

CONCORDE ACCIDENT

25 JULY 2000

THE OCCURENCE

That day, the Concorde registered F-BTSC operated by Air France, flight AF4590, took off from Paris-Charles de Gaulle airport bound for New York, carrying 100 passengers and 9 crew. Two minutes after taking off, the Concorde crashed onto a hotel at Gonesse, less than two kilometres from Le Bourget airport. This tragic event would shake the world of aviation.



14:07: The crew started up the engines for a take-off from runway 26R.

14:34: They taxied to the holding point of runway 26R via taxiway Roméo.

14:42: The controller cleared the crew for take-off.

A few seconds after the captain gave the take-off signal and the co-pilot's call that the decision speed had been reached (150 knots (kt) = 278 km/h), the right front tyre of the left main landing gear burst after running over a metal strip that had fallen from a Continental DC-10; this aircraft had taken off from the same runway, five minutes before the Concorde.

Rubber debris from the tyre struck the underside of the left wing of the Concorde, rupturing the structure of fuel tank No 5. A large fire broke out under the wing, close to the landing gear well.

14:43:13: As the captain started the rotation at a speed of 183 kt (around 339 km/h), the controller informed him of the presence of flames at the rear of the aeroplane; at the same time, the flight engineer (third crew member in cockpit) reported the failure of engine 2.

14:43:22: The engine fire warning sounded and the aircraft reached a speed of 200 kt (approximately 370 km/h).

14:43:59: Several GPWS (Ground Proximity Warning System) warnings sounded and the crew diverted to Le Bourget airport; in the following seconds, the crew had to manually reduce the thrust of engines 3 and 4 in order to balance the aeroplane following the loss of power on engines 1 and 2. This meant that the crew had to substantially increase the aeroplane's pitch attitude. The combination of the lateral asymmetry (a steep left bank partly linked to the destruction of part of the flight controls) and the substantial thrust/drag imbalance resulted in a loss of control.

14:44:31: The Concorde crashed onto a hotel at the intersection of the D902 and N17 roads, 6 km from the end of runway 26R at Paris-Charles de Gaulle airport. The accident killed 113 people: 109 people on board the aeroplane and four people in the hotel.



THE AEROPLANE

Jointly designed by Sud-Aviation in France (now Airbus) and British Aircraft Corporation in the United Kingdom (now BAE Systems), the Concorde was a supersonic aeroplane with a cruising speed of 2,172 km/h (Mach 2.02). It quickly became the dream aeroplane of all aviation enthusiasts, captivated by its design features and aesthetic lines. The first test flights were carried out in 1969, and the first commercial flight on 21 January 1976. This commercial maiden flight was performed by two aircraft. One took off from Paris bound for Rio de Janeiro, while the second took off from London bound for Bahrain.

