

MACH 2

Concorde magazine



From tragedy
to resurrection
*Return to service
in 2001*

Concorde watch
*News from Manchester
and Duxford*

Flying for Live Aid
A mercy mission

Speed meets steam
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INTRODUCTION

In a busy issue, we begin on a rather sombre note with a look back at the aftermath of the Concorde crash at Gonesse, 25 years ago. This harrowing event led to over a year's work, by the airlines and manufacturers on both sides of the channel, as they investigated the cause of the accident. Their efforts were rewarded by the reinstatement of Concorde's Certificate of Airworthiness in 2001, and the return to passenger services. We look back at the investigation and hear from two of the people involved.

July saw another anniversary: 40 years since the Live Aid concert held in London and Philadelphia, USA, to raise funds for people suffering famine in Ethiopia. Concorde was called on to carry rock star Phil Collins so he could perform at both venues. Thus the ultimate symbol of luxury was, in a surreal but uplifting gesture of hope, put to use to help people in dire distress.

Our latest news starts with an account from Graham Cahill, of Heritage Concorde, about a surprising source of help from the world of steam engines. We end with our Concorde Watch report, and a review of a new edition of Supersonic by Lawrence Azerrad.

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From tragedy to resurrection

Katie John, editor, Mach 2

The crash of Air France Concorde F-BTSC was the darkest point in Concorde's history. A quarter of a century later, the grief and trauma of this event is still remembered. In this feature, we look back at the monumental efforts to return Concorde to flight, and hear from some of the people involved in this work.

TWENTY-FIVE YEARS AGO, on 25 July 2000, Air France Concorde F-BTSC (AF4590) crashed at Gonesse, just after take-off from Paris Charles de Gaulle (CDG), killing all of the passengers and crew, as well as four people on the ground. The crash devastated the families and colleagues of those who had died, and horrified the world. From the moment of the accident, work began to understand what had happened and to ensure that such a tragedy could never occur again.

The immediate aftermath

Air France decided to ground their Concorde fleet immediately. British Airways (BA) cancelled that evening's Concorde flights, out of respect for those who had perished, but resumed the next morning after carrying out extensive checks on their aircraft and discussing safety issues with the manufacturers and air safety authorities.

However, on 15 August, the Civil Aviation Authority (CAA) informed BA that Concorde's Certificate of Airworthiness (CoA) would be suspended the next day. The view at the time was that a single tyre burst had caused the crash. This kind of accident should not have been sufficient to bring down the airliner; therefore, the Bureau d'Enquêtes et d'Analyses (BEA) in France and the Air Accidents Investigation Branch (AAIB) in the UK had recommended this measure.

Stood down

British Airways Concorde G-BOAA, G-BOAB, and G-BOAG parked at Heathrow after the fleet was grounded.

Photo: Baz Glenister

Concorde G-BOAC was about to leave as the BA001 flight to New York (JFK), but was called back to the stand. The passengers were disembarked and transferred to a subsonic aircraft. The return flight from New York (JFK) was also cancelled. Captain Les Brodie flew G-BOAB back to Heathrow, with only the flight crew on board. On landing, Alpha Bravo was taken into storage. Neither G-BOAB nor G-BOAA (which had returned from JFK on 12 August) would ever fly again.

One Air France Concorde, F-BVFC, was stranded at JFK immediately after the crash. On 21 September, after a team of engineers had prepared him for flight and after the CoA had been temporarily reinstated, Captain Edgard Chillaud flew Fox-Charlie back empty to CDG, where a crowd of enthusiasts waited to welcome the aeroplane.

Finding a way forward

Members of management from both airlines, together with the aviation

authorities and the manufacturers (EADS for France and BAE Systems for the UK) began meeting from September 2000.

A group of pilots and technical staff from the airlines, plus chief Concorde engineers from Airbus France and Airbus UK, began work on devising modifications for the aircraft that could prevent any similar chain of events from occurring and causing accidents in the future, so that Concorde would be allowed to fly again.

The team identified the following issues to be explored:

- Fire risk from leaking fuel: investigate the fuel tank leak and possible ignition sources.
- Engine surges: study the Olympus engines to establish how hot gases caused the engine surges.
- Engine performance: validate performance of the engine.
- Undercarriage: examine the hydraulic systems to understand the reasons behind the non-retraction of the undercarriage.



The plan takes shape

By the end of 2000, the French accident investigators had found that F-BTSC's fuel tank had not been punctured by debris; instead, when the aircraft's tyre had burst, a large piece flew up and hit the underside of tank no. 5, creating a shock wave in the fuel that caused the tank to burst from the inside and lose fuel at an average rate of 60 litres per second.

The Anglo-French working group devised a plan of modifications that would "break the chain" of the events that had led to the Gonesse tragedy. The plan comprised three main elements:

- Fitting moulded Kevlar linings to the base of the fuel tanks, to minimise leaks.
- Fitting redesigned tyres.
- Armouring the wiring around the undercarriage bay area where the fire had started.

The cost of these modifications was estimated at £1.5 million per aircraft, but this was seen as a worthwhile outlay to get Concorde back in the air.

The fuel tanks

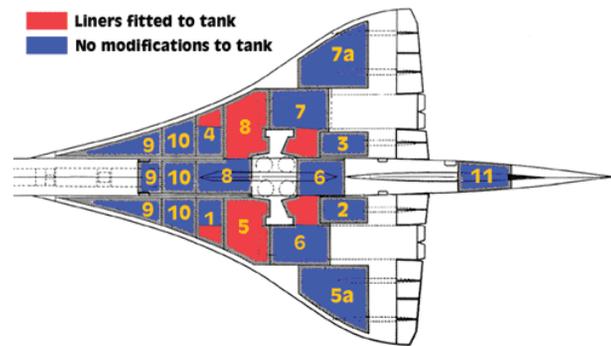
The investigators looked at various possibilities for shielding the fuel tanks. They determined that lining the tanks with Kevlar would give the most effective protection. The proposed modifications were then tested using advanced computer modelling as well as physical trials.

