CÓPY Nr.

MINISTÉRIO DAS OBRAS PÚBLICAS, TRANSPORTES E COMUNICAÇÕES
GABINETE DE PREVENÇÃO E INVESTIGAÇÃO DE ACIDENTES COM AERONAVES
GPIAA

FINAL ACCIDENT REPORT

AIR PORTUGAL

AIRBUS A-310/300

CS-TEW

Descending to Sal
Cape Verde

11th April 1999

GPIAA
Homologo nos termos
do n.º 3 do art.º 26.º, do
D.L. 318/99, de 11/8
26 / JUL / 2007
O Director

FINAL ACCIDENT REPORT Nr. 04/ACCID/1999

NOTE

This report states the technical findings regarding the circumstances and probable causes which led to this accident.

In accordance with Annex 13 to the International Civil Aviation Organisation Convention, Chicago 1944, Council Directive 94/56/EC, 21st NOV 1994, and article 11th nº 3 of Decree-Law nº 318/99, 11th AUG 1999, the sole purpose of this investigation is to prevent aviation accidents. It is not the purpose of any such accident investigation and the associated investigation report to apportion blame or liability.

The only aim of this technical report is to collect lessons which may help to prevent future accidents.

ACRONYMS

A/B	Flight Attendant (*Assistente de Bordo*)
ADC	Air Data Computer
AFM	Aircraft Flight Manual
AFS	Automatic Flight System
AIDS	Aircraft Integrated Data System
ALT	Altitude
ALT/HLD	Altitude Hold
ALT SEL	Altitude Selector
AP	Auto Pilot
APC	Aircraft Pilot Coupling
AP/FD	Auto Pilot / Flight Director
ATC	Air Traffic Control
ATS	Auto Throttle System
A/THR	Auto Thrust
CAS	Calibrated Air Speed
C/B	Steward (*Comissário de Bordo*)
C/C	Purser (*Chefe de Cabina*)
CDU	Control and Display Unit
CI	Investigation Team (*Comissão de Investigação*)
CMD	Command
CVR	Cockpit Voice Recorder
CWS	Control Wheel Steering
DFDR	Digital Flight Data Recorder
DME	Distance Measurement Equipment
EFIS	Electronic Flight Instrument System
FAC	Flight Augmentation Computer
FCC	Flight Control Computer
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FCU	Flight Control Unit
FL	Flight Level
FMC	Flight Management Computer
FMS	Flight Management System
GS	Ground Speed

ACRONYMS (continued)

HDG	Heading
HDG/S	Heading Selector
IAS	Indicated Air Speed
ILS	Instrument Landing System
IRS	Inertial Reference System
IRU	Inertial Reference Unit
LVL/CH	Level Change
NAV	Navigation
NAVAIDS	Navigation Aids
P.DESC	Profile Descent
PF	Pilot Flying
PFD	Primary Flight Display
PNF	Pilot Not Flying
QAR	Quick Access Recorder
QTY	Quantity
SB	Service Bulletin
SEL	Select
SOP	Standard Operating Procedures
SPD	Speed
TAS	True Air Speed
TCC	Thrust Control Computer
TOD	Top Of Descent
VHF	Very High Frequency
V/L	VOR/Localizer
VMO	Maximum Operating Speed
VOR	VHF Omni directional Range
VORTAC	Visual Omni-Range Tactical Air Navigation
V/S	Vertical Speed

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SYNOPSIS

On the 11th of April 1999, the Airbus A-310/300 aircraft, registration CS-TEW, was performing TP-1107 flight, from Lisbon (LPPT) to Sal (GVAC), Cape Verde Republic, carrying on board 10 crew members and 134 passengers.

Airborne from Lisbon at 20:58 UTC[1], it was established on descent for approach to Sal airport, when, about 00:15, passing FL 160, the Auto Pilot (AP) commanded a nose down attitude movement of the aircraft, with its consequent speed increase, which attained and over passed VMO.

The crew, not confident of AP ability to control the speed within limits, disconnected the AP and reverted to manual flying.

That manoeuvre developed a sinusoidal movement of aircraft nose, with high peaks of vertical acceleration, in opposite directions and a very short time, which caused several injuries in aircraft cabin crew and passengers..

Once the aircraft became stabilized, the Auto Pilot was engaged again and the flight proceeded uneventful until landing in Sal, at 00:28.

The investigation of this occurrence was initiated by Civil Aviation National Institute's Safety & Prevention Bureau (INAC GPS), and the file was passed to this Cabinet, later on.

This report has been released in Portuguese and English Languages.
In case of conflict, Portuguese version will take precedence.

1. FACTUAL INFORMATION

[1] – All mentioned times in this report, except when a different reference is made, are UTC (Universal Coordinated Time) time. At that time of the year, local time in Portugal was equal to UTC + 1 and in Cape Verde was equal to UTC -1.

1.1 History of the Flight

The Airbus aircraft, model A-310/300, with the Portuguese registration CS-TEW, was scheduled to operate a regular passengers flight between Lisbon airport (LPPT), in Portugal, and Sal airport (GVAC), in Cape Verde, on the 11th of April 1999 (Flight TP-1107).

With 10 crewmembers (2 pilots and 8 cabin crew) and 134 passengers on board, the aircraft took-off at 20:58 and followed standard route, climbing to a cruise altitude of 35 000' (FL350). The pilot on right hand seat (co-pilot) was the "Pilot Flying" (PF), while the Captain was "Pilot Not Flying" (PNF). According with standard procedures, Auto Pilot Nº 2 (AP2) was engaged in "CMD", flying the aircraft.

At 00:09, being about 90NM far from destination, and following FMS calculations, descent for approach was initiated, using AP2 engaged in Command (CMD), with "PROFILE" selected, and A/THR engaged as well.

