ACCIDENT REPORT OF FLIGHT AF 447

(extracts from INTERIM REPORTS by the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile - www.bea.aero)

Compiled & adapted for training purposes by Thierry HERMAS

Synopsis

Time line

19:03 - Departure at Rio de Janeiro-GIG - **~22:05** AF 447 is passing Natal and is heading out over the Atlantic at 35.000 feet and with 450 knots - **22:33** last radio contact, AF 447 passing INTOL waypoint - **22:48** AF 447 left controlled airspace of CINDACTA 3, north of Fernando de Noronha Island - **~23:00** AF 447 entered a zone of thunderstorm clounds and turbulences - **23:10** ACARS message indicates that the autopilot was disengaged, fly-by-wire systen reverts to alternate law, data from both pitot static ports lost, TCAS antenna at fault - **23:11** both air data units flight computers (ADIRU) failed, standby attitude indicator (ISIS) lost - **23:12** diagreement of ADIRU data - **23:13** two flight management computers (PRIM1 + SEC1) failed - **23:14** AF 447 sent an automated message indicating an electrical problem and a possible loss of cabin pressure - **23:20** - estimated passing of waypoint TASIL - **02:33** alarm war raised and the search rescue mission began -

(11:15 CET - scheduled time of landing at Paris-Charles de Gaulle Airport)

Date of accident

1st June 2009 at around 2 h 15

Site of accident

Near the TASIL point, in international waters, Atlantic Ocean

Type of flight

International public transport of passengers, scheduled flight AF447

Aircraft

Airbus A330-203 registered F-GZCP

Owner

Air France

Operator

Air France

Persons on board

Flight crew: 3
Cabin crew: 9
Passengers: 216

Summary

On 31 May 2009, flight AF447 took off from Rio de Janeiro Galeão airport bound for Paris Charles de Gaulle. The airplane was in contact with the Brazilian ATLANTICO ATC centre on the INTOL – SALPU – ORARO route at FL350. There were no further communications with the crew after passing the INTOL point. At 2 h 10, a position message and some maintenance messages were transmitted by the ACARS automatic system. Bodies and airplane parts were found from 6 June 2009 onwards by the French and Brazilian navies.

Consequences

People & Equipment

All passengers & crew killed ; aircraft destroyed

TECHNICAL DATA

Flight Recorders

According to the information supplied by Air France, the airplane was equipped with two flight recorders, in accordance with the regulations in force:

Flight Data Recorder (FDR)

=> Manufacturer: Honeywell
- Model: 4700
- Type number: 980-4700-042
- Serial number: 11469

This Solid State Flight Data Recorder (SSFDR) has a recording capacity of at least twenty-five hours. The decoding document, supplied with this airplane, has around 1,300 parameters.

Cockpit Voice Recorder (CVR)

=> Manufacturer: Honeywell
- Model: 6022
- Type number: 980-6022-001
- Serial number: 12768

This Solid State Cockpit Voice Recorder (SSCVR) has a recording capacity of at

least two hours in standard quality and thirty minutes in high quality.
Both recorders were equipped with the regulation Underwater Locator Beacons (ULB) whose transmission duration is at least 30 days, on the 37.5 kHz frequency.
Note: the manufacturer of the beacons stated that the duration of transmission was of the order of forty days.

Wreckage and Impact Information

Debris identification

All the pieces of debris were found by the French and Brazilian Navies. They were detailed in a database that includes about 1,000 references concerning the aircraft parts.

Almost all of the aircraft debris was identified and classified by type: cabin, cargo compartment, wing, belly fairing, LDMCR (Lower Deck Mobile Crew Rest). This information completed the position, date and recovery time data that had been referenced previously.

Most of the parts found were low-density honeycomb or composite material parts.