Moulded "egg crate" linings made from Kevlar, impregnated with a waterproof sealant called Viton, were created for fitting to the tanks considered to be most at risk from being hit by debris, as had happened in the tyre burst on F-BTSC. If a fuel tank were to rupture, the liners would be sucked into the hole and plug it, reducing any fuel loss to an estimated 0.4 litres per second. It was also thought that the Kevlar would dampen any shock waves arising within fuel tanks in the event of debris impact.

Modified fuel tanks

Tanks 5 and 8 would be fully lined, and linings would also be fitted to parts of tanks 1, 4, 6, and 7.

Image: concordesst.com



On the basis of the computer modelling results, the team opted to fit linings to the areas that were most at risk of impacts from debris, rather than lining all of the tanks. The linings had to be individually shaped for specific areas of each tank. In addition, each aircraft was slightly different from the others in build, so the liners had to be shaped accordingly. Some had to be returned to EADS in Toulouse for re-modelling so that they would fit.

The linings were shaped like shallow trays. The bases were fitted between the internal spars of the wing skin, and the sides were bolted to the internal structure. The size and the spacing of the bolt holes were pre-determined by the design engineers at EADS. The base of the liners actually sat a few inches above the skin of the tanks; in addition, the liners were perforated, to let fuel flow through them. This allowed the fuel to be used as a heat sink for the wings, as was normal in Concorde, and to move during adjustment of the aircraft's centre of gravity.

British Concorde G-BOAF was selected as the "prototype" for fitting, and the first tank liners arrived at Heathrow in December 2000. Work began in January 2001; a team of 40 engineers would complete the job in 8–10 weeks. Once the installation process had been perfected on G-BOAF, subsequent aircraft would be modified two at a time.

The engines

The airframe and engine manufacturers investigated how the fuel

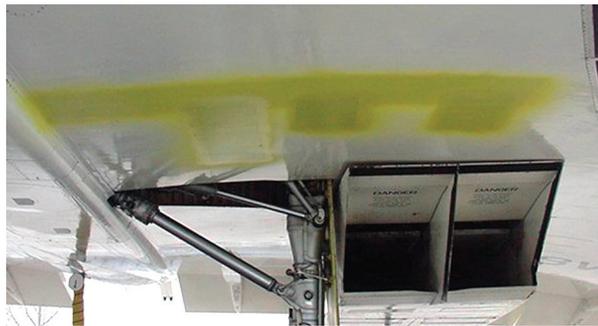
leak and ignition had occurred. Rolls-Royce ran an Olympus 593 engine to destruction at the engine test site at Shoeburyness in Essex, to study the effect that unburnt fuel and gases might have had on the engines, and to find out how engines might recover from surges such as those that had happened to F-BTSC. BAE Systems, at Warton in Lancashire, built a test rig in which they recreated part of the wing, landing gear bay, leg, and air intake, to see where and how the leaking fuel might have ignited on F-BTSC. They determined that the most likely cause of the fire was a spark from damage to the cabling that ran down to the brakes to power the cooling fans. The operating procedures would also be changed to ensure that the electrical supply to the cooling fans was turned off temporarily during take-off.

The investigation continued with ground-running tests. On 18 January 2001 Air France Concorde F-BVFB, temporarily returned to flight status, was flown to Istres, a military base near Marseille in the south of France, to investigate how the fuel would have been ingested into the air intakes during the crash. This testing would also help to confirm the areas that needed to have Kevlar linings.

F-BVFB performed high-speed runs of between 130 and 180 knots (without reheats), while an inert, coloured fluid was pumped from a 50-litre reservoir to three "exit points" on the underside of the wings, just forward of the air intakes

Test area

F-BVFB's wing: the areas stained yellow are the sites where the pipework was fitted for the jets of coloured water.
 Photo: Martine Tlouzeau



for engines 1 and 2, so that engineers could study the likely fuel flow patterns and see where fuel flowing from a ruptured tank might come into contact with the engines or landing gear bays. The test engineer on board the aircraft could select different exit points for the water, and the flow patterns were filmed by cameras mounted on the left landing gear leg. The aircraft was also rotated to an angle of 6° for a few seconds, to simulate take-off. The final test, on 1 February, saw Fox-Bravo reach a maximum speed of 205 knots.

Once the testing was concluded, the aircraft was flown back to Paris on 3 February, under the command of a new flight crew headed by Captain Jean Rossignol.

The tyres

In October 2000, EADS (the European Aeronautic Defence and Space Company, the successors to French Concorde manufacturers Aérospatiale) had asked tyre manufacturers to come up with new designs that would be more resistant to damage from foreign objects. The idea was that the tyre would both resist damage and remain operational even if it were to be damaged.

Michelin had already been working on new tyre technology for aviation, and put forward the “Near Zero Growth” tyre. This was a tyre reinforced with “high-modulus” composite material, which showed less deformation under pressure than the existing Concorde tyres; it was also lighter, giving a substantial saving in weight. If a tyre were to burst, it would fragment into small pieces

rather than the kind of long, heavy strip that had hit F-BTSC's wing.

The new tyres were first tested by Michelin at their factories; they were subjected to loads similar to the weight of a Concorde and run at low and high speeds, from 10 to 385 km/h, passing over an object similar to the metal strip involved in the Gonesse crash. While the older “bias” Concorde tyre suffered damage, the NZG tyre was unaffected.