When passing 170FL, approximately, ATC cleared TP-1107 to continue descent to 2 500' and the PF selected that altitude in the FCU.

Soon after, the AP commanded an aircraft nose down attitude change, which caused a speed increasing, at a rate that showed VMO would be overshot.

The captain (PNF) called for "SPEED" and PF selected LVL/CH and a lower speed (290kts). Even so the speed continued to increase until 346kts CAS and over speed aural warning ("*clacker*") was actuated.

At that point, PF started pulling on control column, trying to bring up the aircraft nose and reduce speed, being seconded by PNF in that action (without PF request or assuming PF duties).

The summation of those forces caused AP2 disconnection and the aircraft reverted to manual control, with both pilots fighting with each other for aircraft stabilization.

That lack of coordination induced several pitch oscillations (*varying from -6.0º to +8.6º*) with vertical acceleration variations (*peaks of +2.42g and -0.09g*), within a very short time (≈ 15"), which created different and alternate moments of levitation and fall, inside the cabin, causing several injuries to cabin crew and passengers alike.

At about 14 600', 50 seconds after AP2 disconnection, a stabilized flight was established, the AP Nº1 was engaged and the flight proceeded to destination, uneventful.

The aircraft landed in Sal at 00:28 and taxied to the apron, entering on chocks at 00:35.

1.2 Injuries

Aircraft attitude variation, with consequent vertical acceleration variation, forced cabin crew members and passengers, especially in the rear part of the aircraft, to jump up and down between cabin ceiling and floor, causing the following injuries:

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	1	0	0
Minor	2	2	0
None	7	132	

1.3 Aircraft Damage

There was no damage to the aircraft.

1.4 Other Damage

There was no third party damage reported.

1.5 Persons Involved

1.5.1 Flight Crew

Flight crew was composed by two pilots (Captain and F/O). The Captain had a great experience in this type of aircraft, but the F/O had just finished his transition course, being this one of his first flights without assistance. Anyway he accumulated a great experience as B-737 pilot, before, as shown on table bellow:

Reference		Captain		F/O	
Personal:	Sex:	M		M	
	Age:	59		54	
	Nationality:	Portuguese		Portuguese	
	Flight License:	ATPL(A)		ATPL(A)	
	Validity:	16 JUL 99		10 OCT 99	
	Ratings:	A-310		B-737; A-310	
	Last Medical Examination:	30 DEC 99		19 MAR 99	
Flight Experience:		**Total**	**On Type**	**Total**	**On Type**
	Total:	13 058:00	3 530:00	4 811:00	58:05
	Last 30 days:	59:37	59:37	58:05	58:05
	Last week:	20:00	20:00	29:29	29:29

1.5.2 Cabin Crew

The cabin crew was composed by eight people (1 Supervisor, 2 Pursers, 3 Stewardesses e 2 Stewards), all duly qualified for the job.

The moment the occurrence took place, in the rear cabin, there were 2 stewardesses and 2 stewards, who were affected by cabin oscillation. Two of them hit the ceiling and fell on the floor of the aircraft cabin, suffering some light injuries. One purser, working in rear "Galley", suffered serious injuries on her head (hit the "call light's panel" on cabin ceiling), right arm and spine. She made a hemotórax with lung collapse.

1.5.3 Passengers

Some passengers, with unfastened seat belts, were thrown into the air, but only two, returning from toilets, suffered some light injuries. After landing they were taken to the hospital but they were released after observation.

1.6 Aircraft

1.6.1 General

The aircraft was a twin-jet transport aircraft, with low wing, retractable tricycle landing gear, seating 202 passengers, with a Maximum Take-Off Mass (MTOM) of 157 000kgs, and the following references:

Reference	Airframe	Engine # 1	Engine # 2
Manufacturer:	Airbus	General Electric	
Model:	A-310/300	CF6-80C2A2	
Serial Nr.:	541	695205	695316
Year of Manufacture:	1990	N/A	N/A
Flight Time:	30 148	23 545	25 355
Landings / Cycles:	8 933	7 229	7 578
Last Inspection:	24/03/1999	24/03/1999	24/03/1999

1.6.2 Automatic Flight System

The aircraft was equipped with an Automatic Flight System (AFS), developed by Aerospatiale and Sextant Avionic, able to control the aircraft in all phases of the flight, using different levels of automation.

The System is composed by:

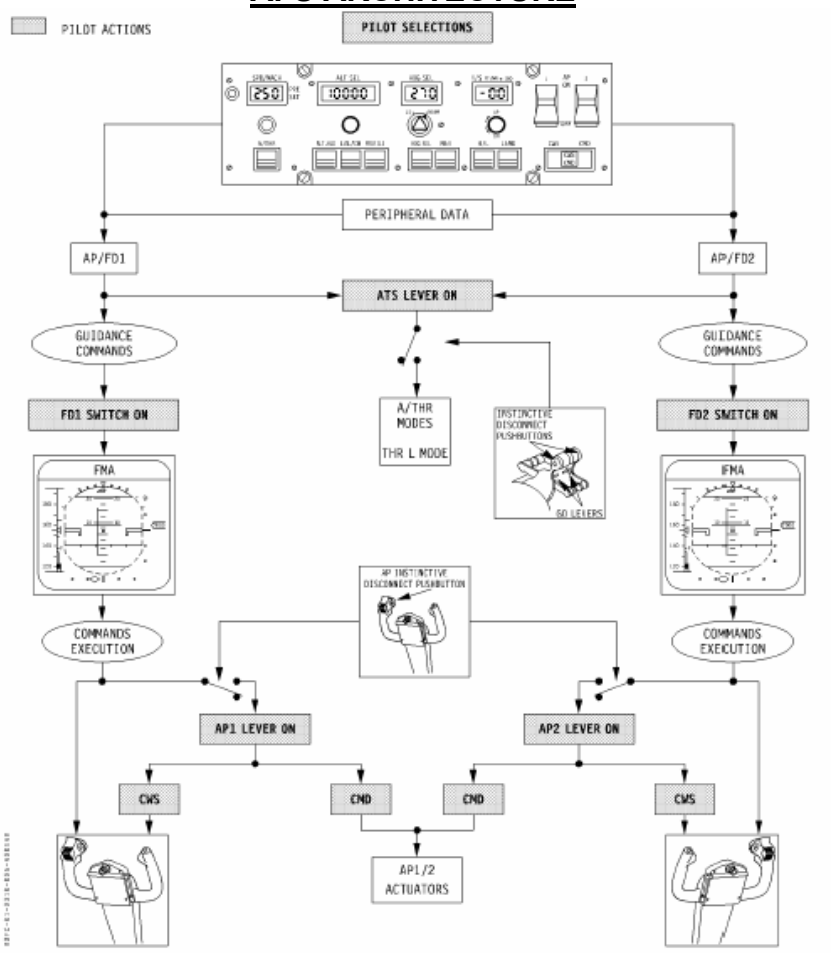
- 2 Auto Pilots (AP1 e AP2);
- 2 Flight Directors (FD1 e FD2);
- 1 Auto-throttle system (ATS).

