

## Concorde's Crash in Paris 25<sup>th</sup> July 2000

### The Dream that ended for Air France as well as British Airways John Cook looks back at the Concorde's Crash

The famous photograph taken at the moment Concorde burst into flames, was taken aboard the Boeing 747 Airliner which had just landed from Japan and was waiting to cross the Concorde runway to gain access to the terminal. On that aircraft were Mr and Mrs Jacques Chirac, the President and First Lady of France.

The official Investigation into the cause of the crash has focused almost exclusively on the fire. French Accident



Investigation Bureau (BEA) agree that a strip of metal on the runway was picked up by one of the plane's wheels, then thrown with great force against one of the fuel tanks which ruptured causing uncontrolled fire. The British media were able to publish a picture of the strip of metal as well as the lump of tyre on their front pages. That fact caused me some concern at the time, who gave out this picture, the investigation had not yet started, a published mistake of this magnitude would have warranted massive damages against the publishers. The BEA Statement went on, hot gases caused two of the engines to fail and despite heroic efforts by Captain Marty and his crew, the crash was inevitable. The British immediately grounded its fleet of Concorde's, as did The French.

Investigations however suggest the truth is more complicated and for Air France and British Airways, more worrying. Almost immediately Sir Malcolm Field, Chairman of British Airways stated, "This is a catastrophic accident." The words "Act of God" was bandied about by many who had an opinion.

British Airways Concorde pilot John Hutchison, has given his assessment of the tragedy, he states: The Fire on its own should have been eminently survivable. "The pilot should have been able to fly himself out of trouble", the reason he did not according to Hutchison, was a lethal cocktail of error and negligence by the maintenance staff of Air France.

When Captain Marty pulled back the control column to raise the nose and take off, the aircraft was travelling at 188knots. the minimum speed for take off was 200 knots.

Within a few weeks of the disaster, I was travelling on a BA conventional flight to Washington BWI, to visit my son. I asked the cabin attendant for permission to visit the cockpit; after about an hour, I was taken forward and strapped into the spare seat in front of the radio consul. I lost no time in introducing the topic of the downed Concorde, Imagine my surprise when I learnt that our pilot was a reserve Concorde pilot and one with a vehement opinion of political involvement, he almost shouted his mantra to me "The loss of one plane does not ground the whole Aircraft Type"!

Whilst he was in full flow, I introduced the "Metal Strip" into the discussion where upon he started teaching me the fundamentals of take off procedures and practice - apparently, whether you take off in a Swordfish canvassed winged plane, or you take off in Concorde, the take off distances for each aircraft are always a near repeat of the previous take off. If your Concorde needs 2 kilometres to take off one day, it wont be three the following day, or one and a half the day after! So if your plane won't take off in the 2 kilometres it usually needs, there must be something wrong.

When my hour was up I went back to my seat and had a Beer.

A half hour before we landed, the attendant returned and asked if I would like to return to the cockpit for landing, I jumped at the invitation and this time was strapped in but with ankle straps (even in the months before 9 /11, British Airways were taking no chances. Another short discussion on 'Concorde', this time about tyres. We were soon down and my son met me at the end of an interesting 7 hour flight.

Whether it was the tip on tyres that day or not, I lost no time in researching this subject, This time I was horrified to learn that Concorde had the worst record on tyre blow outs and near disasters of any aircraft then flying. If that day in Washington, I had flown back by Concorde, I would have had a take off and landing with 30 times more chance of tyre explosions and damage than in any other type of Aircraft

BEA notes that according to the cockpit voice recorder, the instant before Marty 'rotated, his co-pilot screamed "watch out", the report states "It is not possible to explain his exclamation"! The Co-pilot was in an aircraft swerving off the runway at 200 mph and heading towards a fully loaded 747 Aircraft. His exclamation seems reasonably explicable.

But why was the plane in this disastrous position? Shocking evidence suggests that the aircraft was inadequately maintained. The airline's workshop engineers had failed to replace a spacer, a vital component of the landing gear, which keeps the wheels in proper alignment. When these licensed engineers serviced and maintained the undercarriage four days before the disaster, it became apparent that the spacer was not replaced. Although the BEA disputes it, there is compelling evidence that it was the missing spacer which caused the plane to skew to the left, so forcing Captain Christian Marty to leave the ground too early.

Historically, Concorde Pilots and Engineers were fully aware of this iconic aircraft's shocking history of tyre failure and wing damage. Furthermore, as the three man flight crew waited on the runway ready to roll, their plane was more than 6 tonnes over its permitted take off weight. Its centre of gravity was pushed dangerously toward the rear. According to Hutchinson, even before the blow out, Marty was already 'pushing the envelope' of safe flying explored by test pilots in the '70s. Had the plane not hit the metal strip, they would probably have got away with it.

Faced with an emergency, with his plane in the air flying below a sustainable speed, his options were severely compromised. According to Hutchison, Marty found himself trying to save a one-time thoroughbred which was responding like a ' sack of potatoes.

