

Report

Serious incidents on **18 March** and **8 April 2010**
at **Paris Charles de Gaulle Airport (95)**
to the **Boeing 747-400s**
registered **HS-TGL** and **B-HOV**
operated respectively by
Thai Airways International Ltd.
and by **Cathay Pacific Airways Ltd.**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'Écologie, du Développement durable, des Transports et du Logement

Foreword

This report expresses the conclusions of the BEA on the circumstances and causes of these serious incidents.

In accordance with Annex 13 to the Convention on International Civil Aviation, with EC directive 94/56 and with the French Civil Aviation Code (Book VII), the investigation was not conducted so as to apportion blame, nor to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in French is the work of reference.

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Glossary

AD	Aerodrome
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration (USA)
GPU	Ground Power Unit
IPC	Illustrated Parts Catalogue
MOM	Multi Operator Message
NTO	No Technical Objection
NTSB	National Transportation Safety Board (USA)

Synopsis

Date of incident 18 March 2010 at 6h ⁽¹⁾	Aircraft Boeing 747-400, serial number 25366, manufactured in 1991, registered HS-TGL
Place of incident Paris Charles de Gaulle Airport (95)	Operator Thai Airways International Ltd.
Type of flight Public transport of passengers	Persons on board Crew + passengers: 394

⁽¹⁾All times in this report are UTC, except where otherwise specified. One hour should be added to express official time in metropolitan France on the day of the incident to this aircraft.

Date of incident 8 April 2010 at 5h12 ⁽²⁾	Aircraft Boeing 747-400, serial number 25082, manufactured in 1991, registered B-HOV
Place of incident Paris Charles de Gaulle Airport (95)	Operator Cathay Pacific Airways Ltd.
Type of flight Public transport of passengers	Persons on board Crew + passengers: 326

⁽²⁾All times in this report are UTC, except where otherwise specified. Two hours should be added to express official time in metropolitan France on the day of the incident to this aircraft.

Events	Fire in the avionics compartment shortly after connection of ground power unit (GPU).
Consequences and damage	Connectors and electric cables severely damaged, distortion and deterioration of the structural characteristics of the fuselage due to high temperatures, replacement of the onboard computers on HS-TGL following use of the dry-chemical type fire extinguisher, extensive aircraft downtime.

1 - HISTORY OF FLIGHTS

1.1 History of Flights on Arrival

HS-TGL

Flight from Bangkok Airport (Thailand) to Paris Charles de Gaulle Airport, terminal 1.

HS-TGL left Bangkok with an acceptable deferred defect in the inoperative auxiliary power unit (APU). On arrival at gate Z4 at terminal 1 at Paris Charles de Gaulle Airport, the crew kept engine No4 running until a GPU was connected. The crew then shut down engine No4 and the electrical power supply was then supposed to be provided by the GPU.

The ground technicians tried to open the forward and aft cargo hold doors without success. They contacted the Captain, who informed them that there was no electrical power supply on board.

The ground technicians noticed a high level of heat emanating from the fuselage around the GPU connectors. They disconnected the cables and noticed that both the cables and the fuselage were red hot. They opened the avionics compartment inside which they observed flames. They put out the fire with the aid of a 50 kg dry-chemical type fire extinguisher that they emptied. Firemen noted that the fire had stopped when they arrived. Using a thermal camera, a temperature of almost 800 °C was measured in the area.

Note: The investigation was unable to determine the exact chain of actions performed by the ground technicians.

B-HOV

Flight from Hong Kong Airport (Hong Kong, China) to Paris Charles de Gaulle Airport, terminal 2.

After its arrival, the aeroplane was parked at gate A34 at terminal 2 at Paris Charles de Gaulle Airport. During connection of the GPU, the ground technician had some difficulties in supplying electrical current to the aeroplane. On this type of GPU, the power switch remains in current supply position only when the GPU receives a return signal from the aeroplane. Unless this happens, the switch returns to an intermediate position and cuts the power supply. During the incident, the ground technician had some difficulties in supplying electrical current to the aeroplane and held the switch manually, forcing the supply of current. He then noticed a temporary large fall in GPU engine revs.