The AFS includes:

- 2 Flight Control Computers (FCC), one for each AP & FD;
- 1 Thrust Control Computer (TCC) for the ATS;
- 2 Flight Augmentation Computers (FAC);
- 2 Yaw Dampers;
- 2 Pitch Trim;

which receive information from and send command signals to several other systems and unities, installed in the aircraft, providing the necessary means to perform an effective control on horizontal and vertical planes (including speed and engine thrust control) during all flight phases, according with pilot's selections, automatically or reacting to some built-in protection features.

AFS ARCHITECTURE



Picture Nr. 1

Diagram on picture nº 1, above, gives an illustration of the philosophy and design principles behind AFS architecture.

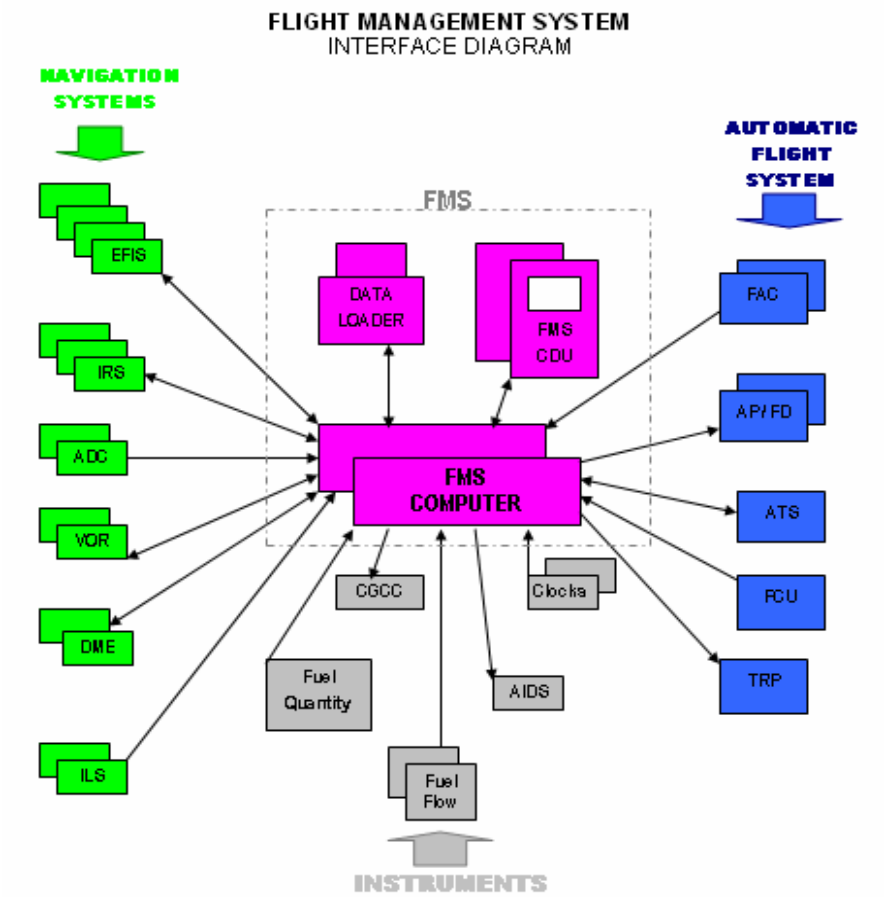
The moment the accident occurred, the aircraft was flying with AP/FD2 engaged, with the following equipments installed:

Equip	Designation	P/N	S/N	Manufact.
FAC 1	Flight Augmentation Computer 1	B471ABM1	?	Sextant
FAC 2	Flight Augmentation Computer 2	B471ABM1	149	Sextant
FCC 2	Flight Control Computer	B470ABM2	241	Aerospatiale

No early reports of malfunction or anomaly, regarding these equipments, were found.

1.6.3 Flight Management System

The aircraft was equipped with a Flight Management System (FMS), which provided guidance for route management and command signals for the AFS, in order to optimize flight plan, according previous defined economic parameters and guide the aircraft along the route, selecting the best altitude and speed. The FMS has been built in duplicate with the interface shown on the diagram bellow (*picture nr. 2*):



Picture Nr. 2

The heart of the system is the Flight Management Computer (FMC), accessible to the pilot through the Control & Display Unit (FMS CDU).

For greater redundancy, both systems work in parallel (being the master the one corresponding to the FD/AP selected), keeping a permanent monitoring and information exchange, in order to detect any failure and, in such a case, revert to the independent mode of operation.

Based on a previous determined cost index, the system performs a route optimization study and defines the best flight level and recommended speeds to attain the expected goals, making a permanent updating, in face of the different flight conditions encountered, regarding the initial forecast, loaded into the system.

