

**TECHNICAL INVESTIGATION INTO THE ACCIDENT OF  
THE B737-800 REGISTRATION 5Y-KYA OPERATED BY  
KENYA AIRWAYS THAT OCCURRED ON THE 5<sup>th</sup> OF  
MAY 2007 IN DOUALA**

## WARNING

By Decision No. 098/PM of 08<sup>th</sup> May 2007, itself modified by Decision No. 099/PM of 09<sup>th</sup> May 2007, the Republic of Cameroon created a technical commission of inquiry to establish the causes, and make the necessary safety recommendations concerning the accident of the B737-800 that occurred in Douala on the 5<sup>th</sup> of May 2007.

This report contains information on the development of the accident, aerodrome infrastructure, aviation personnel and the aircraft concerned.

In accordance with Annex 13 of the International Civil Aviation Convention, this inquiry was not conducted with the goal of apportioning blame or determining individual or collective responsibilities. Its sole objective is to draw lessons from it for the prevention of future accidents.

Consequently, using this report for any goal other than accident prevention is likely to lead to erroneous interpretations.

In this document hours are expressed in local time: UTC+1 in Douala, and UTC in Abidjan.

## Table of Content

List of Abbreviations.....	7
Synopsis.....	8
Summary.....	8
1 – Basic Information.....	9
1.1 Flight history.....	9
1.2 Injuries to person.....	15
1.3 Damage to Airplane.....	16
1.4 Other damages.....	16
1.5 Information on the Personnel.....	16
1.5.1 Flight crew.....	16
1.5.1.1 The Captain.....	17
1.5.1.2 Copilot (First Officer – FO).....	18
1.5.2 Cabin crew.....	19
1.5.3 Accompanying engineer.....	19
1.5.4 Air Traffic Control Personnel.....	19
1.5.4.1 Tower Controller.....	19
1.6 Information Concerning the Airplane.....	20
1.6.1 Airplane.....	20
1.6.1.1 Airframe.....	20
1.6.1.2 Engines.....	21
1.6.1.3 Fuel.....	21
1.6.1.4 Technical Malfunctions.....	21
1.6.1.5 Weight and Balance.....	22
1.6.2 Description of Systems and Elements of the Aircraft Linked with the Accident.....	22
1.6.2.1 The Boeing 737 Cockpit Displays.....	22
1.6.2.2 The Autopilot Flight Director System (AFDS) and the Auto-throttle (A/T) System.....	23
1.6.3 Availability of Transponder, TCAS and EGPWS.....	26
1.7 Meteorological Conditions.....	26
1.7.1 General Meteorological Situation.....	26
1.7.2 General Situation and Evolution of the Weather on that Day.....	27
1.7.2.1 Before the accident.....	27
1.7.2.2 At the time of the Accident.....	28
1.7.2.3 After the Accident.....	28
1.8 Navigation Aids.....	28

1.8.1 The Douala VOR/DME (112.9 MHz).....	28
1.9 Telecommunications.....	28
1.10 Information on the Aerodrome.....	29
1.10.1 Infrastructure.....	29
1.10.2 EDEBA 1E Departure Procedure.....	29
1.11 Flight Data Recorders.....	30
1.11.1 Characteristics of the Recorders.....	30
1.11.2 Recovery of the Recorders.....	30
1.11.3 The FDR and CVR produced the following facts concerning this flight.....	31
1.11.4 The data extracted ... ..	31
1.12 Wreckage and Impact Information.....	32
1.12.1 The accident site is of ... ..	32
1.12.2 The airplane, the engines, ... ..	32
1.13 Medical and Pathological Information.....	32
1.13.1 The remains of the ... ..	32
1.13.2 DNA testing was ... ..	32
1.13.3 The medical records ... ..	33
1.13.4 There is no indication ... ..	33
1.14 Fire.....	33
1.15 Survival Aspects.....	33
1.15.1 The accident occurred ... ..	33
1.15.2 No survivor was ... ..	33
1.16 Tests and Research.....	33
1.16.1 Airplane Performance.....	33
1.16.2 Human Factors.....	35
1.16.3 Flight Simulation.....	37
1.17 Organizational and Management Information.....	37
1.17.1 Information concerning Organizations and their Management whose activities could directly or indirectly have had influence in the operation of the airplane.....	37
1.17.1.1 Airplane Operator.....	37
1.17.1.2 Air Traffic Management.....	38
1.17.1.3 Management of Airport Services and Ground Assistance.....	39
1.17.1.4 Meteorological Services.....	39
1.17.1.5 The Airplane Manufacturer.....	40
1.17.1.6 The Certification and licensing Authority.....	40
1.17.2 Career Evolution.....	41
1.17.2.1 The Captain.....	41