Position of the recovered parts (exterior and cargo)PDDiaDia

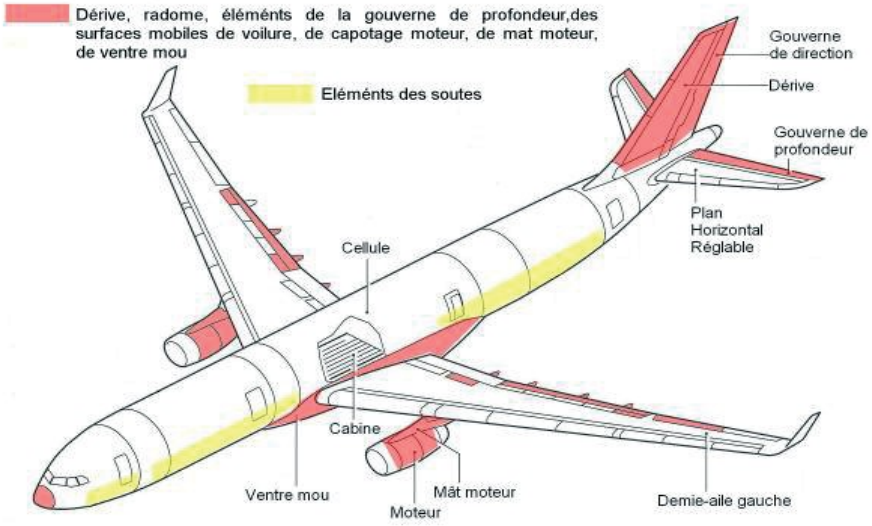


Diagram © www.bea.aero

Visual Inspections

Cabin parts

- A high degree of vertical compression can be seen on the cabin parts such as the galleys, stowage, partitions and toilet doors. This vertical compression is observable from the front (stowage and toilet at the level of door 1) to the rear of the aircraft (Galley G5), and from the right- to the left-hand sides.
Certain overhead luggage racks were found with their fuselage attachment fittings. Besides the damage due to the vertical compression, these fittings have deformations that are due to a forward movement of the overhead luggage racks.

- The lifejackets that were found were all in their packaging.

- Three Cabin Crew seats were recovered. The two seats located on the partition at the level of left-hand door 1 (photos below) were not deformed; which was also the case for the corresponding seat belt fasteners and attachments. The seat located at the level of right-hand

door 2 was damaged due to the deformation of the partition on which it was attached.

Cargo compartment parts

The outer parts making up the LDMCR were all found.
The wall fragments were crumpled. The reconstitution of the ceiling showed it was bent downwards and the floor bent upwards.
These deformations were symmetrical on the left and right sides with respect to the aircraft centreline.

Examination of the passenger oxygen containers

The passenger oxygen containers were all of the same type, with two, three or four oxygen masks depending on their position in the aircraft. Twenty-nine containers were found in the debris.
The deformations observed on three of them showed that they were in the closed position.
Note: the supply system for cabin oxygen is designed to trigger the simultaneous opening of all the containers in case of depressurisation. A test was carried out on F-GZCP in July 2008 during a type C overhaul. This test showed no malfunctions.

Wing and trimmable horizontal stabiliser flight control surfaces

The following parts were found:
- Left wing: part of the inboard aileron, part of the outboard flap trailing edge, spoilers 1 and 6;
- Right wing: part of the outboard flap trailing edge, parts of spoilers 2 and 6;
- Flap track fairings for flaps No. 2, 3, 4 and 5 left-hand side, No. 2, 3 and 4 right-hand side;
- Parts of the left- and right-hand elevators outboard side.

From these observations it can be seen that the general direction of the loads that caused these deformations is bottom-upwards.
Several parts of the flap extension mechanism fairing were found. There were marks on two of them (positioned at the level of flap track No. 3), made by the flap extension track on impact. Analysis of these marks (morphological and dimensional examinations) and comparison with an identical aircraft made it possible to determine that the flaps were in the "retracted" position at the time of impact with the water (measurement of the distance between the track and the lower surface of the flap, position of the carriage on the track).

The deformations observed on the rudder control rod are consistent with this indentation. The deformations of the frames were probably the consequence of the water braking the aircraft's forward movement.

Main Examinations : summary

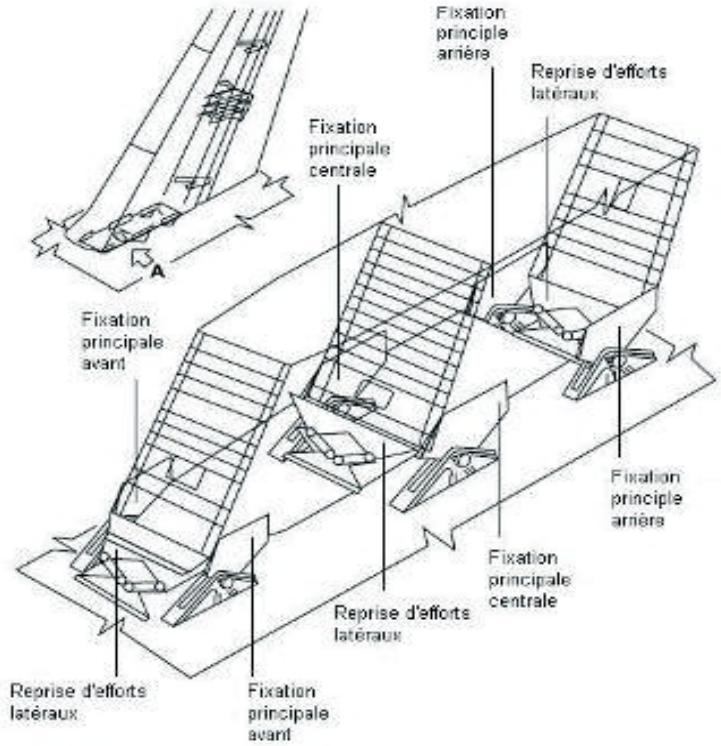
The cabin crew's seatbelts that were found (three out of eleven) were not in use at the moment of impact.