MAIN TECHNICAL CHARACTERISTICS

Design

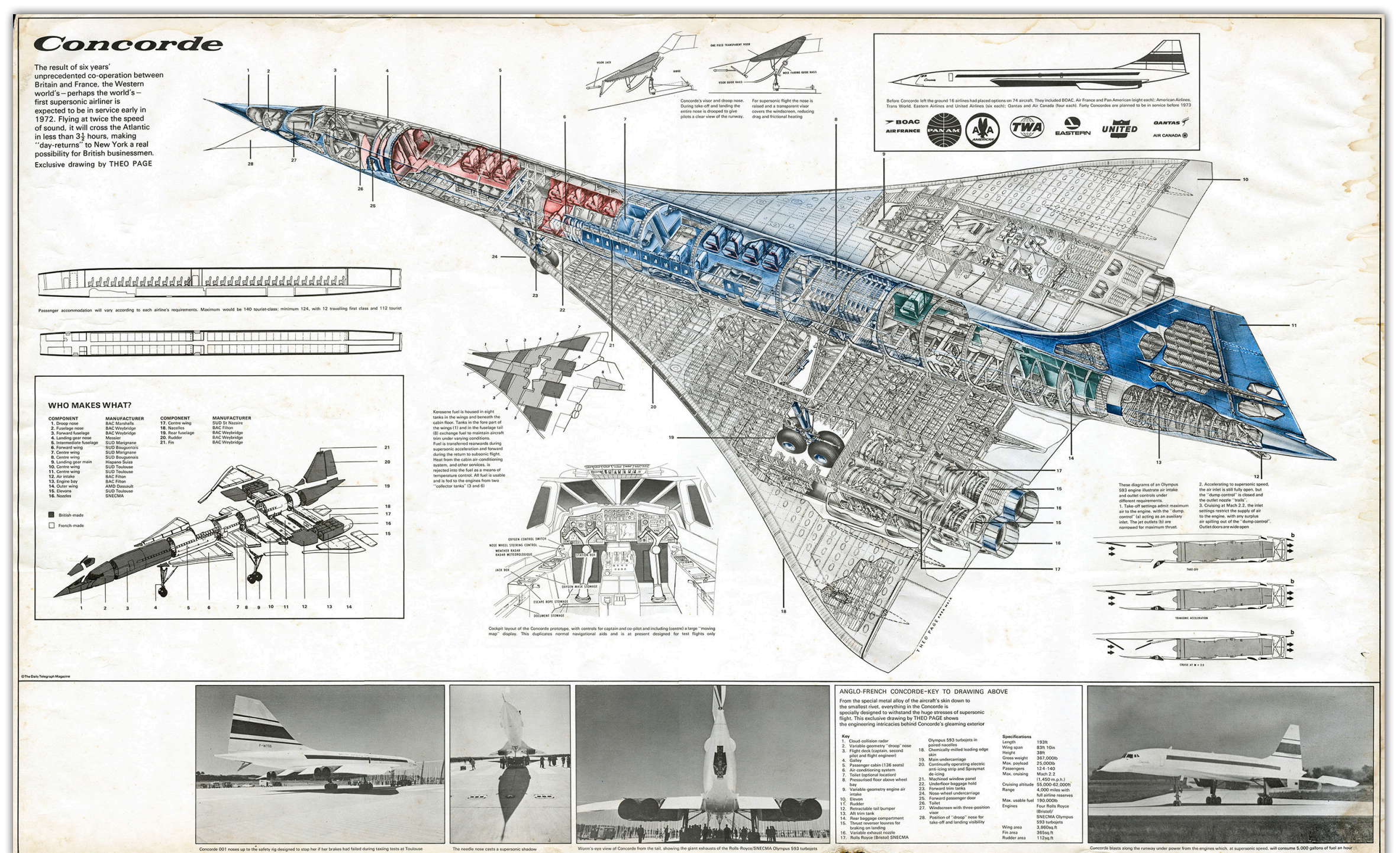
- Deltawings, also known as “gothic” wings: this configuration improved the aeroplane’s stability and lift.
- A droop nose giving pilots better visibility on the ground (nose lowered 5° during ground manoeuvres and take-off/12.5° during landing).