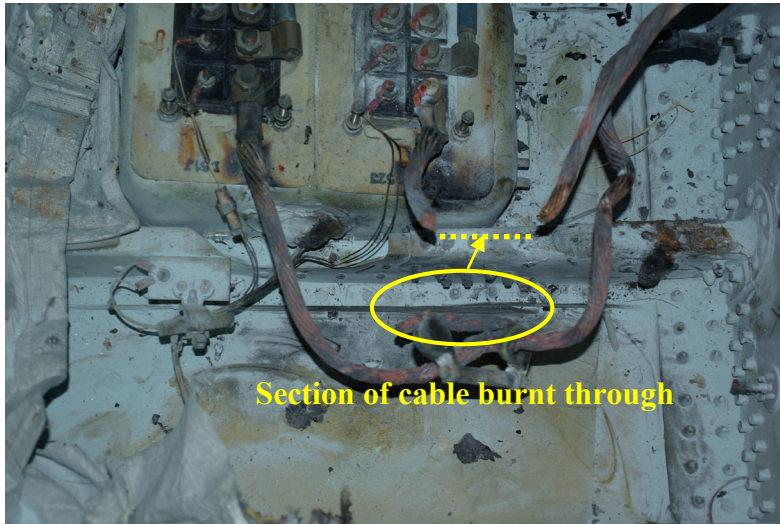
A short time later, he noticed a strong wave of heat and disconnected the GPU cables. An agent from Cathay Pacific Airways then intervened and opened the avionics compartment. He saw flames inside and used a dry-chemical type fire extinguisher to put out the fire.

During both of these events, the passengers were disembarking.

1.2 Damage to Aircraft

HS-TGL

In the avionics compartment, the two cables connecting the neutral to the structure of the aircraft were severely damaged and partially melted. One of them was burnt through in two places by the heat. The insulation blankets were burnt in the area surrounding the electrical connectors. The avionics compartment was filled with dry chemicals from the extinguisher.



Avionics compartment electrical

In this area, the structure of the aircraft's fuselage was subjected to significant heating (800 °C) that required major repair work before the aircraft could be returned to service.

B-HOV

In the avionics compartment, the cables linking the neutral to the aircraft structure were partially melted, but not burnt through. The insulation blankets were burnt in the area surrounding the electrical connectors. In the avionics compartment, a little of the dry chemicals from the extinguisher was present around the connectors though in smaller quantity than in the case of the event involving HS-TGL. The outer connectors showed signs of heating, and bore traces of dry chemicals from the extinguisher.



The overheating caused by the fire led to a deformation of the aircraft fuselage structure. Major repair work also had to be undertaken before the aircraft could be returned to service.

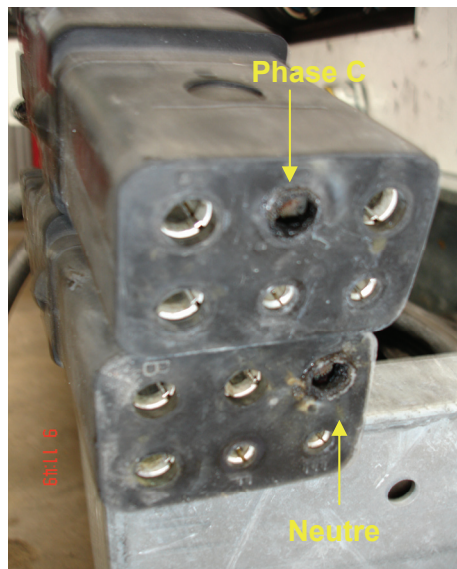
1.3 Examination of GPUs

HS-TGL

After the incident, the GPU was immediately taken out of service. Examinations did not reveal any malfunction or anomalies. The GPU was returned to service.

B-HOV

After the incident, the GPU was immediately taken out of service. The electrical cables between the GPU and the aircraft showed significant signs of heating that led to a reduction in their cross section. The elastomer boxes that surround the contacts also showed signs of heating on the neutral on one plug and on the phase C on the other.