1.18 Additional Information.....	43
1.18.1 DFDR.....	43
1.18.2 CVR.....	43
2 ANALYSES.....	45
2.1 General.....	45
2.2 Flight Operations.....	45
2.2.1 Crew Qualifications.....	45
2.2.2 Operational Procedures.....	45
2.2.2.1 Briefing before Departure and Check List Calls.....	45
2.2.2.2 Radio communications.....	46
2.2.2.3 Engaging of the Autopilot.....	46
2.2.2.4 Technical Calls.....	46
2.2.3 The Piloting of the Airplane... ..	47
2.2.3.1 From lift-off up ... ..	47
2.2.3.2 As the Airplane's... ..	48
2.2.4 Meteorology.....	49
2.2.5 Aerodrome Services.....	50
2.2.6 Ground Handling Services.....	50
2.2.7 Air Traffic Services.....	50
2.2.8 Oversight.....	51
2.2.8.1 Oversight of Kenya Airways.....	51
2.2.8.2 Oversight of Aerodrome Services and Ground Assistance.....	51
2.2.8.3 Oversight of Air Traffic Services.....	51
2.3 The Airplane.....	52
2.3.1 Maintenance of the Airplane.....	52
2.3.2 Weight and Balance.....	52
2.3.3 Systems and Airframe.....	52
2.3.4 Airplane Performance.....	52
2.4 Human Factors.....	52
2.4.1 Training.....	52
2.4.1.1 The Captain.....	52
2.4.1.2 The FO.....	53
2.4.1.3 CRM Training.....	54
2.5 Organization of KQA.....	54
2.6 Medical and Psychological Aspects.....	54

2.6.1	Medical Aspects.....	54
2.6.2	Psychological Aspects.....	54
2.6.2.1	The Captain.....	54
2.6.2.2	The FO.....	55
3	CONCLUSIONS.....	56
3.1	Established Facts.....	56
3.2	Probable Causes.....	57
4	SAFETY RECOMMENDATIONS.....	58
4.1	Oversight of Operators.....	58
4.2	Training.....	58

## APPENDIXES

PlanePicture.net.....	1
Aerial photo of crash site.....	2
KA507 Debris Coordinates.....	3
KenyaAirways_b737_CVR.....	4
TSB Plots KEN 5Y-KYA.....	5
Radio band transcript.....	6



## LIST OF ABBREVIATIONS

ADC	Aéroports du Cameroun
AFDS	Autopilot flight director system
ATL	Aircraft technical log
A/T	Auto throttle
CB	Cumulo Nimbus
CMD	Auto pilot command mode
COMMAND	Call to engage the autopilot in CMD mode
CPL	Commercial Pilot license
CRM	Crew Resources management
CVR	Cockpit Voice Recorder
CWS	Control wheel steering
EADI	Electronic attitude director indicator
FDR	Flight Data recorder
FCC	Flight control computer
FD	Flight Director
FO	First Officer
FMA	Flight mode annunciator
HDG SEL	Heading selection Mode of the AFDS
KQA	Kenya Airways
NTSB	National Transportation Safety Board
PM	Pilot Monitoring
PMC	Principal meteorological Center
RAM	Royal Air Maroc
SOPA	Standard operation procedures Amplified
SOP	Standards operation procedures
TO	Take off
TOGA	Take off and go around
TWR	Control Tower
THR HLD	Throttle Hold
MCP	Mode control panel
FMC	Flight management computer
PAPI	Precision Approach Path Indicator

## **SYNOPSIS**

<b>Operator</b>	Kenya Airways Limited
<b>Aircraft</b>	Boeing 737-800; registration 5Y-KYA
<b>Date and time of accident</b>	Saturday 05 <sup>th</sup> May 2007 at 0008 (local time)
<b>Location of accident</b>	3.95570 N 9.75090 E (03 57 1883 N 009 44 58 E)

The Minister of Transport, who has the statutory responsibility for investigations into accidents and grave incidents concerning aircrafts, accordingly notified the following countries:

- The country of registration and operator of the airplane: Kenya
- The country of conception and manufacture of the airplane: USA
- Other countries concerned: Côte d'Ivoire

The aforementioned countries each designated her accredited representative to the commission of inquiry.