When coupled to the AFS, the FMS "*guides*" the AP along entire route, from take-off to landing.

When the occurrence took place, the FMS computers installed in this aircraft were:

Equip.	Designation	P/N	S/N	Manufact.
FMC 1	Flight Management Computer 1	4052510-974	88101898	Honeywell
FMC 2	Flight Management Computer 2	4052510-974	87110965	Honeywell

Consulting the information available on these equipments (Technical Logs, Hold Item List, Pilot Reports), some oral and written pilot's reports referring momentary and erratic target speed display were found. The highest reported value was *0.96M* and the minimum referred was *129kts*.

All those misreadings occurred on top of or during descent phase, after a long journey over the sea.

1.7 Meteorology

The weather was fine, with sky clear and a North-westerly 50kts wind at 35 000', rotating to a Westerly 17kts wind at 10 000' and North-easterly 10kts wind at surface.

Airbus considers the probability of a momentary tail wind increase, when passing 16 400', based on QAR CAS, TAS and MACH recordings. We sustain that those speed stagnation recordings are not accompanied by a GS increment and so they may correspond to A/THR change from "SPEED" to "RETARD" or they may be due to position updating and route recalculation, by FMC.

There were no reports of turbulence or any other significant meteorological phenomenon.

1.8 Navigation Aids

The aircraft was equipped with standard navigation systems, as required for that flight and as per Airbus A-310 standard equipment configuration. No GPS equipment was installed. FMS navigation was based on inertial navigation system, updated through DME, VOR, VORTAC, ILS or other VHF NAVAIDS signals.

Along the route flown, there are large areas where enroute aircraft can't receive ground stations VHF NAVAIDS signals with enough quality to be used by FMC (*picture nr. 7*).

1.9 Communications

Not applicable.

1.10 Aerodrome

Not applicable.

1.11 Flight Recorders

The aircraft was equipped with the following flight recorders:

a) Cockpit Voice Recorder (CVR) – not specified;
b) Flight Data Recorder (FDR) – Sundstrand, P/N 980-4100 DXUN, S/N 10160;
c) Quick Access Recorder (QAR) – TAPFDR, P+G QAR/0, s/n 755.

CVR has not been stopped or removed from the aircraft and new recordings were overlapping the previous ones, becoming of no interest for the investigation. For that reason the tape was not retrieved nor transcript.

FDR has been removed from the aircraft and sent to TAP lab for reading and decoding. Its recordings were not used for the investigation and the equipment went back to avionics rotary store.

QAR showed high quality recordings and a copy was sent to the manufacturer (Airbus), for analysis. Other copies were provided for the investigation team to follow the sequence of events. In face of the high quality of these recordings, the investigation team considered it was not necessary to decode the FDR recordings.

1.12 Wreckage & Impact

Not applicable.

1.13 Medical or Pathological

Medical reports shown that only the purser, on the rear cabin, suffered serious enough injuries to be confined to hospital and to be submitted to several chirurgical interventions.

All other victims were observed and treated to minor injuries, being released immediately.

1.14 Fire

There was no fire.

1.15 Survival Aspects

"FASTEN SEAT BELTS" signal was unlit, at the time, as it was company procedure to switch it "ON" below 10 000' only, unless present conditions recommended other procedure.

1.16 Tests & Research

As there were no turbulence reports, or other meteo phenomenon, responsible for the registered attitude variations, a thorough QAR study was carried, trying to justify the unexpected pitch variation of the aircraft. A copy of such registration was sent to Airbus.

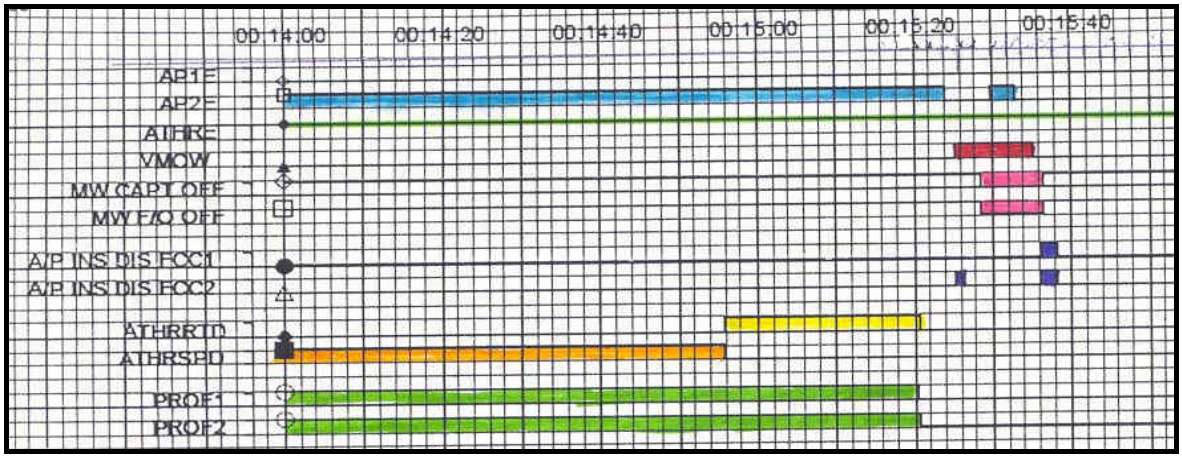
Looking upon those recordings we noticed that:

a) AP2 was engaged and has been disconnected at 00:15:24;

b) A/THR was selected in "SPEED" mode until 00:14:56, when it changed to "RETARD" mode;

c) Between 00:15:25 and 00:15:35 there was a VMO exceedance warning;

QAR – SETINGS & WARNINGS



Picture Nr. 3

d) There was an AP disconnected warning from 00:15:28 to 00:15:36;