The containers recovered closed showed that the passenger oxygen masks had not been released. There had been no cabin depressurisation.
Note: depressurisation means pressure inside the cabin corresponding to an altitude of more than 14,000 ft.
The flaps were retracted at the time of impact with water.

The vertical stabiliser's side panels did not show signs of compression damage. The breaks seen at the level of the lateral load pick-up rods were the result of the backwards movement of the attachments and centre and aft frames. The observations made on the vertical stabiliser are not consistent with a failure due to lateral loads in flight.

The observations made on the debris (toilet doors, partitions, galleys, cabin crew rest module, spoiler, aileron, vertical stabiliser) evidenced high rates of compression resulting from a high rate of descent at the time of impact with the water. This high rate of compression can be seen all over the aircraft and symmetrically on the right- and left-hand sides.

High levels of loading would be required to cause the damage observed forward of the vertical stabiliser (compression failure of the forward attachment). These observations are not compatible with a separation of the aft part of the fuselage in flight.



Stabiliser attachment diagram © www.bea.aero

The damage found at the root of the vertical stabiliser was more or less symmetrical, as were the deformations due to the high rate of compression observed on the various parts of the aircraft. This left-right symmetry means that the aircraft had low bank and little sideslip on impact.
The deformations of the fuselage frames at the root of the vertical stabiliser were not consistent with an aircraft nose-down attitude at the moment of impact.

From these observations it can be deduced that:
- The aircraft was probably intact on impact.
- The aircraft struck the surface of the water with a positive attitude, a low bank and a high rate of descent.
- There was no depressurisation.

Medical and Pathological Information

This section is based on examination of the autopsy reports and photographs of the victims made by the Brazilian authorities and provided to the BEA. It should be noted that interpretation of the injuries is disrupted by the effects of prolonged presence in water.

The autopsies performed made it possible to identify fifty persons: forty-five passengers, four flight attendants, including an in-charge flight attendant, and the Captain.

According to the assigned seat placements at check-in, the passengers were distributed around the cabin as follows:
- Eight were seated in business class between doors 1 and 2;

- Three were seated in business class aft of door 2;

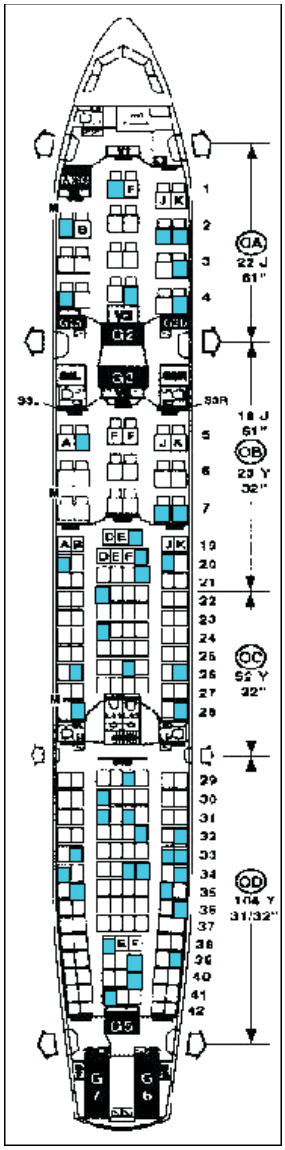
- Twelve were seated in economy forward of the over-wing exits;

- Twenty-two were seated at the rear of the airplane, between the overwing exits and the number 3 doors.

Forty-three of the victims had fractures of the spinal column, the thorax and the pelvis. The fractures described were located mainly at the level of the transition vertebrae.