The shape of the new tyres required some alteration to the shapes of the water deflectors, as well as modification to the design of the brakes to give identical braking power to that for the previous tyres.

In April 2001 Concorde F-BTSD, which had undergone a major check and been temporarily re-certified for flight, made a 3-hour test flight from Paris Charles de Gaulle (CDG) and back again, flown by Captain Edgard Chillaud. On 17 April the aircraft was flown to Istres, under the command of

training Captain André Verhulst, for testing on the new tyres. (The aircraft was flown from Paris to Istres, and then back again, with the existing Goodyear Concorde tyres, as the Michelin tyres had not yet been certified.)

The first tests were ground runs to evaluate the performance of the Michelin NZG tyres as compared to the existing tyres. A total of 14 acceleration and braking tests were carried out, at various speeds and aircraft weights. Different tyres were fitted to different positions on the landing gear bogies for each test, and sensors were fitted to measure the deceleration on each type of tyre. The tests were conducted on both dry and wet runways (the wet conditions provided by vehicles from the airfield fire service, which sprayed water on the runway).

On 2 May, F-BTSD was fitted with a full set of NZG tyres. Flown by Captain Edgard Chillaud, with test pilot Pierre Grange and with British Airways Chief Concorde Pilot Mike Bannister on board as an observer, the aircraft performed two “touch and go” circuits and then a landing with a hard stop. The bad weather on that day served to generate extra data on the way the tyres behaved in wet conditions; the NZG tyres performed extremely well.

On 5 May, F-BTSD was flown back to Orly to be re-painted; the



Return from Orly

F-BTSD lands at Paris Charles de Gaulle after being re-painted at Orly. The Michelin NZG tyres were fitted during testing, but the aircraft was flown to Istres and back with the standard tyres. Photo: Martine Tlouzeau

aircraft would finally return to CDG on 30 May.

Flight testing in the UK

During the spring of 2001, BA Concorde G-BOAF had been undergoing tests at Heathrow. The electrical and hydraulic systems were thoroughly tested. In addition, temperature measurement devices were fitted inside the fuel tanks, and connected to recording equipment in the rear cabin, to verify that the new liners would not affect the way in which fuel was moved around the aircraft for cooling purposes.

Alpha Fox began engine run tests on 3 July, and carried out a taxi test around the airport on 9 July. This enabled the flight crew, headed by Mike Bannister and Civil Aviation Authority (CAA) Chief Test Pilot Jock Reid, to check the steering, navigational, and other systems, which by that point had been out of use for almost a year. The taxi tests also enabled the investigators to see how the Kevlar linings would behave when the aircraft was carrying fuel and moving under her own power. In addition, G-BOAF was fitted with the Michelin NZG tyres.

A further taxi test was carried out on 13 July. Then, on 17 July, with a special dispensation from the CAA for the test flights, Mike Bannister and Jock Reid took G-BOAF to RAF Brize Norton for flight testing. The flight crew also included Captain Les Brodie and flight engineers Trevor Norcott and Robert Woodcock. Also on board was a team of engineers from BA and Airbus UK.

In front of the national media, just before 2.20pm, G-BOAF took off from Heathrow. During the flight, which would last 3 hours 20 minutes, the aircraft headed over the Atlantic and up towards Iceland, then followed the normal Concorde JFK–LHR flight path, before decelerating off the coast of Devon and coming into Brize Norton. The idea was to simulate the duration and

Looking to the future

While the British Airways (BA) fleet was stood down, the airline took the opportunity to renew the cabin décor in anticipation of the return to service, in a plan called “Project Rocket” (see Mach 2, Aug 2024). The new cabin fittings, as well as refreshing the look of the interior, were designed to be lighter than the previous décor; thus, they would help to offset the increased weight from the fuel tank linings. BA also arranged for an iconic photograph of all seven Concorde outside the maintenance hangar.



Photo: Adrian Meredith

conditions of a normal transatlantic flight. Despite the modifications, Alpha Fox behaved perfectly. She landed at the airfield, to be greeted by a crowd of media and Concorde enthusiasts, and performed a nose droop for the spectators.

The first flight was so successful that the engineers only needed one further test flight to validate their data. Before that happened, tests were carried out on the ground, in which the fuel tanks were “run dry” to establish the amount of unusable fuel that would be left in the tanks now that the liners had been fitted.

On 20 July, with the same flight crew as before, G-BOAF left Brize Norton and carried out another supersonic flight via Iceland before returning to Heathrow.

Return to service

Once both airlines were confident that the package of modifications would be approved, work began on

modifying pairs of aircraft in France and the UK. Meanwhile, in August 2001, BA and Air France began crew refresher training to bring the flight crew and cabin crew back to readiness for the resumption of passenger services. G-BOAF also had a re-paint, so she could be presented to VIP customers.

Concorde’s Certificate of Airworthiness was finally restored on 5 September. Concorde G-BOAF and F-BVFB were the first aircraft to have their Certificate of Airworthiness restored; the others would be re-certified once their modifications had been completed.

BA planned five flights to be operated as close as possible to the procedures for a normal transatlantic flight, including meal service, loading of luggage, and rehearsals for check-in and ground staff. Three flights would be loops over the Atlantic; the final two would be flights to JFK and back. Air France

also planned a rehearsal flight to New York.

The first “operational assessment” flight for BA, in which G-BOAF would carry passengers for the first time since August 2000, would be filled with 100 BA employees. The flight would be run as normal from check-in to landing, and fly a supersonic loop halfway across the Atlantic and back to Heathrow.

The date of that flight was 11 September 2001.

The “passengers” were just leaving the aircraft when they learned the dreadful news about the terrorist attack on the Twin Towers in New York. The atrocity would send shockwaves through the aviation industry. It was especially tragic for Concorde: some of the aircraft’s most regular customers had died in the attack.