Investigation suggests Concord need not have been grounded at all, the plane was basically safe, not withstanding the inherent tyre problems. It had not lost a single passenger before Paris, a great record for any type of aircraft. The stresses on Concorde's landing gear are usually severe; unlike ordinary aircraft, its Delta wing generates hardly any 'lift' until the captain pulls up the nose and pitches the plane upwards at an angle of 18 degrees at the point of rotation. Until then, the wheels and bogeys will carry all of Concorde's weight - in the case of a fully laden plane at takeoff, about 185 tonnes. At regular interval of a few hundred flying hours, the various load bearing components must be replaced. When the undercarriage bogeys are taken apart and reassembled, the work must be done strictly within a rigid formula and rigorously checked and inspected, each stage must be signed for.

Concorde F-BTSC went into the hanger at Charles de Gaulle on 18<sup>th</sup> July, a week before the crash the part that was changed was the undercarriage beam - the horizontal tube through which the two wheel axels pass at each end in the middle is the low friction pivot which connects the beam to the vertical 'leg' extending down from inside the wing. The parts of the pivot which bear the load are two steel 'shear bushes'. To keep them in position they are separated by the SPACER: anodised aluminium about 5 inches thick round bar and 12 inches long. When the plane left the hanger on 21<sup>st</sup> July the spacer was missing. After the crash it was found in the Air France workshop, still attached to the old beam which had just been replaced.

In the days before the accident, the plane flew to New York and back twice. At first the load bearing shear bushes remained in the right position, but each time the aircraft took off, the landing gear was retracted into the wing; on the ground the two bushes are positioned horizontally, on either side of the beam, with the gear retracted the right hand bush lies vertically above the left. By the day of the crash the undercarriage leg had moved about seven inches along the pivot, until the two bushes were almost touching. Instead of being held firmly in a tight fitting pivot, the wheels were now free to move three degrees in any direction. The Supermarket Trolley was ready to jam.

Jean-Marie Chauve, who flew Concordes right until his retirement, and Michael Suaud, for many years a Concorde Flight Engineer, believe the undercarriage was already out of alignment when the plane began to move down the runway. They spent six months preparing a sixty page report on the crash, which they submitted to the investigating Judge. Chauve said: The acceleration was abnormally slow from the start. There was something retarding the aircraft, holding it back. In his view, it must have been friction from the undercarriage. There report contains detailed calculations which conclude, that without retardation the plane would have taken off 1,694 metres from the start of the runway, a great distance before meeting the metal strip.

The BEA contest these findings, saying that the acceleration was normal until the tyre burst. It also maintains that even after the blow out, the missing spacer was insignificant. No doubt the Board had access to the previous record of Tyre Bursts.

It may be relevant to slot that information into this page:

**13<sup>th</sup> June 1979:** The no 5 and 6 tyres blew out during a take-off from Washington Dulles International Airport. Fragments thrown from tyres and rims damaged no 2 engine, punctured 3 fuel tanks, cut through several hydraulic lines as well as electrical cables. A large hole was torn from the top of the wing over the wheel well area.

**21<sup>st</sup> July 1979** Another blow out incident during take-off from Dulles Airport. After that second incident the French Director General of Civil Aviation, issued an air worthiness directive and Air France issued a technical information update, each calling for revised procedures. These included required inspection of each wheel and tyre for condition, pressure and temperature prior to each takeoff. In addition crews were advised that landing gear should not be raised when a wheel/tyre problem is suspected.

**October 1979** Tyres no 7 and 8 failed during take-off from New York JFK Airport. In spite of the well publicised danger from the previous incidents, the crew ignored the new safety recommendations raised the landing gear and continued to Paris. There was no subsequent investigation by the French BEA or the NTSB of that incident.

**February 1981.** (Air France F-BTSD) Blew more tyres during take-off again from Dulles Airport. Once again the crew disregarded the new procedures by raising the landing gear. The blown tyres caused engine damage that forced the flight to land at NY JFK Airport. Another NTSB investigation, more criticism of the crew, this time failing to inform the passengers or preparing them for an emergency landing.

Returning to the disaster at Paris CDG Airport, the BEA's critics say that once the tyre burst, the load on the three remaining tyres became uneven, and even if the wheels had been more or less straight before, they now twisted disastrously to the side. There is a remarkable series of photographs in the BEA's own preliminary report. They show the skid marks of four tyres heading off the runway, close to the grassy verge on the runway edge. One picture shows one of the low yellow runway lights smashed by the Concorde's wheel assembly as Captain Marty tried to wrest it into the sky. Industry sources confirm that this had further damaging effects. Until then the number one engine had been functioning almost normally, but when the plane hit the landing light it ingested hard matter which caused it to surge and fail. One expert puts it "you would not see four marks if the wheel had been straight, with the back wheels behind the front, you should not see such marks at all after a normal take-off, this plane was skidding sideways, it was out of control".

