BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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Update on the Investigation into the Accident to flight AF 447 on 1st June 2009

On Sunday 31 May 2009 at 22 h 29 UTC[1] (19 h 29 Rio time), the Airbus A330-203 registered F-GZCP, operated by Air France under flight number AF447, took off from Rio de Janeiro Galeão airport bound for Paris Charles de Gaulle. The airplane was carrying 216 passengers of 32 nationalities as well as 12 crew members. Around 3 h 45 minutes after take-off, the airplane crashed into the Atlantic Ocean about 435 nautical miles north-north-east of Fernando de Noronha island, in the middle of the night and without any emergency message being sent. The last contact between the airplane and Brazilian Air Traffic Control (ATC) had been made around 35 minutes previously.

[1] UTC is the time reference used in aviation. Three hours should be subtracted to express the time in Brazil and two hours added for metropolitan France on the day of the accident.

The Sea Search Operations

The alert[1] was raised by ATC centres almost 7 hours after the last contact with the airplane. A first search phase was then launched with significant naval and air resources supplied by the Brazilian, French and American armed forces.

On June 6, that's to say 5 days after the accident, the first debris floating on the surface was identified. In total, more than 1,000 items of debris and the bodies of 50 persons were recovered. These operations were brought to an end on 26 June, no debris or bodies having then been recovered for several days.

The bodies were taken to Recife to be autopsied by the Brazilian authorities.

From 10 June onwards, undersea search operations were undertaken with acoustic means supplied by France and the US Navy, aimed at localizing the beacons attached to the flight recorders, whose transmission time is 30 days. These operations were brought to an end on 10 July, without the beacons having been located.

The debris was subsequently transferred to the Toulouse aeronautical test centre (CEAT) to be examined by the French authorities.

A further phase of undersea searches was undertaken from 27 July to 17 August with different means since the beacons could no longer be transmitting. This equipment included both sonar and remotely operated undersea vehicles. This new phase also failed to bear fruit.

[2] In case of a loss of contact with an airplane, an alert must be declared by the ATC centres in order to call out emergency services. There are several levels of alerts.

Organisation and Progress of the Investigation

As soon as the accident was known about, the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) was made responsible for the technical investigation. In accordance with the international provisions of Annex 13 to the Chicago Convention regulating aviation investigations, the BEA is competent to undertake investigations into accidents to airplanes operated by French airlines when they occur in international waters. The BEA directed the undersea search operations within this regulatory framework. Accredited representatives from our Brazilian, German, American and British counterparts were associated with the investigation.

Not having been able as yet to find the flight recorders or to be able to examine the wreckage, the main evidence available at this time relates to:

1. The crew
2. The airplane
3. The meteorological conditions
4. The preparation of the flight
5. The flight
6. The ACARS maintenance messages transmitted automatically via satellite to the airline's headquarters
7. The debris
8. The autopsies
9. The events linked to speed measurement inconsistencies

1. The Crew

For long-haul flights, the flight crew, which usually consists of two pilots, is reinforced. Thus, for this flight the crew was made up of a Captain and two co-pilots, all with the appropriate qualifications and experience. On this type of flight, the Captain normally takes a rest during the cruise phase, at a time that is left to his choice, so as to be fresh for the arrival. As a result, at the time of the accident, the Captain may have been taking a rest or may have been at the controls, something that the investigation has not yet been able to determine with certainty.

2. The Airplane

The technical condition of the airplane was normal at the time of take-off. Weight and balance were within the authorized limits. The maintenance actions required had been performed. The fuel loaded on board was greater than the planned consumption for the flight and allowed for an hour's extension of the flight, at the Captain's discretion. Finally, one VHF transmitter out of three was inoperative, without this having any operational consequences.

3. The Meteorological Conditions

The airplane flight path passed through the inter-tropical convergence zone, known as an area of frequent storms. The meteorological analyses made by Météo-France, completed by observations by NASA satellites, indicate that the airplane crossed a barrier of continuous cumulonimbus, an area with turbulence but not lightning, whose development was not sudden. There are no indications that this was an exceptional situation.

4. Flight

• ***Preparation within the airline***

The flight plan had been prepared by the airline's central study service and by the stopover at Rio. It had been given to the crew before departure. They had the latest meteorological information and had been able to consult the meteorological charts and satellite photos at the stopover via the Air France server. Flight preparation was normal.

• ***The flight plan***

On the basis of the elements supplied by the airlines, and in accordance with the regulations in force in Brazil, the flight plan for departure is filed before each departure by the Brazilian ATC service with the control centres overflown. The Dakar control centre did not receive the flight plan: this centre had thus not been informed of the airplane's departure. However, the elements relating to the flight were passed on orally by the Brazilian ATC to Dakar control about 45 minutes before the planned entry into the Dakar zone.

5. The Flight

The last contact with Brazilian ATC occurred at 1 h 35 min 15 UTC, at the edge of radar range: there was nothing amiss at that time. At 2 h 01 UTC, the crew tried in vain for the third time to connect to the ADS-C system of Dakar ATC. This failure resulted in an incorrect transcription by the Dakar controller of the airplane's registration supplied by the Brazilian ATC.