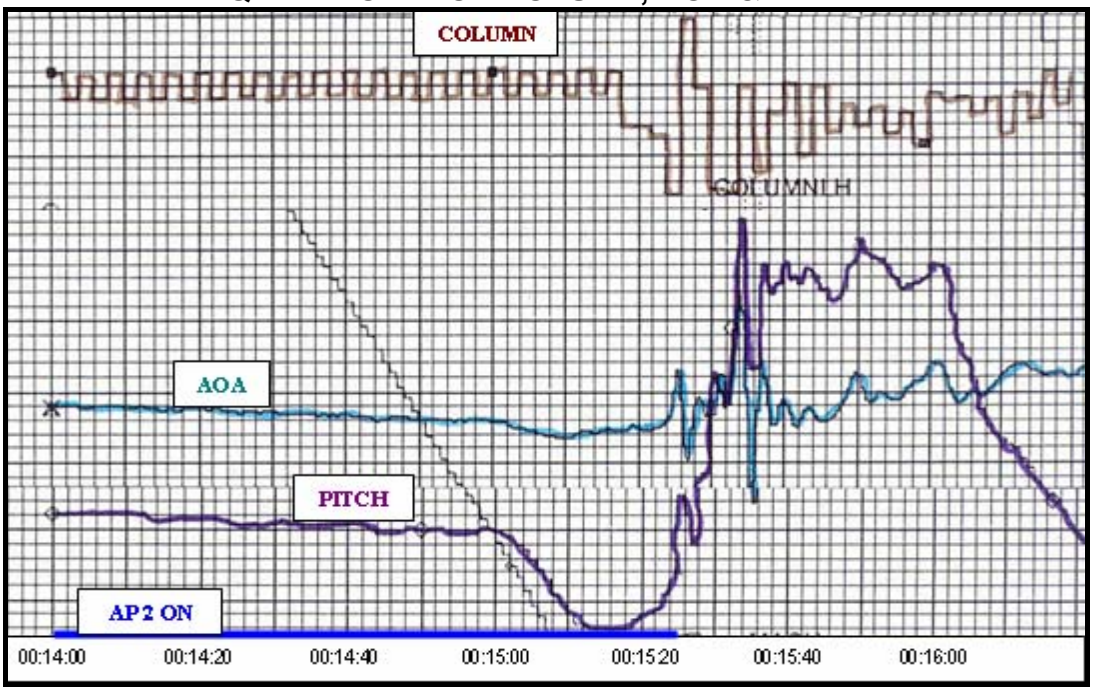
e) The AP Instinctive Disconnect Switch was activated at 00:15:25 (F/O side only) and 00:15:36 (both sides);

f) AFS commanded the descent, maintaining "P.DES" mode from Top Of Descent (TOD) until 00:15:00;

g) Between 00:15:00 and 00:15:24 (when AP was disconnected), PF should try to control speed, selecting "LVL/CHG" and 290kts speed (*these selections were not recorded*);

h) At 00:14:59 we could notice a significant pitch variation, still with AP2 engaged, which attained -6º (*at 00:15:12*);

QAR – CONTROL COLUMN, AOA & PITCH



Picture Nr. 4

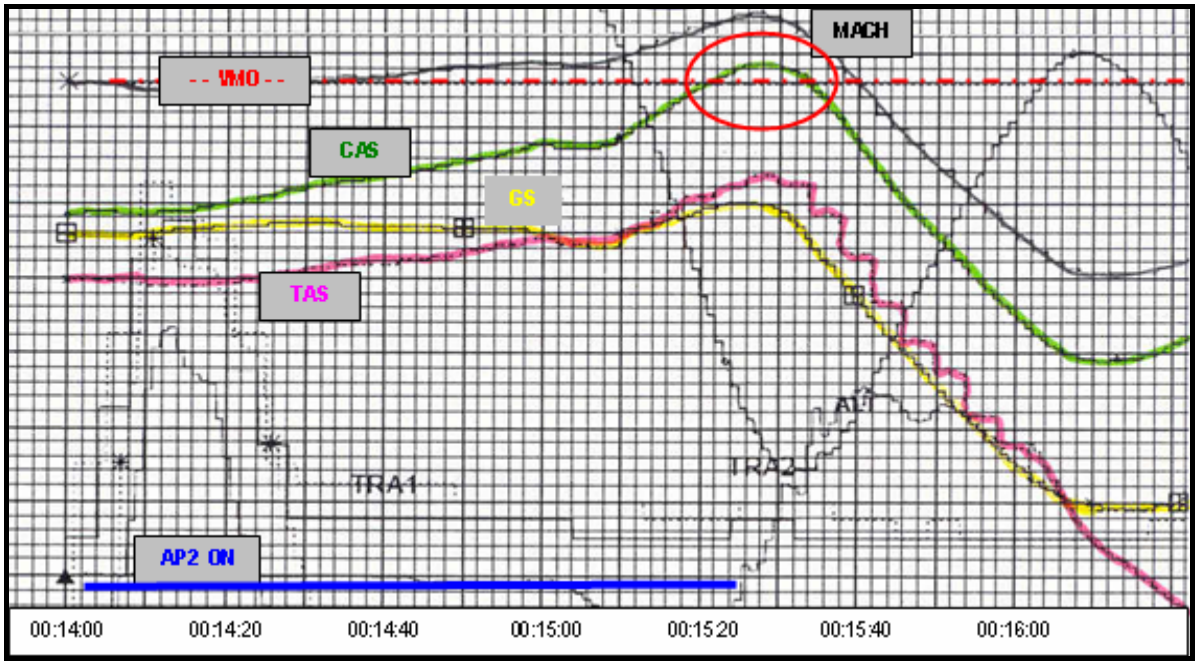
i) At 00:15:00, CAS, TAS and MACH (showing a progressive acceleration from 00:14:20) suffered a momentary stagnation (≈ 6"), without GS sensible variation, at the same time the A/THR changed from "SPEED" to "RETARD", regaining an increase tendency with pitch down movement (00:15:08) and GS accompanying that tendency;

j) At 00:15:20 VMO was attained (and over passed), even if we could confirm a pitch up movement initiated at 00:15:18;

k) Curiously, when pitch started recovering (00:15:18), there was a control column movement on the opposite sense, and 6" later the AP was disconnected, followed by a nose up movement of control column;

l) During the first 6" of manual control, there was an asynchronism between control column movement and pitch tendency (*picture nr. 4*), coinciding with vertical acceleration peaks (*picture nr. 6*);