## **SUMMARY**

During the night of 04<sup>th</sup> May 2007, the B737-800, registration 5Y-KYA, operating as flight KQA 507 from Abidjan international airport (Côte d'Ivoire), to the Jomo Kenyatta airport Nairobi (Kenya), made a scheduled stop-over at the Douala international airport. The weather was stormy. Shortly after take off at about 1000 ft, the aircraft entered into a slow right roll that increased continuously and eventually ended up in a spiral dive.

On the 5<sup>th</sup> May 2007 at approximately 0008 hrs, the airplane crashed in a mangrove swamp South-South/East of Douala. All 114 occupants on board were killed and the airplane was completely destroyed.



# **1- BASIC INFORMATION**

## **1.1 Flight history**

Flight KQA507 is a normal scheduled Kenya Airways flight between Abidjan and Nairobi with a stop- over in Douala.

On the 04<sup>th</sup> May 2007, the flight departed from the parking stand of the Abidjan international airport at 1830. It has on board 55 passengers, of which 38 are to disembark at Douala. The airplane takes off at 1845, and lands at the Douala international airport at 2201 (2101 UTC).

No technical malfunction or anomaly of the airplane is reported at departure from Abidjan.

No incident is reported during this leg of the flight and departure for Nairobi is scheduled for 2300.

At Douala, a ground handling team comprising exclusively of KQA personnel awaits the airplane at stand C5; there is no marshal in place. After landing, the airplane taxis towards stand C7 on the instructions of TWR. The pilot positions the airplane approximately at stand C7 without assistance, and shuts down the engines.

Kenya Airways ground crew delayed the disembarkation of the airplane to have it towed and properly parked at stand C7.

The passengers disembark 20 minutes after engines shut down.

### **Preparation of the Flight**

An employee of the ground handling company (ADC), signs out the meteorological protection file prepared by the Douala Principal Meteorological Center (PMC), and hands it to Kenya Airways ground crew office, which in turn transmits it to the crew on board the airplane.

The KQA engineer accompanying the flight supervises the refueling of the airplane; 9500 kgs of fuel are pumped in; bringing the total quantity of fuel on board to 14200 kg.

KQA ground crew proceeds to embark 91 passengers, of which 02 are added after reopening the doors of the airplane. The total number of persons on board is 114, comprising of 108 passengers and 06 crewmembers.

## Start Up

2233: First contact between flight KQA507 and the air traffic controller on duty at the TWR.

2247: A brief dialogue between the FO and the TWR controller for confirmation of airplane call sign; flight KQA507 instead of KQA504. KQA507 requests and obtains the following start up data from the TWR: “temperature 27, dew point 25, QNH 1010, wind calm, runway 12 for take off (TO)”.

2320: The controller transmits the following start up data to flight RAM287: “temperature 27C, dew point 26C, QNH 1010”.

Following an interruption of their communication by another station, RAM 287 demands confirmation in French. The tower controller replies in French thus: “Je dis temperature 27, dew point 26 et 1010 au QNH. Il est 22H21”. (*I say temperature 27, dew point 26, and 1010 QNH. It is 22H21*). RAM 287 reads back in French and demands the confirmation of visibility 10 km. The TWR responds; “10 km oui”; {10 km; yes}.

At the same time, KQA 507 requests start up clearance from the tower, and obtains it.

2337: KQA 507 announces cancelling start up to wait for a lull in the rainfall.

2354: KQA 507 requests and obtains a new authorization to start up.

2356:44: Beginning of FDR recording (*time reference is taken from the FDR*)

The FCC A is the reference (master)

The two FD are activated

The A/T is armed

The Captain's weather radar is on

The pitch trim is positioned at 6.2 units

2357:49: Flight controls are checked and show a normal range of motion.

2357:59: Flaps selection is 5° down

## Taxi and Take-Off

2358:06.9: The Captain remarks that the two engines are running normally.

2358:42.7: The FO calls for the “before taxi” checklist.

2359:03.7: The “before taxi” checklist is completed.

2359:08.7: The FO requests authorization to taxi. The tower tells him to hold position. During that period of waiting the Captain says: “this thing is moving”. The FO responds: “Yes” and the Captain adds: “there is no way here”.