Performance

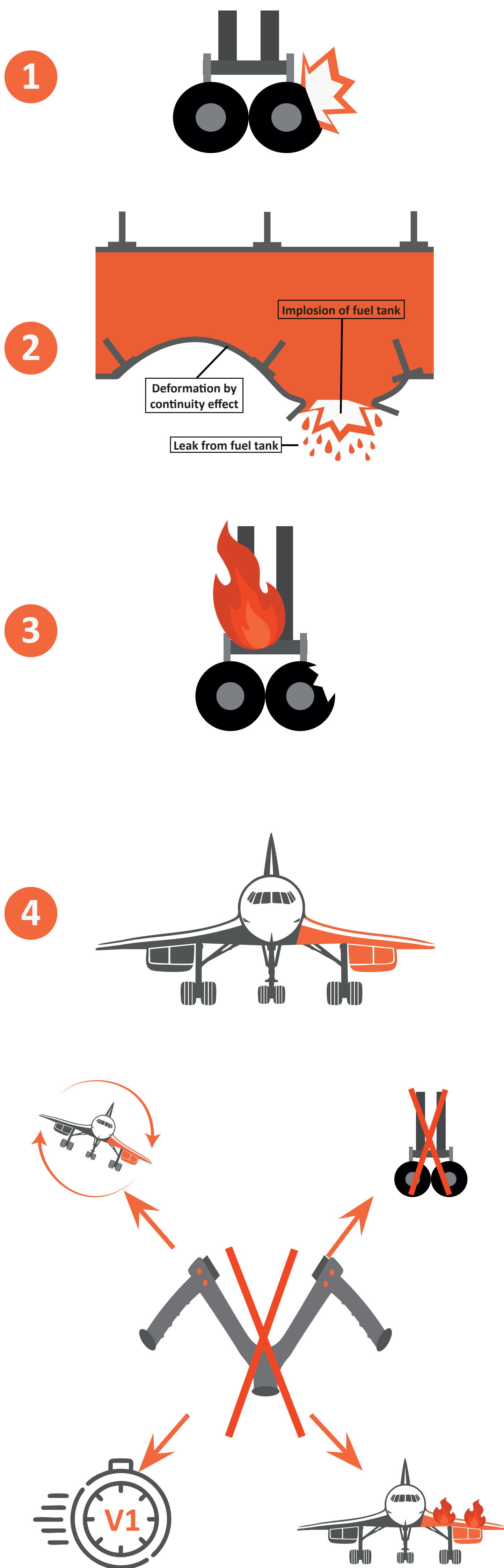
- Four Rolls Royce Olympus 593 turbojets with reheat in order to increase thrust and reach supersonic speeds.
- Maximum speed: 2,369 km/h (Mach 2.23).
- Cruise altitude: 60,000 ft (FL600, around 18,000 m).

Other striking facts

- First civil aeroplane equipped with fly-by-wire and analogue flight controls.
- Holds the record for the fastest commercial flights:
 - Paris/New York in 3 h 30 min (compared to a conventional flight of 8 h 15 min);
 - New York/Paris in 2 h 59 min 40 s, on 24 December 1989;
 - New York/London in 2 h 52 min 59 s, on 7 February 1996;
 - Round-the-world supersonic flight on a passenger plane, record set on 15-16 August 1995, in 31 h 27 min 21 s (with stopovers), including 18 h 40 min 08 s in supersonic flight.



A DESPERATE SITUATION



Tyre burst and projection of debris

As the aeroplane reached a speed of approximately 300 km/h, the right front tyre of the left main landing gear ran over a titanium strip, a relatively rigid metal. The tyre was lacerated and violently exploded. A piece of tyre weighing over 4 kg was propelled upward and forward at very high speed.

Rupture of fuel tank

This piece of tyre struck the underside of the left wing, level with fuel tank No 5. The impact was so violent that it deformed the wall, creating a hydrodynamic shock wave inside the full tank. This internal overpressure caused the tank's structure to collapse from the inside, and a breach at the weakest point of the tank's structure.

Massive leak which immediately caught fire

Approximately 75 litres per second of kerosene escaped through this breach. This pulverized fuel immediately ignited. (The investigation was unable to determine what exactly caused it to catch fire.) A huge sheet of fierce flames clung to the landing gear strut.

Loss of power of two left engines

Engine No 2 (inside left) suffered severe surges as it ingested hot gases from the fire and unburned fuel. It lost almost all its power. The crew shut it down, in accordance with procedures. Engine No 1 (outside left) also lost almost all its power for the same reasons a few seconds later.

Less than two minutes elapsed between the aeroplane running over the metal strip and the collision with the ground. The chain of events was so rapid and violent that the crew never had the time or means to regain control.