QAR - SPEEDS

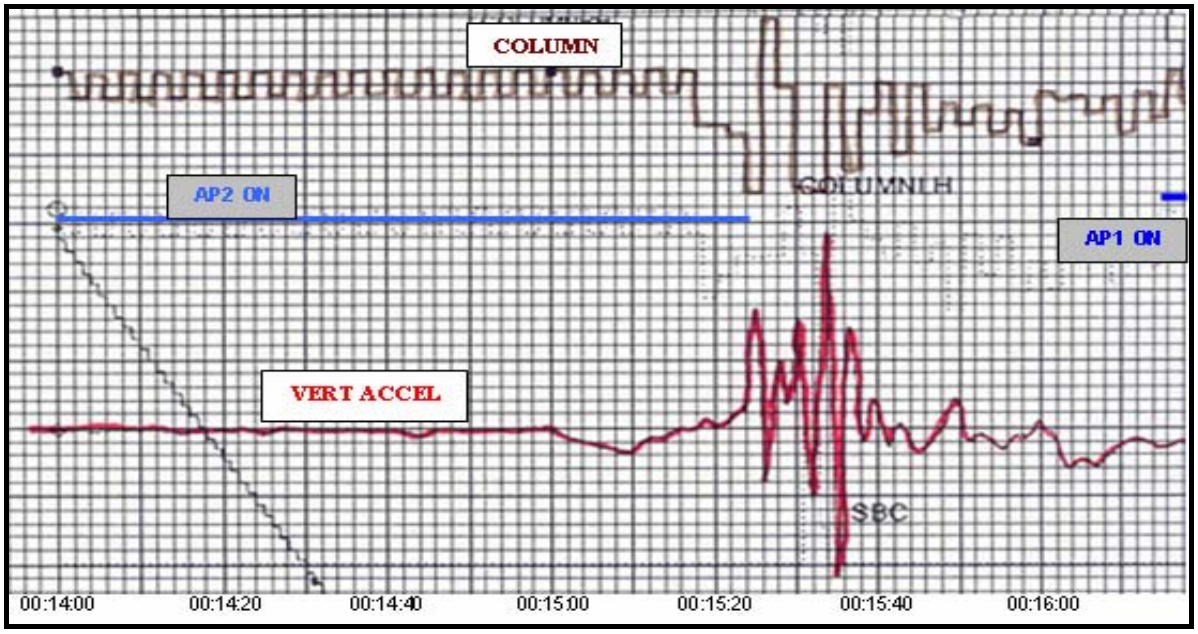


Picture Nº 5

m) After 00:15:32, those movements became synchronized and decreasing its amplitude until normalizing and allow AP1 engagement (00:16:14);

n) Extreme values of control column (-8 / +5), pitch (-6 / +8.6) and vertical acceleration (+2.42 / -0.09) were attained during manual phase of the flight, when speed was at or above VMO.

QAR – CONTROL COLUMN & VERTICAL ACCELERATION



Picture Nr. 6

1.17 Organizational & Management

The Operator was a duly certified enterprise, acting in accordance with aeronautical regulations in force and Air Operator Certificate (AOC) specified requirements and conditions.

Flight procedures followed manufacturer recommendations, were approved by the Authority and referred in Flight Crew Operating Manual (FCOM) and Aircraft Flight Manual (AFM).

Flight Crew Training Programme and Testing followed published procedures and crew actual behaviour was never accepted or justified by Operations and Training Departments.

All maintenance actions, on that aircraft, were performed by Operator's Maintenance & Engineering Department personnel, according with Authority issued certificates and following manufacturer's recommended practices and procedures.

1.18 Additional Information

There's no other relevant information to refer.

2. ANÁLYSIS

2.1 Automatic Flight System (AFS)

2.1.1 Expectancy

According with basic operating principles governing Automatic Flight System (AFS) operation, when engaged in "CMD" and "PROFILE" mode selected, during descent for approach to destination airport, should be expected:

a) The system follows Flight Management (FMS) instructions, adhering to the planned routing and respecting all altitude and speed constraints;

b) The AP/FD commands pitch, in order to followed descent profile, speed or descent rate, according FMC calculations;

c) The A/THR commands engine's power (within TRC established limits), in order to keep FMC target speeds;

d) During entire operation "*Alpha-floor*", "*Underspeed*", "*Overspeed*" and "*Thrust Limit*" protections are armed and should be activated any time specific activation conditions are met.

2.1.2 Performance

On this particular flight, descent has been performed with AP/FD 2 selected in CMD, NAV and P.DES, with A/THR selected.

In such circumstances:

a) AP2 commanded heading and pitch, in order to follow the active route profile as determined by FMC;

b) A/THR, initially in "SPEED" mode, granted that FMC calculated descent speed was maintained;

c) When changing from "SPEED" to "RETARD", A/THR moved to the rear-most position (idle power) and target speed keeping was granted by FCC 2, controlling "*pitch*" and following vertical profile, as determined by FMC;

d) The unexpected pitch-down performed by AP2, at 00:14:59, could only be commanded by FMC, due a vertical profile update;

e) About 16 seconds after pitch-down movement ("*P.DES" mode was still active*), AP2 commanded a pitch recover, probably due to activation of "*Overspeed*" protection;

f) Even so, speed continued to increase (*346kts were attained*), most probably due to an indication delay and/or reduced AP recovering authority, in "P.DES" mode;

g) Pilot "LVL/CH" and lower target speed selection increased AP recovering capacity but speed remained above VMO, with "Overspeed warning" sounding, which led the PF to act on control column, as an instinctive reaction, probably based on his previous experience on a different type of aircraft;

h) All that time A/THR remained in "RETARD", as there was no need for power increase.

