

3 Conclusions

3.1 Findings

1. The aircraft was serviceable and there were no indications of any problems until the right Integrated Drive Generator (IDG) came online after engine start.
2. Within five seconds of the 'No Break Power Transfer', the Bus Power Control Unit (BPCU) detected a fault with the Right Generator Circuit Breaker (RGCB), a Right Main Bus under-voltage was detected, and an unusual 'growling' noise was heard by the flight crew which emanated from the region near the P200 power panel.
3. An 'ELEC AC BUS R' failure caution message appeared on the Engine Indication and Crew Alerting System (EICAS) and the flight crew carried out the checklist items for this message.
4. The RGCB and Right Bus Tie Breaker (RBTB) suffered from severe internal arcing and short circuits which generated temperatures in excess of 1,000°C, and resulted in uncontained failures. The RGCB was probably the first to fail.
5. Molten copper and silver droplets from the failed contactors dropped down through the open base of the P200 panel and ignited the insulation blankets below.
6. The insulation blanket fire spread underneath a floor panel to the opposite P205 power panel, causing heat and fire damage to structure, cooling ducts and wiring.
7. The Main Equipment Centre (MEC) smoke detector was triggered 42 seconds after the electrical failure event.
8. The detection of smoke in the MEC triggered the 'Equipment Cooling Override' mode and displayed a 'EQUIP COOLING OVRD' advisory message to the flight crew but no 'smoke' message.
9. The flight crew first became aware of the smoke four and a half minutes after the failure event, when the tug driver noticed smoke emanating from one of the MEC vents and notified the flight crew via the interphone.

10. The flight crew decided to shut down the right engine and taxi to a nearby stand in order to evacuate the passengers using the steps.
11. The Airfield Fire Service attended the aircraft when it arrived on stand, entered the MEC and discovered significant smoke but no fire.
12. The insulation blankets had self-extinguished and tests revealed that the insulation had similar flame retardant properties to new insulation of the same type.
13. The RGCB and RBTB contactors had suffered such severe internal damage that it was not possible to determine the initiating point of failure or the root cause of failure.
14. A number of possible causes of contactor failure were considered, but there was insufficient evidence to select a most probable cause of failure.
15. The most likely causes of contactor failure included a debris induced short-circuit, a debris induced fouling of the armature, a loss of over-travel due to heat build-up, erosion and/or assembly errors, and arc tracking across the unprotected region of the stationary contact support block.
16. A number of modifications to the contactor design have been carried out that should make the contactor more resistant to failure and more resistant to an uncontained failure.
17. The electrical protection system was not designed to detect and rapidly remove power from a contactor suffering from severe internal arcing and short-circuits.
18. Since the accident a containment tray modification to the power panel has been developed which could have prevented the molten metal droplets from igniting the insulation blankets.

3.2 Causal factors

The following causal factors were identified:

1. An internal failure of the Right Generator Circuit Breaker or Right Bus Tie Breaker contactor on the P200 power panel inside the Main Equipment Centre resulted in severe internal arcing and short-circuits which melted the contactor casings. The root cause of contactor failure could not be determined.
2. The open base of the P200 power panel allowed molten metal droplets from the failed contactors to drop down onto the insulation blankets and ignite them.
3. The aircraft's electrical protection system was not designed to detect and rapidly remove power from a contactor suffering from severe internal arcing and short-circuits.
4. The contactors had internal design features that probably contributed to the uncontained failures.