Despite the trauma of this latest disaster, the modification teams in the UK and France continued to work around the clock to prepare the aircraft for return to service. Air France and British Airways had worked together to complete the modifications; then, on 15 October, the two airlines announced that they would re-start passenger services to New York simultaneously, on 7 November.

Under the gaze of the world’s media, Air France Concorde F-BTSD landed at JFK, followed shortly afterwards by BA Concorde G-BOAE. Rudolph Giuliani, the Mayor of New York, boarded each aircraft to welcome them back and greet the passengers. Once the passengers had disembarked and the luggage had been removed, the two aircraft were posed nose to nose, with both crews and VIPs standing in front of them, for photographs to celebrate the return to service.

As an extra expression of confidence, the British government chartered G-BOAF to take Prime Minister Tony Blair to Washington for a meeting with US President George Bush.

Airworthiness directive

In 2001 the CAA, and the DGAC (the French civil aviation authority) issued the following directive, compliance with which was required before Concorde would be permitted to fly again:

- **Wings:** Fit Kevlar linings within fuel tanks 1, 4, 5, 6, 7, 8
- **Main landing gear and brakes:** Install Michelin NZG tyres on all main wheels, and modify the anti-skid system
- **Wiring:** Reinforce electrical bundles within main landing gear wells
- **Brakes:** Inhibit brake fan electrical supply during take-off and landing
- **Main landing gear front water deflector:** Modify profile to accommodate the NZG tyres; remove the retention cables
- **Flat tyre warning system:** Ensure that flat tyre detection and warning system is working on departure.

A copy of the CAA Emergency Airworthiness Directive can be found on this website: https://www.faa.gov/sites/faa.gov/files/2022-11/EAD_Concorde.pdf

After the grief of the Gonesse crash, and over a year’s intensive work by so many people on both sides of the Channel, Concorde was back in the air where she belonged – a testament to technological excellence and international co-operation.

Mach 2 is indebted to Gordon Roxburgh for allowing his work to be used as reference for this article. A much more extensive account of the return to service can be found on Gordon’s website: concordesst.com

DEDICATION

This feature is dedicated to all those who perished in the crash of F-BTSC (AF4590) on 25 July 2000, to the people who had to investigate this traumatic event, and to all the engineers and crew members who worked so hard to return Concorde to the sky.



A long-awaited return to New York

The BA and Air France Concorde are posed nose to nose, with a gathering of VIPs and crew members, to celebrate the return to scheduled passenger services.

Photo: Matt Campbell / AFP via Getty Images

Lining the tanks

Carl Percey, Licensed Aircraft Engineer, British Airways

Installing the Kevlar linings inside Concorde's fuel tanks was a demanding and complex task. British Airways engineer Carl Percey recalls the work done on G-BOAF, the first of the fleet to have the new linings fitted.

The job of assembling the Kevlar liners was quite daunting on the first aircraft (G-BOAF). However, we had an excellent store-keeper who took it upon himself to make the kits up for each liner.

The first part of the job was obviously to drain the fuel tank and vent it until it was safe enough to work in. Tanks 5 and 8 were easier to work in as they were much larger, especially when you had removed a couple of the Sarma rods (which ran between the top and bottom surfaces of the wing, keeping the two surfaces the correct distance apart). You were only allowed to remove three Sarma rods at any one time, and not all of them were removable. The worse tanks were 1 and 4 as they were very

claustrophobic – once you had entered these tanks you only had about 4 inches above your head.

Not many people could get into those tanks. An ideal candidate for fitting the liners had to be small and supple, with no fear of confined spaces. I myself could only get inside tank 1 on the left-hand wing; as there is a difference between my shoulders, I physically could not get my shoulder into tank 4.

It wasn't a case of "pick a liner and fit it"; there was a lot of fettling required to get it right before you started to drill and bolt the liner in place. After it was drilled off you had to remove and de-burr everything (i.e., smooth the sharp edges of the holes), and Hoover away any debris. In tanks 1 and 4 you could

only spend about 15 minutes in the tank at a time, as it was easy to get cramp. The worst thing was if you got stuck – you had to try not to panic as it would just make matters worse. We tended to work in pairs with one person in the tank and the other person monitoring. Duplicate inspections of each tank were carried out prior to closing it up.

The most satisfying part was for me when G-BOAF went on its test flight in September 2001 – which was sadly overwhelmed by the 9/11 tragedy. At least the liner modification was a success.

Inside the wing

January 2001: Engineer Marc Morley fits a piece of tank lining inside the wing on G-BOAF.

Photo: PA Images / Alamy



The Michelin Near Zero Growth tyre

For this article Mach 2 thanks Pierre Grange, Concorde pilot for Air France, who wrote the original French version for APCOS (the French website for former Concorde personnel) and has kindly permitted it to be translated and included here.

IT COULD BE SAID that it was the new NZG tyre, developed by Michelin during the winter of 2000–2001, that made the resumption of Concorde flights possible. Without this, the modification of fitting the Kevlar linings in the bases of the fuel tanks might not have been sufficient to convince the authorities to re-issue Concorde's Certificate of Airworthiness. Henri Perrier [former Director of the Concorde test flight programme at Aérospatiale, who would oversee the test flights for the return to service in 2001] went further, stating that if EADS had foreseen the arrival of this new-generation tyre, they might not have embarked on the Kevlar modification.

The new design

Each wheel on Concorde's main landing gear supports 23 tonnes, and on take-off it rolls at more than 360 km/hour (200 knots). Concorde, first conceived in the 1960s, was originally equipped with tyres that had an internal "bias" structure (in which the fibres are criss-crossed diagonally). In 1981, Michelin had developed a radial tyre (in which the internal fibres lie at 90° to the axle) for aeronautical use, but by 2001 only 25% of airliners were fitted with these.