The compression fractures of the spinal column associated with the fractures of the pelvis, observed on passengers seated throughout the cabin, are compatible with the effect, on a seated person, of high acceleration whose component in the axis of the spinal column is oriented upwards through the pelvis.

Note: the information from the autopsies does not make it possible to reach a conclusion as to the location of the Captain at the time of the accident.



In blue, the seats occupied by the victims whose bodies were recovered, based on the seats attributed during check-in

Difficulty of the searches

The first difficulty is the remoteness of the zone, which requires transits of the order of two to four days from ports such as Praia (Cape Verde), Natal (Brazil) or Dakar (Senegal).
The absence of any trace of the accident in the first days and absence of an emergency distress message and radar data complicated the searches. The environment is also very unfavourable since the search zones are above the Atlantic ridge close to the equator. This implies that the underwater terrain is rough, with great variations in depth over short distances.
The proximity to the equator affects the modelling of the currents in the estimated accident zone. The lack of available on-the-spot data and the complex oceanic dynamic (notably due to the seasonal start of the northequatorial counter-current during the month of June) also make it difficult to model the marine currents. These factors contributed to making the reversedrift calculations imprecise, added to which it was necessary to make them over a period of five to six days, which accentuated the gaps.

PARTIAL CONCLUSION ON THE ANALYSIS OF THE MESSAGES TRANSMITTED BY *ACARS* ON JUNE 1st FROM 2h10:

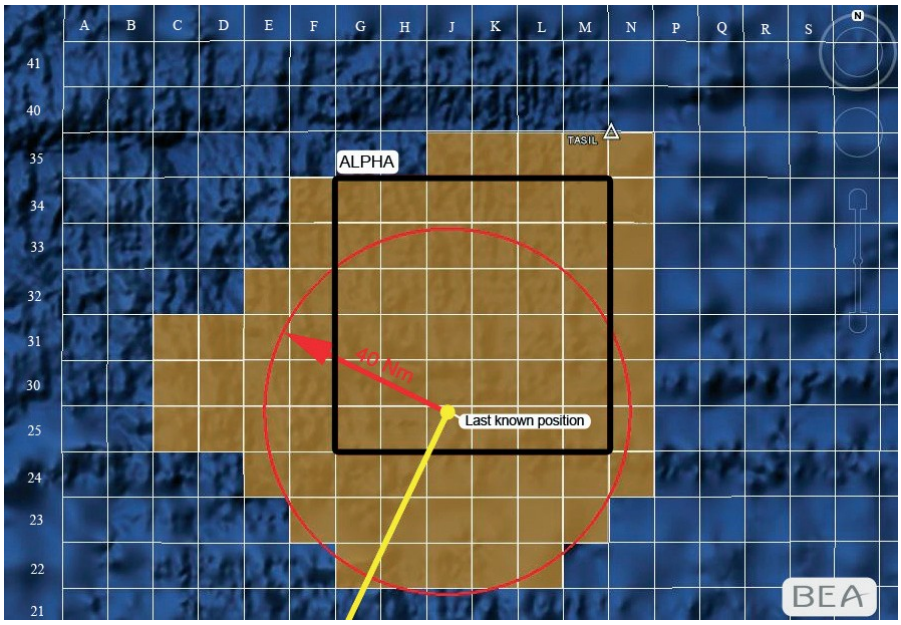
At this stage of the investigation, analysis of the messages makes it possible to highlight an inconsistency in the speeds measured just after 2 h 10 which in that minute generated ten of the twenty-four maintenance messages. Eleven other messages generated between 2 h 10 and 2 h 14 can also be linked to anemometric problems (inconsistencies in the speeds, low speeds and/or erratic speed values).
The aircraft switched to *alternate 2* law in the minute at 2 h 10 and remained in that law until the end of the flight.
No message present in the CFR indicates the loss of displays or of inertial information (attitudes).
Note: in addition, as the ATSB mentions in its second interim report(3) on the incident to the A330-300 that was performing flight QF72, in relation to problems with ADIRU's, the maintenance messages relating to the events on flight AF447 and flight QF72 show significant differences, both in their sequence and in their content.

