

Bureau Enquêtes-Accidents



REPORT

*on the incident on 24 September 1994
during approach to Orly (94)
to the Airbus A 310 registered YR-LCA
operated by TAROM*

YR-A940924A

FOREWORD

This report presents the technical conclusions reached by the BEA on the circumstances and causes of this incident.

In accordance with Annex 13 of the Convention on International Civil Aviation, with EC directive 94/56 and with Law N°99-243 of 29 March 1999, the analysis of the accident is intended neither to apportion blame, nor to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents or incidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, please refer to the original text in French.

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GLOSSARY

ADC	Air Data Computer
AFS	Automatic Flight System
ALT	Altitude
AP	Autopilot
ATHR	Autothrottle
ATIS	Automatic Information Service
ATS	Autothrottle system
CAPT	Capture
CLB	Climb
CMD	Command
CR	Cruise
CRM	Cockpit Resource Management
CVR	Cockpit Voice Recorder
CWS	Control Wheel Steering
DESC	Descent
DME	Distance Measuring Equipment
ECAM	Electronic Centralized Aircraft Monitoring
FAC	Flight Augmentation Computer
FAF	Final Approach Fix
FCC	Flight Control Computer
FCU	Flight Control Unit
FD	Flight Director
FDR	Flight Data Recorder
FIDS	Fault Isolation and Detection System
FL	Flight Level
FLEX TO	Flexible Take Off
FMA	Flight Mode Annunciator
FMS	Flight Management System
GPWS	Ground Proximity Warning System
GS	Glide Slope
HDG	Heading
IAF	Initial Approach Fix
IRS	Inertial Reference System
LOC	Localizer
LVL CHG	Level Change
MCT	Maximum Continuous Thrust
NAV	Navigation
ND	Nose Down
NU	Nose Up
PFD	Primary Flight Display
PTS	Pitch Trim System
TCC	Thrust Control Computer
THS	Trimmable Horizontal Stabilizer
TLA	Throttle Lever Angle
TOGA	Take Off - Go Around
TRP	Thrust Rating Panel
V _{LS}	Velocity Lower Selectable
VS	Vertical Speed
V _{SS}	Velocity Stick Shaker

SYNOPSIS

Date and time

24 September 1994
at 10 h 45⁽¹⁾

Aircraft

Airbus A 310
registered YR-LCA

Site of incident

6 NM east of Paris Orly

Operator

Tarom, Romania

Type of flight

Public transport (passengers)

Persons on board

11 crew
175 passengers

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### Summary

During the approach to Paris Orly, in good weather conditions, the aircraft suddenly started to climb adopting a steep pitch attitude and stalled. The crew managed to recover control of the aircraft and came round to land.

### Consequences

|                   | <i>Persons</i> |                |               | <i>Equipment</i> | <i>Third parties</i> |
|-------------------|----------------|----------------|---------------|------------------|----------------------|
|                   | <i>Killed</i>  | <i>Injured</i> | <i>Unhurt</i> |                  |                      |
| <i>Crew</i>       |                |                | 11            | N/A              | N/A                  |
| <i>Passengers</i> |                |                | 175           |                  |                      |

<sup>1</sup> Except where otherwise indicated, times shown in this report are expressed in Universal Time Coordinated (UTC) and are reset in relation to the aircraft's on-board clock. Two hours should be added to obtain the legal time applicable in metropolitan France on the day of the incident.

# 1 – FACTUAL INFORMATION

## 1.1 History of the Flight

The Romanian Tarom Airbus A 310 YR-LCA, coming from Bucharest as scheduled flight ROT 381, estimated its arrival time at Paris Orly at 10 h 40. The Orly ATIS indicated that runway 26 was in service and visibility announced was ten kilometers with scattered cloud at 2,400 feet.

The aircraft left cruise level 350 at 10 h 30 at the request of regional control. At about 40 NM from the runway, at 10 h 36, it descended through flight level 150. The ATC asked the pilot to accelerate descent so as to reach level 60 in two minutes maximum.

At 10 h 37 m 13 s, the crew contacted approach control. The controller asked them to set a heading of 330° with a base leg for runway 26. The aircraft flew over the Melun VOR at 10 h 38 m 39 s, descended through to 6,600 feet with a ground speed of 400 kt. It was then authorized at 10 h 38 m 44 s to descend to an altitude of 3,000 feet.

At 10 h 41 m 01 s, the approach controller asked the flight crew to change to heading 310 for interception of ILS 26. Conversations in the cockpit show that the runway was in sight, as were certain Parisian monuments.

The Captain was at the controls. He decided to perform an automatic approach and landing. Approach control was not informed of this.

The flight crew started to put the aircraft into the approach configuration, with slats and flaps at 15/0 at 10 h 42 m 05 s, then at 15/15 at 10 h 42 m 53 s. The landing gear was extended at 10 h 42 m 57 s.

Approaching the OYE beacon at indicated speed 250 kt and heading 325, before lining up with the runway, the Captain noted that the aircraft was not capturing the ILS glide slope automatically. He disconnected the AP and continued the approach on manual control, keeping the Autothrottle in operation.

As the aircraft descended through 1,700 feet, at 10 h 43 m 22 s, with a speed of about 195 knots, the Captain asked for flap extension to 20°. The  $V_{FE}$ , the speed limit authorized for this new configuration, is 195 knots. When the flap control was set to 20°, the thrust levers advanced and engine thrust increased.

The flight crew countered the nose-up effect resulting from the increase in thrust by using the pitch controls, with the auto-throttle (ATHR) remaining in automatic mode.

The throttle levers were then quickly brought back to the idle position. At the same time, the trimmable horizontal stabilizer started to move in a nose-up direction.

The nose up effect that resulted was countered by the flight crew through gradual nose-down action on the elevators. When the trimmable horizontal stabilizer reached its maximum nose-up value and the elevators also reached their maximum nose down value, the throttle levers, according to the FDR readout, moved rapidly to their stops.

In a few seconds, the flight path started to rise and the pitch attitude went to 60°. Witnesses saw the aircraft climb. It banked sharply to the left and the right and stalled before adopting a strongly negative pitch attitude (-33 degrees) towards the ground. The maximum altitude reached was 4,100 feet, while a minimum indicated speed of 35 knots was recorded. The stall and ground proximity warnings sounded during the descent. The flight crew managed to regain control of the aircraft, with the lowest point being around a height of 800 feet, that is 240 meters from the ground.

The flight crew then performed a visual circuit, followed from the tower by the controller. The second approach was made with a configuration with slats and flaps at 20/20. Landing took place at 10 h 52 m 25 s. The aircraft went directly to its parking area. After inspections and with authorization from the appointed Investigator-in-Charge, it left Orly for Bucharest, on a ferry flight, on 29 September 1994.

## **1.2 Injuries to Persons**

There were no injured among the one hundred and seventy-five passengers and eleven crewmembers. However, this incident made a strong impression on the passengers.

## **1.3 Damage to Aircraft**

The aircraft remained undamaged.

## **1.4 Other Damage**

None.

## **1.5 Flight Crew**

### Captain:

- Male, 46 years old
- Airline Transport Pilot's License No. 226 issued 24 September 1976, valid to 2 March 1995
- Medical aptitude check valid to 14 January 1995
- Flying Experience
  - total: 12,800 hours
  - on A 310: 1,040 hours
- on A 310: 1,040
- Before being qualified on A 310, the Captain had flown most of his flying hours on BAC 111's.
- A 310 type qualification obtained after training courses No. 6393 on 29 December 1992 and No.1266 on 1 March 1993 with Aéroformation.

- Appraisals of the Captain were generally excellent, though they did, however, call for improvement in working with ECAM and with FMA, as well as with crew co-ordination.
- The investigators were not informed of any previous aeronautical incidents.

#### First officer:

- Male, 41 years old
- Airline Transport Pilot's License No. 319 of 18 May 1981, valid to 9 June 1995
- Medical aptitude valid to 11 January 1995
- Flying Experience:
  - total: 9,828 hours
  - on A 310: 208 hours
- A 310 type qualification issued by Tarom (training course No. 3437 of 14 June 1994).
- The investigators were not informed of any previous aeronautical incidents.

#### Other person in the cockpit:

A third person, a Tarom pilot being familiarized with A 310, was also in the cockpit.

- Male, 41 years old
- Airline Transport Pilot's License No. 531 of 9 January 1992, valid until 5 August 1995
- Medical aptitude valid to 8 July 1995
- Experience:
  - total: 4 848 hours
  - on A 310: 3 hours of familiarization
- The investigators were not informed of any previous aeronautical incidents.

## **1.6 Aircraft Information**

### **1.6.1 Airframe**

- Manufacturer Airbus Industrie.
- type A 310/325.
- Serial number 636.
- registration YR-LCA.
- registration certificate No. 1261 of 17 May 1994.
- Airworthiness Certificate issued on 23 August 1994 by the Romanian Civil Aviation Authority, valid until 26 March 1995.
- last periodic maintenance inspection: inspection C performed 30 March 1994 according to Swissair maintenance program. At that date, the aircraft totaled 4,538 flying hours and 1,326 cycles



## 1.6.2 Engines

- Manufacturer Pratt and Whitney
- type PW 4156 A.
- serial numbers
  - position 1 (left): 724553
  - position 2 (right): 724554
- operation
  - position 1: 6,800 hours, 1 898 cycles
  - position 2: 4,538 hours, 1 326 cycles

## 1.6.3 Weight and Center of Gravity

When the incident occurred, the aircraft weighed 106 tons and with center of gravity of 25 % MAC, these values being within the authorized limits.

## 1.7 Meteorological Information

The overall situation included no potentially dangerous phenomenon for the flight. The meteorological conditions on arrival at Orly were excellent when the incident occurred. "Juliet " information for 10.30 a.m. given by ATIS was as follows :

- Wind: 190°/12 knots
- Visibility: 10 km
- Scattered cloud at 2,400 feet and at 25,000 feet
- Temperature: 21 °C
- Dew point: 11 °C
- QNH: 1013 hPa
- QFE: 1003 hPa

## 1.8 Aids to Navigation

The last inspection of the runway 26 localizer was performed on 9 June 1994. The inspection of the descent localizer was performed on 22 June 1994.

The last weekly inspection of the ILS, performed on 19 September 1994, showed normal operation.

On 24 September 1994, the ILS was working on number two group. No operating anomaly was mentioned in the notebook of the shift technical supervisor responsible for supervision of flight navigation equipment.

Other aircraft which landed at Paris Orly mentioned no anomalies.

## 1.9 Communication

The transcript of communications between the flight crew and the ATC is provided in appendices 2 and 3. These exchanges can be summarized as follows:

- at 10 hours 25, flight, at FL 350, came into contact with Paris Control,
- at 10 hours 29 m 47 s, it was authorized to set a direct heading on VOR MEL and to descend to FL 60,
- at 10 hours 36 m 35 s, Paris Control called back to ask it to increase its rate of descent,
- at 10 hours 37 m 05 s, it was transferred to Orly Approach,
- at 10 hours 37 m 13 s, it came into contact with Orly Approach who gave it heading 330 for a base leg 26,
- at 10 hours 38 m 44 s, it was authorized to descend to 3,000 feet,
- at 10 hours 41 m 01 s, Orly Approach gave it heading 310 to intercept ILS 26,
- at 10 hours 43 m 36 s, it was authorized to land.

## 1.10 Airdrome Information

Orly Airport is a civil airdrome open to public air traffic and is run by Aéroports de Paris. Its reference altitude is 292 feet.

The Orly ILS 26 approach map is shown in appendix 1. Three standard approaches are defined, one on VOR EPR to the west of the airport and two to the east on VOR MEL and BSN. Tarom flights from Bucharest start their initial approach on VOR MEL. The standard approach provides for this beacon being flown over at FL 80 and for the descent to be continued towards FL 60 on a flight path oriented at 353°. Level 60 should be reached seven nautical miles later and the descent be continued towards 3,000 feet. The start of a turn to the left on passing radial 091° of VOR DME OL allows for alignment on the runway axis oriented at 258°. The ILS glide slope is intercepted at 3,000 feet QNH and at a distance of 8.7 NM from OL.

In the event of a go around, the climb is made towards 2,000 feet on heading 243 after radial OL 206 then on OL radial 233 up to a distance of 12 NM from OL. At this point, the climb is continued towards 4,000 feet seeking to close on MEL radial 278 .

## 1.11 Flight Recorders

### 1.11.1 Flight Data Recorder Readout

The references for the flight recorder (FDR) are as follows:

- Manufacturer : LOCKHEED
- Model : 209 F
- P/N : 1007 A500
- S/N : 4505

In compliance with the protocol between the BEA and the Flight Test Center, the processing of data from this recorder was carried out by the latter body. The work was conducted in the presence of the BEA, police officers and a representative of Tarom.

As a direct readout of the recorder gave no result, the tape was extracted and was read out. The observations were as follows:

- the magnetic tape was broken between the first indicator used for detection of the end of the tape and the end thereof (that is 56.5 cm before the end),
- the tape was wound abnormally around its coil. Part of it was tangled and folded back on itself,
- the last data recorded dated from 27 March 1994.

It emerges from these observations that the FDR had not been functioning for nearly six months. Since the pre-flight test performed by the flight crew only checks for the electrical presence of the recorder, they could not detect the fault found nor bring the airline's attention to the equipment failure.

### **1.11.2 Direct Access Recorder Readout**

The cassette from the Direct Access recorder (DAR) was taken from the aircraft. It was read out and analyzed under the control of an investigator from BEA in Bucharest, in the premises of the Technical Division of Tarom, between 26 and 28 September 1994. Representatives from the airline, Airbus Industrie, Romanian Civil Aviation and Swissair were present at this reading.

Tarom possesses the FLIDRAS acquisition and analysis bay, developed by SAS. It had been recently installed. First validation of the readout parameters was conducted using reference documents provided by Airbus Industrie and Tarom.

The recorder was read out. Obtaining data and assigning physical values to it was performed without encountering any particular difficulties.

The validation and correlation work on information from the recorder and the CVR showed the consistency of the two recordings, particularly temporal synchronization and consistency of audio warnings with the associated parameters. However, a desynchronization of eleven seconds interrupted restitution of data from 10 hours 42 m 41 s to 42 m 52 s. The reason for this desynchronization has not been elucidated.

Analysis of the data shows that:

- the automatic pilots were disconnected at 10 h 42 m 28 s,
- the aircraft left level flight at 3 000 feet at 10 h 42 m 35 s,
- the flaps were selected at 20/20 at 10 h 43 m 24 s, with speed being 195 kt. Simultaneously, the speed increased towards 197 kt. Immediately, the Vertical Speed (VS) mode switched to Climb (CLB) and the throttle levers started to advance,

- when they were at 64 degrees, the throttle levers came back to 32 degrees, flight idle position, at 10 h 43 m 51 s,
- a nose up (NU) movement of the THS from  $-3.9$  to  $-13$  degrees (corresponding to the electrical stop) took place between 10 h 43 m 52 s and 10 h 44 m 04 s, at constant speed of 0.9 degrees per second,
- at 10 h 44 m 02 s, the throttle levers moved from flight idle to 84 degrees in two seconds,
- the elevator control was deflected nose down, deflection on the elevator reaching 15 degrees at 10 h 44 m 04 s,
- the aircraft started to climb at 10 h 44 m 10 s, with an extreme attitude,
- mode switched from CLB to ALT at 10 h 44 m 11 s,
- at 10 h 44 m 28 s, the auto-throttle was disconnected,
- deflection of the THS was reduced from  $-12.7$  to  $-8.8$  degrees at 10 h 44 m 32 s,
- the aircraft reached an altitude of 4,100 feet at 10 h 44 m 35 s,
- left and right rolls, with maximum amplitude of 70 degrees and at a high rate (25 °/s), were observed from 10 h 44 m 30 s to 10 h 44 m 48 s,
- at 10 h 44 m 40 s, the aircraft assumed a strong negative attitude ( $-32$  degrees), and in correlation with this, the speed increased significantly,
- the flaps were brought back to  $15^\circ$  at 10 h 44 m 50 s,
- the load factor reached the maximum value of 2.1 g at 10 h 44 m 52 s,
- deflection of the THS went from  $-8.8$  to  $-12.7$  degrees at 10 h 44 m 52 s,
- the two pitch trims were disconnected at 10 h 44 m 56 s,
- the low point was at 880 feet; speed was then 195 kt,
- the two pitch trims were reconnected at 10 h 45 m 52 s,
- three attempts to activate the automatic pilot were made at 10 h 46 m 29 s, 10 h 46 m 35 s and 38 s.

See graphs in appendix 5 and reconstitution of aircraft's movements in appendix 6.

### 1.11.3 Cockpit Voice Recorder Readout

The references of the Cockpit Voice Recorder (CVR) are as follows:

- Manufacturer : LORAL FAIRCHILD
- Type: A100-80
- S/N: 58 850

The CVR, placed under seal, was read out on Sunday 25 September 1994 in the BEA laboratories, in the presence of police officers from the Air Transport Gendarmerie. Also present when data was examined were the aircraft Captain and the Paris representative of Tarom. Two copies, intended for Romanian investigators, were made on the same day.

Conversations in the cockpit were largely in Romanian. The transcript was made at the BEA, with help from representatives of Romanian Civil Aviation; similar work was conducted in parallel in Bucharest. The translation of the transcript is presented in appendix 4.

Analysis of the noises and audio warnings was conducted with co-operation from the airline, the manufacturer and the French General Civil Aviation Directorate (DGAC.).

