

## **Undersea search operations to find the wreckage of the A 330, flight AF 447: the culmination of extensive searches**



The end of phase 4 of the sea searches, which has come to an end following the discovery of the wreckage, provides an opportunity to make an initial review of the searches that have been undertaken over the past 20 months.

To review the known facts, during the night of 31 May and 1<sup>st</sup> June 2009, the Rio-Paris flight AF 447 disappeared off the Brazilian coast, without any emergency message, witnesses or radar traces. During the morning of 1<sup>st</sup> June, significant air and naval forces were mobilised to search for signs of the airplane and any possible survivors. It was only 5 days later, and on the days that followed, that bodies and debris were found floating on the surface of the sea, to the north of the last position transmitted automatically by the airplane.

As the airplane was beyond the range of air navigation radar, the only airplane position available was the reporting point transmitted automatically at 2 h 10 min, a little under 5 min before the time of the end of the flight, which was determined via the maintenance message. Taking into account the maximum possible speed of the airplane, the wreckage of the airplane must then have been within a circle with a radius of 75 km (the Circle) centred on the last known position (LKP). This corresponds to an area of 17,000 km<sup>2</sup>.

The localisation of the first debris floating on the surface of the sea, about 70 km to the north of the LKP, did not make it possible to determine the site of the impact, without precise knowledge of the currents that had made the debris drift since the time of the accident. Further, the various aerial and satellite observations could not find any signs of the airplane. Thus, the position of the indeterminate pollution observed by the Cosmo-Skymed satellite on 2 June at 8 h 15 min 55 sec UTC, about 35 km SSE of the LKP, indicated that the latter was doubtless not linked to the accident.

The acoustic searches to detect the beacons installed on the airplane, which should transmit a signal for at least 30 days, were thus intended to explore as a priority the zone along the airplane's projected trajectory and, according to the time and resources available, the greatest possible area within the Circle. The area where the wreckage was discovered had thus already been explored using these means, without finding the beacons. The reasons for this non-detection will now be analyzed.

At the end of the period of transmissions from the ULB's, the only possible means for detecting the wreckage was thus through the use of sonar detection. It was then estimated that covering the whole of the 17,000 km<sup>2</sup> circle would take at least six months. In order to reduce this period, we tried to limit the search area by evaluating the drift of the debris between the time of the impact and the time it was recovered. In order to do this, the BEA called upon a group of experts from international oceanographic institutes who defined a rectangle with a reduced area of 3,000 km<sup>2</sup>, located to the north-east of the LKP. This zone should have included the place of the impact, with a high degree of probability.

The objective of phase 3 of the searches was thus to explore this rectangle with sonar, including the Remus AUV. The first search period in the month of April 2010 was unsuccessful and was followed by a second period of one month that was intended to cover an adjacent zone, though with no greater success.

The lack of any positive results during the preceding search phases led the BEA to undertake a complete review of both the means used and the zones explored.

In particular, it was necessary to check the predictive ability of the drift calculations. In order to do this, drift buoys were dropped, at the BEA's initiative, from a French Navy aircraft at the beginning of June 2010 in the area of the accident. Tracking them via satellites in the following weeks demonstrated the turbulent nature of the currents in this region and thus the difficulty of predictions.

Analysis of all of the results from the previous searches allowed the BEA to deduce that the zones that had previously been searched using sonar did not need to be explored again, given the performance of this type of equipment.

This was why phase 4 was based on the strategy of a systematic search of all of the zones not explored up to then during phase 2 by the IFREMER SAR sonar and during phase 3 by the REMUS and ORION sonars. This thus led to covering the whole of the remaining area of 10,000 km<sup>2</sup> in the Circle.

The study carried out by Metron at the request of the BEA thus consisted, based on analysis of all of the surface and undersea search data since the accident, to attributing degrees of probability of the presence of wreckage to the various regions in the Circle, given that those that had been covered by sonar were considered "clear".

This study, published on the BEA website on 20 January 2011, indicated a strong possibility for discovery of the wreckage near the centre of the Circle. It was in this area that it was in fact discovered after one week of exploration thanks to the performance of the REMUS AUV's operated by Woods Hole Oceanographic Institution.

## **Conclusion**

The discovery of the wreckage concludes months of searches undertaken in very difficult conditions. It should be noted that, in order to avoid such difficult searches in the future, more frequent position reporting by airplanes is required (flight AF447 transmitted its position only every 10 minutes) This was the subject of a recommendation made by the BEA in its Interim Report on 17 December 2009.

These searches were undertaken on the basis of the BEA's safety mission, which is to determine the causes and circumstances of an accident based on the established facts.

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