The damaged Concorde was in the take-off phase at a speed too high to stop, but without enough power to continue flying. From that moment on, no manoeuvre by the crew could have prevented the accident.

PREVIOUS OCCURRENCES AND STUDIES

Prior to the accident on 25 July 2000, there had been six occurrences where the fuel tank had been perforated. However, these six occurrences differed in their sequence and consequences.

- Four of them occurred during take-off: in two cases, the tyre burst was caused by an object on the runway or by the tyre being deflated; in two other cases, the cause remained undetermined.
 - One while landing
 - One while taxiing
- The tyre had burst because of a jammed braking system.

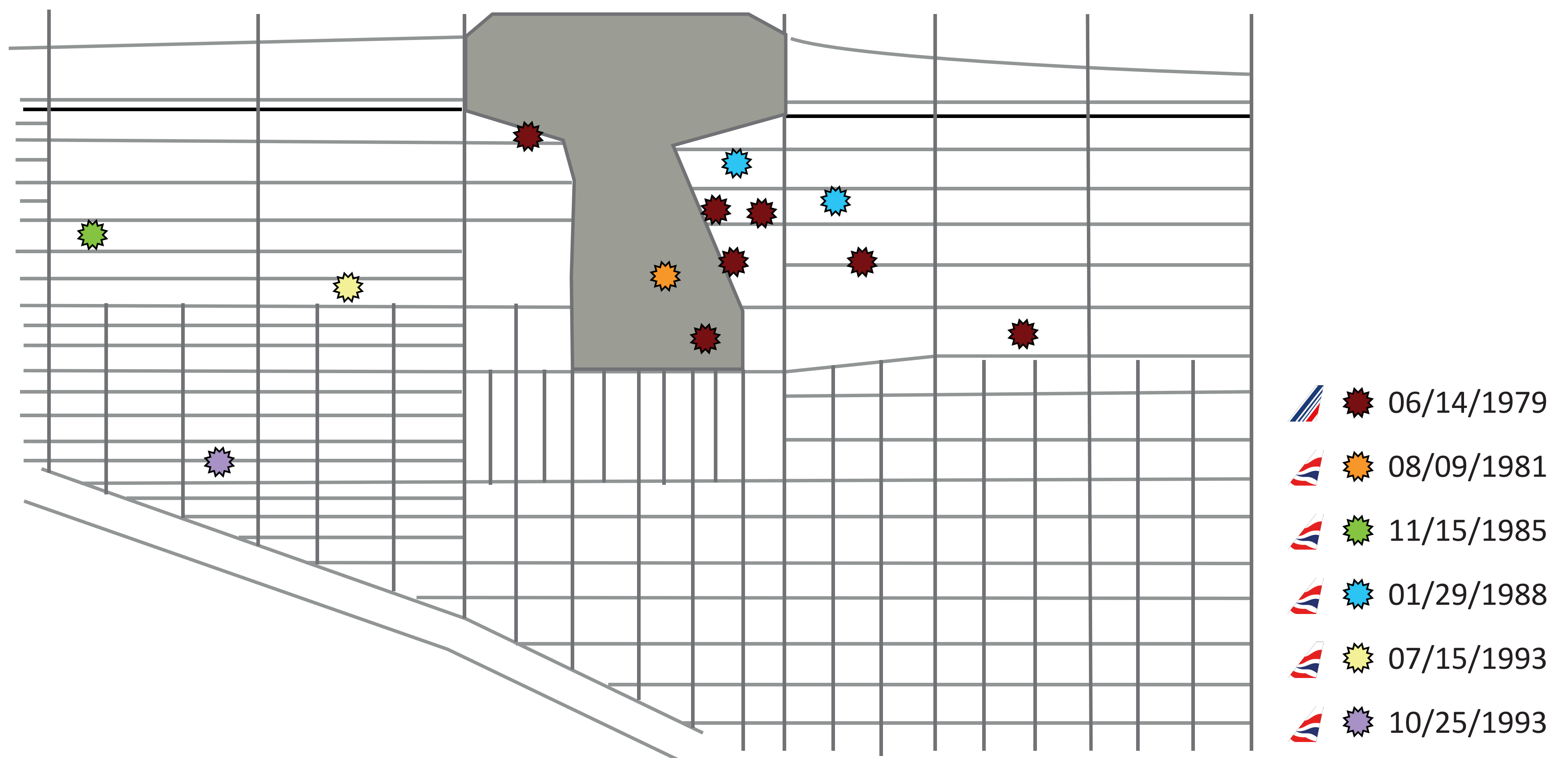


Diagram of impacts with perforation in the six occurrences (right wing and left wing)
- landing gear door in grey -

Of these six occurrences, the one that caused the most substantial damage was on 14 June 1979, in Washington, to the Concorde registered F-BVFC operated by Air France.

Although this occurrence may seem similar to the 25 July 2000 accident, it was never anticipated that the bursting of a tyre could cause a shock wave inside the fuel tank and perforate it from the inside.

In the incident involving the Concorde F-BVFC, several perforations were observed on tanks 2, 5, and 6 (see figure above). One of these perforations was caused by tyre debris, and the others were caused by small aircraft debris from the main landing gear area.

In this incident, the investigators noted that the fuel flow resulting from the three tank perforations was estimated at 4 kg/s (the estimated flow rate on flight AF4590 was approximately 60 kg/s).

INCIDENT TO CONCORDE REGISTERED F-BVFC OPERATED BY AIR FRANCE ON 14 JUNE 1979 AT WASHINGTON

- Two tyres burst with separation of tread during take-off
- Engine damaged, fuel tanks perforated, hydraulic system lost, landing gear jammed
- Emergency landing without casualties
- Tyre inspection procedures reinforced