Concorde's original bias tyre would expand by 8% when it was inflated to its nominal pressure of 15 bars. At take-off speed, the centrifugal forces produced an additional enlargement of 4% of the diameter of the wheel. In total, the tyre was expanded by 12% at the crucial moment of rotation. One can also understand that the tyre tread was put under immense strain. If punctured, it could easily burst and

Tyres in place

Above: the new Michelin tyres fitted on G-BOAD. The re-shaped water deflector can be seen at the bottom right of this image. Photo: Jorge Lásca / Wikimedia Commons (CC BY 2.0)



be shredded, as happened on 25 July 2000 with AF4590.

To give greater resistance to external damage, Michelin's NZG tyre was designed to expand only minimally, hence its name: "Near Zero Growth". Its diameter expanded by only 2% when it was inflated to a pressure of 16 bars (16 kg/m²) and by a further 1% when the tyre was rolling at 360 km/h, giving a total expansion of only 3% at the moment of take-off (compared to 12% for the bias tyre). In these conditions, there was also practically no tension in the tread of an NZG tyre at rotation.

In such take-off conditions, one can compare the tread of a bias tyre to a stretched elastic band, which can easily be cut even with a blunt knife, while if the "elastic" is not stretched, it would be difficult if not impossible to cut it with the same utensil.

Testing the tyres

Michelin carried out numerous bench tests on the tyres at its centres at Almería in Spain and Ladoux in France. They were able to reproduce the 25 July 2000 tyre burst on a bias tyre; they also confirmed that, in the same conditions, the NZG tyre would not burst. They also carried

out three take-off roll – take-off – landing cycles with the tyre, the last with prolonged loading.

The last certification test for Concorde's NZG tyres took place on 2 May 2001 at Istres. Concorde F-BTSD was fitted with the Michelin NZG tyres on all of the wheels apart from the nose wheels and tail wheel. The aircraft flew and carried out two landings.

The new tyre, which would not burst, was a major advance in terms of flight safety, and also provided further benefits: it was 30% lighter than the bias tyre (and 15% lighter than Michelin's existing radial tyre), and also demonstrated that it would wear more slowly with use. For these reasons, after the tyre was fitted to Concorde in 2001, it was also certified for use on numerous other airliners, including the new Airbus types – starting with the A380.

Once again, Concorde was an innovator!

APCOS

For information on the work of APCOS, in French and English, see their website: concordereference.fr

A MERCY MISSION

On 13 July 1985, two simultaneous charity concerts were held in Philadelphia, USA and London, UK for Live Aid, involving the most important rock and pop musicians of the moment. One, Phil Collins, managed to play in both of the concerts – thanks to Concorde.



Playing for time

Phil Collins and his wife at Heathrow, preparing to board G-BOAG; the regular evening Concorde flight had been brought forward a couple of hours for him.

Photo: Trinity Mirror / Mirrorpix / Alamy

IN 1983, famine struck northern Ethiopia, in east Africa. By mid-1984 it had killed an estimated 1 million people. The news reports from Ethiopia horrified the world.

One of those watching was rock star Bob Geldof. Devastated by the images of suffering, he and fellow musician Midge Ure persuaded a constellation of British and Irish music stars to sing for free as the supergroup Band Aid. Their single “Do They Know It’s Christmas?” raised £8 million for famine relief in 1 year.

Geldof then initiated an even bigger event: a charity concert to raise funds for Ethiopia. He wanted the show to be “as big as is humanly possible”, held at venues in the USA and London, and televised around the world. The double event hosted a plethora of the biggest names in pop and rock music.

An audacious plan

Phil Collins was on tour in the United States when he met Robert Plant of Led Zeppelin, who asked him to participate in Live Aid in Philadelphia, USA. Collins accepted.

Then Sting, the former frontman of The Police, asked Collins to accompany him on stage at Live Aid in London. Again, Collins accepted.

However, the concerts would be taking place at the same time on the same day – on opposite sides of the Atlantic Ocean.

The Live Aid promoters managed to overcome this challenge by proposing some tweaks to the schedule – and enlisting the help of Concorde. The exercise had to be planned down to the smallest detail.

A transatlantic feat

13 July 1985: Phil Collins appeared at Wembley Stadium at just after 3pm, performing his hits including “In the Air Tonight” and “Against All Odds”, then performing backing vocals for Sting’s hit “Every Breath You Take”.

As soon as he had finished his performance, Collins boarded a helicopter flown by Noel Edwards – a helicopter pilot as well as a DJ and TV presenter who had made his own programme about Concorde.

At Heathrow, British Airways Concorde G-BOAG was waiting; the scheduled evening flight had been brought forward for this occasion. During the flight, Collins broadcast live to Philadelphia. He explained why he had accepted this challenge: “Basically the reason I’m doing this is that it can be done.”

On landing at JFK, Collins took another helicopter to Philadelphia. At the John F. Kennedy stadium, at 8pm local time, Collins went straight into performing three songs as drummer for Eric Clapton, then played his solo set, and finished by drumming for Led Zeppelin.

Funny old world, wasn’t it?

At the start of his performance, Phil Collins commented on the technological marvels that had made this feat possible: “I was in England this afternoon. Funny old world, isn’t it?”

That flight on Concorde would underline Phil Collins’ reputation as a star, as well as highlighting the urgency of the mission to help Ethiopia. It would be remembered as one of the stand-out events of the Live Aid concert, which was watched on TV by over a billion people globally, and would eventually raise a total of £150 million. And Concorde G-BOAG played her own part in making the world a smaller place, just for one day.