Study of the CVR recording provides the following facts:

- the Captain declared at 10 h 41 m 50 s: "*I can fly it like this, until we land*" <sup>(2)</sup>,
- the automatic pilots were disconnected at 10 h 42 m 28 s and the corresponding audio warning (cavalry charge) was heard, followed by the "triple click" audio warning indicating a degradation in the category of automatic landing,
- the signal "altitude alert" was heard at 10 h 42 m 37 s, shortly after the aircraft left the altitude of 3,000 feet. The altitude of 4 000 feet was then displayed on the FCU as the altitude to reach in the event of go around,
- the aircraft was configured for approach and landing as from 10 h 42 m 49 s, with the slats and flaps being extended to 15/15 at 10 h 42 m 53 s and the landing gear at 10 h 42 m 59 s. The flaps were extended to 20/20 on request from the Captain at 10 h 43 m 23 s. The speed of 147 kt was displayed on the FCU,
- the noise of the engines was heard to increase at 10 h 43 m 34 s,
- clearance for landing was received at 10 h 43 m 36 s,
- from 10 h 43 m 47 s, the Captain showed his astonishment at the aircraft's behavior. The co-pilot said "*take over manually*". At 10 h 4 m 01 s, the Captain declared "*Hey, its doing a go around*",
- from 10 h 43 m 53 s, the "whooper", audio warning indicating elevator trim movement, was heard for ten seconds, preceded and followed by two selector noises, the first one second before and the second half a second after,
- at 10 h 44 m 04 s, the engine rpm noise was increasing,
- at 10 h 44 m 21 s, the Captain asked the co-pilot to issue a "MAYDAY" message,
- at 10 h 44 m 28 s, the third man in the cockpit said four times "*we're falling*",
- at 10 h 44 m 31 s, aerodynamic and engine pumping noises were recorded,
- at 10 h 44 m 44 s, the stall warning was heard for the first time for 1.5 seconds, then at 10 h 44 m 47 s and at 10 h 44 m 49 s,
- the GPWS warning was heard for the first time as "terrain, terrain" at 10 h 44 m 52 s, then five seconds later in the form of "whoop, whoop, pull-up",
- at 10 h 45 m 08 s, as approach control had given freedom of maneuver for landing on 26 "... as you like for landing two six", the co-pilot answered "we've had some problems with the auto-pilot", which he completed in Romanian speaking to the Captain at 10 h 45 m 18 s, "*... it won't disconnect*",
- at 10 h 45 m 18 s, the engine rpm showed fluctuations,
- at 10 h 45 m 34 s, the landing gear was being retracted,
- at 10 h 45 m 43 s, the cabin crew made a passenger announcement,
- at 10 h 45 m 45 s, the co-pilot said "pitch trim OFF", this announcement being followed by a selector noise,
- at 10 h 45 m 59 s, the "whooper", preceded and followed by two selector noises was heard for two seconds,
- at 10 h 46 m 00 s, approach control asked "... do you agree to turn left on the ILS now", the co-pilot answered "yes, we can do it",
- at 10 h 46 m 06 s, the co-pilot said "*there it is, its working correctly*",

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<sup>2</sup> This paragraph uses a convention whereby exchanges in Romanian translated into English are shown in *Italics* while speech originally in English is shown in normal characters.

- at 10 h 46 m 09 s, the Captain asked "*stay like that... leave it, leave it*"; the "whooper" was again heard at 10 h 46 m 23 s,
- at 10 h 46 m 29 s, 10 h 46 m 35 s and 38 s, the flight crew three times attempted to activate the automatic pilot. The "Cavalry charge" signal for disconnection of the AP was heard until 10 h 46 m 47 s, the co-pilot having declared "Auto-pilot OFF" at 10 h 46 m 42 s,
- at 10 h 47 m 20 s, in answer to a question from approach control "do you have full control of your aircraft now?" the co-pilot answered "approximately fifty per cent of... about fifty per cent is under control". The Captain completed this with the comment "Euh... for the moment",
- at 10 h 47 m 39 s, control proposed "assistance after landing" and the flight crew accepted this,
- at 10 h 48 m 12 s, the co-pilot asked the Captain "*are we going to trim?*", a "whooper" signal lasting one second preceded and followed by two selector noises was recorded twice at 10 h 48 m 12 s and 10 h 48 m 23 s,
- at 10 h 48 m 24 s, the co-pilot repeated "*look at trim, look how it's gone*". The Captain answered "*leave it*",
- final approach clearance was received at 10 h 49 m 30 s,
- at 10 h 50 m 02 s, the landing gear was being maneuvered to extend. At 10 h 50 m 19 s, the co-pilot proposed extending the flaps. This proposal remained unanswered. He repeated it at 10 h 50 m 40 s "*flaps, yes ?*". The slats and flaps were extended to 20/20 at 10 h 50 m 45 s, after checking of the speed "*wait ! speed, select me...*" at 10 h 50 m 41 s,
- at 10 h 51 m 10 s, after confirmation of flaps extension to 20, the announcement "one four seven" was made by the co-pilot who declared at 10 h 51 m 22 s "*so, it's stabilizing and speed's decreasing*". The Captain asked "*hold speed please*", this being confirmed by the co-pilot at 10 h 51 m 40 s "*I'm holding speed*",
- from 10 h 48 m 12 s to 10 h 52 m 01 s, sixty selector noises were recorded, similar to the pressure-release noise of a pushbutton. The "whooper" was heard twice,
- at 10 h 52 m 00 s, the Captain said "*release the control column*",
- at 10 h 52 m 02 s, the Captain refused to extend the flaps to 40,
- at 10 h 52 m 10 s, the "too low flaps" alert was heard twice,
- at 10 h 52 m 16 s, the "glide slope" alert was heard seven times,
- at 10 h 52 m 25 s, a noise similar to landing was recorded, at 10 h 53 m 29 s a "whooper" signal lasting six seconds ended with "stabilizer one nose up",
- from 10 h 50 m 28 s to 11 h 01 m 25 s, in a largely incoherent conversation on the ground, the two pilots and the airman present in the cockpit gave their impressions on the event. They can be classified according to the following themes:

**a/ on the auto-throttle**

co-pilot: "*It started to increase thrust, I don't know why, but it increased thrust for no reason ... just like in a Go-Around*"

Captain: "*The engines increased power and it started to climb ... it started to climb, I couldn't control it!*".

**b/ on the automatic pilot**

Captain: "*Something's happened here!*"

co-pilot: "*The automatic pilot has got something wrong ... We must avoid using the automatic pilot, bring it back to manual!*"

Captain: "*Sure*"

3rd person: "*But what's happening? You stayed on AP until flying down low, didn't you?*"

Captain: "*No, no, I disconnected it, I disconnected the AP, sure I did*"

3rd person: "*It didn't obey you*"

Captain: "*It stayed practically...*" (incomplete)

3rd person: "*On auto, and it started off...*"

Captain: "*We won't fly it until it is under control. We won't fly it*".

**c) on the aircraft flight path**

Captain: "*I don't know how far up we went*"

co-pilot: "*We were close to sixty knots!*"

3rd person: "*Two thousand eight hundred, twenty-eight... it was... It was almost vertical!*"

**d) on the maneuver to recover from stall**

Captain: "*... from here, up here, I'm just afraid of going over on our back... from here, I've got to stop it from stalling, when it starts to go down, I have speed...*" (Reference to the two rolls at seventy degrees left and right and comment on recovery from stall).

## **1.12 Examination of the Aircraft after the Incident**

An inspection of the aircraft was made under the control of the Autoritatea Aeronautica Civila Romana, the Romanian civil aviation authority, by Tarom technicians assisted by Swissair (which ensures level C maintenance on behalf of Tarom), Airbus Industrie and Pratt and Whitney.

During the aircraft stall, the compressors surged. The engines were therefore also checked.

The BEA investigators were present at this work, which also contributed to the search for the technical causes of the incident. Subsequent to the inspection, the Romanian CAA delivered an authorization for return to service.

In parallel with these inspections, tests of the flight control system in automatic and manual modes were performed in the presence of the BEA, according to the procedures for on-line verification. The individual test of the calculators and wiring and the test of the LAND mode revealed minor anomalies that are not likely to lead to operational defects.

The FCU, FAC and trim-switch subassemblies making up the trimmable horizontal stabilizer control circuit were removed for the purposes of the investigation. Their inspection in a specialized workshop showed that the functional characteristics of these subassemblies were within the standards for acceptance on entry into service.

## **1.13 Medical and Pathological Information**

No medical examination or analyses were made on crewmembers.

## **1.14 Fire**

Not applicable.

## **1.15 Survival Aspects**

Preparation of the cabin with a view to landing had been implemented before the event and the occupants of the aircraft were all seated, with seat belts fastened. No one was injured.

## **1.16 Tests and Research**

### **1.16.1 Description of Systems**

The A310 is equipped with an Automatic Flight System (AFS) that controls the aircraft in the pitch, roll and yaw axes. The AFS also controls the aircraft speed and engine thrust.

The AFS mainly comprises four independent subsystems:

- Thrust Control Computer (TCC),
- Automatic Pilot (AP) and Flight Director (FD),
- Flight Advisory Computer (FAC),
- Flight Information Display System (FIDS).

#### **1.16.1.1 Auto-throttle**

The role of the auto-throttle in the Automatic Flight Control assembly is to adjust the thrust of the engines so the aircraft attains the desired performance. Its logic aims at translating an AFS request for a given thrust into an engine instruction.

##### **1.16.1.1.1 Auto-throttle Architecture**

The auto-throttle includes:

- a selector panel for maximum thrust mode and automatic or preset mode,
- a Thrust Control Computer (TCC),
- a thrust control servomotor connected mechanically to the throttle levers.

##### **1.16.1.1.2 Operating Modes and Sub-modes**

Working with the automatic pilot and Flight Director modes, the auto-throttle in one of the TOGA/FLEX TO, CL, CR, MCT modes gives:

- the maximum thrust for take-off, climb and go around,
- positioning of the throttle levers at TLA minimum (Idle) for descent (RETARD mode),



- positioning of the throttle levers for acquisition and maintaining speed or Mach requested by the SPD-Mach speed mode,
- the maximum thrust required for climb mode (CLB) and minimum thrust for descent mode (DESC)
- the thrust required for PROFILE mode.

Switching modes and sub-modes in relation with the Flight Director and the Automatic Pilot modes is managed automatically by the FMC when the PROFILE mode is active. In all the other modes, switching is managed by the TCC: when the AP/FD is in flight path mode (VS, ALT, GS, etc.), the TCC controls speed and activates the SPD-Mach mode; when the AP/FD controls speed (LVL CHG, SRS or GO AROUND modes), the TCC controls thrust and activates the THRUST mode in climb or RETARD in descent.

Auto-throttle operation automatically leads to arming of the Alpha-floor function. When this function is activated by the AFS, the thrust increases automatically up to the limit value for go around.

The AFS LVL CHG mode can be used to attain the selected altitude, with the automatic pilot or the Flight Director maintaining speed. If the altitude selected is greater than the altitude of the aircraft, CLB mode is activated, the auto-throttle switches to THR mode and applies maximum thrust displayed on the TRP (Thrust Rating Panel). By design, when the slats are extended, thrust increases up to go around thrust. If the selected altitude is less than the altitude of the aircraft, DES mode is activated, the auto-throttle switches to RETARD mode and applies minimum thrust.

#### 1.16.1.1.3 Activation - Inhibition

Arming the auto-throttle is obtained by maneuvering the ATS1 or ATS2 lever on the ATS panel. The auto-throttle function is activated by pressing the ATHR button of the FCU or, on take-off, by pressing the "GO LEVERS" buttons located on the throttle levers.

Auto-throttle disconnection is obtained:

- by acting on one of the instinctive disconnection buttons located on the throttle levers,
- by a second action on the ATHR pushbutton,
- by positioning the ATS arm levers on OFF,
- automatically if one of the setting conditions is lost.

#### 1.16.1.1.4 Displays

The activated modes are displayed on the FMA. In addition, the keys corresponding to the different maximum thrusts (TOGA, MCT, CL, CR, Auto and FLEX TO) are illuminated on the TRP.

## 1.16.1.2 Automatic Pilots and Flight Directors

### 1.16.1.2.1 Functions

The AP's role is:

- to stabilize the aircraft about its center of gravity while maintaining the vertical speed and set heading ,
- to keep the aircraft on its acquired flight path (mode hold),
- to acquire a new flight path (mode acquisition),
- to perform an automatic landing,
- to select automatically from among the command modes for thrust the appropriate mode according to the longitudinal mode chosen.

The role of the FD in manual piloting is to provide flying indications using trend bars shown on the Primary Flight Display

- in pitch if a longitudinal mode is active,
- in roll if a lateral mode is active,
- in yaw for certain automatic take-off and landing phases.

### 1.16.1.2.2 Operating Modes

The operating modes common to the Flight Directors and Automatic Pilots are:

- in lateral modes : RWY, NAV, VOR, LOC, HDG and HDG SEL
- in longitudinal modes : SRS, LVL CHG, ALT, VS, PROFILE
- in combined modes: LAND and GO AROUND.

Modes are selected on the FCU. The button moved sets the associated mode and lights up. Modes are activated by :

- the GO LEVERS located on the throttle levers, to activate SRS modes on the ground or GO AROUND in flight,
- on the FCU, by pulling the buttons assigned to control of vertical speed, heading and altitude,
- or by pushing the ALT HLD, LVL CHG, PROFILE, HFG SEL, NAV, VOR/LOC or LAND buttons.

#### *Operation of longitudinal modes*

There are six longitudinal modes: Level Change (LVL CHG), Altitude Hold (ALT HLD), Profile and Vertical Speed (VS), SRS and ALT\*.

The Vertical Speed mode is the most basic longitudinal mode. As far as altitude is concerned, the Altitude Hold mode leads to holding altitude and the Level Change mode to acquisition of the altitude displayed in the ALT SEL window.

LVL CHG controls combined Automatic Pilot and auto-throttle actions so as to perform an altitude change automatically, the AP/FD maintaining the selected speed while the auto-throttle maintains maximum thrust on climb or minimum thrust on descent.

The angular velocity for movement of the engine power levers controlled by the auto-throttle is constant, one degree per second.

In automatic pilot and with the auto-throttle active, execution of the LVL CHG CLB is in three stages: climb to Vsel, altitude capture then hold. Computers manage thrust and determine the aircraft's attitude. If no AP is active but if the auto-throttle is active, thrust is displayed by the auto-throttle and the attitude to follow is indicated to the flight crew by the Flight Director. When neither the AP's nor the auto-throttle are active, LVL CHG cannot be executed, except by following the FD bars manually and positioning the throttle levers manually.

To inhibit or cancel LVL CHG, the flight crew can either cancel the mode by pressing the LVL CHG pushbutton on the FCU, or inhibit it by disconnecting the ATHR, thus making the LVL CHG virtual, or by choosing another vertical mode.

Note: ALT HLD and Profile modes together with LAND, SRS, RWY, GO AROUND modes, not used during the incident, will not be described.

#### 1.16.1.2.3 Subassemblies

The AP-FD assembly includes two common FCC computers and an FCU controller. In addition, the following items form part of the system:

- Flight Mode Annunciators and FD trend bars,
- The control actuators for control surfaces and dynamic sensors integrated in the control surface control mechanisms,
- The control buttons:
  - GO LEVERS, integrated in the throttle levers,
  - AP instinctive disconnect, situated on the inside of the outer control column horn

#### 1.16.1.2.4 Operation

The Automatic Pilots and Flight Directors can be operated separately or jointly.

If no AP is active on command (CMD), the indications of the FMA and the FD on PFD1 will be associated with FD1, and reciprocally for PFD2 and FD2.

If an AP is on CMD, the two FMA's will be associated with it but the FD bars on PFD1 and 2 will remain associated with the corresponding FD 1 and 2.

Combined operation of FD and AP:

- when the AP is on CMD it keeps the aircraft on the path by executing maneuver orders given by the computers. The trend indications from the FD(s) continue to be represented by the bars on the PFD's.
- When the AP is on CWS (control wheel steering) it keeps pitch attitude and bank attitude to their values, such that the flight crew can then change them. The FD then works independently of the AP.

#### 1.16.1.2.5 Display

##### a) *For an active FD*

There is no FD activation or disconnection button. As soon as the computers are powered up, and on condition that the conditions for activation are fulfilled (availability of FCC, FAC, IRS, ADC and FCU), both FD's are automatically activated in the basic VS and HDG modes. Signaling will then be as follows:

- FD1 and FD2 light up respectively on FMA1 and FMA2.
- VS and HDG light up green on both FMA's,
- The trend bars appear on both PFD's.

##### b) *For disconnection of an FD*

On disconnection the above display disappears and "FD" appears in red letters on the PFD corresponding to the unavailable FD.

##### c) *For an active AP*

An AP is activated by moving the corresponding lever on the FCU. It will be in CMD mode. Display will then be as follows:

- lever in high position,
- CMD lit up in window under levers,
- CMD1 (or 2), or DUAL indicator if both AP's are active on FMA.

The aircraft can then be flown according to the crew's requests, in CWS mode.

##### d) *For disconnection of an AP*

- manual disconnection: flight crew can disconnect the AP
  - either by pressing the instinctive disconnection button,
  - or by setting the lever to OFF on the FCU.

The distinctive "cavalry charge" audio warning is sounded. Disconnection is indicated on the FMA and

- the lever is in low position (OFF),
  - the CMD or CWS flag alarm switches off in the FCU window.
- disconnection in the event of excess force applied to the control : display will be identical to that in the previous case.

### 1.16.1.3 Controlling the Longitudinal Axis

#### 1.16.1.3.1 Controls

Pitch attitude controls include, in addition to elevator controls :

- a PTS panel,
- two electrical trim control switches located on the control column outer horn,
- a manual trim control wheel.

#### 1.16.1.3.2 Checks

Pitch attitude is controlled by elevators using the control column.

Setting the position of the THS in the range  $+3^\circ$  nose down (ND) to  $-14^\circ$  nose-up (NU) cancels control column effort.

THS setting electrical control orders may come either from the flight crew if the AP is disconnected, or from the automatic pilot. The speed of the adjustment depends on the configuration and speed range of the aircraft. Trim with electrical control has a deflection range of  $2.5^\circ$  (ND) to  $13.5^\circ$  (NU). When commanded by the flight crew, its speed, which depends on the aircraft speed, will at most be equal to  $0.9^\circ$  per second; when commanded by the AP, its speed, which depends on the slats/flaps configuration, is at least equal to  $0.5^\circ$  per second.

#### 1.16.1.3.3 Display

A special audio signal called a "whooper" is associated with the THS being moved when commanded electrically by the pilot. This signal is emitted as soon as the duration of the THS movement exceeds one second. The "whooper" will not sound when the THS is commanded by the AP.

The position of the THS is identified on the graduated wheel adjacent to the manual control wheel.

On the ECAM, the "Flight controls" page indicates the position of the control surfaces and, in particular, those for the THS and the elevators.

Disconnection of the pitch trims, effected by the return to low position of the two levers, is indicated by a special message in red letters on the ECAM backed up by an audio warning.

#### 1.16.1.3.4 THS Trim System Safety

The lever of one of the two THS trim system control circuits can only be activated or held in position if the conditions for activation are all fulfilled. In the event of damage to one circuit, the second will automatically take over and the ECAM will indicate the failure. In the event of failure of both circuits, the ECAM will indicate this and a "single chime" warning is sounded.

The trim manual control wheel can override all the other THS setting modes. Moving it leads to the two adjustment circuits being disconnected by electrical control.

#### 1.16.1.4 Protection of Flight Envelope

Each of the two Flight Advisory Computers (FAC) provides calculations for the following functions as displayed on the PFD:

- speed trend,
- limit speeds,
- minimum speed for retraction of flaps and slats,
- maneuver speed single engine conditions in clean configuration,
- protection with respect to maximum angle of attack and wind shear.