John Hutchinson said; "the blow out alone would not cause these marks, you'd get intermittent blobs from flapping rubber, but these are very clear skids"

Marty tried to overcome the drift to the left by applying right turn to the rudder, it made negligible difference. The BEA countered that the leftwards 'Yaw' was caused not by faulty landing gear, but by the loss of thrust from engines one and two'.

There are several problems with this analysis. First, as the BEA's own published data reveals, the thrust from engine one was almost normal until the end of the skid, when it ingested parts of the landing light . It is simply not true that the 'Yaw' began when both engines failed.

Second, those who fly the plane say that the loss of engine power will not cause an uncontrollable Yaw. Concorde's engines unlike, say a 747, are not mounted out near the wing tips, but close to the tail and fuselage. Concorde Captains and pilots have all practiced loss of engines in the 'simulator' and many of them have experienced it for real. All agree, in John Hutchison's words "it's no big deal, you're not using anything like the full amount of rudder to keep the plane straight: the yaw is totally containable."

The fact that Marty had to rotate the plane, 11 knots below it's minimum stipulated rotation speed, was always going to make it difficult to save. In the event he never got close to V2 the 220 knot air speed that would have represented stable flight. For a few seconds in the agonising minute between take-off and catastrophe he reached 210 knots, only for the number one engine, which had begun to recover - to fail for a second time.

Despite everything against him- the skewed bogey and the fire - other avoidable factors were making it further more difficult to rescue the plane. When Marty paused at the start of the runway, his instruments told him he had 1.2 tonnes of extra fuel which should have been burnt during taxiing. In addition a further 500 kgs of baggage that was not included in the manifest and had been loaded at the last minute. These took the total mass to 186 tonnes, a tonne above the aircraft's certified maximum weight, which the plane had been designed to safely operate at.

Meanwhile, in the interval between Concorde leaving the terminal and arriving at the runway, the wind direction had changed and was now from behind at 8 knots. Although the control tower gave this information to the aircraft, the cockpit voice recorder shows there was no reaction. Had they paused for a moment they might have recomputed the data on which they had planned their takeoff. If they had, they would have learnt a very worrying fact. Flying a tonne over maximum take off weight is unlawful. However more important than this is the RTOW, the regulated takeoff weight. As Marty released the brakes on 25<sup>th</sup> July with the 8knot wind behind him, the RTOW had dropped to 180 tonnes, at least six tonnes less than the weight of Flight 4590.

John Hutchison said 'the change in the wind was an incredible revelation, Marty should have insisted on taxiing back to the other end of the runway as most pilots have done in the past. and taken off into the wind.' They were 6 tonnes overweight and already at the limits of the envelope. He concluded 'Once the wind had changed, they were beyond it'. The extra weight had a further consequence beyond simply making it harder to get into the air. It had shifted the Centre of Gravity backwards; the extra luggage almost certainly went into the rear hold, and all the extra fuel was in the rearmost no11 tank. A planes COG is expressed as a percentage, so many percentage fore or aft.

Brian Trubshaw and John Cochrane, Concorde's two Test Pilots when the plane first took to the air, set the aft operating limit at 54%. Beyond that limit the plane was likely to rear up backwards and crash, exactly as flight 4590 did in its final moments over Gonesse. Some gave the figure as high as 54.6% and even with four engines working normally, this figure takes you well beyond the point where the two test pilots would have been prepared to tread. As the fuel gushed from the hole in the forward number five tank, the COG moved further to the rear. Once again Air France and Captain Christian Marty had closed off their options. Marty's crew were to do so one final time. When the plane was just 20feet off of the ground, the flight engineer shut down the ailing number two engine. French and British pilots agree that this was another disastrous mistake which breached all procedures. The engine itself was not on fire, and as the tank emptied and burnt itself out it would probably have recovered. The drill for shutting down an engine requires the crew to wait until the flight is stable at 400ft, and to do so then only on receipt of a direct order from the Captain.

However the investigators concluded:- The aircraft was overloaded by 810kgs above the maximum safe takeoff weight, any effect on takeoff performance from this excess weight was negligible. After reaching takeoff speed, the tyre of the number two wheel was cut by a metal strip lying on the runway, which came from the thrust reverser cowl door of the number 3 engine of a Continental Airlines DC10 that had taken off from the runway several minutes before. This strip, installed in Huston Texas had been neither manufactured nor installed in accordance with the procedures as defined by the manufactures.

The aircraft was airworthy and the crew were qualified. The landing gear that later failed to retract, had not shown serious problems in the past. Despite the crew being trained and certified, no plan existed for the simultaneous failure of two engines on the runway, as it was considered highly unlikely. Aborting the takeoff would have led to a high speed runway excursion and collapse of the landing gear, which also would have caused the aircraft to crash. While two of the engines had problems and one of them was shut down the damage to the plane's structure was so severe that the crash would have been inevitable, even with the engines operating normally.