The Live Aid flight

Phil Collins' trip to New York for Live Aid went off without a hitch, thanks to very careful planning by British Airways. BA Concorde engineer Pete Comport recalls the work that went on behind the scenes to make this feat possible.

I will begin by giving some background to the thinking behind the process for planning the Concorde flight for Live Aid.

The Concorde fleet was unique within British Airways (BA): it was the only fleet of aircraft to be wholly managed by a discrete group of engineers. All of the other BA fleets were scheduled for operations by a central group of aircraft engineering and operations managers (passenger loads, aircraft range, etc), and were based in the airlines central control centre. In Concorde's case, a technical operation control centre managed the scheduling of each and every Concorde. This was based within Technical block "B" hangar, the home of Concorde from its very first passenger flight until the hangar was demolished to make way for a commercial cargo unit.

Maintenance schedules

All aircraft have a dedicated regime of maintenance, which is controlled by a legally binding document known as the Aircraft Maintenance Programme. This programme is managed in to a schedule of maintenance (AMS), which, in the case of Concorde, was implemented by a group of qualified Concorde engineers known as Concorde Tech Operations managers. They were aided by Technical Assistants, who issued the necessary documentation to ensure all work is recorded and certified by a suitably qualified engineer as required by law.

Each aircraft has its own record of all Engineering Maintenance actions, and each and every action will have a specific time period – be they limited by hours flown, landings made, engine start/stop cycles, or

The art of maintenance

G-BOAC in the maintenance hangar. The scheduling of maintenance and flying time was a complex task throughout Concorde's time in service.

Photo © Steve Fitzgerald



calendar life. Examples will include a "transit" check (testing certain critical systems, such as the Centre of Gravity indication and warning systems, for correct operation), right up to the highest-level maintenance checks to inspect the aircraft structure for fatigue.

Concorde is a complex aircraft; its technology and sphere of operation was unique in commercial aviation, especially given the era and technologies employed and developed for the aircraft. As a consequence, the Concorde maintenance programme is conservative, with the schedules for inspection, testing and replacement of vital components lower compared to subsonic aircraft's maintenance programmes.

The need to keep each aircraft's maintenance programme separated from the others, to avoid multiple aircraft grounded for planned maintenance, was a high priority. Any small fleet of aircraft comes with constraints: limited spares are often an issue, and training for engineers (be that availability of tutors or of equipment) also put constraints on the capacity to maintain multiple aircraft at the same time. Other constraints, such as engineers qualified to certify Concorde, were vital

to maintaining the operation, along with tooling-specific hangar docking and system testing equipment.

Scheduling aircraft to ensure that key resources were available was a significant consideration for Concorde's flying programme. (For example, there was only one set of spare main undercarriages, and a limited number of air conditioning heat exchangers.) Ensuring that they were not all needed in the same time frame was vital if you didn't want multiple Concordes grounded for the same maintenance task.

To meet the above requirements, Concorde Tech would actively slow the flying rate for various Concordes to separate the bigger checks, be they the 300-hour service check or the bigger "inter" checks at 1200 hours. This occasionally made the flying schedule for the fleet just that bit more of a Rubik's cube puzzle.

Planning for Live Aid

In the case of the Phil Collins dash between his Live Aid performances, the 13 July 1985 early evening flight to New York's JFK Airport was not out of the ordinary. Many VIPs regularly flew this route. The only difference on this occasion was that around 1.5 billion folk were eagerly

awaiting the pop star’s performance on both sides of the Atlantic on that day, so perhaps this particular flight’s profile might just be that little bit higher for the evening supersonic flight to the US of A?

In addition to the maintenance considerations described above, the fleet was undergoing a re-paint. Paint slots in the specialist dedicated hangar were very valuable, with the queue for the new Landor livery long. Fortunately, Alpha Golf had had the new Landor scheme applied as part of its long-awaited return to service earlier that year (see Mach 2, February 2020), following a long grounding awaiting the supply of spare parts. Many hours of research, sourcing and repair or overhaul of the missing components meant that Alpha Golf now had more than its fair share of recently overhauled components.

Further to this, as part of the re-introduction to service, Alpha Golf had recently completed a Certificate of Airworthiness “Air Test” followed by a crew training sortie based at Prestwick in Scotland. This was followed by a series of scheduled flights to both JFK and Miami. All of this work provided a good understanding of how the aircraft was performing. Therefore, selecting Golf was the natural choice. All that was needed

was to ensure this aircraft was in the right place at the right time.

The Concorde fleet’s flying schedule for the day of Live Aid was busier than normal: Alpha Bravo and Alpha Charlie returning from JFK, Alpha Delta in Miami, Alpha Alpha on its 300-hour service check, and Alpha Echo on unscheduled maintenance with a fuel leak, which needed fuel tank entry. With four out of the seven aircraft unavailable and two additional sorties (charters), the options for a standby aircraft were limited.

Even Alpha Golf was away for most of the day, based at Fairford and flying at the Royal International Air Tattoo (RIAT) with the Red

Arrows. The aircraft was at least in the UK, though, with a schedule that offered a small amount of time for any unscheduled “Tech Log “maintenance, should it be required.

Alpha Fox was also in the UK at Stansted, landing back at Heathrow that afternoon; she would have been a substitution if Alpha Golf had gone “Tech”. The flying schedule would have been carefully orchestrated over several days to have both aircraft at LHR.

Alpha Golf on display

G-BOAG at RIAT, where she took part in a flying display before carrying out the Live Aid flight.

Photo © Mike Freer / Wikimedia Commons (GFDL 1.2)



Concorde schedules

The timetable below shows the flight schedules for G-BOAG and proposed replacement aircraft G-BOAF on 13 July 1985 – giving an idea of the tight timescale and the demands made on both the aircraft themselves and the maintenance team.

