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Air Accidents Investigation Branch

Department for Transport

AAIB Bulletin S2/2007 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	Boeing 777-222, N786UA
No & Type of Engines:	2 Pratt & Whitney PW4090 series turbofan engines
Year of Manufacture:	1997
Date & Time (UTC):	26 February 2007 at 1000 hrs
Location:	London (Heathrow) Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 20 Passengers - 185
Injuries:	Crew - None Passengers - None
Nature of Damage:	Heat and fire damage to the right main power distribution panel, surrounding structure and components inside the Main Equipment Centre
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience: (Hours all approximate)	18,000 hours (of which 2,800 hours were on type) Last 90 days - 215 hours Last 28 days - 65 hours
Information Source:	AAIB Field Investigation

The investigation

The aircraft operator's duty manager at Heathrow notified the Air Accidents Investigation Branch (AAIB) of the accident at 1140 hrs on 26 February 2007 and the investigation commenced the next day. The Chief Inspector of Air Accidents has ordered an Inspector's Investigation be conducted into the circumstances of this accident under the provisions of the *Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996*. This is a preliminary report detailing the facts of the accident: no analysis has been attempted.

History of the flight

The aircraft was pushed back from the stand with the auxiliary power unit (APU) running, the towbar was disconnected and both engines were started in quick succession. The flight crew, comprising a commander, operating co-pilot and relief co-pilot (occupying the jump seat), reported that the engine starts appeared to be normal. At about the time when the engine integrated drive generators (IDGs) would normally come online, the flight crew saw the instrument displays flicker and heard a low-pitched, intermittent growling noise coming from the aft right side of the flight deck. A few seconds later, they received an Engine Indication and Crew Alerting System (EICAS) caution for 'ELEC AC BUS R', indicating that the right Main AC Bus had failed. The right 'GEN CTRL OFF' light also illuminated on the overhead panel, which indicated that power had been cut from the right IDG. Subsequently they observed that, on the 'R BUS TIE' switch, the 'ISLN' caption had illuminated, which indicated that the right bus tie breaker had been triggered to open.

The Flight Data Recorder (FDR) revealed that 40 seconds after both engines had stabilised at ground idle, the smoke detector inside the Main Equipment Centre (MEC)[1] detected smoke. Coincident with this, the Cockpit Voice Recorder (CVR) recorded sounds of equipment powering down and crew comments to the effect that the whole right main bus had failed.

The flight crew selected the EICAS 'ELEC AC BUS R' irregular checklist and completed the first action of selecting the right generator control switch to OFF and then to ON again. About two and a half minutes after the electrical failure they became aware of a faint electrical burning smell and shortly afterwards noticed the 'EQUIP COOLING OVRD' message on the EICAS. At this point the commander ordered the co-pilot to shut down the right engine.

The ground handling crew observed smoke emanating from the MEC vent at the front of the aircraft and alerted the flight crew. Two minutes later ATC advised that smoke had been seen coming from the aircraft and that the fire service had been requested to attend as a precaution. The aircraft was taxied onto a nearby stand using the left engine. Once on stand the flight crew shut down the left engine and the APU, by which time light smoke was present in the flight deck. ATC further advised that smoke had been seen coming from the forward outflow valve. Approximately twelve and a half minutes after the electrical failure the batteries were switched off and the passengers and crew disembarked the aircraft via steps placed at door 2L.

Airfield Fire Service personnel checked the aircraft's MEC, which was filled with smoke, but did not detect any fire. They manually opened the forward cargo

Footnote

[1] The MEC is located beneath the flight deck and contains the majority of the aircraft's electric and avionics equipment. The FDR parameter which indicates smoke in the MEC is identified as 'EE Bay Smoke Warn'.

compartment and removed two cargo pallets to check for any additional signs of fire, but none were found. The smoke slowly cleared in the MEC to reveal obvious signs of fire damage.

Smoke detection within the Main Equipment Centre

A smoke detector is connected to the supply and vent lines of the Forward Equipment Cooling System within the MEC. When smoke is detected, the cooling system transitions to override mode and an 'EQUIP COOLING OVRD' message is displayed on the EICAS. The override mode relies on a differential between the cabin and ambient pressure to vent smoke. This method is ineffective whilst the aircraft is stationary on the ground. However, no Master Warning, Master Caution or 'smoke' message is triggered.