1.4 Additional Information

The GPUs used on aeroplanes such as the B747-400 supply 115 V / 400 Hz current, on three phases: A, B and C, through two electrical connectors in order to spread the intensity. Each plug has six pins: the three phases, the neutral, as well as the two smaller pins that are used for communication between the GPU and the aeroplane's electrical circuit.

GPUs are used by personnel from sub-contractors that deal with ground services. These ground technicians receive limited training and have a limited knowledge of aeroplane electrical systems.

The two GPUs were essentially identical. They were neither used nor maintained by the same companies. The manufacturer of the two GPUs was contacted in order to determine if there were any precursor incidents. It said that it was not aware of any previous similar events.

The BEA also asked Boeing, through the NTSB, to supply feedback on similar incidents. Since 2001, Boeing knew of eight other similar cases on Boeing 747-400 for which the types of GPU used are not given:

- ❑ 15/01/2001 at Toronto (Canada): superficial damage to the fuselage;
- ❑ 01/12/2002 at Toronto: damage not stated;
- ❑ 26/12/2002 at Paris CDG: superficial damage to the fuselage;
- ❑ 09/10/2007 at Unalakleet (Arkansas, USA) : damage unknown;
- ❑ 03/01/2008 at New-York JFK (USA): damage not stated;
- ❑ 27/01/2008 at New-York JFK (USA): damage not stated;
- ❑ 06/02/2009 at Unalakleet (Arkansas, USA): damage not stated;
- ❑ 08/12/2009 at Unalakleet (Arkansas, USA): damage not stated.

Observation of the damage showed that in all of these cases the phase C had been connected directly to the neutral.

An internal Boeing study, undertaken in 2002, showed that the composite material guide, which ensured positioning of the ground power receptacles, could be damaged. In this situation, it is possible to align the plugs incorrectly. At the time, Boeing had not identified the problem as having any effect on safety.



Example of incorrect connection (Boeing source)

1.5 Measures Taken by the Manufacturer

Following the first event reported to Boeing in 2001, an NTO was supplied to the operator concerned to install the guide from the B767 (Ref. MS.17845-1) in place of the part initially installed on the B747-400 (Ref. 66-9236). The replacement part ensures precise guidance. It is made of metal and is much more robust. It has been installed as a production part on the B747-400 since 2003.

According to Boeing, no cases of incorrect alignment have been reported to them on aeroplanes equipped with the MS17845-1 guide.



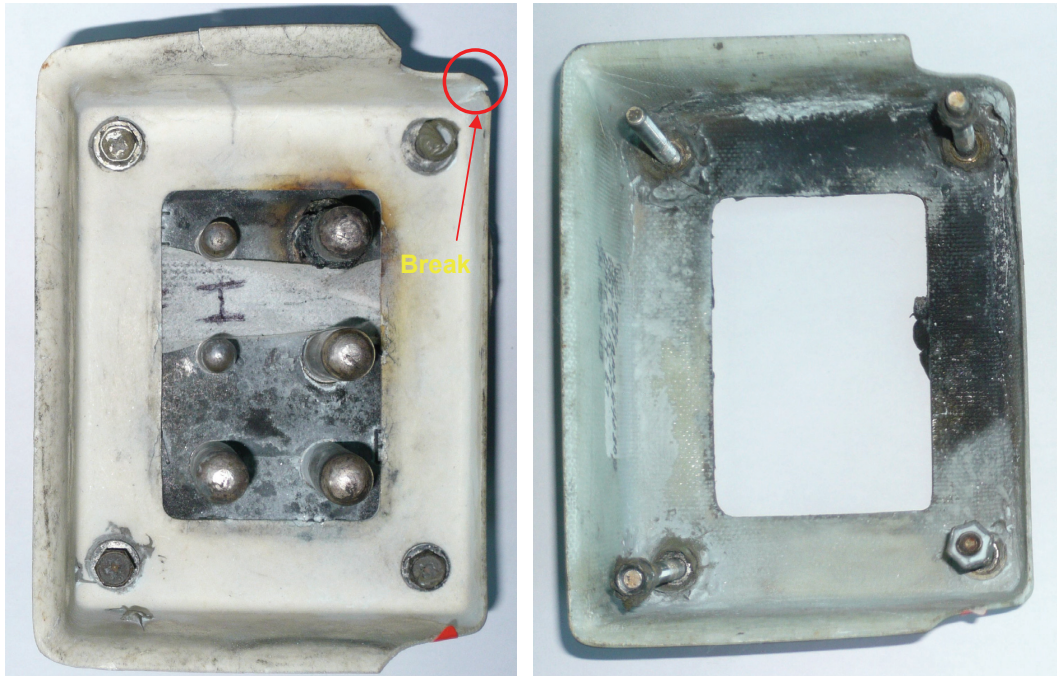
In February 2008, Boeing issued an MOM (No1-760857507) to all B747-400 operators. In this communication, the manufacturer stated that two cases of incorrect alignment of one of the electrical connectors had been reported that had led to the connection of the phase C to the neutral. It recommended that operators check the condition of the guides and replace them if they were broken. It also recommended reinforcing the procedures on the ground during GPU connection. At this stage, Boeing only mentioned the installation of the MS17845-1 guide as optional in the B747 IPC.