Meteorological Conditions

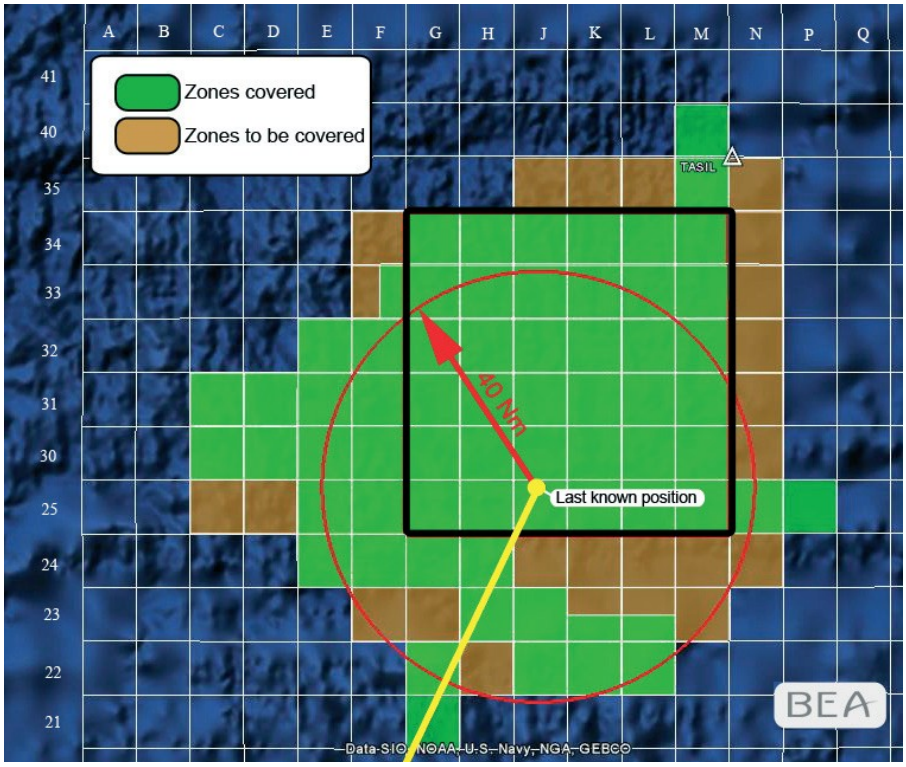
Meteorological Analyses

The additional analyses on the meteorological situation in the accident zone, based on the study of the observations made at 2 h 30 UTC by the Tropical Rain Measuring Mission (TRMM) satellite, are included in appendix 3.

Though the TRMM lightning imager indicates an absence of lightning in the accident zone at 2 h 30 UTC, the infrared image taken at the same time is consistent with those of Meteosat 9: taken together, this information does not make it possible to conclude that there was a sudden and exceptionally intense development of the convective activity between 2 h 07 and 2 h 30 UTC. Analysis of the observations by the TRMM TMI instrument, the only one operating in the microwave area, indicates the presence of strong condensation around 10,000 metres altitude, lower than the altitude of the cumulonimbus tops. This strong condensation would correspond to convective towers active at this altitude, which confirms the strong probability of notable turbulence within the convective cluster that was crossed by planned flight path of flight AF447.



Undersea search zone © www.bea.aero



Zones covered using the acoustic research resources © www.bea.aero

SEARCHING FOR THE WRECKAGE

Preparing phase 2

As the *Pourquoi Pas?* was present in the zone, it was decided to send the IFREMER's TAS (Towed Acoustic Sonar) to Dakar so it could be installed on the *Pourquoi Pas?* at the time of its remobilisation in order to launch the next phase of the search operations.
Squaring line (J-M 24), inside the 40 Nm circle, had not been explored for lack of time in phase 1. Phase 2 consisted of covering this zone and then completing knowledge of the bathymetry within a 40 km circle.
Note: The bathymetry of the zone, made up of a plain and slight slopes, was compatible

with the use of a towed sonar.
For this exploration mission on the site, the *Pourquoi Pas?* was equipped with an TAS, the *Victor* ROV, the *Nautile* submarine and an SMF.

IFREMER's TAS

The TAS was designed by IFREMER to study the geological nature and structure of the seabed at great depths (200 to 6,000 metres). It has also been used to search for wreckages
This side-scan sonar operating at a frequency of 180 kHz makes it possible, thanks to its imaging resolution (1 pixel for 25 cm), to carry out detailed studies of the seabed to complement other on-board systems designed for larger scale surveys.
The TAS consists of a torpedo-shaped vehicle (the fish) weighing about 2.4 tonnes that supports two rectangular antennas, about one metre long, installed on either side of the "fish".
The towed acoustic system can cover relatively large surface areas thanks to its operating speed of about two knots, and its scanning range which can cover a strip about 1,500 metres wide.

