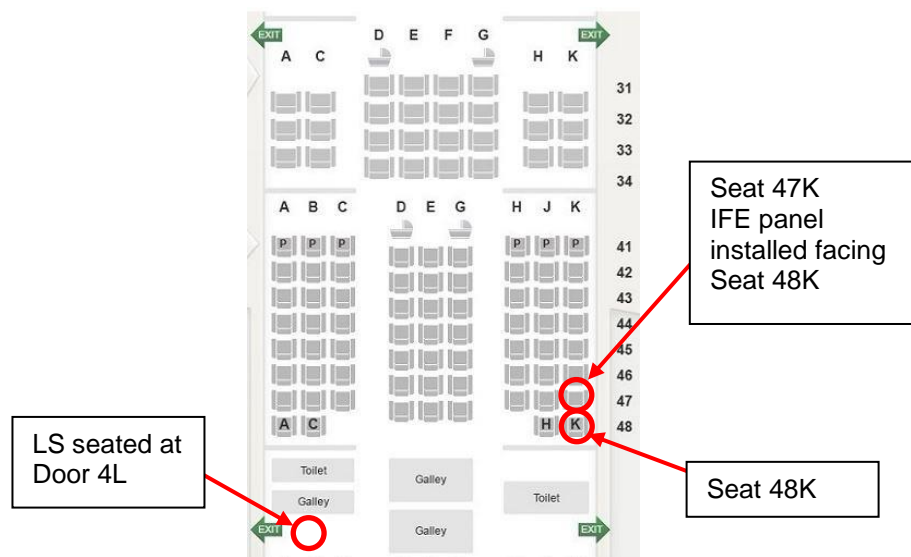


Figure 1: Seat location of IFE

¹ According to this passenger, he had attempted to charge his laptop using the right USB port before the aircraft took off from Narita Airport, but as his laptop was not charging, he disconnected the laptop from the USB port and did not use any of the USB ports for the remainder of the flight.

- 1.1.3 The LS then requested the FS to fetch the fire extinguishers. Meanwhile, the LS called the In-Flight Manager (IFM) via cabin intercom to inform him of the developing situation. The IFM immediately informed the flight crew of the situation.
- 1.1.4 By then, the passengers at the affected seat rows of 47 and 48 had already been moved to the rear of the cabin. The FS returned with two fire extinguishers. Smoke was first observed to be emitting from the IFE panel followed by sparks appearing. The FS discharged one bottle of fire extinguisher at the smoking IFE panel. As a precautionary measure, he also discharged the second bottle at the IFE panel. The IFM was at the scene and observed that the situation was now under control. The IFM then returned to his seat and updated the flight crew that the cabin situation was under control.
- 1.1.5 The affected passengers were relocated to other seats. The FS sat at seat row 48 with a third fire extinguisher on hand and monitored the situation during the landing.
- 1.1.6 When the aircraft had just touched down on the runway, the FS saw smoke and electrical sparks coming from the IFE panel at the back of Seat 47K. There was smoke coming from the bottom of the seat as well. He also saw, from a viewing hole on the rear of the IFE panel, what he described as a 'lighted flame'. The FS immediately discharged the third fire extinguisher. The IFM also turned off the IFE Master Power switch at the IFE Crew Terminal located at Door 2L. This turned off the electrical power to the entire IFE system in the cabin. There was no further smoke or fire observed. The aircraft rolled out of the runway and taxied to the parking bay without further incident.
- 1.2 In-flight Entertainment System
- 1.2.1 The IFE unit for each seat typically comprises these features:
- (a) Display panel
 - (b) Multiport jack (MPJ) panel
 - (c) Handset
 - (d) Audio jack