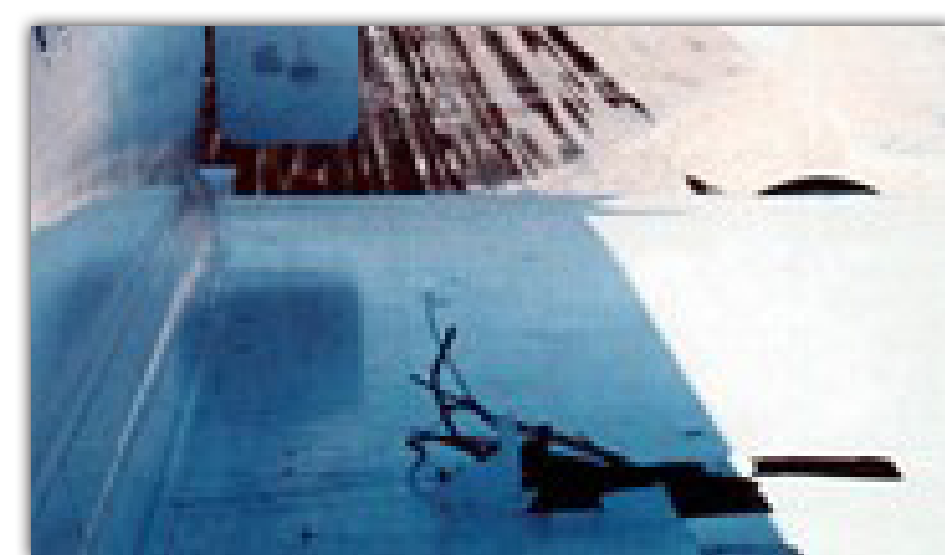
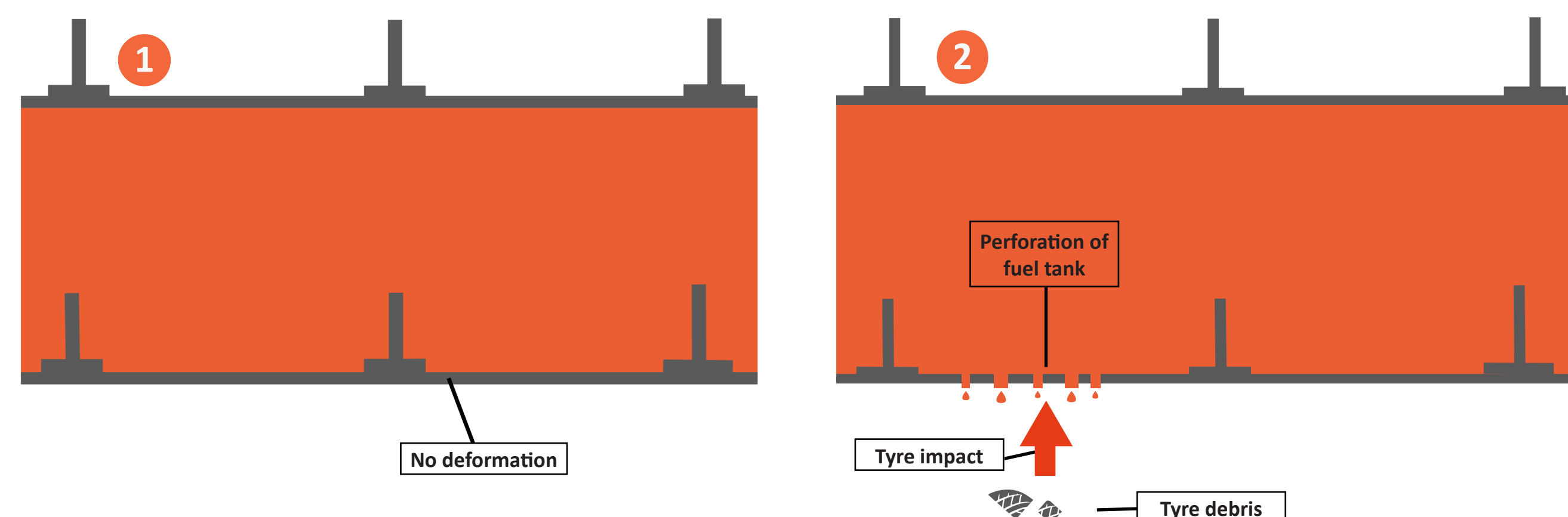