Electrical power distribution

The electrical power system on the Boeing 777 normally operates as two independent l power channels. Each channel has a Main AC Bus. During normal flight operations the Left Main AC Bus receives power from the left engine IDG and the Right Main AC Bus receives power from the right engine IDG. On the ground, the APU or external power sources can be used to provide power to both main busses. A top level schematic of the power distribution system is shown in Figure 1. The flow of power is controlled by contactors which open and close; seven contactors are shown in Figure 1 which include the right generator circuit breaker (RGCB) and right bus tie breaker (RBTB). The RGCB, RBTB and Right Main Bus are components of the P200 Electrical Load Management System (ELMS) power panel located in the right forward section of the MEC.

Damage to the aircraft

An inspection inside the MEC after the accident revealed extensive heat and fire damage to the P200 power panel as shown in Figure 2. The worst affected components of the power panel were the RGCB and RBTB contactors, parts of which had melted and vaporised. There was evidence that molten metal had dripped down onto the insulation blankets beneath this panel. Extensive fire damage to the fire-retardant insulation blankets located behind and beneath the power panel under the floor, had occurred as shown in Figure 3. Nearby components including a floor panel, equipment cooling system ducting, other wire bundles and some structural frames and stringers in the vicinity were later determined to have suffered sufficient heat damage to require replacement.

Detailed examination

The P200 power panel was removed from the aircraft for a more detailed examination. The examination revealed that both the RBTB and RGCB had suffered from extreme heating and electrical arcing. The