Significant points following the analysis of these 13 events of losses or indicated speed anomalies

In the cases studied, it is notable that:
- the airplane remained within its flight envelope during these relatively short events;
- the FD remained connected;
- the auto-thrust had been disconnected before the anomalies in one case.
In the other cases, either the autothrust remained connected, or the *thrust lock* function remained active several dozen seconds before the manual adjustment on the thrust.

Crew Reactions

This type of anomaly most of the time leads the AP to disengage, the FD to disappear, the autothrust to pass to *thrust lock* and the airplane to switch flight controls to *alternate law*.
The pilot flying gives priority to piloting the airplane and to the airplane flight path, by maintaining a cruise attitude or by performing a descent to increase the margins for evolution within the flight envelope. The descent can also be decided following the triggering of the *stall warning*.

The reappearance of the flight directors on the PFD when two air speeds will be calculated that can lead the crew to rapidly engage the autopilot. However, these speeds, though of the same order, can be erroneous and weak and thus lead the autopilot to command movements of the flight control surfaces that are inappropriate for the real speed of the airplane.
In case of automatic disconnection of the autothrust with activation of the *thrust lock* function, the absence of appropriate manual adjustment of thrust can present a risk of an attitude/thrust mismatch, especially when this disconnection occurs with a low N1 value.

Stall warning

Nine cases of triggering of the *stall warning* were observed.

Note : the manufacturer's additional abnormal STALL warning procedure is included in appendix 5.

The stall warning triggers when the angle of attack passes a variable threshold value. All of these warnings are explicable by the fact that the airplane is in *alternate law* at cruise mach and in turbulent zones. Only one case of triggering was caused by clear inputs on the controls.

Note: at high altitude, the stall warning triggers in alternate law on approach to the stall. The stall manifests itself particularly through vibrations.

DATA COLLECTED FROM THE ANALYSIS OF THE FLIGHT RECORDERS:

For two years, the aviation world has been waiting to find out what the black boxes from Air France 447 would reveal about the doomed airliner's fate. Today, French aviation authorities offered a first glimpse, releasing a four-page document that, while light on details, offered a summary timeline of events in the last few minutes before the plane crashed into the South Atlantic.
The data recorders tell a chaotic tale: At 2 am Greenwich Mean Time on June 1, 2009, as the plane is about to enter an area of heavy thunderstorms, one of the two co-pilots makes an announcement over the PA system that the flight will soon be experiencing increased turbulence. Other flights crossing this stretch of ocean around the same time have gone out of their way to avoid the storms; evidently the co-pilots believe they can pick their way through the worst of it with their weather radar. At 2:08, one says to the other, "You can maybe go a little to the left." The plane starts a gentle left turn. But apparently the weather is worse than they had anticipated. Just two minutes later, the autopilot disengages itself, forcing one of the co-pilots to take manual control of the plane. He pulls back on the controls, sending it into a climbing left turn. Though his indicators are showing a dramatic loss of speed, he continues to pull back, and the

plane experiences an aerodynamic stall. With a catastrophic loss of lift, the plane plummets at 10,000 feet per minute.
At 2:14 am, Air France 447 hits the water. When it does, it is traveling at 107 knots with its nose still high, at an angle of 16 degrees above the horizon.
What does this report tell us that we didn't know already? First, it largely confirms the rumors that have been swirling in the press over the course of the last week. The captain was away from the cockpit when the crisis began to unfold, and the plane pitched up during the crisis, contributing to an aerodynamic stall. The speed and angle of the plane as it crashed explains the condition of some of the recovered crash debris, which showed compression from below.
One surprising fact that emerged today is that the co-pilots at the controls spent most of the final moments trying to raise the nose of the Airbus 330. As even the most inexperienced pilot knows, pointing the plane upward is the worst thing to do in the event of a stall. Two possible explanations come to mind. The first is that he panicked. The second is that he believed that the plane had not stalled, but rather that it was caught in an intense downdraft; these are known to reach speeds of up to 100 mph inside thunderstorms.

Accident to the Airbus A330-203 flight AF 447 on 1st June 2009 - Update on Investigation

At this stage of the investigation, as an addition to the BEA interim reports of 2 July and 17 December 2009, the following new facts have been established:

- The composition of the crew was in accordance with the operator's procedures.
- At the time of the event, the weight and balance of the airplane were within the operational limits.
- At the time of the event, the two co-pilots were seated in the cockpit and the Captain was resting. The latter returned to the cockpit about 1 min 30 after the disengagement of the autopilot.
- There was an inconsistency between the speeds displayed on the left side and the integrated standby instrument system (ISIS). This lasted for less than one minute.