Based on the above mentioned facts, we may conclude there has been no abnormal performance or behaviour of Automatic Flight System (AFS).

2.2 Flight Management System (FMS)

Flight Management Computer (FMC) makes its calculations based on the actual position of the aircraft and its relation to the different waypoints along flight plan route. More precise is actual position calculation, more precise will be the route profile computation.

Actual position determination is based on information from Inertial Reference System (IRS), improved by radio-navigation information from DME, VOR, VORTAC and ILS.

When the aircraft is out of reach of those radio signals (*or they don't meet required quality*), which provide an update, actual position accuracy starts degrading, once it depends only on IRS information and the IRUs are subject to precession errors.

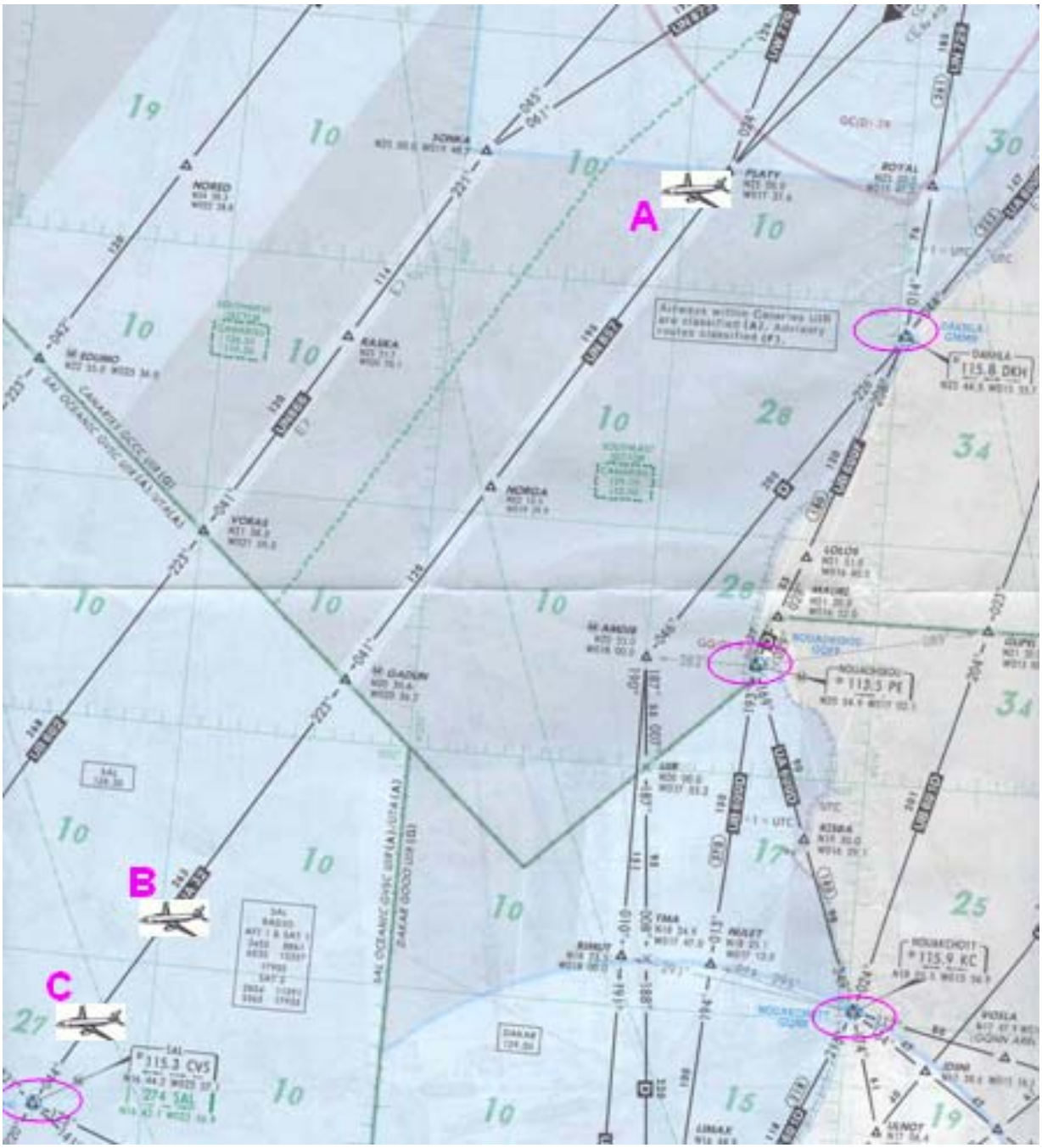
Flying the programmed route (*picture nr. 7*), the aircraft flew for a long period out of reaching of suitable such NAVAID signals and, consequentially, unable to make an update of its position.

Between points "A" and "B", it was almost impossible to get a signal quality capable of provide enough reliability for position update.

In such a case, FMS would be affected by position accuracy deterioration and its navigation accuracy was degraded.

It's understandable that, approaching destination, Sal NAVAIDs became available and the system started a position update process and, consequentially, a flight plan revision.

That flight plan revision, should have determine a substantially different distance to destination and, considering the altitude and speed constraints of flight plan, the FMC calculated a higher descent rate and/or descent speed, sending that order to the AFS.