The following symbols and functions are used in this report:

- $V_c$  trend: speed trend. This is the speed the aircraft will reach in ten seconds at constant acceleration.
- $V_{LS}$  (velocity lower selectable). This is the minimum speed which can be selected and is defined for the aircraft configuration with a margin in relation to the stall speed.
- $V_{SS}$  (velocity stick shaker). This is the speed corresponding to activation of the stick shaker calculated at 1.1 times the stall speed. It corresponds to an angle of attack of ten degrees in clean configuration and 17.5 degrees in other configurations.
- $V_{MAX}$  (for selectable  $V_{max}$ ).  $V_{MAX}$  is the upper speed limit for the flight envelope. It depends on the aircraft configuration. At the time of the incident,  $V_{FE}$  (maximum speed, flaps extended) was  $V_{MAX}$ .

These speeds are shown on the PFD. If a speed less than  $V_{LS}$  or greater than  $V_{MAX}$  is displayed on the auto-throttle,  $V_{LS}$  or  $V_{MAX}$  is taken into account by the latter.

- Protection with respect to maximum angle of attack. This protection is organized around the three following angle of attack thresholds in the 20/20 aircraft configuration, with landing gear extended:
  - the Alpha-floor threshold, at  $14^{\circ}5$  angle of attack, triggering a go around at a high rate if the ATHR is engaged. The throttle levers will then be advanced at a speed of  $8^{\circ}/s$ .
  - the Alpha-trim threshold, at  $16^{\circ}$  minus the product calculated from the angle of attack derivative, which automatically reduces the THS setting by  $4^{\circ}$ .
  - The trigger threshold for the stall warning system (audio warning and stick shaker), at  $17^{\circ}5$ .
- Speed protection. The AFS includes a speed protection function that is only active in Vertical Speed mode. This is intended to maintain the aircraft within the flight speed range certified for the various configurations.

If the aircraft climbs and too high a vertical speed is selected, the speed will be reduced. When it reaches  $V_{LS} + 5$  kt, the LVL CHG mode replaces VS and will

capture the altitude selected on the FCU. If this altitude is greater than that of the aircraft, the CLB mode will be activated, the auto-throttle will command maximum thrust and the automatic pilot will command a pitch attitude appropriate to the speed. The aircraft will continue to climb while remaining within the certified speed.

If the aircraft descends and too high a vertical speed is selected, the speed will increase. When it reaches  $V_{MAX}$ , LVL mode CHG replaces VS. If the altitude selected is less than the altitude of the aircraft, the auto-throttle will set the engines at idle and the automatic pilot will command an attitude enabling speed to be maintained. The aircraft will continue to descend while remaining within the certified speed. The following paragraph is taken from the Airbus Industrie FCOM (see appendix 8):

#### SPEED PROTECTION

In V/S mode, the priority will be given to the vertical speed, against the speed.

If vertical speed is not compatible with selected speed, the speed will decrease or increase towards  $V_{LS}$  or  $V_{MAX}$ . But on reaching  $V_{LS} + 5$  KT (when vertical speed is positive) or  $V_{MAX}$  (when vertical speed is negative), the AP/FD will automatically change to LVL/CHG mode with selected speed as reference.

$V_{FE}$  for the slats and flaps at 15° configuration is 210 kt. It is 195 kt for flaps at 20°. It is the positioning of the flaps selector and not extension thereof which introduces the new  $V_{FE}$ . As a result,  $V_{MAX}$  instantaneously switches from 210 to 195 kt on selection of flaps from 15 to 20°.

Further, when the speed reaches  $V_{FE} + 4$  kt, the system gives an audio warning in the form of a “Continuous repetitive chime”.

### 1.16.2 Simulation

The intermediate approach, final approach until the onset of the pitch attitude and the stabilization phase coming out of the stall were simulated on the Airbus Industrie simulator in Toulouse and the Swissair simulator in Zurich.

The aim of this simulation was to check the behavior of the aircraft and its flyability in the different phases and unusual configurations encountered during the event.

The full (between +70 ° and -70 °) and rapid (at a maximum rate of 25 °/s) roll phase could not be simulated. However, it was demonstrated that the first roll to the left could be ascribed to the Captain’s involuntarily input on the left control column horn. This input created an aileron deflection of twelve degrees, enough to bring the aircraft to the speed of 180 kt in roll at a constant rate of four degrees per second. Neither the aircraft’s passing through the peak of its trajectory at an altitude of 4,100 feet nor its behavior during the stall could be simulated.

The simulation recommenced in the phase at the end of the stall, just before pullout. This was performed with a load factor of 2.1 G, which can be attributed to a combination of the following factors :

- the anti-stall function , which brought the THS back to its previous deflection of 12.7° as soon as the stall conditions disappeared,
- the slackening of the Captain's efforts on the stabilizer,
- the pitch-up moment generated by the application of thrust.

It has been shown that the aircraft without trim control can be flown, for example at a speed of 160 kt, but this situation is potentially dangerous. In fact, application of maximum thrust can at any time trigger a nose up attitude.

It should be noted that the flight crew performing the simulation was warned of the event. They were familiar with and followed the standard approach procedure naturally, particularly relative to observation of  $V_{FE}$ , the display of altitude for go around and capture of LOC and glide. They bore in mind the procedures to cancel mode reversion or to make it virtual. They did not hesitate as the interpretation of the "whooper" nor on counter maneuver. When they applied TOGA thrust, it was checked pitch-up moment was triggered.

Under the combined effect of the out of trim condition and TOGA thrust, pull-up is clearly superior to that during rotation at take-off.

### **1.16.3 AP Conditions**

During the descent the two AP's were activated for automatic approach and landing. At 10 h 42 m 28 s, before they had intercepted the ILS localizer, the Captain deactivated them. The "cavalry charge" warning was cancelled by the flight crew, without comment.

The AP's were then to remain on OFF up to the end of the flight, with the exception of an extremely brief activation at 10 h 46 m 34 s.

When the recorded data was studied, a large number of actions on the instinctive disconnection button were noted, the first of these lasting twenty-four to thirty-two seconds started between two and six seconds after trim had reached the full nose up position. These repeated actions and the content of the conversations recorded by the CVR indicate that the Captain was in doubt as to disconnection of the AP.

Three attempts to activate the AP's were also noted after 10 h 46 m 29 s. These attempts were met by failure, probably due to the force then being exerted on the elevator control. They were marked by "cavalry charge" warnings.

### **1.16.4 Successive AFS Modes**

On disconnection of the AP's at 10 h 42 m 28 s, the FD switched to VS and LOC modes.

The value for vertical speed VS displayed on the FCU was not announced by the flight crew. The graphs give a rate of descent of 1,500 feet/m and a slight deviation between the FD trend bar and the aircraft model.



The recorded parameters show a change from VS mode to CLB at 10 h 43 m 25 s, at the moment of flaps 20/20 selection. We saw that this was a mode reversion due to the drop in  $V_{MAX}$  to 195 kt when the flaps were extended and a transient increase in speed. Mode reversion took place in CLB mode, and not DES, due to premature display of go around altitude of 4,000 feet. At the same moment, the throttle levers were advanced at a rate of one degree per second, this being the speed for advance during increase of thrust commanded automatically by the auto-throttle.

The following modes were then recorded:

- CLB and HDG until 10 h 44 m 11 s,
- ALT from 10 h 44 m 15 s to 10 h 44 m 47 s,
- VS from 10 h 44 m 51 s.

At 10 h 44 m 37 s, the pitch attitude and roll attitude reached high values from which the PFD is, by design, automatically purged of a certain number of items of information so as to show only the more significant information. The FD bars disappeared from the screen.

The auto-throttle disconnected at 10 h 44 m 28 s due to the non-availability of angle of attack data from the sensors that were considerably disturbed by the strong inflight drift. It was to remain OFF until landing.

At 10 h 52 m 07 s, while the aircraft was on short final approach, the recording shows a switch of AFS VS mode. This second automatic mode reversion is the result of a reduction in speed to  $V_{LS} + 5$  kt. As the auto-throttle was this time on stop, the throttle advance was not increased automatically. The Flight Director provided the pitch attitude to follow, which the flight crew does not seem to have noticed.

## 1.17 Eyewitness Accounts

A large number of people observed the event, in particular:

- the controller on duty in the Orly tower,
- the co-pilot of a DELTA Airlines aircraft, at the holding point on threshold 26,
- an engineer from the DGAC French Civil Aviation Authority on duty at Orly,
- the Captain of Air Liberté flight VD871 on final approach behind YR-LCA.

Their eyewitness accounts concur and confirm the aircraft's path during the incident.

## **2 - ANALYSIS**

### **2.1 ATC Actions**

The aircraft left its cruise level late, on instruction from the ATC. The IAF, the MEL VOR, was flown over at an indicated speed greater than 300 kt whereas speed is limited to 250 kt below level 100. ATC asked the flight crew, who announced a vertical speed of 4,000 feet per minute, to accelerate its descent to level 60, which, according to standard procedure, should be reached 7 NM after passing MEL.

Heading 330 given by approach control tended to bring the aircraft practically to the FAF for immediate interception of the ILS. Heading 310 reduced the closing angle for the aircraft's route in relation to the ILS axis. This angle was still too wide for the aircraft to align comfortably on the ILS and follow it immediately, all the more in that the indicated speed was still about 235 kt on interception.

This type of procedure is a practice that allows for traffic to be accelerated when meteorological conditions are favorable, which was the case. The flight crew could, however, in compliance with regulations, express its disagreement if they considered headings given would lead the aircraft to intercept the ILS too close to the final descent point. They did not do so.

There was no radio communication exchanged during the incident itself.

After the aircraft came out of the stall, the controller suggested to the flight crew that they stay on heading 180. This complies with the operational instruction aimed at keeping any aircraft with reduced maneuverability to the south of Orly. They were then left the choice of heading to return to their final approach as they wished.

New clearance for landing was given at 10 h 49 m 54 s. Note that no superfluous requests as to the cause of the incident were made by the controller.

### **2.2 Incident Sequence**

The CVR transcription does not indicate an approach briefing. The Captain was performing an automatic approach.

In level flight at 3,000 feet, the aircraft crossed the glide slope before intercepting the localizer. The flight crew seems to have attributed non-capture of glide to automatic pilot system malfunction, whereas the system logic subordinates it to that of the localizer, and disconnected the automatic pilot. The systems configuration then became AP OFF and ATHR ON. The aural warnings announcing disconnection of the AP and downgrading from CAT 3 to CAT 1 of the system landing capability were not commented on by the flight crew.

The aircraft was now in being flown manually and locked onto the localizer at an angle of 52° at 210 kt. It was high in relation to the glide slope and to the north of the

localizer axis. Aligned and set to descend, the speed was too high and the indicator for deviation in relation to the descent glide slope showed one point. The vertical speed was not commented on.

At about 2,750 feet, when the "altitude alert" signal sounded, the co-pilot selected 4,000 feet as the altitude to reach in the event of aborted approach, in order to cut off the warning signal.

This selection, before the capture of runway alignment, was premature and its value was greater than the level-off altitude following a go around.

Although the throttle levers had been in "flight idle" position, the speed remained high, the aircraft being two hundred feet above the glide slope. The Captain decided to put it in landing configuration. On each of the successive extensions of slats, flaps and landing gear, the speed was close to the maximum authorized value.

The flaps were positioned at 20 degrees as soon as the speed of 195 kt, that is  $V_{FE}$ , was reached. A temporary and minimal excess of  $V_{FE}$  (two knots for two seconds), perhaps on going through turbulence, was recorded. The speed protection logic then triggered mode reversion, thus initiating CLB mode due to the altitude selected being higher than the aircraft's altitude.

This change was not noted by the flight crew who were apparently not reading the FMA and did not notice the LVL CHG pushbutton illuminated on the FCU. They did not comment on the "triple click" signal.

While the throttle levers were advancing at their nominal speed on automatic by one degree per second, an action, which seems to have been unintentional and unconscious by one of the pilots, on the elevator trim control button led to deflection of the THS, at constant angular velocity, over ten seconds, up to the maximum value of thirteen degrees nose up. Although the characteristic "whooper" aural alarm was heard continuously for ten seconds, it was not commented on by the flight crew and led to no reaction from them.

This was probably the Captain's responsibility, who was at the controls. It may be explained :

- either by incorrect positioning of the left hand on the control column which would have caused the thumb to press the trim control button,
- or following confusion between two buttons, that of the trim control and that of the instinctive AP disconnect.

This pilot has considerable experience on the BAC 111, an aircraft on which the pushbutton on the left control column horn is the automatic pilot instinctive disconnection control. We may surmise that when he sought to counter the aircraft's tendency to pitch up without understanding its origin, confusion could have set in and having reverted to old reflexes in seeking to disconnect the automatic pilot (already disconnected) he operated the control located in the same place as the AP disconnection on BAC 111.

The co-pilot's phrase "*take over manually*" is not sufficiently explicit. As the aircraft was no longer on automatic pilot, it would have been more appropriate to say "*disconnect the auto-throttle*". This may also mean that the co-pilot believed that one automatic pilot had remained active.

In any event, deflection of the THS created a strong nose up force to the aircraft that the pilot countered by energetic efforts on the elevators, which put the aircraft in a totally out of trim situation.

This out of trim situation was the second crucial feature in the sequence of events in the incident, the first having been the AFS mode reversion.

It seems that the flight crew was unaware of this total out of trim situation. They did not carry out the instructions provided for in the event of "High Pitch Force" or "Abnormal pitch behavior" that provide a response to this situation.

As the auto-throttle was still in operation, the pilot overrode it by manually moving the throttle levers to flight idle for ten seconds before suddenly pushing them back to the maximum thrust position. Four seconds later, he moved them rapidly to flight idle for two seconds, before again pushing them to maximum thrust.

To try and explain the first positioning of the throttle levers to maximum thrust, we can propose two hypotheses :

- the Captain, noticing the strong reduction in the VC trend, may have thought that the speed was going to decrease significantly. He may have advanced the throttle to avoid stalling,
- the Captain, noticing the problem in the pitch attitude, which would prevent him from continuing his landing, seems to have decided to climb so as to obtain more favorable conditions to deal with the problem.

No reason was found for the two other movements of the throttle levers and interviews with the flight crew did not contribute to an understanding of this. It is also clear that the crew, after such a stressful event, could neither remember all their actions, often probably of an instinctive nature, nor even less explain them.

Under the aerodynamic effect of THS deflection and under the mechanical effect of thrust, the aircraft was thus subjected to a nose up force that could not be controlled by elevators. It rapidly assumed an extreme pitch attitude and angle of attack.

The level of force applied on the elevators with just the left hand, while the right hand was maneuvering the engine throttle levers, induced load on the aileron controls. The aircraft then went into a regular and slow roll.

The flight crew was thus confronted by four problems, with the need to:

- Hold the aircraft on a descending path
- Counter the nose up tendency and control thrust
- Pilot the aircraft by switching to instrument flight
- Analyze and decide.

The Captain reached a point of saturation and so announced a MAYDAY situation, meaning he indicated that he was in a critical situation. It should be noted here that the flight crew neither acted in a coordinated manner nor relied on rules for dealing with an emergency situation. The Captain did not delegate any task or action to the co-pilot who, in turn, proposed no emergency action. Any notion of managing the flight crew seems to have been forgotten.

The FD indications on the pitch attitude to be followed to reach an altitude of 4,000 feet could only be interpreted with great difficulty by the flight crew. Also, due to high pitch attitudes, the PFD was automatically purged, to leave essential information only.

The aircraft thus reached an altitude of 4,100 feet on the verge of a stall, with a minimum recorded speed of about 35 kt. The protection system against high angles of attack cut in and reduced THS deflection from  $-12.7$  to  $-8.8$  degrees, and as a result, the angle of attack from 42 to 30 degrees. The PF does not seem to have noticed the THS pitch down movement, particularly given that a movement of the THS commanded by the automated systems is not announced by the “whooper”. This triggered a reduction in pitch attitude. The aircraft did, however, stall; the “Cricket” stall warning signal and stick shaker were only activated later during descent (see paragraph 2.3.2 below).

Immediately before, during and after the stall, due the unreliability of the total pressure, the ADC no longer provided speed data, resulting in automatic disconnection of the ATHR, with the throttle levers remaining in the maximum thrust position.

Just before the stall, the Captain pulled the control column fully back, bringing the elevator to 23 degrees nose up. He then pushed it fully forward, while continuing to counter the roll of 75 degrees to the right with the ailerons. The statistical data shows that, when confronted by a stall, in 80% of cases, pilots pull back the control column, in a sort of reflex movement, which continues the loss of control.

The aircraft was subjected to a series of four full and rapid rolls. The first was attributed to the force brought to bear by the pilot on the left part of the control column; the following ones were due to pilot overcompensation on the roll then the stall. Having pulled the control column fully back and thus caused maximum nose up pitch, the pilot rectified this by pushing the control column fully forward. The aircraft dipped, with its nose going under the horizon by  $32^\circ$ . The roll-off from  $+50$  to  $-32^\circ$  in seven seconds was remarkable.

During the descent, the pilot, helped by the automatic setting of the THS to  $-8.8$  degrees, reduced angle of attack, gained speed by reducing drag, performed a gentle pull-out (load factor of 2 g for five seconds) and adjusted power. The aircraft came out of the stall at a height of eight hundred feet, still out of trim. The flight parameters were apparently stable thanks to thrust modulation.

Alpha-trim protection was automatically cancelled as soon as the aircraft came out of the stall : the THS returned to its previous deflection of  $-12.7$  degrees. This automatic movement, without a “whooper”, seems to have gone unnoticed by the

Captain. The Captain flew the aircraft, still totally out of trim, on a slightly rising trajectory, and set thrust to around 60% of N1. The speed decreased regularly and reached 140 kt. This situation carried a high potential risk : in the event of an increase in thrust for any reason, the aircraft would inevitably have started climbing with a high angle of attack.

The co-pilot, reading the ECAM, announced "*Pitch trim off*". In fact, the drifting caused by the rolls had disturbed angle of attack assessment and led to their automatic disconnection. The co-pilot re-engaged them and performed tests by deflection in both directions. The "whooper" was identified and the co-pilot declared the trim setting system to be operational. He reduced deflection to  $-8.4$  degrees. This action to reduce the THS angle was beneficial. It nevertheless remains an example of simultaneous piloting, performed without the knowledge of the pilot flying.

On an outward leg on heading 120, the aircraft at 195 kt and at 2,000 feet was now only slightly out of trim (THS  $-8.4$  degrees nose up; pitch  $8^\circ$  nose down).

The Captain at first refused to use THS trim. About eighty seconds later, inputs recorded on the FDR and selector noises on the CVR show that he used it but without announcing it, by short touches identical to his way of using trim before the event was triggered. Five minutes after total deflection of the THS, the aircraft was correctly trimmed and piloting had returned to normal.

