

No. 2Bristol - 170 F-BENF aircraft, crashed at Tanezrouft
Sahara, on 29 July 1950Circumstances

The aircraft whilst on a flight from Algiers to Gao crashed at Tanezrouft (Sahara) on 29 July 1950, killing all thirty-two persons on board.

Investigation and Evidence

The aircraft left Aoulef for Gao at 0242 hours and at 0248 reported its take-off to Aoulef adding "visibility good, climbing to cruising altitude, maintaining watch and keeping contact with Gao and Tessalit". At 0255 the aircraft again called Aoulef reporting that it would call that station again at 0400 hours. No further message was received from the aircraft. It was estimated by stopped watches on victims that the crash occurred at 0410 hours.

The crash was located 50 km to the west of the imperial route linking Adrar to Bidon V, on flat, hard, stony ground suitable for landing even at night with landing lights. This area, known as the Tanezrouft (land of thirst), is complete desert without water holes or any human, animal or vegetable life, with temperatures unbearably high making the task of the rescue unit and investigators particularly difficult.

Parts of the aircraft were scattered over a wide area indicating failure of the aircraft during flight. Three parts were clearly separated from the rest of the wreckage; the main starboard fuel tank, the booster pump and its attachment to the fuel tank.

The centre section of the wing structure lay right side up. It was broken off at the starboard side at the spar fitting connecting the outer wing structure with the central portion. A section of this spar fitting was examined by the Service technique de l'aéronautique and by the manufacturer. No trace of fatigue was discovered, however, they were clear failures. The centre section of the wing was broken off on the starboard side, along the plane of the rib connecting it with the outer wing section.

The centre section of the wing was broken off on the port side in an entirely different manner. The flanges of the front spar remained attached to the central portion of the wing, but the web had disappeared, the rivets which held it to the flange having loosened.

The rear spar, on the other hand, lacked its flanges, but part of the web remained. This type of failure shows that the port wing was subjected to very strong vibrations before its component parts fell off, one after another. The main port fuel tank was in place. Part of the upper surface was dismantled in order to gain access to the booster pump which was found to be intact. The following parts were still attached to the central portion of the wing: the complete left-hand landing gear, the fuselage bulkhead, and the radio equipment.

Outer portions of the wing

The port wing was in two sections. The starboard wing was in one piece. In both cases the ailerons were torn off and were found respectively -

starboard aileron - 100 metres from the starboard wing port aileron
- 200 metres from the left part of the wing.

The tail plane

The units of the tail plane were all found together. However, part of the starboard horizontal stabilizer and one unit that could not be accurately identified were found 700 metres from the main parts of the tail plane.

The tail wheel landing gear, the stern post and part of the rear section of the fuselage remained attached to the tail plane assembly.

The right side of the stabilizer bore scratches and tears, probably caused by some part of the wing flying off in flight.

Tail Control Surfaces

The elevator was still attached to the horizontal stabilizer but was almost completely crushed by the impact.

The rudder trim tabs, spring tabs or manually controlled tabs were found either on the control surfaces themselves or nearby.

It was impossible to determine their position at the moment of impact, since they could have been moved by the impact itself and by the failures of the control lines.

The wing flaps were set in the landing position (approximately 15°).

The starboard flap was separated from the larger wing units but had still attached to it several of the plates of the trailing edge of the wing.

The port flap remained attached to the centre section.

Fuselage

Only the flooring, which forms the strongest part of the fuselage, was found more or less intact. The sides of the fuselage came apart, so that the sheeting was scattered about and blown around by the sandstorms which occurred after the accident.

The forward fuselage doors were found 200 metres from the floor. They were bolted at the time of the impact. The upper door of the radio operator's station was found 300 metres from the cockpit. It was also bolted at the time of the crash.

The cockpit was upside down and was crushed by the impact.

Landing Gear

The tail-wheel gear was intact and attached to the tail plane assembly.

The left main landing gear leg was still attached to the centre section of the wing.

The right main landing gear leg was separated from the wing structure and was found 40 metres from the centre section.

None of the three tires had been punctured and they were not much damaged by the impact. There was no sign of abnormal wear to indicate that the aircraft had dragged along the ground.

Power Units

The two power units were found lying about 100 metres from the centre section of the wing.

1) Starboard Power Unit -

Except for one propeller blade which broke off at the impact, all the various parts of this unit were grouped together.

The propeller was in the feathered position. Only one of the two remaining blades was bent, as the engine stopped at the impact.

2) Port Power Unit -

The various units, mounting, engine and propeller were separated.

The propeller pitch was close to the feathered position. The propeller was still windmilling at the time of the impact, which explains the twisting of the blades and their being torn from the shaft. The engine showed signs of a localized fire of which there was no trace on the centre section of the wing.

The engines and propellers could be examined only superficially. The oil and fuel filters were clean. From what could be seen of the cylinders and pistons these showed no indication of seizing nor of any faulty operation.

Controls

As the cockpit was crushed it was impossible to determine with any accuracy the condition of the various controls.

It was impossible to determine whether the automatic pilot was on or off.

The various control levers were found in the following positions:

- Contacts: cut
- Throttle: cruising position
- Fuel supply valves: -
- Main starboard tank: closed
- Main port tank: open
- Change-over: on
- Trim tab controls: -
- Rudder: +3
- Elevator: +1
- Aileron: +1 on right side

The two landing lights were extended into the landing position, the starboard light being somewhat more extended than the port light.

The position of the three parts of the wreckage much farther south (500 metres) than the remainder indicated that the damage that had caused the accident occurred near the main starboard tank.