Following the two serious incidents that occurred to HS-TGL and B-HOV, Boeing quickly issued a second MOM (No1-1564169238) that informed operators of the new cases that had led to the fire in the insulation blankets. It mentioned that the MS17845-1 guide would become the preferred part in its IPC. It recommended that operators check the condition of the guides and replace them in case of any damage.

The guide made of composites installed on B747-400 type aeroplanes is also installed as standard in production on all types of B747, as well as on the B737-300, -400 and -500. Boeing indicated that several cases of overheating were reported on all these types of aeroplanes. The incorrect alignment of the electrical connectors was only demonstrated on the B747-400. On all of these B747 models, the MS17845-1 guide has also become the preferred part only recently.

1.6 Tests Performed

Following the serious incidents to HS-TGL and B-HOV, some tests were performed in cooperation with Cathay Pacific Airways and one of the GPU maintenance companies. The original guides from B-HOV were removed. One of them was broken.



Guides from B-HOV

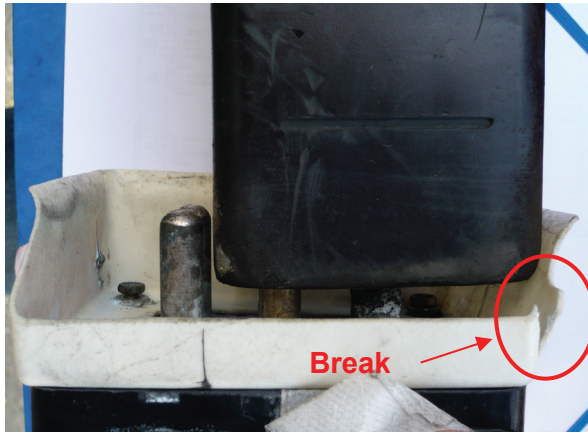
Observation of the burn marks on the external connectors on B-HOV indicate that the electrical connector plugged into connector No2 (on the right in the photo below) was incorrectly positioned. The connector guide was not broken. It was not possible to determine which electrical connector was incorrectly positioned on the HS-TGL.



Electrical connectors from B-HOV a short time after the incident

Tests were carried out with the various guides: the broken guide on B-HOV; the unbroken guide on B-HOV and an MS17845-1 guide. The objective was to try to connect an electrical connector with an incorrect alignment, with each of the various guides.

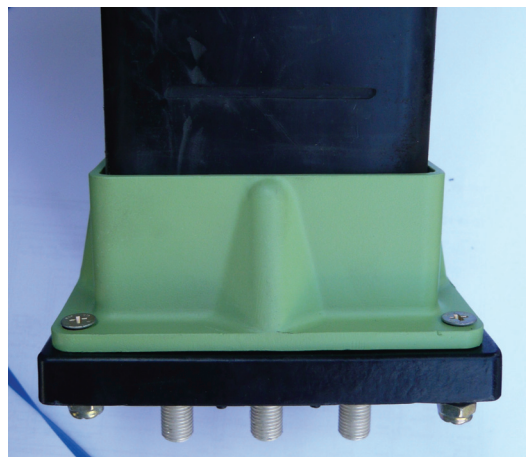
With the original guide, broken, incorrect connection is easy. Engagement was incomplete but contact was established:



With the original guide, unbroken, incorrect connection was also possible even if it needed slight force. Engagement was not complete but contact was established.



