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One of the engines 'had a catastrophic failure'

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Published: 12:00AM BST 26 Jul 2000

THE risk of fire and explosion due to uncontained failure of the engine that powers Concorde was first raised in 1976.

This feature of the Rolls-Royce SNECMA Olympus 593 was discussed in a report by British Aerospace. Rolls Royce yesterday declined to comment. "The risk of fire and explosion in aircraft fuel tanks in the Concorde due to uncontained failure of the Olympus 593 engine was initially recognised in a British Aerospace report by Wallin (1976)," said BlazeTech, a company based in Cambridge, near Boston, which uses computers to model accidents.

In a postscript to this report it added: "The risk of ignition was dismissed because no such event had been observed in 21 historical cases of uncontained engine failure." However, a BlazeTech study conducted in the aftermath of the loss of TWA Flight 800 in 1996 suggested that the fuel tanks can explode, "though the conditions required for their occurrence have a very low probability".

If engine failure is uncontained, a hot fragment of metal can enter the ullage - the space above the liquid fuel in the tank - and ignite the fuel vapours. BlazeTech also found that "hydrodynamic ram" can occur, when a fragment enters the liquid fuel with sufficient force to make the tank rupture. Either of these events can explode the tank and cause the immediate loss of the aircraft.

Unlike most modern civil aircraft, Concorde's four engines are embedded in the wings, next to the fuel tanks, rather than suspended beneath them. It is on the four Rolls-Royce engines that accident investigators will focus. Concorde can cope with the loss of power from one engine: in January, an engine was shut down on a Concorde as it approached Heathrow and, at the time, it was said by BA that the plane was capable of flying on only two.

Last night, a spokesman for Rolls-Royce said it was premature to speculate. However, an engine problem was also cited by Jean-Cyril Spinetta, Air France chief executive and chairman, adding that it had nothing to do with cracks found recently in some of the jets' wings.

Pictures and eye witnesses confirm the likelihood of engine failure. Sid Hare, an American pilot, said: "I knew it was in trouble. One of the two engines on the left side obviously had a catastrophic failure. It was trailing flames, 200 to 300ft behind the airplane. It probably wiped out the engine next to it, so the airplane was then trying to climb on only two engines. He kept trying to get the nose up to gain altitude, which eventually caused a stall."

These are "all the hallmarks of an uncontained engine failure" that can produce high-speed, hot fragments that can penetrate fuel tanks, commented a British Airways pilot. "If you get an uncontained engine failure it is a very grave event, and catastrophic in an embedded engine, as with Concorde."

There are many possible initial causes of the failure, from a bird strike to fatigue of an engine component. Investigators will also check if the engines had been recently overhauled. On average, Concorde's Olympus engines are removed for overhaul once a year.

The vast majority of parts are inevitably replaced during the course of routine maintenance, so the engines are continually being upgraded to boost reliability. Compared to a typical RB211 engine powering a Boeing 747, for example, their removal rate is high (after 2,000 hours, compared with 20,000 hours), but this is due to two main factors: the improvements in technology between older and newer engines, and the harsh environment at supersonic speeds.

The Olympus is also the only civil jet engine to use the reheat technique, in which fuel is injected into the engine's exhaust gases to produce additional heat and thrust for take-off and transonic acceleration. Concorde takes off at 220mph, compared with 165mph for most subsonic aircraft, requiring extra power, which is gained by using reheat, where fuel is pumped into the jet pipe and set alight to give extra thrust.

Each year every Concorde undergoes a rigorous servicing regime of between 30 and 60 days, and gets a five-month-long major check every five to six years. Two years ago, British Airways said that it aimed to keep the aircraft flying until at least 2006 and the Concorde Relife Group aimed to keep it going until 2014.