Landing took place in configuration with slats and flaps 20 , which in the final approach, led to the announcement "too low flaps" from the GPWS. LOC interception took place by visual alignment with the runway axis. The aircraft crossed the glide slope, remained above then, finally, went below it. These deviations were not announced. The "glide slope" aural warning was heard on final approach.

On final approach, on reducing speed, the AFS triggered a mode reversion from VS to SPD. As the auto-throttle was disconnected and the flight crew was getting ready to land, this new mode reversion went unnoticed.

To summarize, this second approach was neither prepared nor stabilized.

Note : the CVR shows no attempt to determine the anomaly felt on the longitudinal attitude control system, THS and pitch. More generally, there would not seem to have been actions which could be called "return to basics" on the part of the flight crew. In the present case, this would have involved:

- setting the aircraft trim, if necessary using the mechanical control wheel,
- returning to standard flight situation, normal visual flight circuit, briefing and check-list,
- possibly reactivating certain elements of the AFS, after consulting the ECAM.

As soon as the situation seemed to have stabilized, conversations resumed in the cockpit. Neither the auto-throttle, nor THS deflection, nor the variations in thrust were mentioned. Neither was mode reversion from VS to LVL CHG brought up. The conversation mainly concerned the AP. The flight crew did not carry out a briefing for the new approach.

## 2.3 Operation of AFS Protection

### 2.3.1 Protection of Speed Envelope

The aircraft speed exceeded  $V_{FE}$  before capture of ILS. Note that in these circumstances, protection against an overspeed is ensured according to the two following thresholds:

- when the speed becomes equal to  $V_{FE}$ , by switching to LVL CHG mode.
- when the speed reaches  $V_{FE} + 4$  kt, by sounding a Continuous Repetitive Chime.

The choice of LVL CHG as protection against excess speed led, in the circumstances of the incident, to an increase in thrust at a moment where the goal was to reduce speed, this being incompatible with the goal sought.

We may note that, if the automatic pilot had been active, it would have caused a nose up attitude, which would also have surprised a flight crew in the middle of intercepting a localizer and whose first objective was to reach the runway.

### 2.3.2 Analysis of the Stall Protection Logic

Stall protection is organized around three angle of attack thresholds, that for Alpha-floor, that for Alpha-trim and that for triggering the stall warning (see 1.16.1.4).

Alpha-floor protection could not play its role as, when angle of attack of  $14.5^\circ$  was reached, the throttle levers were already on maximum thrust.

Alpha-trim protection was triggered at a value for angle of attack of slightly less than  $15^\circ$  in conditions where the flight dynamics were close to the extreme. It should be noted that it also functioned after coming out of the stall by giving the opposite order to the THS.

The stall warning did not sound and the stick shaker did not operate in the flight phase prior to the stall. When questioned, the aircraft manufacturer indicated that the cause for non-operation of these two warnings was the disturbance of the angle of attack sensors due to the dynamics of the aircraft's movements, with the speed having dropped below 60 kt before the angle of attack reached  $17.5^\circ$ . The flight crew had, however, been warned of the approach of a stall by buffeting.

## 3 - CONCLUSIONS

### 3.1 Findings

- The flight crew was properly licensed to conduct the flight. A third pilot undergoing familiarization was in the observer's seat.
- The meteorological conditions were excellent.
- The aircraft was normally certified and maintained. No non-availability of equipment (with the exception of the FDR) was noted. Ground checks after the incident, and subsequent flights of the aircraft showed no evidence of any operating anomaly.
- The Captain, at the controls, started an automatic approach.
- Approach control asked the aircraft to shorten its path, which led to ILS interception closer to the runway than provided for by standard procedure.
- According to the systems logic, the glide, encountered before the localizer, was not automatically captured . The Captain then disconnected both automatic pilots, leaving the auto-throttle in operation.
- An altitude of 4,000 feet was selected before establishment of the aircraft on ILS as go around altitude. The go around altitude in the procedures is 2,000 feet.
- When flaps were selected at 20 degrees, the speed was slightly greater than  $V_{MAX}$ , which activated speed protection, leading to reversion of VS mode to LVL CHG mode.
- Due to the altitude selected being greater than that of the aircraft, the auto-throttle commanded an increase in thrust. The pilot maintained the aircraft on descent.
- He accidentally caused the trim to its electrical stop at thirteen degrees nose up, which put the aircraft in a totally out of trim situation.
- To counter the effect of THS deflection, he moved the elevator control to its mechanical stop of fifteen degrees nose down, by effort applied on the control column.
- A sudden increase in thrust was commanded manually.
- Under the effect of the additional force, the aircraft pulled up rapidly. The pilot continued to counter by continuous effort on pitch and by temporarily holding the thrust levers in the idle position. He neither corrected trim, which remained on pull-up stop nor disconnected the auto-throttle.



- The aircraft took a path with a very steep slope, with roll angle reaching extremely high values. It climbed to an altitude of 4,100 feet and minimum speed recorded was 35 kt. Alpha-trim protection reduced the THS deflection by four degrees.
- Under the effect of strong drift on full and rapid rolls, the angle of attack sensors were disturbed, which led to automatic disconnection of the two pitch-trims. The auto-throttle was inhibited for the same reasons.
- Due to the dynamic of the aircraft's movements, the stall warning and the stick shaker did not function in a preventive manner.
- The flight crew regained control of the aircraft after the stall.

### **3.2 Probable Causes**

The direct causes of the unusual attitudes and the stall to which the aircraft was subjected were a movement of the THS towards the full pitch-up position and a rapid increase in thrust, both of which maneuvers were due to the Captain, following an AFS mode reversion which was not understood. The pitch-up force caused a sudden change in attitude that the flight crew was unable to contain with the elevators.

The following elements contributed to the incident:

- Too rapid an approach, due to a late start in the descent, followed by a reduction of the standard procedure.
- Inadequate crew resource management.
- Premature selection of the go around altitude and precipitous setting of the configuration with slats and flaps at 20-20, which led to activation of the speed protection.
- Difficulty in understanding the action of the auto-throttle increasing thrust in its overspeed protection function.

## 4 - RECOMMENDATIONS

### 4.1 Measures Taken

After the incident and on the basis of the first facts established as communicated by the BEA<sup>(3)</sup>, the French Civil Aviation Authority (Direction Générale de l'Aviation Civile) informed French operators of the Airbus A 310 and A 300-600 (these two types have identical protection). It asked them in particular first to draw the attention of flight crews to the need to respect limit speeds provided for different aircraft configurations and, secondly, to ensure they are fully informed as to the logic of the protection system in the event of abnormal speed.

The DGAC also warned the civil aviation authorities of the countries using these aircraft, recommending them to take similar action with the operators under their authority.

### 4.2 Intermediate Recommendation

Following several accident investigations in which the Bureau Enquêtes-Accidents participated, the following recommendation was issued on 24 January 1995:

*Various incidents or accidents (see list below) involving public transport aircraft show the following common characteristics:*

1) Configuration: Automatic Pilot and/or auto-throttle lever (or auto thrust) in operation.

2) Circumstances: pilot flying overrides (voluntarily or involuntarily) the Automatic Flight System, or acts contrary to the indications of the Flight Director.

3) Aggravating circumstances:

a) the pilot flying is not always aware of his action in opposition with the Automatic Flight Systems and never perceives the consequences thereof,

b) the pilot not flying (even instructors) is not aware of the conflict between the pilot at the controls and the Automatic Flight Systems.

4) Consequences:

\* the reaction of the Automatic Flight Systems leads to potentially dangerous configurations: out of trim, engine thrust incompatible with the trajectory chosen by the pilot, etc.

\* Flight crew,

- either is not aware of the situation, and thus cannot take corrective measures,
- or observes the aircraft configuration without understanding the causes. This incomprehension (also related to limited knowledge of systems) leads to a loss of time in analyzing the situation, or even to an erroneous analysis, generally associated with a lack of adequate communication between crew members

*This has led to highly dangerous attitudes: extreme attitudes or rolls, loss of speed (including stalls) or excess speed, etc.*

<sup>3</sup> See preliminary report, published 3 November 1994.

As a result, the Bureau Enquêtes-Accidents recommends:

- **that a study be launched so that the pilot's priority over all Automatic Flight Systems is maintained in all circumstances.**

**This could be done :**

**a) by the disconnection of Automatic Flight Systems (automatic pilot and auto-throttle lever or auto thrust) in the event of conflict between the pilot's actions and those of the Automatic Flight System or Flight Director.**

**b) and/or by clear information in the cockpit (possibly an alarm) warning the flight crew of such a conflict.**

**List of events:**

1. Incident to an A 300-B4 on approach to Helsinki (Finland) on 9 January 1989
2. Accident to the A320-231 VT-EPN at Bangalore (India) on 14 February 1990
3. Incident to the A310 D-ADAC on approach to Moscow on 11 February 1991
4. Accident to the B747-400 F-GITA at Tahiti-Faaa on 13 September 1993
5. Accident to the A310-300 F-OGQS near Novokuzniesk (Siberia) on 22 mars 1994
6. Accident to the A300-600 B1816 at Nagoya on 26 April 1994
7. Incident to an A310-325 on approach to runway 26 at Orly on 24 September 1994

## **4.3 New Recommendations**

### **4.3.1 Speed Protection System Activation Display**

The flight crew noticed neither the initiation of the flight envelope speed protection nor the mode change which resulted from it. Further, we may note that the denomination "LVL CHG" is inappropriate to indicate activation of speed protection. LVL CHG is the process used and not the goal.

The BEA considers that recommendation 4.4.2 issued in the context of the investigation into the accident that occurred on 20 January 1992 near Mont Ste Odile corresponds to the problem identified here. It is repeated below, with the grounds given:

*In its analysis of this accident, the commission has been led to note deficiencies in the effectiveness of the display to the flight crew of the various active modes, the references used, actions in progress and targets pursued with regard to the Autopilot devices, notably in the vertical plane. Most particularly, in the opinion of the commission, the total information presented is inadequate in terms of its likelihood of alerting a crew, who at a given moment have an incorrect mental picture of the state of the automatic devices.*

*In practice, a good number of observations made by the commission apply to one degree or another to all new-generation aircraft ...*

**Consequently, the commission recommends that for all new-generation aircraft:**

***- consideration should be given by the competent authorities and organizations with a view to improving, in a standardized fashion on an international basis, the presentation and the symbols for displays and information relating to the different Autopilot active modes, notably in the vertical plane.***

#### **4.3.2 Successive Type Ratings**

The investigation showed that the Captain may have activated the trim control by mistake, wishing to activate the Autopilot instinctive disconnection, this latter control being placed in that position on the BAC 111 he had piloted before.

As a result, the Bureau Enquêtes-Accidents recommends:

- **that a study, using specialists in behavioral science, examine how reflexes and habits, possibly acquired on previously flown aircraft, may be taken into account when moving on to a new type of aircraft.**

## **APPENDICES**

### **Appendix 1**

Paris Orly Approach Charts

### **Appendix 2**

Transcript of radio communications between the aircraft and the Regional Control center

### **Appendix 3**

Transcript of radio communications between the aircraft and Orly Approach

### **Appendix 4**

CVR transcript (in French)

### **Appendix 5**

DAR parameters

### **Appendix 6**

Reconstitution of the aircraft's path from data recorded by the DAR

### **Appendix 7**

Flight track reconstituted from radar recordings

### **Appendix 8**

Extract from the A310 FCOM relating to speed prot





CRNA/Nord

Athis-Mons  
Feuille N° 1

le

14/11/94

10:15

INCIDENT:24 SEPTEMBRE 1994  
CV/mag

Ref 658 G 94

Communications RADIOTELEPHONIQUES échangées le **24/09/94**  
entre **ROT 381.** et PARIS CONTROLESecteur **AO**  
Fréquence **135,3**

Platine E 6 P 52

| Heures UTC      | DE             | COMMUNICATIONS                                                                                                          |
|-----------------|----------------|-------------------------------------------------------------------------------------------------------------------------|
| <b>10.25.00</b> |                | <b><i>Début d'écoute</i></b>                                                                                            |
| <b>10.25.08</b> | <b>ROT381</b>  | <b>PARIS, bonjour ROT 381.</b>                                                                                          |
| <b>10.25.28</b> | <b>ROT381</b>  | <b>ROT 381 flight level 3.5.0.</b>                                                                                      |
|                 | <b>Paris C</b> | <b>ROT 381 bonjour maintain 3.5.0 and what is your present heading?</b>                                                 |
|                 | <b>ROT381</b>  | <b>Heading 2.9.3.</b>                                                                                                   |
|                 | <b>Paris C</b> | <b>Okay for spacing, turn left heading 2.7.0.</b>                                                                       |
|                 | <b>ROT381</b>  | <b>Left heading 2.7.0.</b>                                                                                              |
| <b>10.29.47</b> | <b>Paris C</b> | <b>ROT381 proceed Melun now</b>                                                                                         |
|                 | <b>ROT381</b>  | <b>Proceeding to Melun, ROT381 ... (illisible).</b>                                                                     |
|                 | <b>Paris C</b> | <b>OKay, ROT381 descent down flight level 6.0.</b>                                                                      |
|                 | <b>ROT381</b>  | <b>Descending 6.0.</b>                                                                                                  |
| <b>10.36.35</b> | <b>Paris C</b> | <b>ROT 381 Say your rate of descent</b>                                                                                 |
|                 | <b>ROT381</b>  | <b>Two thousand.</b>                                                                                                    |
|                 | <b>Paris C</b> | <b>ROT381 increase rate of descent to be steady flight level 6.0 in two minutes maximum and contact Orly 1.2.0.8.5.</b> |
|                 | <b>ROT381</b>  | <b>1.2.0.8.5 bye, bye.</b>                                                                                              |
| <b>10.37.05</b> | <b>ROT381</b>  | <b>Paris Orly bonjour, ROT381</b>                                                                                       |
|                 | <b>Paris C</b> | <b>ROT381 Orly 1.2.0.8.5.</b>                                                                                           |
| <b>10.38.00</b> |                | <b><i>Fin d'écoute</i></b>                                                                                              |



Incident ROT 381  
du 24.09.94

Transcription de l'enregistrement des communications radiotéléphoniques échangées  
entre Orly Approche et ROT 381 - LIB 871 - AMX 448

Fréquence : 120,85 Mhz

1

| DE<br>COL. 1 | A<br>COL. 2 | HEURE UTC<br>COL. 3 | COMMUNICATIONS<br>COL. 4                                           | OBSERVATIONS<br>COL. 5 |
|--------------|-------------|---------------------|--------------------------------------------------------------------|------------------------|
| ROT 381      | OL/APP      | 10h37'13"           | - Orly bonjour - TAROM 3.8.1.                                      |                        |
| OL/APP       | ROT 381     |                     | - TAROM 3.8.1 turn right heading 3.3.0 for base leg runway 2.6.    |                        |
| ROT 381      | OL/APP      |                     | - .... right heading 3.3.0 for base runway 2.6.                    |                        |
| ROT 381      | OL/APP      | 10h38'40"           | - TAROM 3.8.1 - 6.0.                                               |                        |
| OL/APP       | ROT 381     |                     | - TAROM 3.8.1 descend 4.000 feet correction 3.000 feet on 1.0.1.3. |                        |
| ROT 381      | OL/APP      |                     | - 3.000 - 1.0.1.3.                                                 |                        |
| OL/APP       | ROT 381     | 10h41'02"           | - TAROM 3.8.1 turn left heading 3.1.0 intercept I.L.S runway 2.6.  |                        |
| ROT 381      | OL/APP      |                     | - Left - heading - 3.1.0 intercepting ILS 2.6.                     |                        |
| ROT 381      | OL/APP      | 10h43'31"           | - On final 2.6 TAROM 3.8.1.                                        |                        |
| OL/APP       | ROT 381     |                     | - 1.3.8.                                                           |                        |
| OL/APP       | ROT 381     |                     | - Cleared to land 3.8.1 wind 3 - 2.00 degrees/10 Knots.            |                        |
| ROT 381      | OL/APP      |                     | - ... cleared to land. Thank you.                                  |                        |
| -            | -           | 10h44'01"           | - ->                                                               | Modulation             |
| OL/APP       | ROT 381     | 10h44'24"           | - Euh TAROM 3.8.1 turn left if you want heading 1.8.0.             |                        |
| ROT 381      | OL/APP      |                     | -                                                                  | Pas de réponse         |
| OL/APP       | ROT 381     | 10h44'46"           | - TAROM 3.8.1 do you hear me ?                                     |                        |

Incident ROT 381  
du 24.09.94

Transcription de l'enregistrement des communications radiotéléphoniques échangées  
entre Orly Approche et ROT 381 - LIB 871 - AMX 448

Fréquence : 120,85 Mhz

2

| DE      | A       | HEURE UTC | COMMUNICATIONS                                                                                                                                            | OBSERVATIONS         |
|---------|---------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| COL. 1  | COL. 2  | COL. 3    | COL. 4                                                                                                                                                    | COL. 5               |
| OL/APP  | ROT 381 | 10h44'49" | - Do you hear me ?                                                                                                                                        |                      |
| OO/APP  | LIB 871 | 10h44'56" | - Liberté 8.71, il va y avoir un "CRASH" à l'entrée de la piste alors euh tournez à gauche cap 180.                                                       |                      |
| -       | -       | 10h45'02" | - - - - - Commandes                                                                                                                                       |                      |
| OL/APP  | ROT 381 | 10h45'10" | - TAROM 3.8.1 if your hear me as you like for landing 2.6.                                                                                                |                      |
| OL/APP  | LIB 871 | 10h45'19" | - LIBERTE 8.71 ne tournez pas au cap Sud, gardez l'axe pour l'instant s'il vous plaît, gardez l'axe.                                                      |                      |
| LIB 871 | OL/APP  | 10h45'24" | - 8.71 on garde l'axe et on a visuel sur l'avion qui a repris de l'altitude.                                                                              |                      |
| OL/APP  | LIB 871 | 10h45'30" | - Oui qui a repris de l'altitude après un décrochage, euh gardez l'axe liberté 8.87 et Liberté 8.87 ⊕ autorisé à l'atterrissage 26. 200 degrés/10 noeuds. | ⊕ = blanc            |
| LIB 871 | OL/APP  | 10h45'45" | - 8.7.1 on atterrit piste 26.                                                                                                                             |                      |
| OL/APP  | LIB 871 | 10h45'49" | - Liberté 8.7.1 appelez sur 118,7.                                                                                                                        |                      |
| LIB 871 | OL/APP  | 10h45'51" | - 118,7.8.71.                                                                                                                                             |                      |
| OL/APP  | ROT 381 | 10h45'53" | - TAROM 3.8.1 do you want to come back on the I.L.S now ?                                                                                                 |                      |
| AMX 448 | OL/APP  | 10h45'59" | - ..... 48 we're you giving back.                                                                                                                         | (réponse de AMX 448) |
| OL/APP  | ROT 381 | 10h46'03" | - Yes are you ? do you agree to turn left on the I.L.S now ?                                                                                              |                      |
| AMX 448 | OL/APP  | 10h46'08" | - Yes we can do it.                                                                                                                                       | (réponse de AMX 448) |
| OL/APP  | ROT 381 | 10h46'10" | - OK so turn left heading 0.2.0.                                                                                                                          |                      |
| AMX 448 | OL/APP  | 10h46'12" | - 0.2.0 thank you.                                                                                                                                        | (réponse de AMX 448) |