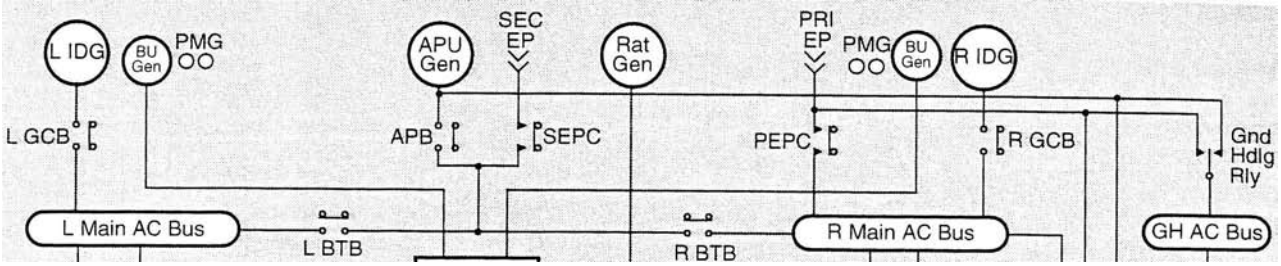

Figure 1

Boeing 777 electrical power distribution schematic

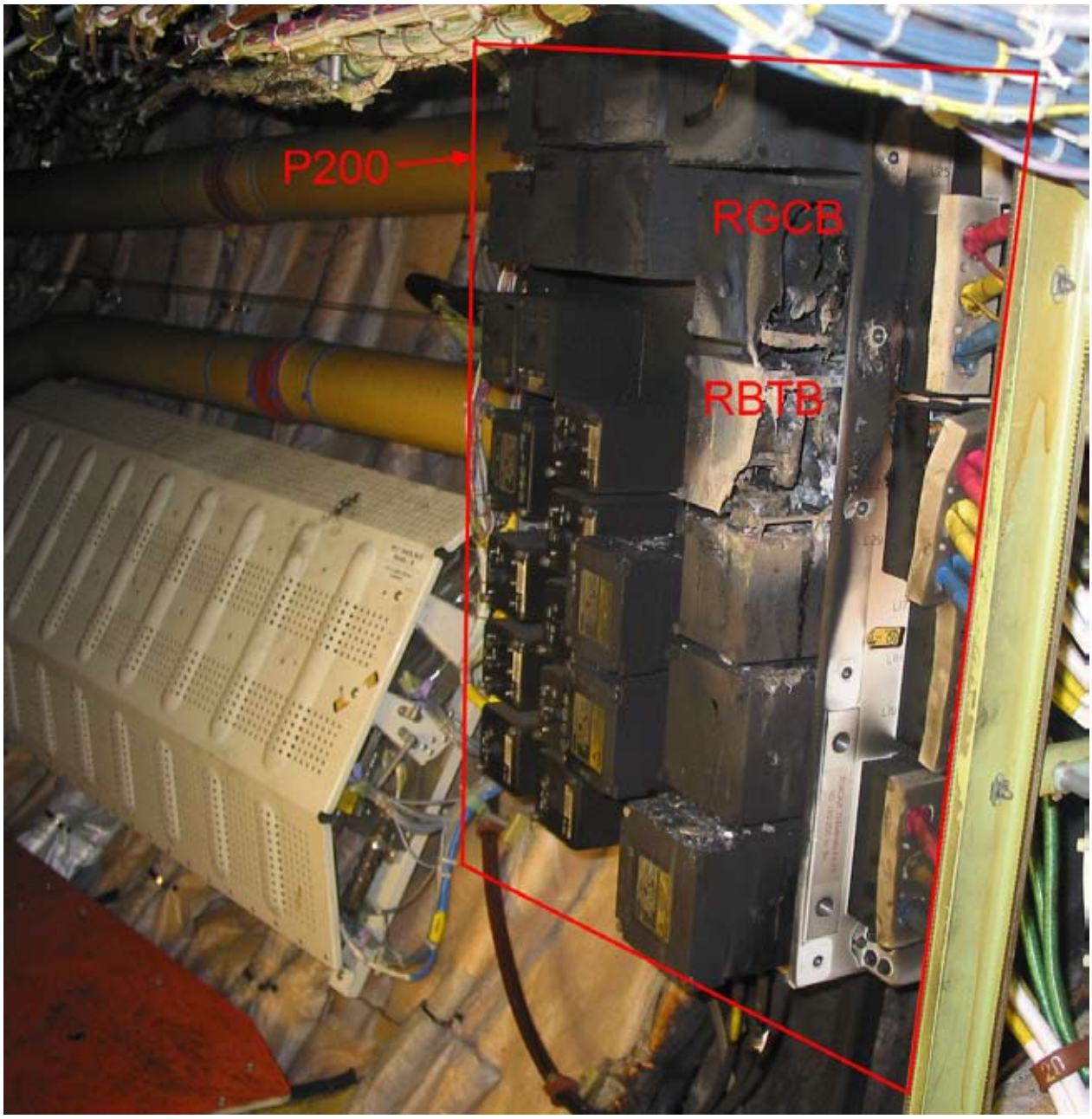

Figure 2

Fire damage to P200 panel, showing burnt-out RGCB and RBTB contactors
(panel cover has been removed in this photograph)

main moveable contacts within both contactors were destroyed. There was some insulation damage to the bus bars within the panel in the vicinity of the RBTB. The damage to the surrounding components of the power panel appeared to be a consequence of a failure within either the RBTB or RGCB.

History of the contactors

The serial numbers on the RBTB and RGCB contactors were unreadable as a result of the fire damage, but an initial inspection of the aircraft's maintenance records revealed that neither component had been

replaced since the aircraft was manufactured in 1997. At the time of the accident the aircraft had completed 6,622 flight cycles and flown for 43,519 hours. The RBTB and RGCB share the same contactor part number and there is no maintenance requirement to replace either contactor after a fixed time or flight cycle period.

Previous incidents and preventative action

Prior to this accident the aircraft manufacturer was involved in investigating 11 in-service reports of power panel overheat events, three of which involved major damage to the panels. The affected panels were the P200 and P300, and the affected contactors were the RBTB, Auxiliary Power Breaker (APB) and the Primary External Power Contactor (PEPC). These previous events all involved Boeing 777 aircraft fitted with ELMS II power panel, which is a modified version of the ELMS I power panel fitted to N786UA, although many components including the contactors are the same. As a result of these incidents the aircraft manufacturer published details of preventative action that operators could take, in its 777 Fleet Team Digest No 777-FTD-24-06005.

Further investigation

The AAIB is working with the US National Transportation Safety Board (NTSB), the aircraft manufacturer, the aircraft operator, the power panel manufacturer and the contactor manufacturer to try and determine the cause of the failures within the electrical power system. Further investigation is also being carried out into understanding how the fire spread and how to improve fire protection within the MEC. The AAIB will publish a full report on this accident when the investigation has been completed.

Figure 3

Burnt aircraft structure and insulation blankets located directly below P200 panel (viewed looking aft with floor panel removed)

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