	Flt #	Departure time	From	APT code	To	APT code	Arrival time
G-BOAG	100	09:07	Heathrow	LHR	Fairford	FFD	09:28
G-BOAG	100	13:02	Fairford	FFD	Heathrow	LHR	14:26
G-BOAG	195/2	18:12	Heathrow	LHR	New York	JFK	21:37
G-BOAF	100	10:51	Heathrow	LHR	Stansted	STN	11:16
G-BOAF	100	12:55	Stansted	STN	Stansted	STN	14:19
G-BOAF	100	15:35	Stansted	STN	Heathrow	LHR	15:54

Data courtesy of Heritage Concorde

Steam meets speed

During the years of preservation and restoration, Concorde has received help from many quarters. Graham Cahill of Heritage Concorde recounts a recent instance of welcome practical support, from a very different setting – the world of steam trains.

I'm always amazed at how big the engineering is on Concorde. I'll go out and buy something (like, say, a compressor), which seems big when it arrives – then when I stand it next to Concorde, it's tiny by comparison. Well, the other week I experienced something even bigger.

Churnet Valley Railway

A view of the museum site: a fantastic place with a team of passionate volunteers.

Photo: Graham Cahill



The back story...

Two years ago, I asked for help in producing some axle stands for Concorde G-BOAC in Manchester. We had quotes such as £11,000 for four axle stands, which for a museum is simply a crazy amount to talk about. We discussed with museum managers the pro's and con's of filling the tyres with foam (including discussions with locations that had done this on other aircraft); the recommendation was to avoid if possible. Then I had a message from a passionate restorer saying, "Yes, we could probably make those axle stands for you, and do it for free!"

Never being one to look a gift horse in the mouth my answer was, "Wow, can you really?" Enter the passionate volunteers and restorers of the Churnet Valley Steam Railway in Staffordshire, and a guy called Greg who is in charge of engineering works at the railway.

The plan takes shape

We provided drawings for Greg to work off, and next thing we knew, we were seeing if our drawings were as accurate as his engineering clearly was. The stands (not yet complete) fitted brilliantly!

Here is the interesting bit. Some weeks later, on 10 June, the now engineered, welded and powder-coated stands were completed and ready for collection from the Steam Railway. Just a few hours' drive from

my house, I arrived at the most amazing place I have ever seen in terms of engineering, volunteering and preservation – the Churnet Valley Engineering workshops. Greg, unfortunately, was not available so I was greeted by a chap called John Peake who was so enthusiastic and passionate about what they do there.

On a quick tour, I was amazed to see steam and diesel engines in various stages of restoration, complete steam trains due for restoration, and shiny engines that were restored. The workshops contained some of the biggest engineering machinery I'd ever seen. A lathe the size of my house, computer-driven milling machines, equipment that dwarfed operators. Then on to the coach works, where volunteers were carefully manufacturing parts for ages-old rolling stock.

I collected the axle stands and headed home. The drive back had me thinking: although different to

aircraft, the passion of this group of people is so similar that we all have common ground. Thank you so much, Churnet Valley Steam Railway; thanks Greg for making these for us; thanks John for the tour; and thanks to Castle Blasting for powder-coating these for free.

The axle stands for the main landing gear were delivered to Manchester on 2 July, and will be fitted soon. The Churnet team will also be making the nose leg gear stands to our spec in the near future.

For details about the Churnet Valley Railway and Castle Blasting, see:

churnetvalleyrailway.co.uk/
castleblasting.co.uk/

Finished axle stands

Right: The main gear stands in place.

Below: Each stand has a plaque to commemorate the late John Dunlevy.

Photos: Graham Cahill





CONCORDE WATCH

Concorde G-BOAC

British production aircraft

Location: Runway Visitor Park, Manchester, UK

Reporter: Graham Cahill **Date:** 4 June and 2 July 2025

The team for these visits consisted of Graham Cahill with John Hepple of the Runway Visitor Park (RVP). The tasks completed were as follows:

1. Cabin lighting

We fitted the final three or four rows of cabin lighting as outlined in the previous Mach 2 report (May 2025). The LED strips had failed due to a bad batch. This job is now done and the cabin looks great again, especially with the newly restored seats.

2. Tyres

The tyres were inflated again, hopefully for the second to last time. As outlined in this month's issue (see article on previous page), we will be fitting axle stands as soon as the team is available to fit them. Inflation of the tyres took most of one day to complete.



Flight engineer's panel

A new LED lighting strip has been installed over the panel to give better general illumination.

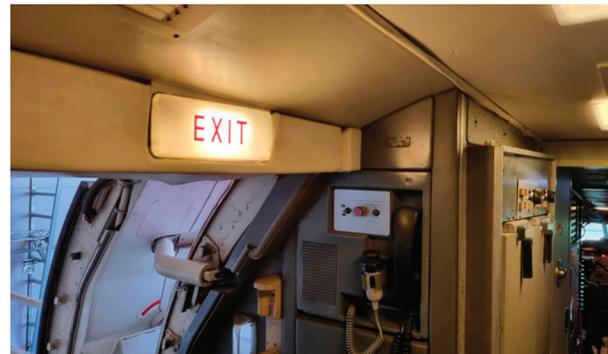
Photo: Heritage Concorde



Exit sign

The exit signs over the cabin doors have been restored and are now fully working again.

Photo: Heritage Concorde



3. Nose

We inspected the nose and found no issues. G-BOAC is not losing any oil, and her nose system is currently in A1 condition.

4. Cockpit lighting

Further work was done to the tunnel to the cockpit, which has brightened up the area for visitors. We have fitted an LED strip to the engineer's panel, which gives good light for the cheaper tours. In addition we have replaced the filament spotlights in the cockpit with LEDs. We have

Inflating the tyres

All of the tyres were inflated. This job should no longer be needed once the new axle stands are in place.