J/ nt ROT 381  
 09.94

Transcription de l'enregistrement des communications radiotéléphoniques échangées  
 entre Orly Approche et ROT 381 - LIB 871 - AMX 448

Fréquence : 120,85 Mhz

| DE      | A       | HEURE UTC | COMMUNICATIONS                                                          | OBSERVATIONS |
|---------|---------|-----------|-------------------------------------------------------------------------|--------------|
| COL. 1  | COL. 2  | COL. 3    | COL. 4                                                                  | COL. 5       |
| OL/APP  | AMX 448 | 10h46'13" | - MEXICAN 4.4.8 turn left heading 0.8.0.<br>please.                     |              |
| AMX 448 | OL/APP  | 10h46'15" | - Roger we go turn left heading 0.8.0.                                  |              |
| OL/APP  | ROT 381 | 10h47'10" | - TAROM 3.8.1 turn left heading 0.1.0.                                  |              |
| ROT 381 | OL/APP  |           | - Roger.                                                                |              |
| OL/APP  | ROT 381 |           | - Do you have full control of your aircraft<br>now ? Is it ok for you ? |              |
| ROT 381 | OL/APP  |           | - Yes Sir..... control.                                                 |              |
| ROT 381 | OL/APP  |           | - Do you read ?                                                         |              |
| OL/APP  | ROT 381 |           | - You request assistance after landing TAROM<br>3.8.1 ?                 |              |
| ROT 381 | OL/APP  |           | - Affirm, affirm we are on heading now 0.7.0<br>maintening 2000.        |              |
| OL/APP  | ROT 381 |           | - Yes, turn left heading 0.1.0.                                         |              |
| ROT 381 | OL/APP  |           | - Left heading 0.1.0.                                                   |              |
| OL/APP  | ROT 381 | 10h48'10" | - TAROM 3.8.1 turn left heading 3.0.0 to<br>intercept your ILS.         |              |
| ROT 381 | OL/APP  |           | - Understood, left heading on 0.1.0 to<br>intercept the ILS for 2.6.    |              |
| OL/APP  | ROT 381 | 10h48'40" | - TAROM 3.8.1 turn left heading 3.0.0<br>intercept ILS.                 |              |
| ROT 381 | OL/APP  |           | - Left heading 0 - 3.0.0 intercepting<br>ILS 2.6.                       |              |
| OL/APP  | ROT 381 |           | - 3.0.0.                                                                |              |
| ROT 381 | OL/APP  |           | - 3.0.0.                                                                |              |

## APPENDIX : CVR TRANSCRIPT

### FOREWORD

The following is a transcript of elements which were comprehensible, at the time of the preparation of the present report, on the cockpit voice recorder. This transcript contains conversations between crew members, radiotelephonic messages between the crew and Air Traffic Control services and various noises corresponding , for example, to the use of controls or to the alarms.

The reader's attention is drawn to the fact that the recording and transcription of the CVR are only a partial reflection of events and of the atmosphere in the cockpit. Consequently, the utmost care is required in the interpretation of this document.

Communications recorded on the CVR which concern other aircraft are not transcribed.

In the preliminary report, the times shown in the transcript was the time read out from the CVR with the time given by the controller during VHF communications. The synchronized DAR data and CVR recording are noted here in UTC time as recorded on board the aircraft.

### GLOSSARY

- UTC Time : UTC time given by the control tower recording
- Track 1 : Captain's headset microphone including conversations on VHF between the co-pilot and the ATC.
- Track 3 : Cockpit area microphone
- (1) : Voice of the Captain
- (2) : Voice of the Co-pilot as recorded on the CAM or on VHF during communications with ATC
- (3) : Third person in cockpit
- PA : Public Address
- Ctl : Air Traffic Control (ATC)
- (\*) : Words not understood
- (@) : Various noises, alarms
- (...) : Words or groups of words which, at the time they were spoken neither interfered with the normal conduct of the flight nor add any elements useful for the analysis or understanding of this event.
- ( ) : Words or groups of words where some doubt persists or which necessitated extensive repeated listening.
- 2/3 : The speaker could not be identified

| UTC time     | Track 3 Cockpit Area Microphone        | Track 1 Hot Mike                   | VHF | Observations                |
|--------------|----------------------------------------|------------------------------------|-----|-----------------------------|
| 10h 34mn 37s |                                        |                                    |     |                             |
| 10h 34mn 43s | (3) (...)                              |                                    |     |                             |
| 10h 34mn 47s |                                        | (1) (...)                          |     |                             |
| 10h 34mn 49s | (3) (...)                              |                                    |     |                             |
| 10h 34mn 50s |                                        | (1) (...)                          |     |                             |
| 10h 34mn 51s | (3/2) (...)                            |                                    |     |                             |
| 10h 34mn 54s |                                        | (1) (...)                          |     | Laughter                    |
| 10h 34mn 55s | (@)                                    |                                    |     |                             |
| 10h 35mn 10s |                                        | (@) (1) Yes                        |     | Cabin Call (1 chime)        |
| 10h 35mn 14s |                                        | (1) Yes                            |     |                             |
| 10h 35mn 16s | (2) By pass (*) Auto brakes            |                                    |     |                             |
| 10h 35mn 20s | (2) The test !                         |                                    |     |                             |
| 10h 35mn 21s |                                        | (1) I've put it on automatic to... |     |                             |
| 10h 35mn 31s | (2) Turned to Altimeters               |                                    |     |                             |
| 10h 35mn 33s |                                        | (1) One zero one three             |     |                             |
| 10h 35mn 35s | (2) Yes, so, completed the cross check |                                    |     |                             |
| 10h 35mn 36s |                                        | (1) Yes, Yes                       |     |                             |
| 10h 35mn 38s | (3) It's turbulence which (*)          |                                    |     |                             |
|              |                                        | (1) Yes                            |     |                             |
| 10h 35mn 42s | (3) (...)                              |                                    |     |                             |
| 10h 35mn 43s |                                        | (1) (...)                          |     |                             |
| 10h 35mn 46s | (3) (...)                              |                                    |     |                             |
| 10h 35mn 55s | (3) (...)                              |                                    |     |                             |
| 10h 36mn 56s | (2/3) (...)                            | (1) (...)                          |     | Laughter                    |
| 10h 36mn 06s |                                        | (1) (...)                          |     | Public Address Announcement |
| 10h 36mn 33s |                                        | (1) (...)                          |     |                             |

| UTC time     | Track 3 Cockpit Area Microphone              | Track 1 Hot Mike               | VHF                                                                                                                                                              | Observations                       |
|--------------|----------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 10h 36mn 35s |                                              |                                | (Ctl) Tarom three eight one say rate of descent                                                                                                                  |                                    |
| 10h 36mn 38s |                                              | (1) Four thousand              |                                                                                                                                                                  |                                    |
| 10h 36mn 39s |                                              |                                | (2) Four thousand                                                                                                                                                |                                    |
| 10h 36mn 41s |                                              |                                | (Ctl) Tarom three eight one increase rate of descent to be setting flight level six zero in two minutes maximum and contact Orly one two zero decimal eight five |                                    |
| 10h 36mn 50s |                                              | (1) Are you crazy ?            | (2) (*)                                                                                                                                                          |                                    |
| 10h 36mn 52s |                                              | (1) Are you crazy?             |                                                                                                                                                                  |                                    |
| 10h 37mn 00s |                                              | (1) They're crazy !            |                                                                                                                                                                  |                                    |
| 10h 37mn 03s |                                              |                                | (2) (*)                                                                                                                                                          |                                    |
| 10h 37mn 05s |                                              |                                | (Ctl) Tarom three eight one Orly one two zero eight five                                                                                                         |                                    |
| 10h 37mn 11s |                                              | (1) One two zero eight five ok |                                                                                                                                                                  |                                    |
| 10h 37mn 13s |                                              |                                | (2) Paris hello Tarom three eight one                                                                                                                            | End of Public Address announcement |
| 10h 37mn 15s |                                              |                                | (Ctl) Tarom three eight one turn right heading three three zero for base leg runway two six                                                                      |                                    |
| 10h 37mn 20s |                                              |                                | (2) ...right heading three three zero for base runway two six                                                                                                    |                                    |
| 10h 37mn 31s | (2) It's decided then, we're going to land ! |                                |                                                                                                                                                                  |                                    |
| 10h 37mn 35s |                                              | (1) Listen to the I L S !      |                                                                                                                                                                  |                                    |
| 10h 37mn 45s | (2) I heard it                               |                                |                                                                                                                                                                  |                                    |
| 10h 37mn 46s |                                              | (1) (...)                      |                                                                                                                                                                  |                                    |
| 10h 37mn 47s |                                              | (1) (...)                      |                                                                                                                                                                  |                                    |
| 10h 37mn 49s |                                              | (1) (...)                      |                                                                                                                                                                  |                                    |
| 10h 37mn 50s | (3) (...)                                    |                                |                                                                                                                                                                  | Laughter                           |
| 10h 37mn 53s |                                              | (1) (...)                      |                                                                                                                                                                  |                                    |

| UTC time     | Track 3 Cockpit Area Microphone                   | Track 1 Hot Mike                                                                         | VHF                                                                                                            | Observations |
|--------------|---------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------|
| 10h 37mn 55s |                                                   | (1) (...)                                                                                |                                                                                                                |              |
| 10h 38mn 01s | (3) (...)                                         |                                                                                          |                                                                                                                | Laughter     |
| 10h 38mn 08s |                                                   | (1) (...)                                                                                |                                                                                                                |              |
| 10h 38mn 21s |                                                   | (1) It took it                                                                           |                                                                                                                |              |
| 10h 38mn 22s | (2) It took it                                    |                                                                                          |                                                                                                                |              |
| 10h 38mn 24s | (2) One thousand                                  |                                                                                          |                                                                                                                |              |
| 10h 38mn 36s |                                                   | (1) Give him six zero, and ask him for the speed                                         |                                                                                                                |              |
| 10h 38mn 39s |                                                   |                                                                                          | (2) Taron three eight one six zero                                                                             |              |
| 10h 38mn 44s |                                                   |                                                                                          | (Ctl) Taron three eight one descend four thousand feet... correction three thousand feet on one zero one three |              |
| 10h 38mn 50s |                                                   |                                                                                          | (2) Three thousand one zero one three (*)                                                                      |              |
| 10h 39mn 01s |                                                   | (1) Four thousand one zero....                                                           |                                                                                                                |              |
| 10h 39mn 03s | (2) One three                                     |                                                                                          |                                                                                                                |              |
| 10h 39mn 04s |                                                   | (1) One three                                                                            |                                                                                                                |              |
| 10h 39mn 05s |                                                   | (1) Set on my side                                                                       |                                                                                                                |              |
| 10h 39mn 07s | (2) (*)                                           |                                                                                          |                                                                                                                |              |
| 10h 39mn 11s | (2) Exactly the glide slope interception altitude |                                                                                          |                                                                                                                |              |
| 10h 39mn 13s |                                                   | (1) Yes                                                                                  |                                                                                                                |              |
| 10h 39mn 17s |                                                   | (1) Is the L S right ?                                                                   |                                                                                                                |              |
| 10h 39mn 18s | (2) Set                                           |                                                                                          |                                                                                                                |              |
| 10h 39mn 19s |                                                   | (1) Set on my side                                                                       |                                                                                                                |              |
| 10h 39mn 34s |                                                   | (1) There you are, we go into the clouds and nothing happens, we're just shaken up a bit |                                                                                                                |              |
| 10h 39mn 37s | (3) We can't see any more.....                    |                                                                                          |                                                                                                                |              |
| 10h 39mn 38s |                                                   | (1) Yes                                                                                  |                                                                                                                |              |

| UTC time     | Track 3 Cockpit Area Microphone                                                  | Track 1 Hot Mike                                                    | VHF                                                                                             | Observations   |
|--------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------|
| 10h 39mn 40s | (3) (*)                                                                          | (1) Yes, yes                                                        |                                                                                                 | Laughter       |
| 10h 39mn 43s |                                                                                  | (1) These are good weather clouds                                   |                                                                                                 |                |
| 10h 39mn 44s | (3) Yes, yes, yes                                                                |                                                                     |                                                                                                 |                |
| 10h 39mn 56s | (3) Isn't aviation wonderful!                                                    |                                                                     |                                                                                                 | Laughter       |
| 10h 40mn 00s | (3) To hell with it !                                                            |                                                                     |                                                                                                 | Joke           |
|              |                                                                                  | (1) Aviation is tough tough tough for us                            |                                                                                                 |                |
| 10h 40mn 02s |                                                                                  | (1) It's beautiful, just look at it ! (...)                         |                                                                                                 | Laughter       |
| 10h 40mn 11s | (2/3) As we were saying                                                          |                                                                     |                                                                                                 | Joke           |
| 10h 40mn 22s |                                                                                  | (1) There it is, a runway over there see how many runways there are |                                                                                                 |                |
| 10h 40mn 30s | (2) A thousand until... (*)                                                      |                                                                     |                                                                                                 |                |
| 10h 40mn 31s |                                                                                  | (1) Set                                                             |                                                                                                 |                |
| 10h 40mn 49s | (3) I think it's a pleasure to fly a thing like this                             |                                                                     |                                                                                                 |                |
| 10h 40mn 59s | (@)                                                                              |                                                                     |                                                                                                 | Selector noise |
| 10h 41mn 00s | (2) Speed A S and target is set                                                  |                                                                     |                                                                                                 |                |
| 10h 41mn 01s |                                                                                  | (1) Set                                                             |                                                                                                 |                |
| 10h 41mn 01s |                                                                                  |                                                                     | (CtI) Taron three eight one turn left heading three one zero intercept I L S for runway two six |                |
| 10h 41mn 06s |                                                                                  |                                                                     | (2) Left heading three one zero intercepting I L S two six                                      |                |
| 10h 41mn 16s | (2) It's still good here                                                         |                                                                     |                                                                                                 |                |
| 10h 41mn 22s | (2) (*) ... Three thousand. There's a plane over there, at about three hundred d |                                                                     |                                                                                                 |                |



| UTC time     | Track 3 Cockpit Area Microphone                               | Track 1 Hot Mike                                                                                                                   | VHF                                                                | Observations                                                                                                     |
|--------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| 10h 41mn 44s |                                                               | (1) Over there, somewhere, is the runway, you can see it there where there's that empty space                                      |                                                                    |                                                                                                                  |
| 10h 41mn 47s | (3) So, how long are you going to fly like this on autopilot? |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 41mn 50s |                                                               | (1) Je peux le piloter comme ça jusqu'à ce que l'on atterrisse. Voilà, vous pouvez voir la Tour Eiffel, là devant, vous la voyez ? |                                                                    |                                                                                                                  |
| 10h 41mn 53s | (3) Yes, yes, yes                                             | (1) On voit la Tour Eiffel là où est le bâtiment noir et au dessus, à l'autre bout c'est Saint-Paul et Montparnasse....            | You can see the Eiffel Tower there where the black building is and |                                                                                                                  |
| 10h 42mn 01s | (3) Aha, Aha !                                                |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 02s |                                                               | (1) ... toute la partie, là-bas                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 05s |                                                               | (1) Slats fifteen                                                                                                                  |                                                                    |                                                                                                                  |
| 10h 42mn 06s | (@)                                                           |                                                                                                                                    |                                                                    | Bruits de sélecteur                                                                                              |
| 10h 42mn 07s | (2) Set                                                       |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 09s | (2) One eight one                                             |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 10s |                                                               | (1) Set                                                                                                                            |                                                                    |                                                                                                                  |
| 10h 42mn 11s | (2) On voit aussi la piste                                    |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 15s |                                                               | (1) Mais, il est fou ? !                                                                                                           |                                                                    |                                                                                                                  |
| 10h 42mn 24s |                                                               | (1) Mais il est fou ? !                                                                                                            |                                                                    |                                                                                                                  |
| 10h 42mn 28s | (@)                                                           |                                                                                                                                    |                                                                    | Bruit de sélecteur similaire à la palette PA qui tombe et alarme déconnexion Pilote Automatique (Cavalry charge) |
| 10h 42mn 30s | (2) Tiens ! il n'a pas pris la pente !                        |                                                                                                                                    |                                                                    |                                                                                                                  |
| 10h 42mn 32s | (@)                                                           |                                                                                                                                    |                                                                    | Triple click                                                                                                     |
| 10h 42mn 33s |                                                               | (1) Il n'a pas pris la direction !                                                                                                 |                                                                    |                                                                                                                  |

| UTC time     | Track 3 Cockpit Area Microphone                   | Track 1 Hot Mike                                         | VHF | Observations                                                                                           |
|--------------|---------------------------------------------------|----------------------------------------------------------|-----|--------------------------------------------------------------------------------------------------------|
| 10h 42mn 34s | (2) Maintenant, il l'a prise                      |                                                          |     |                                                                                                        |
| 10h 42mn 36s | (2) (*) Vertical speed ...                        |                                                          |     |                                                                                                        |
| 10h 42mn 37s | (@) (2) Loc star                                  |                                                          |     | Altitude alert (8s)                                                                                    |
| 10h 42mn 42s |                                                   | (1) Tais-toi ! ... (...)                                 |     | Argot                                                                                                  |
| 10h 42mn 44s | (3) C'est la piste, ça ?                          |                                                          |     |                                                                                                        |
| 10h 42mn 46s |                                                   | (1) Quatre mille tu as dit ?                             |     |                                                                                                        |
| 10h 42mn 47s | (2) Quatre mille, Yes, Yes, pour la remise de gaz |                                                          |     |                                                                                                        |
| 10h 42mn 48s |                                                   | (1) C'est ça la piste !                                  |     |                                                                                                        |
| 10h 42mn 49s |                                                   | (1) Ah, qu'est-ce que je voulait dire, sors un Slats ... |     |                                                                                                        |
| 10h 42mn 52s | (2) ... Flaps ... (@)                             |                                                          |     | Bruits de sélecteur similaires à la sélection de sortie des flaps                                      |
| 10h 42mn 53s |                                                   | (1) ... Flaps fifteen                                    |     |                                                                                                        |
| 10h 42mn 55s | (@) (2) je l'ai sorti                             |                                                          |     | Bruit de sélecteur                                                                                     |
| 10h 42mn 57s |                                                   | (1) The gear down                                        |     |                                                                                                        |
| 10h 42mn 59s | (2) Je sors Gear Down (@)                         |                                                          |     | Bruit de sélecteur similaire à la sélection de mouvement du train suivi du bruit de mouvement du train |
| 10h 43mn 05s | (2) (*) ça, c'est la piste                        |                                                          |     |                                                                                                        |
| 10h 43mn 09s | (@)                                               |                                                          |     | No smoking gong                                                                                        |
| 10h 43mn 10s | (3) Le train ?                                    |                                                          |     | Bruits de sélecteurs                                                                                   |
| 10h 43mn 12s | (2) Yes, Yes il est sorti                         |                                                          |     |                                                                                                        |
| 10h 43mn 13s | (2) C'est bien on l'a sorti (@)                   |                                                          |     | Annonce Public Address.<br>2 bruits de sélecteur similaires à une action sur le trim                   |
| 10h 43mn 14s | (@)                                               |                                                          |     | 2 bruits de sélecteur similaires à une action sur le trim                                              |