The four fuel tanks (two main and two auxiliary) are located in the compartments formed by the upper surface, the lower surface, the front and rear spars and two ribs. They rest on the lower surface over wooden felt-covered supports and are held in place by steel webbing which is also protected by felt. The handling straps are of braided cotton.

The compartment in which each tank is located has a few small diameter holes in the lower surface to permit release of fuel arising from faulty filling or from leakage from the tank itself. The compartment has no ventilation, however. The electrical circuits which are installed in the compartments (junction box, fuel gage potentiometer, wires) provide a risk of explosion: gaseous mixture formed by gasoline vapour and possibility of spark from the electrical circuits (poor contact, broken wire, etc.).

It was stated that if explosion of a gaseous mixture were to occur between the tank and the sheeting which covers it on the outside, the removable panel for gaining access to the tank, which forms the upper surface, would normally be the first to give. It will be noted that this panel was actually torn off the centre section of the aircraft whereas the other panels suffered relatively little damage.

Without waiting the results of the investigation, the Secrétariat Général à l'Aviation Civile et Commerciale requested the manufacturer to study and make the modifications required to remedy this defect. The modification was made by September 1950.

The manufacturer also sent appropriate technical instructions to other users of this type of aircraft.

Two theories were advanced on the sequence of events leading to the final crash.

Theory I

First phase of the accident

- a) Explosion occurred in the main starboard tank compartment.

(Such an explosion was possible, as already indicated, owing to the lack of ventilation in the compartment and the presence therein of electric circuits.

Inadequate sealing due to cracking of the fuel tanks had been reported on many occasions. Moreover, during the night refuelling at Aoulef, where the lighting is poor, fuel may have filtered into the compartment and not have completely drained out through the holes in the lower surface of the wing.

Circumstances could therefore have favoured such an explosion).

- b) The tank access panel on the upper surface of the wing was partly torn off and, owing to the shock wave, followed by aerodynamic depression, the tank flew out of its position.

(The tank, the booster pump and the cover of the latter were found within a circle 80 metres in diameter located approximately 500 metres from the outer section of the starboard wing.

The manufacturers design office stated that, in the event of an explosion, the upper surface would be the first to give.

The booster pump gear case was crushed by inertia of the liquid at the moment the tank hit the ground.

Note.- No carbon deposit indicating partial combustion was found on the tank or in the compartment.)

c) The aircraft failed to maintain its heading and began a turn to the right. The pilot then took the following action:

i) tried to keep the aircraft on course by operating the tabs, particularly the rudder tab;

ii) cut the starboard engine which was receiving no fuel and feathered its propeller;

iii) closed the valve of the fuel line from the starboard tank to the engine and, possibly not realizing the cause of the damage, switched to cross-feed,

Realizing that it was impossible to continue the flight, the pilot took the action required to make a forced landing. For this purpose he -

i) extended the landing lights;

ii) set the flaps in the landing position.

(It should be noted that the lowering of the flaps might have occurred accidentally during the subsequent failure of the wing structure. However, evidence would seem to discount the possibility of the flaps having been lowered by accident.)

iii) cut the port engine and feathered its propeller.

d) When the main starboard tank flew out, it may have struck the starboard stabilizer which became detached from the tail plane a few moments after the explosion. One of the walls of the starboard tank also flew off.

Second phase of the accident

a) The aircraft lost more and more height and an involuntary turn to the right became sharper. The vibrations caused by the tears on the upper surface of the wing became more marked and were perhaps increased by the lowering of the wing flaps, followed by loss of speed and displacement of the centre of torsion towards the trailing edge.

The vibration caused the outer portion of the starboard wing to break since it had become weaker than the port wing as a result of the damage to the compartment. The failure occurred near the tank where the outer section and centre section of the wing join.

b) The aircraft had now lost the outer starboard section of the wing but was otherwise more or less intact.

The outer section of the port wing then began to disintegrate under the action of the violent vibrations. This part would appear to have fluttered violently before breaking, judging by the appearance of the failure of the centre section.

c) What remained of the aircraft disintegrated at low altitude as a result of the vibration and the excessive centrifugal stresses. The position in which the bodies were found shows that the floor of the fuselage hit the ground in a flat spin.

Theory II

The manufacturer suggested that the accident might have occurred as follows:

The pilot noticed a smell of gasoline in the cockpit, which was strong enough to affect him. This leak was either from a broken lead or from bad sealing of a joint. As the cockpit was at lower pressure than the wing and the cabin, harmful vapours could penetrate into it. Being unable to stop the leak, the pilot prepared to land and started to operate the flap and landing light controls. Just at that moment, a spark possibly caused by starting an electric motor, caused the aircraft to explode.

This theory confirms that the accident occurred in two stages and explains, to some extent, the way in which the wreckage was scattered.

However, it does not permit any reconstruction of the path of the aircraft nor does it explain the reason why the main starboard tank and the accessories were found quite apart from the remainder of the wreckage.

Result of the Investigation

The investigation showed that:

Neither the aircraft, the crew, nor the airline were contravening the regulations in force at the time.

The rule requiring radiotelephony contact every half hour was not observed between Aoulef and the scene of the accident.

The compartments in which the fuel tanks were contained were unventilated and they could have exploded owing to the fact that electric cables passed through them.

Probable Cause

The accident was probably caused by an explosion in the wing compartment containing the main starboard fuel tank. This explosion tore off part of the upper wing surface which started a vibration of the wing structure which then caused multiple failures in flight.