Up to the last position report point, transmitted automatically via the ACARS messages, the airplane had not deviated from the planned route by more than 1 nautical mile. A possible alteration of the route, as made by other flights crossing the area at the same period of time, could only have happened in the last 5 minutes of the flight.

6. The ACARS Maintenance Messages

The first of the ACARS messages, linked to a speed measurement inconsistency problem, was sent at 2 h 10, at the same time as the last position message.

The ACARS messages are sent automatically, without any intervention by the pilot, to the airline's headquarters for maintenance reasons. Their content and their frequency are determined by the airline; they do not contain information on the flight parameters, only those on the state of the systems and on the position of the airplane.

The origin of all of the ACARS messages received is now understood. Almost all of them were linked to faults in speed measurement.

7. The Debris

Examination of the debris indicates that the airplane struck the surface of the sea violently, with a slight pitch-up attitude and no bank. With the possible exception of minor elements, the airplane was intact at the moment of the impact since the debris found came from all over the airframe. The airplane was pressurized and no preparation had been made for ditching. The wing was in cruise configuration.

8. The Autopsies

The identification of the victims made it possible to determine that they were positioned all around the cabin.

The autopsies indicate that the majority of injuries was compatible with a violent shock upwards from below.

9. Events Linked to Speed Measurement Inconsistencies

The Pitot probes are tubes that allow measurement of the airplane's speed in relation to the air. They are one of the elements in a chain of measurements that also enable determination of the air temperature and Mach number (relation between airplane speed and the speed of sound). This equipment is thus essential to the conduct of the flight.

Airplanes are equipped with 3 Pitot probes whose indications are compared. It was an inconsistency in the measurements that initiated the disconnection of the various flight control systems: autopilot, autothrust and flight director.

• Certification of the Pitot probes

During airplane type certification, the conformity of various systems to the certification criteria is checked via calculations and tests. All of the probes installed on the Airbus responded not only to the criteria in force, but also to more strict specifications established by the manufacturer and, consequently, approved by the certification authorities.

Nevertheless, these criteria do not cover all of the situations that modern long-range airplanes can encounter. In fact, they cruise at very high flight levels for which the composition of the cloud mass is not taken into account precisely.

• History of the Pitot probes on A330/A340

Incidents of inconsistency in airspeed measurements[3] linked to the blockage of the Pitot probes through icing has not, until now, been systematically reported by aircrew to their airlines[4], since they have generally been considered to be controllable events. Those that were reported to Airbus and to the EASA had been classified as not requiring immediate measures. Nevertheless, as a result of the increase in the number of incidents reported from September 2008 on, a certain number of measures were taken successively by Airbus and the airlines, previous to the accident, aimed at changing the probe models.

Thus, a first delivery of Thales model BA probes, intended to replace the AA model that was installed on the accident airplane, arrived at Air France 6 days before the accident.

• Analysis of previous incidents

In the context of this investigation, the BEA has performed a detailed analysis of 13 significant events involving 5 airlines operating A330/A340 airplanes. Around forty other reported events could not be analysed completely due to missing data.

The events analysed possess a certain number of similarities:

- they occurred in air masses that were highly unstable and the seat of deep convection phenomena;
- autopilot disengaged in all of the cases;
- the maximum continuous invalid recorded speed duration was three minutes and twenty seconds;
- the uncommanded altitude variations remained within a range of more or less one thousand feet;
- the airplane always remained within its flight envelope.

Summary

At this stage of the investigation, despite the extensive analyses carried out by the BEA on the basis of the available information, it is still not possible to understand the causes and the circumstances of the accident.

The BEA confirms that the phenomenon of inconsistency in the measurement of airspeeds was one of the elements in a chain of events that led to the accident, though this alone cannot explain it.

The BEA notes that several measures relating to crew training and the replacement of Pitot probes on A330/A340 have already been taken by airlines and Airbus.

Nevertheless, it is necessary at this stage to make two recommendations:

- The first is based on the work of an international group launched by the BEA, and is aimed at improving the effectiveness of the equipment for localizing airplanes and collecting the recorded data for analysis in case of an aviation accident, when such an event occurs over the sea. This means being able to obtain more quickly and surely the data required for the understanding of the accident;
- The second aims at better characterizing the composition of the cloud masses at high altitude in which long-range airplanes fly and to draw conclusions in relation to airplane certification.

The next Phase of the Investigation

The BEA is continuing its investigation based on the elements that are available today.

However, understanding this accident requires analysis of the data from the flight recorders and, in their absence, an examination of the wreckage. That is why the BEA has launched the preparatory work for undertaking a new phase of sea searches with the aim of starting in February 2010.

[3] In English, known as UAS, for unreliable air speed.

[4] Pilots are obliged to report to their airline any events that threaten safety. The airlines then inform the authorities and the manufacturer of the airplane, according to the seriousness of the event.

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