| UTC time     | Track 3 Cockpit Area Microphone      | Track 1 Hot Mike                     | VHF                                                                            | Observations                                                      |
|--------------|--------------------------------------|--------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------|
| 10h 43mn 16s | (@)                                  |                                      |                                                                                | 2 bruits de sélecteur similaires à une action sur le trim         |
| 10h 43mn 22s |                                      | (1) Flaps twenty                     |                                                                                |                                                                   |
| 10h 43mn 23s | (@)                                  | (1) Et, un quatre sept               |                                                                                | Bruits de sélecteur similaires à la sélection de sortie des flaps |
| 10h 43mn 24s | (@)                                  |                                      |                                                                                | 2 bruits de sélecteur similaires à une action sur le trim         |
| 10h 43mn 26s | (2) Un quatre sept (@)               |                                      |                                                                                | Bruits de sélecteur                                               |
| 10h 43mn 27s | (@)                                  |                                      |                                                                                | 2 bruits de sélecteur similaires à une action sur le trim         |
| 10h 43mn 28s | (@)                                  | (1) Dis-lui que nous sommes on final |                                                                                | Triple click                                                      |
| 10h 43mn 30s | (@)                                  |                                      | (2) On final two six Taron three eight one                                     | Bruit de sélecteur                                                |
| 10h 43mn 32s | (@)                                  |                                      | (Cti) one three eight                                                          | 6 bruits de sélecteur similaires à trois actions sur le trim      |
| 10h 34mn 34s | (@)                                  |                                      |                                                                                | Régime moteur en augmentation                                     |
| 10h 43mn 36s |                                      |                                      | (Cti) cleared to land three eight one wind three two hundred degrees ten knots |                                                                   |
| 10h 43mn 40s |                                      |                                      | (2) Cleared to land... Thank you                                               |                                                                   |
| 10h 43mn 41s | (@)                                  |                                      |                                                                                | 2 bruits de sélecteur similaires à une action sur le trim         |
| 10h 43mn 42s | (2) (*) à deux cents avec ten milles |                                      |                                                                                |                                                                   |
| 10h 43mn 43s | (2) Donc, à gauche                   |                                      |                                                                                |                                                                   |
| 10h 43mn 47s |                                      | (1) Hé ! qu'est-ce qu'il fait ! ?    |                                                                                |                                                                   |
| 10h 43mn 50s | (@)                                  |                                      |                                                                                | Bruit de sélecteur                                                |
| 10h 43mn 51s | (@)                                  |                                      |                                                                                | Bruit de sélecteur                                                |

| UTC time     | Track 3 Cockpit Area Microphone       | Track 1 Hot Mike                  | VHF                                                                                 | Observations                                                                               |
|--------------|---------------------------------------|-----------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 10h 43mn 52s | (@) (2) Prends le manuellement        |                                   |                                                                                     | Bruit de sélecteur similaire au bouton de trim pressé puis 1s plus tard début du whooler   |
| 10h 43mn 53s | (@)                                   |                                   |                                                                                     | régime moteur en diminution                                                                |
| 10h 43mn 54s | (@)                                   |                                   |                                                                                     | Bruit de sélecteur                                                                         |
| 10h 43mn 56s | (@)                                   | (1) Affiche moi une vitesse ici ! |                                                                                     | Bruit de sélecteur                                                                         |
| 10h 43mn 59s | (2) cent trente quatre ?              |                                   |                                                                                     |                                                                                            |
| 10h 44mn 01s |                                       | (1) Hei, il remets les gaz !!     |                                                                                     |                                                                                            |
| 10h 44mn 03s | (@)                                   |                                   |                                                                                     | Fin du whooler puis 0,5 s plus tard bruit de sélecteur similaire au bouton de trim relâché |
| 10h 44mn 04s | (@)                                   |                                   |                                                                                     | Bruit de régime moteur en augmentation                                                     |
| 10h 44mn 06s | (@)                                   |                                   |                                                                                     | Bruits de sélecteurs                                                                       |
| 10h 44mn 09s |                                       | (1) Hei !                         |                                                                                     |                                                                                            |
| 10h 44mn 10s |                                       | (1) Hei !                         |                                                                                     | Bruits de sélecteurs                                                                       |
| 10h 44mn 16s |                                       | (1) Hei !                         |                                                                                     |                                                                                            |
| 10h 44mn 17s | (2) Hei, mais qu'est-ce qu'il a ? !   |                                   |                                                                                     |                                                                                            |
| 10h 44mn 21s |                                       | (1) MAY DAY !                     |                                                                                     |                                                                                            |
| 10h 44mn 22s | (2) Qu'est-ce que tu veux lui faire ? |                                   | (Ctl) Euh ... Taron three eight one turn... left if you want heading one eight zero |                                                                                            |
| 10h 44mn 27s | (3) Hélas, on tombe                   |                                   |                                                                                     |                                                                                            |
| 10h 44mn 28s | (3) On tombe, on tombe, on tombe !    |                                   |                                                                                     |                                                                                            |
| 10h 44mn 31s | (@) (2) Les Flaps ?                   | (1) (*)                           |                                                                                     | Début des bruits aérodynamiques et pompage moteur                                          |
| 10h 44mn 33s | (@)                                   |                                   |                                                                                     | Single Chime                                                                               |
| 10h 44mn 35s | (@)                                   |                                   |                                                                                     | Single Chime                                                                               |
| 10h 44mn 37s | (@)                                   |                                   |                                                                                     | Continuous Repetitive Chime (3 sec)                                                        |

| UTC time     | Track 3 Cockpit Area Microphone        | Track 1 Hot Mike          | VHF                                                                        | Observations                          |
|--------------|----------------------------------------|---------------------------|----------------------------------------------------------------------------|---------------------------------------|
| 10h 44mn 41s | (@)                                    |                           |                                                                            | Single Chime                          |
| 10h 44mn 42s | (@)                                    |                           |                                                                            | Continuous Repetitive Chime (0,5 sec) |
| 10h 44mn 44s | (@)                                    |                           | (Ctl) Taron three eight one do you hear me?                                | Alarme décrochage (Cricket)(1,5 sec)  |
| 10h 44mn 47s |                                        | (1) Aie !                 |                                                                            | Alarme décrochage (1 sec)             |
| 10h 44mn 48s |                                        |                           | (Ctl) Do you hear me?                                                      |                                       |
| 10h 44mn 49s | (2) (*)                                |                           |                                                                            | Alarme décrochage (1,5 sec)           |
| 10h 44mn 52s | (VS) TERRAIN<br>TERRAIN                |                           | (2) We get some problems!                                                  |                                       |
| 10h 44mn 57s | (VS) WHOOP<br>WHOOP PULL UP            |                           |                                                                            | Announce Public Address               |
| 10h 45mn 01s | (2) Doucement,<br>doucement à droite   |                           |                                                                            |                                       |
| 10h 45mn 03s | (2) Lève-la !                          |                           |                                                                            |                                       |
| 10h 45mn 06s | (2) Qu'est-ce qu'il a ?<br>!           |                           |                                                                            |                                       |
| 10h 45mn 08s |                                        |                           | (Ctl) Taron three eight one if you hear me as you like for landing two six |                                       |
| 10h 45mn 13s |                                        |                           | (2) We've have some problems with the Auto Pilot !                         |                                       |
| 10h 45mn 18s | (@) (2) Non, mais il ne déconnecte pas |                           |                                                                            | Fluctuations de régime moteur         |
| 10h 45mn 23s | (2) Veux-tu, que je rentre le train ?  |                           |                                                                            |                                       |
| 10h 45mn 25s |                                        | (1) Non, non              |                                                                            |                                       |
| 10h 45mn 29s | (2) Veux-tu, que je rentre le train ?  |                           |                                                                            |                                       |
| 10h 45mn 30s |                                        | (1) Non                   |                                                                            |                                       |
| 10h 45mn 32s |                                        | (1) Rentre le train !     |                                                                            |                                       |
| 10h 45mn 33s |                                        | (1) Hei rentre le train ! |                                                                            |                                       |

| UTC time     | Track 3 Cockpit Area Microphone                     | Track 1 Hot Mike  | VHF                                                                                           | Observations                                                                                                                                                                  |
|--------------|-----------------------------------------------------|-------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10h 45mn 34s | (2) Je le rentre (@)                                |                   |                                                                                               | Bruits de sélecteur similaires à la sélection de mouvement du train puis bruits de mouvement du train                                                                         |
| 10h 45mn 37s | (@)                                                 |                   |                                                                                               | No smoking gong                                                                                                                                                               |
| 10h 45mn 41s | (@)                                                 |                   |                                                                                               | Bruit de sélecteur                                                                                                                                                            |
| 10h 45mn 42s | (3) C'est fini ? !                                  |                   |                                                                                               |                                                                                                                                                                               |
| 10h 45mn 43s |                                                     |                   |                                                                                               | Annonce Public Address                                                                                                                                                        |
| 10h 45mn 44s | (@)                                                 |                   |                                                                                               | Bruit de sélecteur                                                                                                                                                            |
| 10h 45mn 45s | (2) Pitch trim off ! (@)                            |                   |                                                                                               | Bruit de sélecteur                                                                                                                                                            |
| 10h 45mn 47s | (2) Pitch trim off !                                |                   |                                                                                               |                                                                                                                                                                               |
| 10h 45mn 52s | (@)                                                 |                   | (CtI) Taron three eight one do you want to come back on the I L S now                         | Bruit de sélecteur                                                                                                                                                            |
| 10h 45mn 55s | (3) Il s'asseyait sur la queue ?                    |                   |                                                                                               |                                                                                                                                                                               |
| 10h 45mn 55s |                                                     | (1) Just a moment | (2) Just a moment please, just a moment                                                       |                                                                                                                                                                               |
| 10h 45mn 58s | (@)                                                 |                   |                                                                                               | Bruit de sélecteur similaire au bouton de trim pressé suivi 1 seconde plus tard par le whooler pendant 2 secondes puis bruit de sélecteur similaire au bouton de trim relâché |
| 10h 46mn 00s | (@)                                                 |                   | (CtI) Yes are you? do you agree to ... to turn left on the I L S now?<br>(2) Yes we can do it | Bruits de sélecteur similaires à plusieurs actions sur le trim                                                                                                                |
| 10h 46mn 04s | (3) Comment, est-ce qu'on peut décrocher comme ça ? | (1) We...         |                                                                                               | 2 bruits de sélecteur similaires à une action sur le trim                                                                                                                     |
| 10h 46mn 06s | (@) (2) Le voilà, il fonctionne correctement        | (1) (*)           |                                                                                               | 2 bruits de sélecteur similaires à une action sur le trim                                                                                                                     |
| 10h 46mn 07s | (2) Descends un peu pour que je ...                 |                   |                                                                                               |                                                                                                                                                                               |

| UTC time     | Track 3 Cockpit Area Microphone                        | Track 1 Hot Mike                               | VHF | Observations                                                                                                                                                                 |
|--------------|--------------------------------------------------------|------------------------------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10h 46mn 09s | (@)                                                    | (1) Reste comme ça !                           |     | 2 bruits de sélecteur similaires à une action sur le trim                                                                                                                    |
| 10h 46mn 10s | (2) Il reste à l'horizontal                            |                                                |     |                                                                                                                                                                              |
| 10h 46mn 13s | (@)                                                    |                                                |     | Bruit de sélecteur                                                                                                                                                           |
| 10h 46mn 16s |                                                        | (1) Laisse-le, laisse-le, pour que je le sente |     |                                                                                                                                                                              |
| 10h 46mn 17s | (2) Je le laisse                                       |                                                |     |                                                                                                                                                                              |
| 10h 46mn 19s | (2) Yes, pour augmenter un peu la vitesse (@)          |                                                |     | 2 bruits de sélecteur similaires à une action sur le trim                                                                                                                    |
| 10h 46mn 22s | (2) Extraordinaire ! (@)                               |                                                |     | Bruit de sélecteur similaire au bouton de trim pressé suivi 1 seconde plus tard par le whooler pendant 1 seconde puis bruit de sélecteur similaire au bouton de trim relâché |
| 10h 46mn 23s |                                                        |                                                |     |                                                                                                                                                                              |
| 10h 46mn 25s | (2) Est ce que je connecte le Pilote Automatique ?     |                                                |     | Diminution régime moteur                                                                                                                                                     |
| 10h 46mn 27s |                                                        | (1) Yes, connecte-le !                         |     |                                                                                                                                                                              |
| 10h 46mn 28s | (2) Hai (interjection), il marche                      |                                                |     |                                                                                                                                                                              |
| 10h 46mn 29s | (@)                                                    |                                                |     | Bruit de sélecteur similaire à la palette PA qui tombe puis alarme déconnexion Pilote Automatique (Cavalry charge)                                                           |
| 10h 46mn 31s | (2) Il s'est rendu tranquille maintenant ... (...) (@) |                                                |     | 2 bruits de sélecteur similaires à une action sur le trim                                                                                                                    |
| 10h 46mn 33s |                                                        | (1) Connecte le Pilote Automatique !           |     |                                                                                                                                                                              |

| UTC time     | Track 3 Cockpit Area Microphone  | Track 1 Hot Mike                                                           | VHF                                                                    | Observations                                                                                                       |
|--------------|----------------------------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| 10h 46mn 35s | (2) Je l'ai connecté !           |                                                                            |                                                                        | Bruit de sélecteur similaire à la palette PA qui tombe puis alarme déconnexion Pilote Automatique (Cavalry charge) |
| 10h 46mn 37s |                                  | (1) Connecte le Pilote Automatique !                                       |                                                                        |                                                                                                                    |
| 10h 46mn 38s | (2) J'ai connecté le deuxième    |                                                                            |                                                                        |                                                                                                                    |
| 10h 46mn 39s | (@)                              |                                                                            |                                                                        | Cavalry charge                                                                                                     |
| 10h 46mn 40s | (2) Il ne se connecte plus !     |                                                                            |                                                                        |                                                                                                                    |
| 10h 46mn 42s | (2) Auto Pilot off !             |                                                                            |                                                                        |                                                                                                                    |
| 10h 46mn 43s | (@))                             |                                                                            |                                                                        | Cavalry charge                                                                                                     |
| 10h 46mn 45s |                                  | (1) Dis-lui que nous sommes sur ce cap.. et ... nous avons des problèmes ! |                                                                        |                                                                                                                    |
| 10h 46mn 47s | (@)                              |                                                                            |                                                                        | Cavalry charge                                                                                                     |
| 10h 46mn 49s |                                  |                                                                            | (2) Paris, Tarom three eight one                                       |                                                                                                                    |
| 10h 46mn 54s |                                  |                                                                            | (2) Paris, Tarom three eight one                                       |                                                                                                                    |
| 10h 46mn 58s |                                  | (1) Hei !                                                                  |                                                                        |                                                                                                                    |
| 10h 46mn 59s | (2) Il n'entend pas !            |                                                                            |                                                                        |                                                                                                                    |
| 10h 47mn 00s |                                  | (1) Change la station radio                                                |                                                                        |                                                                                                                    |
| 10h 47mn 04s | (2) Zero ... five                |                                                                            |                                                                        |                                                                                                                    |
| 10h 47mn 06s | (3) Pose le sur un de ces champs |                                                                            |                                                                        | Blague                                                                                                             |
| 10h 47mn 10s |                                  |                                                                            | (Ctl) Tarom three eight one turn left heading zero one zero            |                                                                                                                    |
| 10h 47mn 14s |                                  |                                                                            | (2) Tarom (*) zero one zero we are maintaining two thousand now        |                                                                                                                    |
| 10h 47mn 19s |                                  | (1) Hei !                                                                  |                                                                        |                                                                                                                    |
| 10h 47mn 20s |                                  |                                                                            | (Ctl) Do you have full control of your aircraft now? is it ok for you? |                                                                                                                    |



| UTC time     | Track 3 Cockpit Area Microphone           | Track 1 Hot Mike                          | VHF                                                                               | Observations |
|--------------|-------------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------|--------------|
| 10h 47mn 22s |                                           | (1) Euh... for the moment                 | (2) Approximately fifty percent of... about fifty percent is under control        |              |
| 10h 47mn 36s | (2/3) (*)                                 |                                           | (2) Do you read?                                                                  |              |
| 10h 47mn 37s |                                           | (1) Sur quelle radio station es tu ?      |                                                                                   |              |
| 10h 47mn 39s |                                           |                                           | (Ctl) Do you request assistance after landing Tarom three eight one?              |              |
| 10h 47mn 42s |                                           | (1) Affirmative                           |                                                                                   |              |
| 10h 47mn 43s |                                           |                                           | (2) Affirm, affirm we are on heading now zero seven zero maintaining two thousand |              |
| 10h 47mn 48s |                                           |                                           | (Ctl) Yes, turn left heading zero one zero                                        |              |
| 10h 47mn 51s |                                           |                                           | (2) Left heading zero one zero                                                    |              |
| 10h 47mn 54s | (2) (...) qu'est-ce qu'il a fait ?        |                                           |                                                                                   | Argot        |
| 10h 47mn 56s |                                           | (1) Hei !                                 |                                                                                   |              |
| 10h 47mn 58s | (2) Presque la limite                     |                                           |                                                                                   |              |
| 10h 47mn 59s |                                           | (1) Je n'ai jamais rencontré ça de ma vie |                                                                                   |              |
| 10h 48mn 00s | (2) Moi, non plus                         |                                           |                                                                                   |              |
| 10h 48mn 02s | (3) J'ai eu une telle malchance ?         |                                           |                                                                                   |              |
| 10h 48mn 04s |                                           | (1) Je ne sais pas ce que ...             |                                                                                   |              |
| 10h 48mn 06s | (3) Non ?                                 |                                           |                                                                                   |              |
| 10h 48mn 07s |                                           | (1) Il s'est passé quelque chose ici      |                                                                                   |              |
| 10h 48mn 10s | (2) Le pilote automatique a quelque chose |                                           |                                                                                   |              |