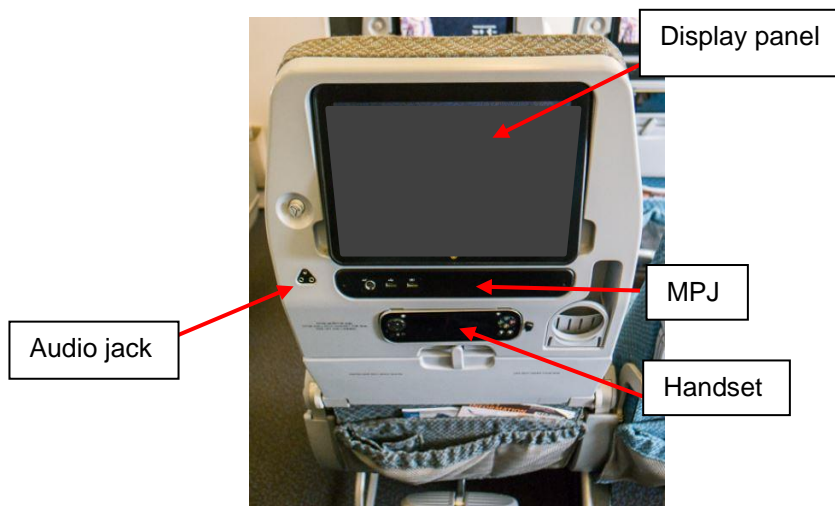


Figure 2: IFE components

1.2.2 Electrical power to the IFE units installed on seat rows 47 (H/J/K) is delivered from the same source through the following components:

- (a) Seat power module (SPM)
- (b) SPM maintenance switch (under seat 47H)²

1.2.3 The MPJ panel contains two USB ports and an iPod connector.

1.2.4 The SPM maintenance switch controls the power from the SPM to the IFE units on the designated row of seats. When the switch is toggled to the OFF position, electrical power is disabled to the IFE units. The electrical power is supplied to the cabin column via cable harnesses that link all the seat rows in a series. Switching off the SPM maintenance switch only disables electrical power to that particular seat row's IFE units. Unless the IFE Master Power switch is turned off, the main electrical power is still being supplied to the seats in the cabin column.

1.2.5 For a front row seat such as 41K, the MPJ panel, handset and audio jack are located underneath the seat and not together with the display panel. The display panel is separately stowed in the armrest of the seat.

² Typically, each row of three seats has one SPM maintenance switch controlling the IFE power supply. The SPM maintenance switch on row 47 switches off the IFE equipment installed on 47H/J/K which is for use by passengers on 48H/K.

