

Case study on scanning electron microscopy (SEM)

Emergency landing at Heathrow

When a system on an aircraft fails, the full extent of the problem must be determined to find a solution and avoid the failure happening again, especially when lives are at risk. When a Boeing 767 was forced to carry out an emergency landing at Heathrow airport in 1998 the Air Accident Investigation Branch (AAIB) had to conduct an enquiry into the cause of the incident. ERA was able to assist AAIB by using a variety of techniques including scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) analysis to identify materials within and adjacent to the failure site. This helped to identify the cause of the incident and to reduce the risks of a similar event occurring.

The aircraft was cruising near Paris during a flight from Zurich on route for Washington DC, when abnormal warnings appeared on the flight deck instrumentation and circuit breakers began tripping. The commander decided to divert and land at Heathrow.

The aircraft subsequently landed safely, but after it had turned off the runway smoke appeared at the forward end of the passenger cabin. As a result, the commander ordered an evacuation. Fortunately there were no casualties but a thorough enquiry had to be conducted.

As part of the investigation ERA carried out SEM/EDX analysis on a number of samples from the aircraft's electronic and equipment bay. It emerged that the tripping of multiple circuit breakers had been caused by the occurrence of electrical arcing and associated thermal damage to a wiring loom adjacent to a corner of the galley chiller unit within the bay. This in turn had resulted in thermal damage to an adjacent loom and smoke generation.

The investigations also showed that prior damage to the wiring loom insulation had occurred due to abrasion by the chiller unit during its removal and re-installation.

ERA suggested that although the conductors of the wires in the loom had been exposed by mechanical damage they would not necessarily have arced immediately. The wires were operating at voltage levels that were insufficient to cause an immediate failure. It was thought that additional factors such as moisture or conducting matter would have been required on the wire surface to initiate arcing and carbonisation of the insulation.

Further SEM/EDX analysis revealed that aluminium alloy swarf was present within the bay prior to the accident and had probably assisted the onset of arcing between adjacent damaged wires in the loom. Incorrect installation of the chiller unit, with its heat exchanger exhaust fitted with a blanking plate, would have caused warm exhaust air to discharge from an alternative upper vent which was capable of blowing any aluminium swarf around the wiring looms.

By carrying out this analysis, ERA helped AAIB identify a number of causal factors. AAIB subsequently released an enquiry report on this incident that included eleven safety recommendations to prevent further similar occurrences.