Photo: Heritage Concorde

illuminated the exit signs that are above the main exit doors. The lighting project is taking us a while to complete due to the care that we have to take in fitting new supply cables at 12 volts, so this will be an ongoing project.

5. Hydraulic power pack

We have now fitted the desiccant air filter to the power pack on board BOAC, along with a new oil level switch (as outlined in previous Mach 2 article, May 2025).

6. Reheat switches

We have replaced the reheat switches with new spares from the John Dunlevy spares collection. These reheat switches have been a problem

for many years, dating back to prior to 2011, having been loosened and broken at some point.

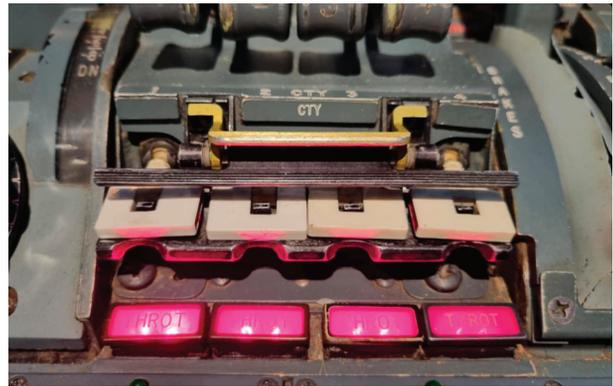
To find out more about the RVP, or to visit Concorde, please see their website. Please be aware that the RVP will be closed on 2 September and 8 October for special events.

runwayvisitorpark.co.uk/bookings/book-a-tour/

Restored re-heat switches

A full set of new switches, from the collection of the late John Dunlevy, has been fitted to replace the broken switches.

Photo: Heritage Concorde



Concorde G-AXDN

British pre-production aircraft

Location: Imperial War Museum, Duxford, UK

Reporter: Graham Cahill

Date: 11 June and 8 July 2025



The team for this visit was Graham Cahill and Justin Robson. The following tasks were completed.

1. Nose

We inspected the nose pipework and actuators. We found no issues that we were not already aware of; in fact, apart from the seeps on the actuators, the pipework was found to be in good condition. The seeps will be addressed once we have received revamped replacement actuators, which Brooklands Museum have agreed to provide. (Many thanks to them and their team, along with British Airways, who granted permission to use them.) Since February we have lost no more than a quarter of a can of oil from the

nose; the trained Duxford Aviation Society (DAS) volunteers have been on top of this issue.

2. Intakes

We delivered and presented to the Duxford Aviation Society (DAS) one torque tube for G-AXDN's intake restoration. (See Mach 2, May 2025.) We managed to obtain one torque tube for the intake of the aircraft; we still require one more, together with one intake actuator. We will be keeping an eye out for these items. The parts will be fitted to the aircraft so at least one intake will be complete.

The torque tube is the part that moves the ramp doors up and down. There are two in each intake.



Changes for G-AXDN

Above left: Concorde G-AXDN in the re-organised AirSpace hall. Above: Chrissie Eaves-Walton (right) accepts the torque tube from Graham Cahill (left) on behalf of DAS. *Photos: Heritage Concorde*

G-AXDN had all of them removed some years ago to maintain the flying fleet. G-AXDN is arguably the most important Concorde for intake testing and the successful completion of sustained Mach 2 flight. She was used as a test bed for the new (at the time) digital intake system, so we feel at least one intake should be restored.



New additions

Left: the cameras installed in the intakes, which have also been illuminated.

Below right: The time clock can be seen at the bottom of this image.

Photos: Heritage Concorde

for the time clock to go than the aircraft John loved so much and spent so much time testing back in the 1970s. Another gap filled in the observer's desk.

For further information on G-AXDN and the work of the Duxford Aviation Society, see the DAS website: duxfordaviationsociety.org/

3. Spare parts

We need to collect spare parts for Brooklands to use on G-BBDG, and one stock part. (See Mach 2, May 2025.)

4. Ice desk monitor

Investigate the fault on the ice desk monitor. One monitor had failed and has now been replaced; we will attempt to fix the one that was removed. We will also purchase a further two spare monitors in the coming weeks.

5. Ice desk camera system

Continue work on the camera system so DAS can easily explain the system to tour visitors. This has been an ongoing task.

We are using the original wiring loom for the cameras, which runs up to the ice desk. (No mean feat!) We are fitting small cameras inside

the intakes, which will give visitors a view of what the ice desk cameras actually saw during testing. This will probably be used for special tours by DAS, along with the existing ice desk video.

We have now completed wiring of the two intake cameras; they work really well. Next time we will light up the intakes and fit prints of the engines inside the engine bay so visitors do not see empty lit bays. We will also continue with the third and last camera wiring just below the exit door for a view of the wing.

6. Time clock

We fitted an original time clock, which was in the John Dunlevy collection. It is now back on board G-AXDN, in the correct location, for thousands of people to see. Norma Dunlevy, John's widow, could not think of a better location



Supersonic, by Lawrence Azerrad: new edition



SUPERSONIC
THE DESIGN AND
LIFESTYLE OF CONCORDE

Lawrence Azerrad
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www.prestel.com

First reviewed by Mach 2 in October 2018, this stylish book has now been re-issued in an enlarged edition, with sumptuous photographs of Concorde as well as of objects included in the author's extensive collection of Concorde memorabilia. A treat for the eyes as well as the mind, Lawrence Azerrad's aesthetic response to the aircraft celebrates it as a technological marvel and historical icon, and includes eye-witness accounts from some of the people who helped to make the Concorde experience possible.