1.3 Damage to aircraft

1.3.1 Seat 47K's back shell casing and the MPJ suffered heat and fire damages.

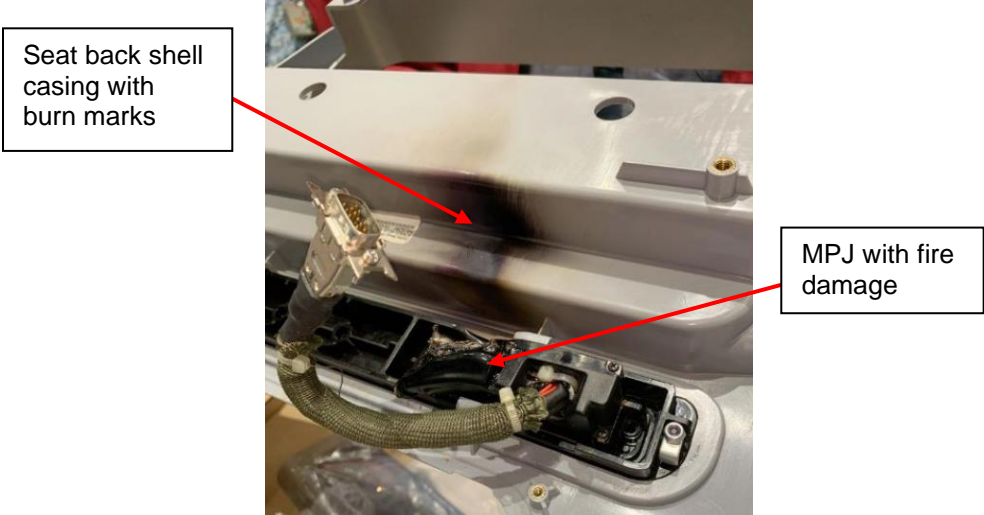


Figure 3: Heat damage to seat back shell casing and the MPJ

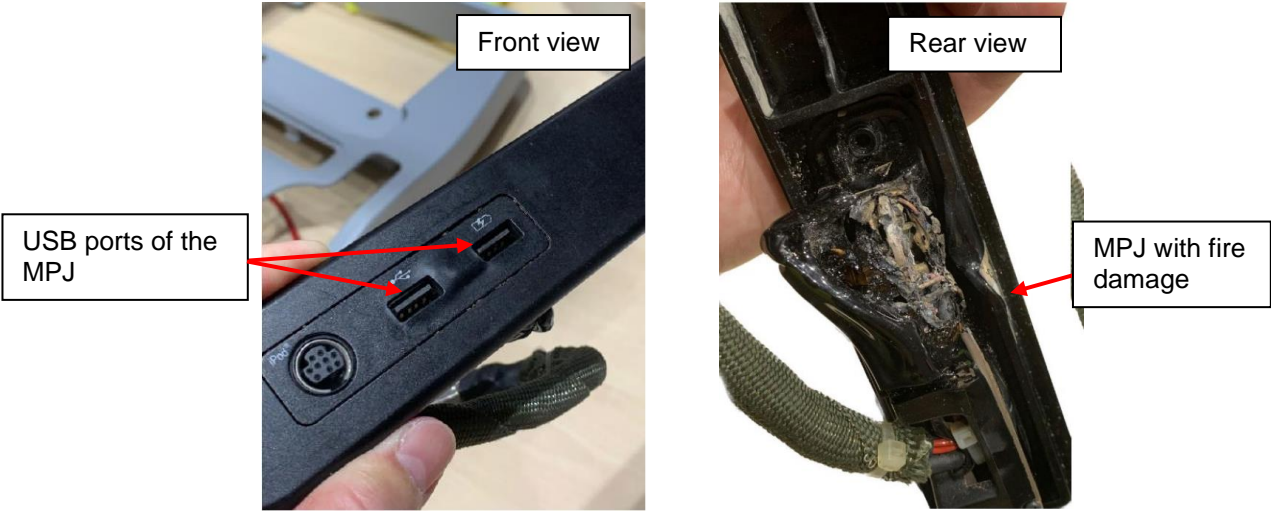


Figure 4: Heat damage to the MPJ and USB ports

1.4 Personnel information

1.4.1 Leading Steward/Door 4L

Age	42 years old
Qualification (Last Recurrent Training)	9 January 2023
Total experience	17 years 10 months
Duty time in last 48 hours (prior to operating current flight)	9 hours
Rest period in last 48 hours (prior to operating current flight)	23 hours

1.4.2 Flight Steward/Door 3R

Age	29 years old
Qualification (Last Recurrent Training)	22 December 2022
Total experience	10 years 6 months
Duty time in last 48 hours (prior to operating current flight)	9 hours
Rest period in last 48 hours (prior to operating current flight)	23 hours

1.4.3 In-Flight Manager/Door 2L

Age	54 years old
Qualification (Last Recurrent Training)	16 June 2022
Total experience	30 years 10 months
Duty time in last 48 hours (prior to operating current flight)	9 hours
Rest period in last 48 hours (prior to operating current flight)	23 hours

1.5 Additional information

1.5.1 Previous smoke incident and subsequent inspection

1.5.1.1 According to the operator, on 23 March 2023, i.e. four days before the 27 March 2023 incident, there was smoke and burning smell emitting from the MPJ panel located underneath seat 41K of the same aircraft. There was no external heat damage observed and the affected IFE components were replaced.

1.5.2 Internal examination of the MPJ circuit

1.5.2.1 Following the incident on 27 March 2023, the aircraft operator carried out a more in-depth investigation of the IFE electrical system and found previously undetected damage to the wires and cable insulation on the folding arm-type IFE display panel at Seat 41H. The wires were found with damaged insulation and exposed bare wire. This resulted in a shorting condition where the 28V IFE power supply was unintentionally connected, via the chassis ground wiring system, to all the other IFE units within that cabin column.



Figure 5: Damaged wire and cable insulation found

1.5.2.2 The IFE manufacturer examined the damaged MPJ circuit of the IFE unit from the 23 March 2023 incident and found that the power switch component of the USB circuit had been exposed to high voltages and had some heat damage.

1.5.2.3 The IFE manufacturer also examined the damaged MPJ circuit of the IFE unit from the 27 March 2023 incident and found signs of liquid ingress on the IFE frame.

