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Concorde – From Beginning to End

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Serious design work on what was to become Concorde started in the UK in 1958/9. Collaboration with France began in 1962, following an intergovernmental agreement.

Much of the technology input to the design came from the UK. Aircraft such as the Fairey Delta 2 (1952), Handley Page HP 115 (1961), Bristol Siddeley Type 221, a much modified FD2 with an ogee wing shape (1964) and the Bristol Siddeley Type 188 (1962) all represented important technology demonstrators for the Concorde design. Significant data on the effects of engine location on the consequences of engine failure were also obtained from the US Convair Hustler (1962).

Initially aircraft manufacturers were required to submit plans for a Super-Sonic Transport (SST) aircraft operating at Mach 1.2, 1.8, 2.2 and 3. The Bristol 221 was selected as the basis for the SST design. The Bristol Aeroplane company had already been split into Bristol Aircraft and Bristol Aero Engines. The former was integrated into the British Aircraft Corporation (BAC) in 1959 and the latter eventually became part of Rolls-Royce in 1966. The final design for Concorde was thus a joint design between BAC and Sud Aviation (SUD) of France and the engines were a joint Rolls-Royce and SNECMA of France development of the original Bristol Olympus engine. The configuration defined by this design remained substantially unchanged right through to production.

There were also two competing SST aircraft being designed in the 1960s. These were the Boeing 2707 (developed only to the wooden mock-up stage) and the Tupolev 144 (otherwise known as Concordski) which flew just ahead of Concorde in 1969. In addition the US were developing the Rockwell B-70 supersonic bomber (1964).

One of the most difficult design areas for Concorde proved to be the engine/intake combination. The Olympus engine was originally designed for V-bomber applications. Rolls-Royce/SNECMA further developed the Olympus engines for Concorde such that their thrust was increased by a factor of three. The problem to be overcome was the extreme range of airspeeds at the engine air intake. This meant that the intake was required to reduce the airspeed from Mach 1.91 down to Mach 0.5 between the front of the air intake and the front of the engine, i.e. the compressor face. At the same time the air intake was required to allow the aircraft to operate at comparatively low speeds during take-off, landing and subsonic flight. The necessary control was effected by incorporating front and rear ramps and an air bleed door into the air intake section of the engine system. The bleed door was used during landing to reduce the air flow to the engine and hence the engine thrust and also to prevent any engine surges, for example, following the ingestion of water on the runway. The fact that the engines remained surge free under all operating conditions was an important feature of Concorde. In addition the engine air intakes were fitted with “directors/wedges” to take out the adverse effects of the air boundary layer accumulated as the air passed under the wing in front of the intakes. Both the Tupolev 144 and the Rockwell B70 suffered from problems with their engine air intakes but in these instances the design problems were not solved as successfully as with Concorde.

The movements of the engine ramps and bleed door were controlled by an analogue electro-mechanical control system. Overall the air intake control laws were three times more complex than those of the actual engine.

The aircraft fuel was contained in 13 separate tanks and it was necessary to move the fuel from one tank to another to compensate for the changes in the aircraft centre of lift which occur with changing Mach number. In an emergency slow down it was necessary to achieve a rapid transfer of fuel from the back to the front tanks in order to maintain aircraft stability. This was tested during development using a complex and very large fuel transfer test rig.

The engines were mounted on the aircraft such that they could flex independently of the other parts of the aircraft structure. The full engine system was tested in a full size test cell at the National Gas Turbine Establishment (NGTE), Pyestock, UK. The system was also tested in a Major Failure Test Rig where it was subject to the full aircraft hot/cold temperature cycle. Further engine tests were

carried out on the Vulcan Flying Test Bed. The single Concorde Olympus engine, mounted for test with a representative intake under the Vulcan fuselage, could provide sufficient power to maintain the aircraft in flight without the use of any of the aircraft's own engines.

Thoughout most of its in-service life Concorde was subject to only minor problems requiring rectification. The Gonesse accident in France was the exception. Here a piece of metal, which had previously dropped off a Continental Airlines aircraft on take-off from Paris Charles de Gaulle airport, was spun round by the Concorde tyre and then propelled upwards towards one of the aircraft fuel tanks. The piece of metal hit a relatively thick section of the fuel tank casing and produced a shock wave which was transmitted to a thinner section of the casing. This ruptured causing a fuel spillage. In addition the control electrics in the wheel well were damaged. It was not possible to retain control in this situation given that the aircraft was fully loaded and in the process of taking off. As a result the aircraft crashed at Gonesse not far from the airport.

The remaining Concorde aircraft were retired from normal airline service in 2004.

Concorde – The Last Touchdown (at Filton, Bristol on 26th November 2004)