
Cabin fire, BAC One Eleven 501EX, G-AWYS

Micro-summary: This BAC One Eleven experienced smoke and fire during cruise.

Event Date: 1998-01-04 at 0907

Investigative Body: Aircraft Accident Investigation Board (AAIB), United Kingdom

Investigative Body's Web Site: <http://www.aaib.dft.gov/uk/>

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BAC One Eleven 501EX, G-AWYS

AAIB Bulletin No: 2/98 Ref: EW/C98/1/1 Category: 1.1

Aircraft Type and Registration:	BAC One Eleven 501EX, G-AWYS
No & Type of Engines:	2 Rolls-Royce Spey 512-14DW turbofan engines
Year of Manufacture:	1969
Date & Time (UTC):	4 January 1998 at 0907 hours
Location:	In cruise between Belfast and Birmingham
Type of Flight:	Public Transport
Persons on Board:	Crew - 5 - Passengers - 87
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	15,100 hours (of which 7,000 were on type) Last 90 days - 38 hours Last 28 days - 7 hours
Information Source:	AAIB Field Investigation

History of the flight

During a flight from Belfast to Birmingham, the flight crew heard a series of 'popping' sounds and observed smoke coming from the 'hat-rack' stowage area behind the commander's seat. The senior cabin attendant (SCA) pulled the oven circuit breaker and went on to the flight deck to investigate. She saw an orange flame at the rear of the lower shelf on which were stowed the pilots' smokehoods, and fired a short burst of BCF extinguishant into the area. This extinguished the flame, but it subsequently re-ignited and two additional bursts of BCF were needed to finally put the fire out. The SCA, who had inhaled both smoke and BCF fumes, then removed the two smoke hood boxes, encountering some difficulty in unfastening the associated securing straps. She then returned aft in order to clear and secure the cabin, during which the passengers remained calm.

After closing the flight deck door, the flight crew donned their oxygen masks and transmitted a 'Mayday' call declaring their intention to divert into Liverpool. The appropriate smoke/fire drills were completed and the aircraft made an uneventful landing after receiving ATC assistance, which the commander later described as "excellent".

After the aircraft had been shut down, firemen retrieved a small oxygen mask pouch, made from a padded plastic material, from behind an electrical relay panel located at the rear of the lower stowage shelf. It was apparent that the pouch had fallen into this area through a one inch gap at the rear of the top shelf. Two burnt patches were visible on the pouch which, by their shape, appeared to have resulted from contact with two cables that were connected to pins on one of the adjacent relays. The insulation on the two cables was locally charred, and there was some 'sooting' evident on the neighbouring cables. The two damaged cables were tied back and the associated relay, which controlled the cabin sidewall lighting, was removed. The aircraft was then recovered to the operator's maintenance base at Birmingham for a more detailed investigation.

Examination of the aircraft

The stowage compartment concerned was located on the left side of the short corridor onto the flight deck, bounded at the rear by the vestibule bulkhead and at the front by the bulkhead behind the commander's seat. The front bulkhead contained a number of circuit breakers, including those that protected the cabin sidewall lighting which had not tripped during the incident. The relay mounting panel, which contained three relays, was attached to the lower shelf of the stowage compartment. It was protected from articles placed in this area by a full-width panel fitted between the floor and the top shelf. However, a one inch gap existed between the rear of the top shelf and the fuselage trim panel which had allowed the oxygen mask pouch to fall onto the cables that were connected to the rear of the relay receptacle. The pouch had been part of a therapeutic oxygen kit that was no longer used by this operator, and had probably been left on the aircraft for a number of months, although it was not possible to ascertain how long it had been lodged behind the relay panel.

The relays had not been installed during aircraft manufacture, but formed part of a modification to the cabin lighting system, designed in 1984, embodied by a former operator of this aircraft. The cabin sidewall lighting relay switched 115V/AC from the Nos 1 and 2 AC busbars to the left and right cabin sidewall lights respectively. A 7.5 amp circuit breaker was installed in each of the supply cables on the busbar side of the relay.

Upon removal of the relay, it was apparent that the two pins that supplied current to the left and right lights had been in a 'hot' condition. This was indicated by localised charring of the silicone rubber seal interposed between the relay and its receptacle, and can be seen on the accompanying photograph (photographs of the pouch and the rear of the relay receptacle are also presented). It was found that two seals had been assembled onto the relay instead of one, leading to the possibility of higher resistance connections due to the slightly shorter length of pin engagement in the receptacle sockets. The UK agent for the manufacturer of the relay advised that the identification numbers on the relay suggested that it was some nine years old, and thus likely to be near the end of its useful life. The internal contacts on any relay tend to wear and become 'pitted' with use, leading to higher resistances and hence power consumption. Some assessment of the internal condition of a relay can be obtained by measuring the voltage drop between the 'IN' and 'OUT' pins with a representative current applied. The manufacturer indicated that typical values for the voltage drop were 125 millivolts (mV) for a new unit, 150 mV whilst in service, and 175 mV for a relay at the end of its useful life. The airline's avionics department measured the subject relay, with

the rated current of 10 amps applied, and recorded 290 mV for both the left and right cabin light contacts.

All relays tend to become hot during operation, due mainly to the heat generated by the energising coil, but also due to resistances in the internal contacts. The heat is dissipated by means of conduction along the connecting cables and by radiation. However, the additional power consumed by the unit due to the developing high resistances is likely to have been around 1 to 1.5 watts (per cable) above the normal in-service value, which is unlikely to have resulted in a significant temperature rise in the two cables lying in contact with the oxygen mask pouch. It seems more probable that the pouch acted as a thermal insulation blanket such that the normal amount of heat energy in each of the cables could not be dissipated at its usual rate, leading to elevated temperatures and eventual combustion of the pouch material and cable insulation. If this was the case, it is likely that the pouch fell into its as-found position relatively recently. There would have been no significant change in the current passing through the cables, thus explaining why the associated circuit breakers did not trip. Both circuit breakers were subsequently tested and found to be satisfactory. The 'popping' noise heard by the crew was not fully explained, but in the absence of evidence of significant arcing from the damaged cables it was considered that this was probably due to the pouch material combusting.

The hat-rack stowage area on another of the airline's BAC One-Eleven aircraft, which had also been modified by the same earlier operator, was examined during the investigation. The top shelf had been removed, although the shelf mounts had been retained. The relay installation appeared to be the same electrically, but the panel on which it was installed was protected by a metal box, as opposed to the full width panel used on this aircraft. The operator intends to modify affected aircraft by installing a screen which will extend over the full height of the stowage area in order to eliminate the possibility of loose articles falling behind the relay mounting panel.