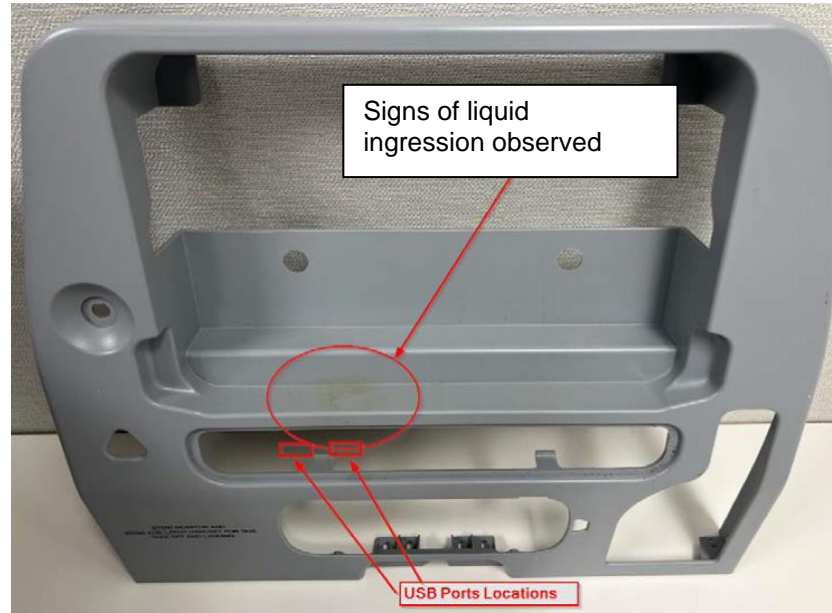


Figure 6: Liquid ingress found on the IFE frame by IFE manufacturer (27 March 2023 event)

1.5.2.4 The IFE manufacturer opined that the IFE smoke event arose from the following:

- (a) As a result of damaged wires and cable insulation, the IFE panel was exposed to a high voltage (28V) via the chassis ground which was shared between seats in the same cabin column.
- (b) A shorting between this high voltage chassis ground and the digital ground on the MPJ caused by the liquid that had ingressed onto the IFE frame.
- (c) This shorting resulted in overvoltage and heat damage and thus smoke.

1.5.3 Modifications provided by IFE Manufacturer

1.5.3.1 Previous cases of MPJ USB port damage suggests that when passengers use the MPJ USB port, there is a possibility of shorting if the digital ground on the MPJ contacts the internal USB shielding which is connected to the chassis ground, thus linking the digital ground with the chassis ground. An overvoltage could result if the chassis ground had previously been shorted and is presently

being subjected to a high voltage. Electronic devices typically used by passengers and which can be connected to the USB port could internally connect the USB shield and digital ground, and induce an overvoltage condition.

1.5.3.2 The IFE manufacturer had issued two MPJ design improvement (known as MOD 3 and MOD 4) to address the overvoltage in the MPJ. These modifications:

(a) isolated the digital ground by incorporating a capacitor in the circuit path of the USB shielding to prevent a current flow from the chassis ground to the digital ground; and

(b) made the USB connector less susceptible to damage through a redesign.

1.5.3.3 The IFE manufacturer had recommended the replacement of IFE units with units in which the MPJ has incorporated MOD 3 and MOD 4, to be performed on a failure attrition basis. The MPJ involved in the 23 and 27 March 2023 incidents had not incorporated MOD 3 and MOD 4.

2 ANALYSIS

- 2.1 A previously undetected wire damage on the folding arm-type IFE display panel at seat 41H resulted in a shorting condition where 28V high voltage main power was presented to all other seats' IFE units within the cabin column concerned via the chassis ground wiring system.
- 2.2 In addition to this latent exposure to the high voltage coming from the chassis ground, a secondary exposure to liquid ingress on the MPJ panel established a connection between this high voltage chassis ground and the digital ground within the MPJ panel. This resulted in an overvoltage condition and heating within the IFE unit that led to smoke and sparks forming.
- 2.3 Despite the cabin crew having turned off the SPM maintenance switch under Seat 47H to cut off the IFE power supply to that seat row, Seat 47's MPJ panel was still exposed to high voltage coming through the chassis ground from Seat 41H due to the damaged cable harness³. As a result of this continued heat stress to the MPJ USB port, a second occurrence of smoke and electrical sparks resulted. It was only after the IFM had turned off the IFE Master Power switch, which cut off the electrical power to the entire IFE system in the cabin, was the high voltage coming through the chassis ground shut off.

³ The seat rows 48 and row 41 are in the same cabin column and share the same chassis ground.

3 **CONCLUSIONS**

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- 3.1 The IFE smoke was the result of an overvoltage condition and heating within the IFE unit which originated from a combined fault of damaged cable harness and liquid intrusion.

4 **SAFETY ACTIONS**

Arising from discussions with the investigation team, the IFE manufacturer has taken the following safety actions.

- 4.1 The IFE manufacturer recommends periodic checks on the cable harness in the seats' armrest mechanism every 5 to 7 years to detect any signs of incorrect or degenerated cable routing and clamping which can lead to cable damage.

5 SAFETY RECOMMENDATION

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

It is recommended that:

- 5.1 The aircraft operator replace MPJ with those that have incorporated MOD 3 and MOD 4 on the B777 fleet. [TSIB Recommendation RA-2024-001]