- After the autopilot disengagement:
- The airplane climbed to 38,000 ft.
- The stall warning was triggered and the airplane stalled.
- The inputs made by the PF were mainly nose-up.
- The descent lasted 3 min 30, during which the airplane remained stalled. The angle of attack increased and remained above 35 degrees.
- The engines were operating and always responded to crew commands.
- The last recorded values were a pitch attitude of 16.2 degrees nose-up, a roll angle of 5.3 degrees left and a vertical speed of -10,912 ft/min.

History of Flight and New Findings (29 July 2011)

The flight can be broken down into three phases:
Phase 1: from the beginning of the CVR recording until the disconnection of the autopilot
Phase 2: from the disconnection of the autopilot to the triggering of the stall warning
Phase 3: from the triggering of the stall warning to the end of the flight

Phase 1 : from the beginning of the CVR recording until the disconnection of the autopilot

At the beginning of the CVR, shortly after midnight, the airplane was in cruise at flight level 350. Autopilot 2 and autothrust were engaged. The flight was calm. The crew was in VHF contact with the Recife ATC centre.
The crew mentioned the high temperature (normal plus eleven) and noted that the meteorological conditions did not pose any problems.
The Captain proposed that the copilot take a rest due to the length of his shift. The latter answered that he didn't feel like sleeping.
At 1 h 35 min 15, the crew informed the ATLANTICO controller that they had passed the INTOL point then announced the following estimates: SALPU at 1 h 48 then ORARO at 2 h 00. He also transmitted his SELCAL code and a test was undertaken, successfully.
At 1 h 35 min 46, the controller asked him to maintain FL350 and to give him his estimate for TASIL point.
Between 1 h 35 min 53 and 1 h 36 min 14, the controller asked again for the estimated time at TASIL with no response from the crew. There was no more contact between the crew and the ATC organisations.
A 1 h 55, the Captain woke the second copilot and announced "[…] he's going to take my place".
Between 1 h 59 min 32 and 2 h 01 min 46, the Captain attended the briefing between the two copilots, during which the PF said, in particular "the little bit of turbulence that you just saw […] we should find the same ahead […] we're in the cloud layer unfortunately we can't climb much for the moment because the temperature is falling more slowly than forecast" and that "the logon with Dakar failed". The Captain left the cockpit.

Findings:
- The Captain's departure occurred without clear op erational instructions.
- The crew composition was in accordance with the op erator's procedures.
- There was no explicit task-sharing between the two copilots.

The airplane approached the ORARO point. It was flying at flight level 350 and at Mach 0.82 and the pitch attitude was about 2.5 degrees. The weight and balance of the

airplane were around 205 tons and 29% respectively. Autopilot 2 and auto-thrust were engaged.

• The weight and balance of the air plane were within operational limits

At 2 h 06 min 04, the PF called the cabin crew, telling them that "in two minutes we should enter an area where it'll move about a bit more than at the moment, you should watch out" and he added "I'll call you back as soon as we're out of it".
At 2 h 08 min 07, the PNF said "you can maybe go a little to the left […]". The airplane began a slight turn to the left, the change in relation to the initial route being about 12 degrees. The level of turbulence increased slightly and the crew decided to reduce the speed to about Mach 0.8.

• The crew had noticed returns on the weather radar.
• The crew made a heading change of 12° to the left of its route.

<u>Phase 2:</u> from the disconnection of the autopilot to the triggering of the stall warning

At 2 h 10 min 05, the autopilot then auto-thrust disengaged and the PF said "I have the controls". The airplane began to roll to the right and the PF made a left nose-up input. The stall warning sounded twice in a row. The recorded parameters show a sharp fall from about 275 kts to 60 kts in the speed displayed on the left primary flight display (PFD), then a few moments later in the speed displayed on the integrated standby instrument system (ISIS).

• The AP disconnected while the air plane was flying at upper limit of a sligh tly turbulent cloud layer.
• There was an inconsistency between the measured speeds, likely as a result of the obstruction of the Pitot probes in an ice crystal environment.
• At the time of the autopilot disconnection, the Captain was resting.

At 2 h 10 min 16, the PNF said "so, we've lost the speeds" then "alternate law protections […]"
The airplane's pitch attitude increased progressively beyond 10 degrees and the plane started to climb.