| UTC time                     | Track 3 Cockpit Area Microphone                      | Track 1 Hot Mike                 | VHF                                                                                   | Observations                                                                                                                                                                 |
|------------------------------|------------------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10h 48mn 12s<br>10h 48mn 13s | (2) Allons nous trimer (@)<br>(3) Prend-le à la main |                                  | (CtI) Taron three eight one turn left heading three zero zero to intercept your I L S | Bruit de sélecteur similaire au bouton de trim pressé suivi 1 seconde plus tard par le whooler pendant 1 seconde puis bruit de sélecteur similaire au bouton de trim relâché |
| 10h 48mn 16s                 |                                                      |                                  | (2) Understood left heading on zero one zero to intercept the I L S for two six       |                                                                                                                                                                              |
| 10h 48mn 21s                 | (2) Tu l'entends ?                                   |                                  |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 22s                 |                                                      | (1) Hà ?                         |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 23s                 | (@)                                                  |                                  |                                                                                       | Bruit de sélecteur similaire au bouton de trim pressé suivi 1 seconde plus tard par le whooler pendant 1 seconde puis bruit de sélecteur similaire au bouton de trim relâché |
| 10h 48mn 24s                 | (2) Regarde, le Trim comme il est parti              |                                  |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 25s                 |                                                      | (1) C'est ça ! Laisse-le !       |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 27s                 |                                                      | (1) Laisse-le comme ça !         |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 28s                 | (2) Je l'ai laissé, tu le sens bien ?                |                                  |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 31s                 |                                                      | (1) Quelle distance donne-t-il ? |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 33s                 | (2) Zero one zero                                    |                                  |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 35s                 | (2) Tu es a dix mille                                |                                  |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 39s                 |                                                      |                                  | (CtI) Taron three eight one turn left heading three zero zero, intercept I L S        |                                                                                                                                                                              |
| 10h 48mn 42s                 |                                                      |                                  | (2) Left ...                                                                          |                                                                                                                                                                              |
| 10h 48mn 43s                 |                                                      |                                  | (2) Left heading zero ...                                                             |                                                                                                                                                                              |
| 10h 48mn 45s                 |                                                      | (1) Three zero zero              |                                                                                       |                                                                                                                                                                              |
| 10h 48mn 46s                 |                                                      |                                  | (2) Three zero zero intercepting I L S two six                                        |                                                                                                                                                                              |

| UTC time     | Track 3 Cockpit Area Microphone    | Track 1 Hot Mike                     | VHF                                                                                             | Observations                                              |
|--------------|------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 10h 48mn 49s |                                    |                                      | (Ctl) Three zero zero                                                                           |                                                           |
| 10h 48mn 51s |                                    |                                      | (2) Three zero zero                                                                             |                                                           |
| 10h 48mn 54s | (2) Tu le sens bien, Yes ?         |                                      |                                                                                                 |                                                           |
| 10h 48mn 56s |                                    | (1) Il est comme ça !                |                                                                                                 |                                                           |
| 10h 48mn 58s | (2) Il a quelque chose ... (*) (@) |                                      |                                                                                                 | Diminution régime moteur                                  |
| 10h 49mn 00s | (2) On peut sortir les Flaps ok ?  |                                      |                                                                                                 |                                                           |
| 10h 49mn 03s | (2) On peut sortir les Flaps ?     |                                      |                                                                                                 |                                                           |
| 10h 49mn 04s |                                    | (1) Non, Non !                       |                                                                                                 |                                                           |
| 10h 49mn 07s |                                    | (1) Laisse comme-ça !                |                                                                                                 |                                                           |
| 10h 49mn 08s | (2) (*) je le laisse               |                                      |                                                                                                 |                                                           |
| 10h 49mn 13s | (2) Tu vois la piste, non ?        |                                      |                                                                                                 |                                                           |
| 10h 49mn 14s |                                    | (1) Yes                              |                                                                                                 |                                                           |
| 10h 49mn 18s | (2) (*)                            |                                      |                                                                                                 |                                                           |
| 10h 49mn 20s |                                    | (1) Tiens une main sur les moteurs ! |                                                                                                 |                                                           |
| 10h 49mn 21s | (2) Je les tiens, je les tiens.    |                                      |                                                                                                 |                                                           |
| 10h 49mn 25s | (@)                                |                                      |                                                                                                 | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 49mn 27s | (3) (*) vous l'avez en manuel      |                                      |                                                                                                 |                                                           |
| 10h 49mn 30s | (2) On a pris le localizer .... ?  |                                      | (Ctl) Taram three eight one you are cleared for final approach two six call one one eight seven |                                                           |
| 10h 49mn 34s |                                    |                                      | (2) One eighteen seven bye bye                                                                  |                                                           |
| 10h 49mn 40s | (2) (...)                          |                                      |                                                                                                 |                                                           |
| 10h 49mn 50s | (3) Turbulence ?                   |                                      | (2) Tower bonjour Taram three eight one                                                         |                                                           |

| UTC time     | Track 3 Cockpit Area Microphone                                                                     | Track 1 Hot Mike                            | VHF                                                                                   | Observations                                                                                              |
|--------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| 10h 49mn 50s | (@)                                                                                                 | (1) Quelle turbulence ? il est responsable! |                                                                                       | 2 bruits de selecteur similaires à une action sur le trim                                                 |
| 10h 49mn 52s | (@)                                                                                                 |                                             |                                                                                       | 2 bruits de selecteur similaires à une action sur le trim                                                 |
| 10h 49mn 54s | (@)                                                                                                 |                                             | (Ctl) Taron three eight one cleared to land two six two two zero degrees twelve knots | 2 bruits de selecteur similaires à une action sur le trim                                                 |
| 10h 49mn 58s | (@)                                                                                                 |                                             | (2) We are cleared to land                                                            | 2 bruits de selecteur similaires à une action sur le trim                                                 |
| 10h 50mn 00s | (2) Train, Flaps, je sors quelque chose ?                                                           |                                             |                                                                                       |                                                                                                           |
| 10h 50mn 02s | (@)                                                                                                 | (1) Sors le trains !                        |                                                                                       | Bruits de selecteur similaire à une action de mouvement du train suivi par le bruit de mouvement du train |
| 10h 50mn 07s | (2) Nous ne devons plus utiliser le Pilote Automatique !                                            |                                             |                                                                                       |                                                                                                           |
| 10h 50mn 10s |                                                                                                     | (1) Ah ?                                    |                                                                                       |                                                                                                           |
| 10h 50mn 11s | (2) Nous ne devons plus utiliser le Pilote Automatique, amène le en manuel                          |                                             |                                                                                       |                                                                                                           |
| 10h 50mn 13s | (@)                                                                                                 |                                             |                                                                                       | No smoking gong                                                                                           |
| 10h 50mn 14s |                                                                                                     | (1) Sûrement !                              |                                                                                       |                                                                                                           |
| 10h 50mn 19s | (2) Je sors des Flaps ?                                                                             |                                             |                                                                                       |                                                                                                           |
| 10h 50mn 21s |                                                                                                     | (1) Moi, ...                                |                                                                                       |                                                                                                           |
| 10h 50mn 22s | (2) Il a commencer à remettre les gaz, je ne sais pas pourquoi, mais il a remis les gaz sans raison |                                             |                                                                                       |                                                                                                           |
| 10h 50mn 28s |                                                                                                     | (1) Tu sais... quel a été le problème ?     |                                                                                       |                                                                                                           |

| UTC time     | Track 3 Cockpit Area Microphone                           | Track 1 Hot Mike                                                                                      | VHF | Observations                                                     |
|--------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------------------|
| 10h 50mn 29s | (2) Dis-le                                                | (1) Les moteurs augmentaient la puissance et il a commencer à monter ...                              |     |                                                                  |
| 10h 50mn 32s | (2) J'ai vu, j'ai poussé moi aussi, j'ai poussé moi aussi |                                                                                                       |     |                                                                  |
| 10h 50mn 34s |                                                           | (1) Il a commencé à monter, je ne pouvais pas le contrôler, comme ça, je ne pouvais pas le contrôler. |     |                                                                  |
| 10h 50mn 40s | (2) Flaps, Yes ?                                          |                                                                                                       |     |                                                                  |
| 10h 50mn 41s |                                                           | (1) Attends ! la vitesse, sélectionne-moi...                                                          |     |                                                                  |
| 10h 50mn 43s | (2) Ah... j'ai vu la vitesse                              |                                                                                                       |     |                                                                  |
| 10h 50mn 45s |                                                           | (1) Sors, sors les Flaps                                                                              |     |                                                                  |
| 10h 50mn 47s | (@) (2) Fait !                                            |                                                                                                       |     | Bruits de sélecteur similaires à l'action de sélection des flaps |
| 10h 50mn 58s | (2) Nous l'avons récupéré du décrochage !                 |                                                                                                       |     |                                                                  |
| 10h 50mn 59s |                                                           | (1) Flaps vingt...Yes,... nous l'avons récupéré du décrochage                                         |     |                                                                  |
| 10h 51mn 04s | (3) Il n'y a plus de problème, non ?                      |                                                                                                       |     |                                                                  |
| 10h 51mn 05s | (2) Non, il n'y en a plus ... non                         |                                                                                                       |     |                                                                  |
| 10h 51mn 06s |                                                           | (1) Reste tranquille !                                                                                |     |                                                                  |
| 10h 51mn 07s | (3) (...)                                                 |                                                                                                       |     |                                                                  |
| 10h 51mn 08s | (@) (2) Je t'ai mis Flaps twenty                          |                                                                                                       |     | Bruit de sélecteur similaire à l'action de sélection des flaps   |
| 10h 51mn 09s |                                                           | (1) Yes                                                                                               |     |                                                                  |
| 10h 51mn 10s | (2) One four seven                                        |                                                                                                       |     |                                                                  |

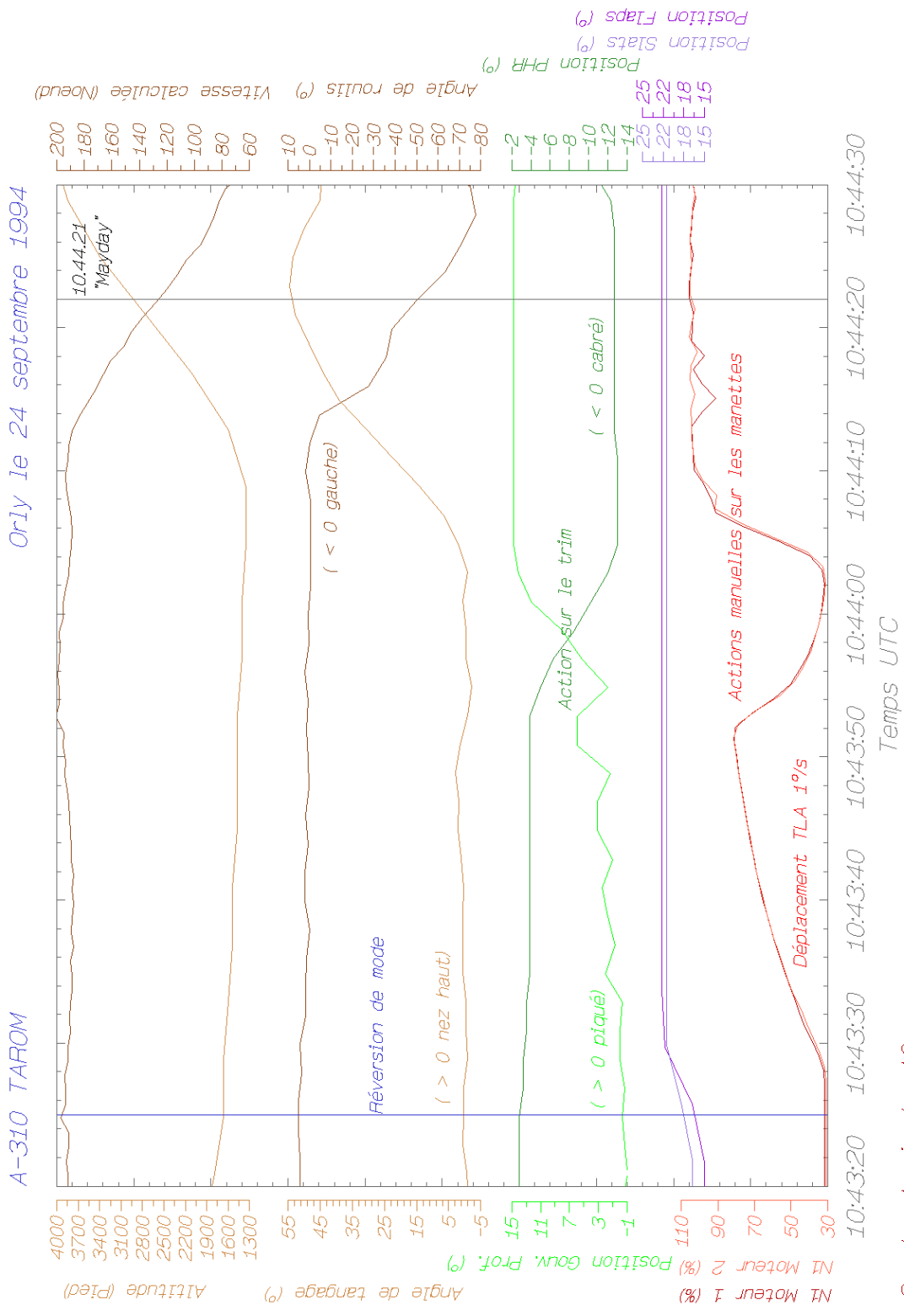
| UTC time     | Track 3 Cockpit Area Microphone                  | Track 1 Hot Mike                                        | VHF | Observations                                              |
|--------------|--------------------------------------------------|---------------------------------------------------------|-----|-----------------------------------------------------------|
| 10h 51mn 18s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 20s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 21s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 22s | (2) Donc, il stabilise et la vitesse décroît (@) |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 24s | (2) C'est bien, garde la comme ça...             |                                                         |     |                                                           |
| 10h 51mn 25s |                                                  | (1) Tiens la vitesse, s'il te plaît !                   |     |                                                           |
| 10h 51mn 26s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 29s | (2) Je te réduirai d'eux. Je vais t'aider (@)    |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 29s |                                                  | (1) Fait attention, laisse moi ça, pour que je n'ai ... |     |                                                           |
| 10h 51mn 30s | (2) (*)                                          |                                                         |     |                                                           |
| 10h 51mn 31s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 35s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 38s | (2/3) Comme ça...                                |                                                         |     |                                                           |
| 10h 51mn 40s | (2) Je te tiens la vitesse                       |                                                         |     |                                                           |
| 10h 51mn 41s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 43s | (@)                                              |                                                         |     | 2 bruits de sélecteur similaires à une action sur le trim |

| UTC time     | Track 3 Cockpit Area Microphone                       | Track 1 Hot Mike    | VHF | Observations                                              |
|--------------|-------------------------------------------------------|---------------------|-----|-----------------------------------------------------------|
| 10h 51mn 46s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 49s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 50s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 51s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 55s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 56s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 57s | (@)                                                   |                     |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 51mn 59s | (2) Tu veux Flaps forty                               |                     |     |                                                           |
| 10h 52mn 00s |                                                       | (1) Lâche le manche |     |                                                           |
| 10h 52mn 01s | (2) Flaps forty, d'accord ?                           |                     |     |                                                           |
| 10h 52mn 02s | (@)                                                   | (1) Non, Non        |     | 2 bruits de sélecteur similaires à une action sur le trim |
| 10h 52mn 03s | (VS) FOUR HUNDRED                                     |                     |     |                                                           |
| 10h 52mn 04s | (2) Mais, laisse que je te les mette une autre fois ! |                     |     | Blague                                                    |
| 10h 52mn 06s | (2) Tu vas voir !                                     |                     |     | Blague                                                    |
| 10h 52mn 08s | (VS) THREE HUNDRED                                    |                     |     |                                                           |
| 10h 52mn 09s | (2) Reste-là !                                        |                     |     |                                                           |

| UTC time                     | Track 3 Cockpit Area Microphone                          | Track 1 Hot Mike       | VHF | Observations                                                                                                               |
|------------------------------|----------------------------------------------------------|------------------------|-----|----------------------------------------------------------------------------------------------------------------------------|
| 10h 52mn 10s<br>10h 52mn 11s | (@) (VS) TOO LOW FLAPS, TOO (@) LOW FLAPS, TOO LOW FLAPS |                        |     | 2 bruits de sélecteur similaires à une action sur le trim<br><br>2 bruits de sélecteur similaires à une action sur le trim |
| 10h 52mn 13s                 | (2) Flaps, d'accord ?                                    |                        |     |                                                                                                                            |
| 10h 52mn 14s                 | (2) Je te met forty ?                                    |                        |     |                                                                                                                            |
| 10h 52mn 16s                 | (@) (VS) GLIDE SLOPE, ...                                |                        |     | 2 bruits de sélecteur similaires à une action sur le trim, le glide slope est annoncé 7 fois                               |
| 10h 52mn 18s                 |                                                          | (1) Tais-toi ... (...) |     |                                                                                                                            |
| 10h 52mn 20s                 | (VS) FOURTY                                              |                        |     |                                                                                                                            |
| 10h 52mn 21s                 | (VS) THIRTY                                              |                        |     |                                                                                                                            |
| 10h 52mn 22s                 | (VS) TWENTY                                              |                        |     |                                                                                                                            |
| 10h 52mn 23s                 | (2) Je l'ai retenue !<br>(VS) TEN                        | (1) Retiens ta main !  |     |                                                                                                                            |
| <b>10h 52mn 25s</b>          | (@)                                                      |                        |     | Bruit similaire à l'atterrissage                                                                                           |