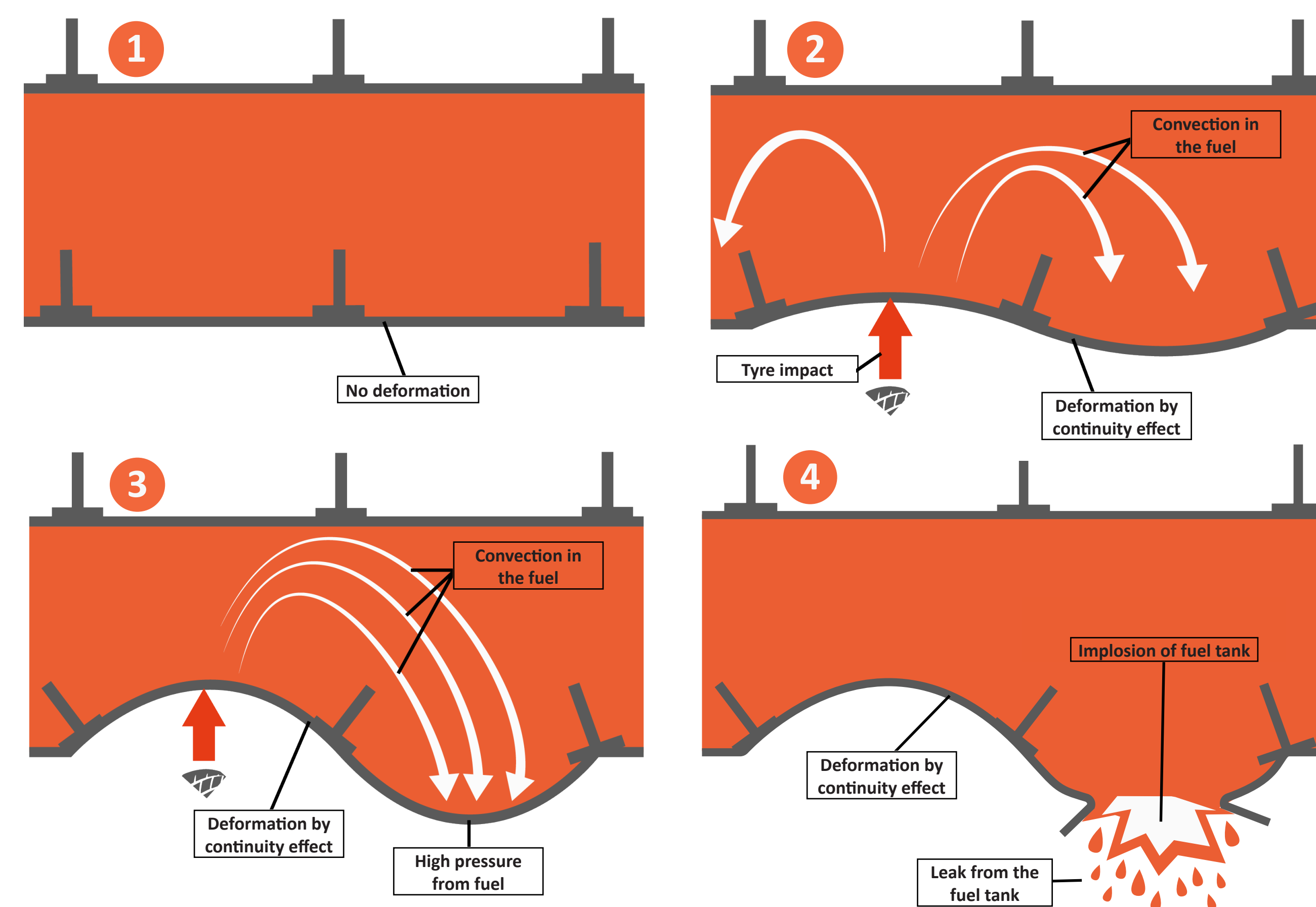
Photo (viewed from above) of damage to the left wing of F-BVFC, following the penetration of wheel No 5 debris



Photo showing the perforation of the fuel tank located in the left wing of F-BVFC and the fuel leak

ACCIDENT TO CONCORDE REGISTERED F-BTSC OPERATED BY AIR FRANCE ON 25 JULY 2000 AT GONESSE

- Tyre burst due to a metal strip on the runway
- Fuel tank perforated by shock wave, fire, loss of engine power, landing gear and flight controls jammed
- 113 fatal injuries
- Concorde flights suspended, technical and structural modifications, new certifications, resumption of flights



Part of tank No. 5



Titanium strip found on the runway

BEA'S RECOMMENDATIONS

The day after the accident, Air France's six remaining Concorde's stopped carrying out commercial flights pending the initial results of the investigation.

On 16 August, the BEA recommended that *"The Certificates of Airworthiness of Concorde be suspended until appropriate measures have been taken to ensure a satisfactory level of safety as far as the tyre destruction based risk is concerned."* This recommendation jointly issued by the BEA and British AIB, was immediately accepted and implemented.

In early 2001, Kevlar liners were introduced into the fuel tanks to prevent leaks following structural damage, and the Concorde's were equipped with new radial tyres.

In November 2001, flights resumed at a time when the sector was facing a full-blown crisis following the September 11 attacks. This resumption of flights would be short-lived, especially since the modifications to the fuel tanks made the Concorde heavier and reduced its passenger capacity.

The former enthusiasm was no longer there, and the supersonic aircraft failed to win back public confidence. Air France decided to discontinue Concorde operations, the final flight taking place on 23 May 2003. British Airways ceased operations in October 2003.