With the MS17845-1 metal guide, incorrect alignment of the electrical connector was impossible:



2 - FINDINGS

- ❑ On B-HOV one of the electrical connectors was correctly lined up on connector No1 while the second was misaligned on connector No2. On circuit No2 the phase C supplied by the GPU was directly linked to the aeroplane's neutral.
- ❑ On B-HOV, the ground technician's action in holding the connecting switch in the on position prolonged the supply of current in a short-circuit situation.
- ❑ It was not possible to determine the configuration of the electrical connectors and the sequence of actions carried out by the ground technician during the HS-TGL incident.
- ❑ Ground technicians using the GPU receive limited training and have limited technical knowledge of the aeroplane's electrical system.
- ❑ On B-HOV, the guide made of composite materials on connector No1 was broken.
- ❑ The condition of the guides on HS-TGL could not be checked.
- ❑ The tests performed show that it is possible to plug in an electrical connector in an incorrect position, even with a guide in good condition.
- ❑ The short-circuit situation caused by a misalignment of the electrical connectors caused intense overheating in the avionics compartment that led to significant damage and a fire in the insulation blankets.
- ❑ The damage caused to the two aircraft led them to be immobilized for several weeks, to the need for major repairs and could have led to the loss of the aircraft if the fires had not been contained in time.
- ❑ The technical problem had been known to Boeing since 2001. A solution had been available since this date and had been applied in production since 2003. This solution consists of fitting the B767 guide.
- ❑ No cases of incorrect alignment have been reported to Boeing on aeroplanes fitted with the MS17845-1 guide.

3 - ANALYSIS AND CONCLUSION

Both incidents were caused by a short-circuit in the avionics compartment, a short time after the connection of the GPUs, during supply of electrical current. In both cases, the short-circuits resulted in a fire starting while the passengers were disembarking.

It was shown that one of the two GPU electrical connectors was incorrectly connected on the B-HOV. It is likely that the same applied to HS-TGL.

This incorrect connection associated with inappropriate actions by ground technicians, was the cause of the two incidents.

The design of the electrical connector guides, installed on Boeing 747-400 before 2003, allows this incorrect connection to occur. These same guides were also installed originally on all other types of B747 as well as on the B737-300, B737-400 and B737-500. However, the NTSB has specified that no known cases of damage have been reported to Boeing on 737 models.

4 - SAFETY RECOMMENDATIONS

Note: In accordance with article 10 of Directive 94/56/THIS on accident investigations, a safety recommendation shall in no case create a presumption of blame or liability for an accident or incident. Article R.731-2 of the Civil Aviation Code specifies that those to whom safety recommendations are addressed should make known to the BEA, within a period of ninety days of reception, the actions that they intend to take and, if appropriate, the time period required for their implementation.

A fire of electrical origin in a confined area of an aeroplane can have very serious consequences for the aeroplane, which may include its destruction. If the fire is not brought under control in time, this can constitute a danger for those on board, in particular during passenger disembarkation.

The misalignment of one of the electrical connectors led to a short-circuit. A solution was developed by Boeing, which consisted of installing the guide referenced P/N MS17845-1., initially installed on the Boeing 767. Boeing has, since then, not been informed of any cases of misalignment on aeroplanes equipped with this guide. Furthermore, Boeing recommends that operators of B747 should check the condition of the existing guides and, in case of damage, replace them with the recommended guide MS17845-1. This recommendation does not make it mandatory to systematically replace the existing guides.

Consequently, the BEA recommends that:

- **EASA and the FAA make mandatory the replacement of the original parts, with the reference 66-9236, by parts with the reference MS17845-1 on all versions of B747 aeroplanes.**

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