• Even though they identified and announced the loss of the speed indications, neither of the two copilots called the procedure "Unreliable IAS".
• The copilots had received no high altitude training for the "Unreliable IAS" procedure and manual air craft handling.
• No standard callouts regarding the differences in pitch attitude and vertical speed were made.
• There is no CRM training for a crew made up of two copilots in a situation with a relief Captain.

The PF made nose-down inputs alternately to the right and to the left. The climb speed, qui which had reached 7,000 ft/min, dropped to 700 ft/min and the roll varied between 12 degrees to the right and 10 degrees to the left. The speed indicated on the left side increased suddenly to 215 kt (Mach 0.68).

• The speed displayed on the left PFD remained invalid for 29 seconds.

The airplane was then at an altitude of about 37,500 ft and the recorded angle of attack was around 4 degrees.
From 2 h 10 min 50, the PNF tried several times to call the Captain back.

<u>Phase 3:</u> from the triggering of the stall warning to the end of the flight

At 2 h 10 min 51, the stall warning triggered again. The thrust levers were placed in the TO/GA detent and the PF maintained his nose-up input. The recorded angle of attack, of the order of 6 degrees at the triggering of the stall warning, continued to increase. The trimmable horizontal stabiliser (THS) began moving and passed from 3 to 13 degrees nose-up in about 1 minute; it remained in this position until the end of the flight.

• The approach to stall was characterised by the triggering of the warning, then the appearance of buffet.
• A short time after the triggering of the stall warning, the PF applied TO/GA thrust and made a nose-up input.
• In less than one minute after the disconnection of the autopilot, the airplane was outside its flight envelope following the manual inputs that were mainly nose-up.
• Until the airplane was outside its flight envelope, the airplane's longitudinal movements were consistent with the position of the flight control surfaces.
• Neither of the pilots made an y reference to the stall warning.
• Neither of the pilots formally identified the stall situation.

About fifteen seconds later, the speed displayed on the ISIS increased suddenly towards 185 kts.

• The invalidity of the speed displayed on the ISIS lasted 54 seconds.

It was then consistent with the other speed displayed. The PF continued to make nose-up inputs. The airplane's altitude reached its maximum of about 38,000 ft; its pitch attitude and its angle of attack were 16 degrees.
At 2 h 11 min 42, the Captain came back into the cockpit. In the following seconds, all of the recorded speeds became invalid and the stall warning stopped.

• The Captain came back into the cockpit about 1 min 30 after the autopilot disconnection.
• The angle of attack is the parameter that enables the stall warning to be triggered; if the angle of attack values become invalid, the stall warning stops.

• By design, when the speed measurements were lower than 60 kts, the 3 angle of attack values became invalid.
• Each time the stall warning was triggered, the angle of attack exceeded its theoretical trigger value.
• The stall warning was triggered continuously for 54 seconds.

The altitude was then around 35,000 ft, the angle of attack exceeded 40 degrees and the vertical speed was around -10 000 ft/min. The airplane's pitch attitude did not exceed 15 degrees and the engine N1 was close to 100%. The airplane was subject to roll oscillations that sometimes reached 40 degrees. The PF made a nose-up left input on the sidestick to the stop that lasted around 30 seconds.

• The airplane's angle of attack was not directly displayed to the pilots.

At 2 h 12 min 02, the PF said "I don't have any more indications", and the PNF said "we have no valid indications". At that moment, the thrust levers were in the IDLE detent and the engines' N1's were at 55%. Around fifteen seconds later, the PF made pitch-down inputs. In the following moments, the angle of attack decreased, the speeds became valid again and the stall warning was triggered again.
At 2 h 13 min 32, the PF said "we're going to arrive at level one hundred". About fifteen seconds later, simultaneous inputs by both pilots on the sidesticks were recorded and the PF said "go ahead you have the controls".
The angle of attack, when it was valid, always remained above 35 degrees.

• Throughout the flight, the movements of the elevator and the THS were consistent with the pilot's inputs.
• The engines were working and always responded to the crew's inputs.
• No announcement was made to the passengers.

The recordings stopped at 2 h 14 min 28. The last recorded values were a vertical speed of -10,912 ft/min, a ground speed of 107 kts, pitch attitude of 16.2 degrees nose-up, roll angle of 5.3 degrees left and a magnetic heading of 270 degrees.
No emergency message was sent by the crew. The wreckage was found on the seabed at 3,900 m on 3 April 2011, 6.5 nautical miles north-north-east of the last position transmitted by the airplane.

(TH : 31/07/2011 - TO BE CONTINUED…)