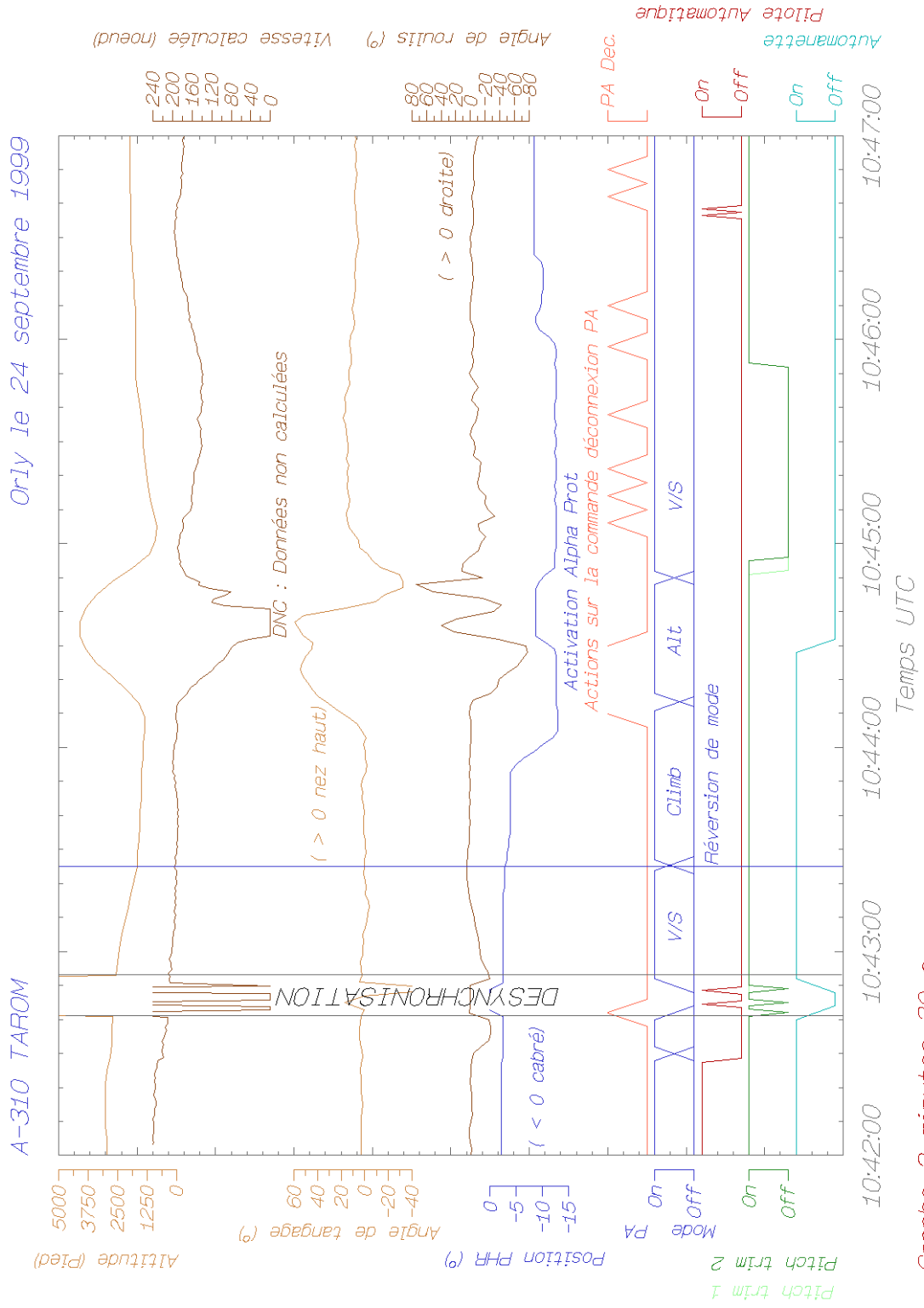
# YR-LCA



Graphe 1 minute 10 s avant le décrochage

Laboratoires du Bureau Enquêtes-Accidents

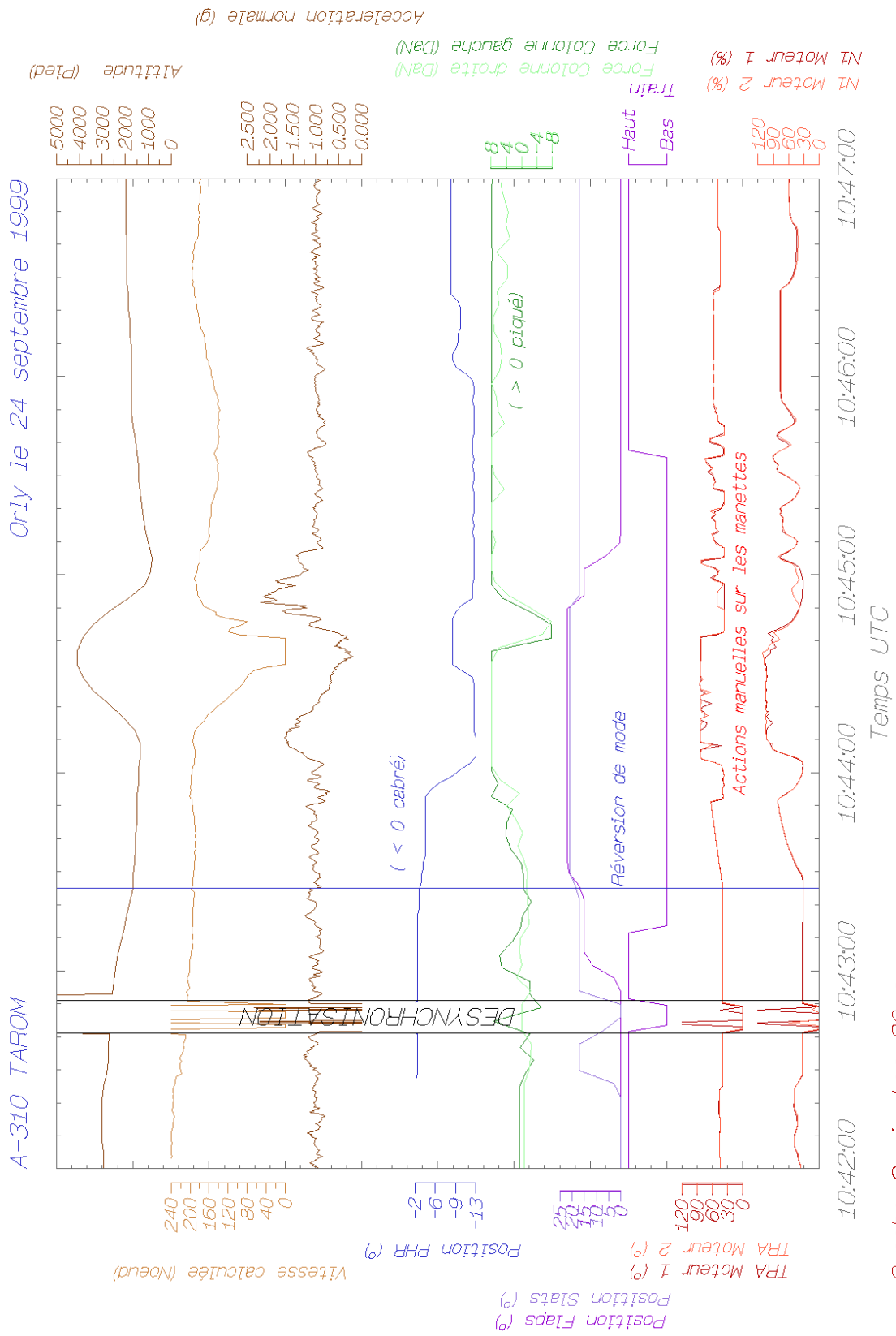
# YR-LCA



Graphe 2 minutes 30 s avant et après le décrochage

Laboratoires du Bureau Enquêtes-Accidents

# YR-LCA



Graphe 2 minutes 30 s avant et après de décrochage

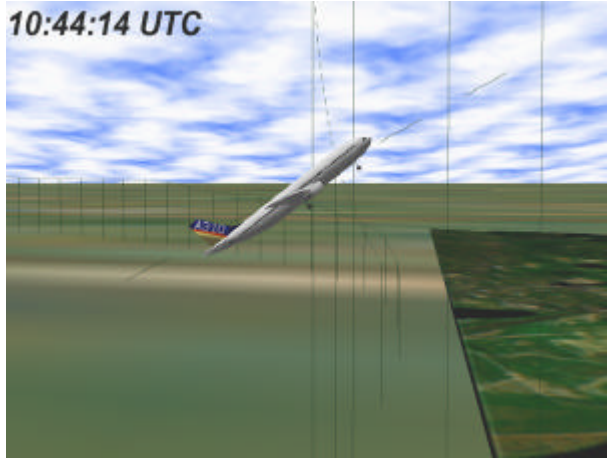
Laboratoires du Bureau Enquêtes-Accidents

## Reconstitution of the aircraft's path from data recorded by the DAR

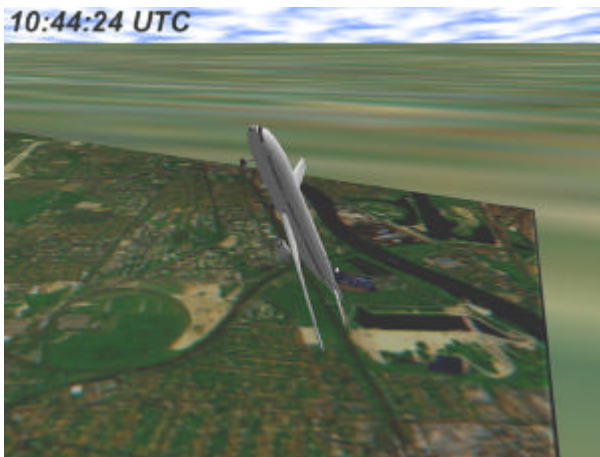
10:44:09 UTC



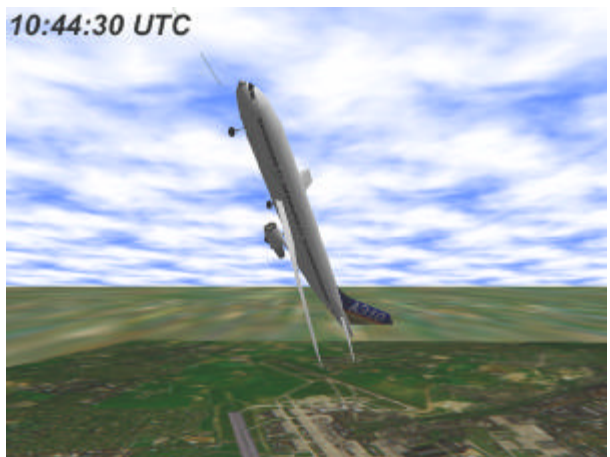
10:44:14 UTC



10:44:24 UTC



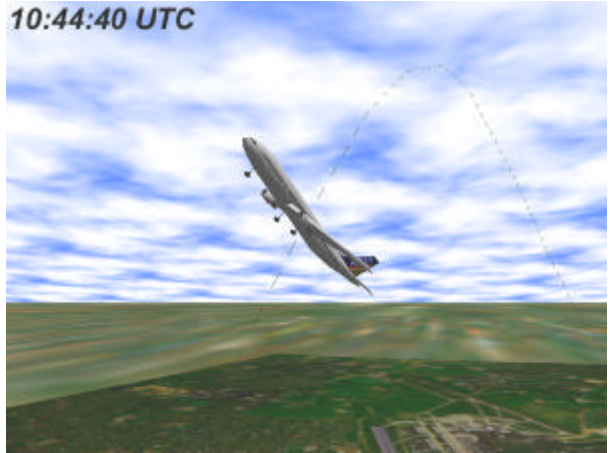
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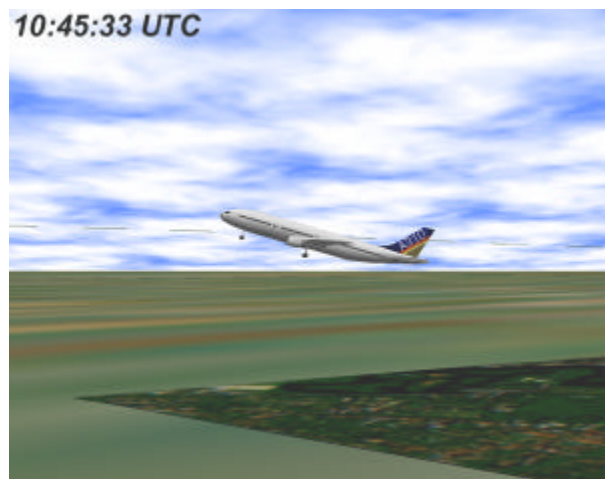
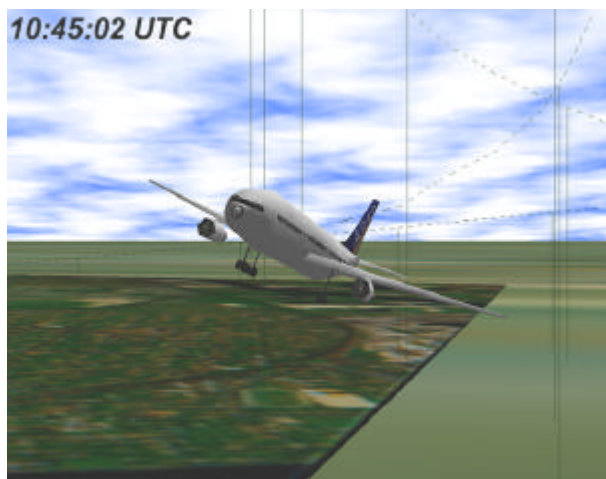


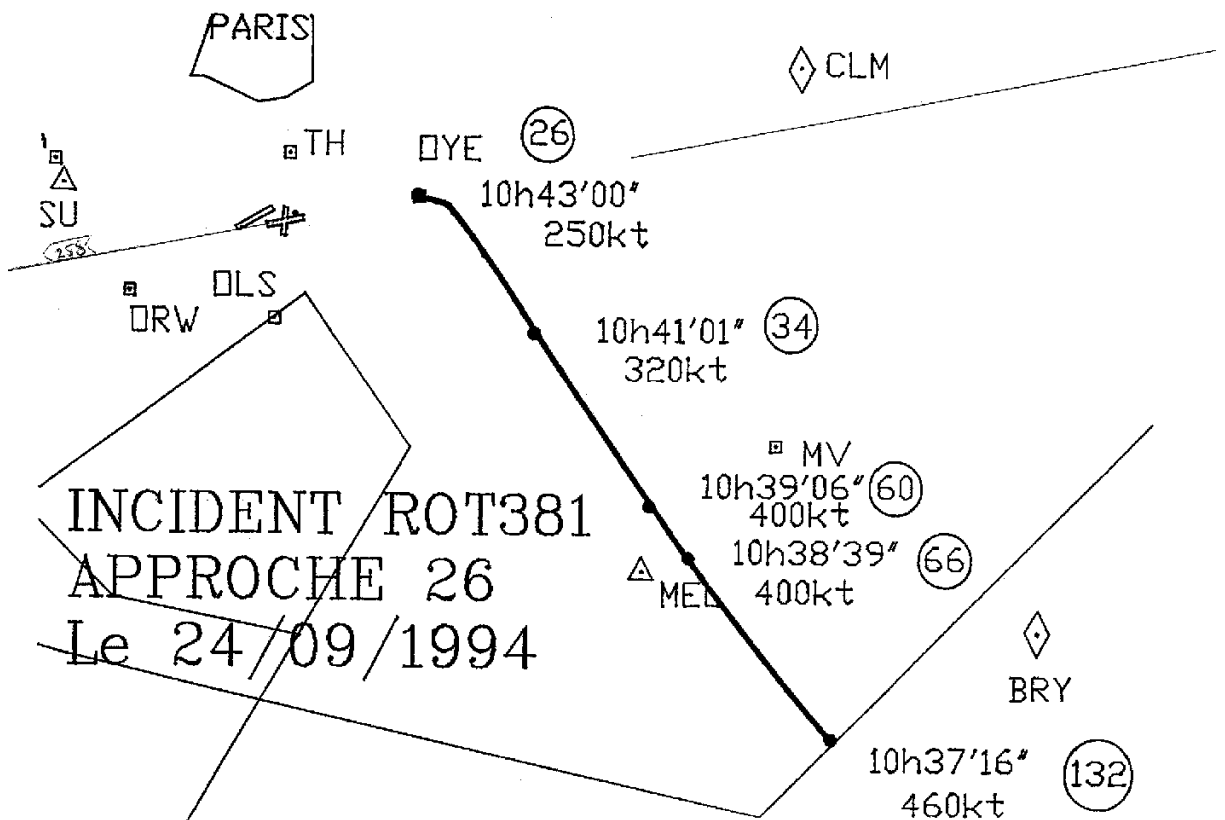
10:44:35 UTC



10:44:40 UTC







|                                                                                                                                  |                                |  |                  |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--|------------------|
| <br><b>A310</b><br>FLIGHT CREW OPERATING MANUAL | <b>AUTOMATIC FLIGHT SYSTEM</b> |  | 1.03.65          |
|                                                                                                                                  | AUTOPILOT/FLIGHT DIRECTOR      |  | PAGE 2           |
|                                                                                                                                  | LONGITUDINAL MODES             |  | REV 17   SEQ 020 |

### V/S MODE

Vertical Speed (V/S) is the BASIC LONGITUDINAL MODE of AP/FD. It maintains the V/S at the time of engagement, and also, will acquire and maintain a new V/S when selected on the FCU.

The commands to be executed are indicated on the PFD by the PITCH BAR.

#### ENGAGEMENT

V/S is engaged

- when FD's are engaged. This normally occurs when the AP/FD system is electrically energized on ground.
- by pulling the V/S knob on FCU, provided LAND mode is not active in the track phase.
- by pressing an illuminated longitudinal mode pushbutton if this mode is in active phase (this longitudinal mode disengages and V/S engages).
- at AP engagement in CMD if the associated FD is not operative (failure not affecting the AP or FD/FPV switch set to FPV or OFF position). In this case the other basic mode - HDG - is also engaged.
- when, being in altitude capture phase (ALT\* mode), a new altitude (causing loss of capture conditions) is set on the FCU.
- when a lateral mode is engaged after GLIDE CAPTURE phase and before LAND TRACK phase (LAND mode active).
- when a failure (in a non basic mode except pitch TAKE OFF and GO AROUND modes) causes disengagement of both AP/FD's. In this case, the FD's reengage in basic modes (V/S and HDG) after a delay and the FD BARS flash for 10 sec or less if a non basic mode is re-engaged.

The FCU does not disengage from pitch TAKE OFF or GO AROUND modes when both AP/FD's go to OFF.

Note : In all cases, V/S mode engages on the preselected vertical speed set on the counter or on the present A/C vertical speed if the counter is dashed.

V/S mode engagement leads to SPD or MACH mode engagement in ATS (the counter will synchronize on the A/C speed if it was dashed, which is the case when PROFILE mode is engaged).

#### DISENGAGEMENT

V/S is disengaged

- by manual selection of ALT, LVLCH, PROFILE, TAKE OFF or GO-AROUND mode
- automatically :
  - when ALT\* mode is activated.
  - when GLIDE CAPT phase of LAND mode is activated.

#### SPEED PROTECTION

In V/S mode, the priority will be given to the vertical speed, against the speed. If vertical speed is not compatible with selected speed, the speed will decrease or increase towards VLS or VMAX. But on reaching VLS + 5 KTS (when vertical speed is positive) or VMAX (when vertical speed is negative), the AP/FD will automatically change to LVLCH mode with selected speed as reference.