Picture Nr. 7

Passing position “C”, the AP 2 received that order and commanded a “pitch” down movement, increasing speed and descent rate.

A probable speed reading delay and the AP reduced authority in “P.DES” mode, may justify the aircraft punctual speed overrun (*picture nr. 5*).

Anyway, “Overspeed” protection was activated with AP2 still in “P.DES” mode (*pitch recovering was initiated*). When “LVL/CH” was selected, due AP greater authority, pitch corrective action was improved (*picture nr. 4*).

2.3 Crew Behaviour

Noticing the sudden nose down movement of the aircraft and corresponding acceleration in speed and descent rate, PNF called "*SPEEEED*", PF decided to cancel "PROFILE" and selected LVL/CH mode and 290kts, in order to interfere directly on speed control.

Even so, due the high speed trend, the AP let the speed approach and surpass VMO.

The PF, in face of the "Overspeed warning", instinctively, pulled on the control column, trying to override the AP and keep speed inside limits. As the AP was engaged in "CMD", it didn't follow that instruction but, by that time, the PNF pulled on the control column as well, ***without request of or information to PF***.

The summation of those two forces was greater than AP's pitch target disconnecting force and the AP2 disconnected.

That abnormal AP disengagement, the uncoordinated forces applied to control column and the high sensitivity of flight controls at high speeds, caused several longitudinal oscillations of the aircraft with high vertical acceleration values (*peaks of +2.42g and -0.09g in 2"*).

Looking into QAR recordings we may notice a slight disagreement between control column position and pitch indications, which could be understood as an "Aircraft Pilot Coupling" (APC) phenomenon and may be responsible for oscillation's amplitude worsening. Nevertheless, the irregular AP disengagement process and the fact the aircraft being flown fourhanded in an uncoordinated manner, was the main reason for such pitch oscillations.

If AP Instinctive Disconnect Switch (IDS) have been used (***as recommended on all aircraft manuals and Company standard operating procedures***), if there were not two pilots simultaneous flying inputs on control column, Those oscillations would be avoided.

An AFS malfunction should be discarded, as no reports were found regarding AFS behaviour. So, we may accept that, if there has been no pilot action, the AP would recover from the overspeed excursion without any consequences.

3. CONCLUSIONS

3.1 Findings

Based on what has been exposed, we may conclude that:

1st The aircraft was performing a regular passengers transport flight, as per published Schedule and AOC conditions and entitlements;

2nd The crewmembers were qualified for that flight, their licenses were valid and they have complied with required training programme;

3rd Aircraft Airworthiness Certificate was valid, the approved maintenance programme has been complied with and there were no anomaly reports that could impair aircraft airworthiness;

4th There was no report of significant atmospheric phenomenon which could influence events development and sequence (*Airbus theory of momentary tail wind is not proved and we have a different understanding for speed stagnation*);

5th Descent was performed with AP 2 engaged in "CMD", "PROFILE" mode selected and A/THR engaged;

6th Passing FL 160, AP commanded a nose down movement, with consequent CAS increasing;

7th PF tried to keep speed under control by selecting an AP different mode of operation, but he didn't manage to prevent momentary VMO exceedance;

8th Reacting to over-speed aural warning (*clacker*), both pilots acted on pitch control, pulling on the control column, overrode the AP and discontinued the automatic recovering tendency, gaining manual control of the aircraft;

9th That Auto Pilot disconnecting manoeuvre was in contradiction with Company SOP, AFM, FCOM, FCTM and all manufacturer recommendations and procedures;

10th During manual flight phase, due pitch control movement amplitude and aircraft high speed, the aircraft was submitted to several pitch oscillation manoeuvres, with extreme vertical acceleration peaks (*+2.42g & -0.09g*);

11th These vertical acceleration variations forced some occupants to violently impact aircraft ceiling and floor, causing serious injuries on one purser and minor injuries on two cabin crew and two passengers;

12th The aircraft suffered no damage.

3.2 Causes of the Accident

3.2.1 Primary Cause

Manual actuation of aircraft pitch control by both pilots (**in a simultaneous and uncoordinated way**), when the aircraft was flying at speeds near and above VMO, disconnecting the Auto Pilot in contradiction with recommended Standard Operating Procedures, inducing rapid and large pitch oscillations, creating opposite heavy vertical loads, is considered the main cause of this accident.

3.2.2 Contributory Factors

The following were considered as Contributory factors:

1st The limited cover of VHF stations, suitable for FMS position update process, along the route to be flown;

2nd FMC order to AP commanding a rate of descent increase with a consequent air speed increase, once the engines were running at idle power;

3rd Limited AP authority to control the high speed increase trend, in reaction to "overspeed" protection;

4th Pilot Flying limited experience on this type of aircraft, which led him to instinctively act on control column, with AP engaged in "CMD", due habits and previous experience in different equipment;

5th Pilot Not Flying attempt to assist Pilot Flying in controlling speed by control column actuation, without request from PF and giving no advice of his actions or taking-over control of the aircraft, disregarding SOP;

6th Company policy on "FASTEN SEAT BELTS" usage, which specified the signal should be selected "ON" below 10 000' only, unless other situation dictated other procedure;

4. SAFETY RECOMMENDATIONS

After this accident occurred, technological evolution dictated the introduction of several modifications on management systems and flight equipment and procedures, which contributed to improve flight performance and minimize such occurrences.

A special reference must be made to Airbus SB-2039 FCCs PN B470ADM, mandatory from 31-July-2001, which improved flight control at marginal speeds.

The operator developed new procedures and policies regarding Flight Crew training & checking, in order to emphasise the observance of approved procedures and recommendations.

The selection of “FASTEN SEAT BELTS” to “ON” position is now mandatory for the entire climb and descent phase of the flight, irrespective of meteorological conditions.

Lisbon, 09th of July 2007

The Investigator In Charge,

António A. Alves