2359:23: RAM 287 requests in French: “une dernière météo SVP” (*Lastest meteorological report please*). The TWR controller responds in French: “...visibilité 800 m, vent calm, pluie et orage modérés, cloud SCT a 300 pieds, BKN a 1000 pieds, CB a 1600 pieds tous secteurs, tempo, visibilité 1500 m, pluie modérée et orage”. {*...visibility 800 m., wind calm, rain and moderate thunder storms, clouds scattered 300 ft, Broken 1000 ft, cumulo nimbus 1600 ft all sectors, tempo, visibility 1500 m, moderate rain and thunder storms*}. RAM 287 again requests in French; “d’après la météo, l’orage va partir dans combien de temps? {*According to meteorological service, the storm will go away after how much time?*} The TWR controller telephones the meteorological office and shortly after that responds: “...la visibilité va avoir une légère amélioration, mais l’orage va s’installer jusqu’au matin”. {*The visibility will improve slightly but the thunder storm will persist till morning*}.

2359:47.3: KQA 507 is cleared to taxi and backtrack for runway 12. The FO announces 106 passengers, 08 crew members, and 05 hours and 45 minutes of endurance.

0000:06: KQA 507 begins taxiing for runway 12.

0001:15: The weather radar of the FO is switched on.

0001:46.4: The FO reads back the departure clearance: “Cleared after departure runway 12, cleared to Nairobi flight level three seven zero, EDEBA 1E departure Kenya 507”; and TWR demands that he call back when ready for take-off.

0004:19: The FO announces the “before take off” checklist completed.

0004:24.3: The head of the cabin crew announces to the pilot that the cabin is ready for take off.

0004:38.6: The captain requests a modification of the departure clearance thus: “And ahh tower from Kenya five- zero- seven, after departure we would like to maintain ahh slightly left of runway heading due to weather ahead”; the FO corrects: “right”, and the Captain confirms: “sorry slightly right”. The TWR approves.

0005:26: The pre-selected heading is 118°, pre-selected initial climb speed is 150 kts, A/T is activated in mode TOGA, N1 is stabilized at 99%, and the take off run begins; the captain is the pilot flying.

0005:52.7: The V1 automatic annunciator sounds; the FO confirms V1.

0005:55.9: The FO calls, “rotate” and simultaneously the captain initiates rotation.



0006:00: The airplane takes off.

### After Take-Off

0006:09: The landing gear is retracted.

As soon as the airplane is airborne, it has a net tendency to roll to the right; the pilot reacts immediately by input of  $30^\circ$  of left roll on the control wheel, and then turns the wheel back to the neutral position and continues to modulate left control wheel to maintain wings level. The bank angle of the airplane stays within the limit of  $3^\circ$  right.

The captain continues to make inputs on the flight controls, (roll), to the left between 500 and 1000 ft; the tendency of the airplane to roll to the right is controlled and bank angle remains at less than  $1^\circ$ .

During the same period, several inputs on the pitch trim for nose up attitude are also apparent.

0006:24: At about 1000 ft climbing, all action on the flight controls ceases till 0007:19.

0006:26: The Captain calls HDG SEL, and the FO responds: "select checked". The FDR indicates:

- Altitude: 1140 ft
- Heading:  $118^\circ$
- Pitch:  $+15^\circ$
- Speed: 164 kts
- Bank angle: less than  $1^\circ$
- Flaps: down,  $5^\circ$

0006:27: The HDG SEL knob is moved from  $118$  to  $132^\circ$ . At the same time the roll to the right recommences.

0006:28.8: The captain says: "I will keep somewhere around here".

0006:33: The HDG SEL knob is moved from  $132$  to  $139^\circ$ . The roll command bar of the flight director again moves to the right. The FDR indicates:

- Altitude: 1300 ft.
- Heading: increasing.
- Pitch:  $+10^\circ$
- Speed: 175 kts.
- Bank angle:  $6^\circ$ , right
- Flaps: down,  $5^\circ$

0006: 40.8: Climb power is selected; FO calls "N1". The roll command bar of the flight director starts moving to the left. The FDR indicates:

- Altitude: 1600 ft.

- Heading: 127°
- Pitch: +11°
- Speed: 182 kts.
- Bank angle: 11°, right.
- Flaps: down 5°

00:06:41.8: The Captain calls: "OK COMMAND"; The FO does not respond. The FDR indicates several inputs on the pitch trim for nose up, due to the speed trim system; The autopilot is not engaged.

0006:45.1: The FO requests: "I remain on legs?" The Captain responds "Yup"

0006:49: The roll command bar of the flight director moves to the left. The FDR indicates:

- Heading: passing 139°.
- Bank angle: 15°, right.

0006:55: The HDG SEL knob is moved to the left from 139 to 120°.  
The roll to the right continues, and reaches 20° bank angle.

0006:59: The FO initiates change of altimeter setting. Both pilots execute the change and mutually verify it.

The FDR indicates:

- Pressure altitude: 2400 ft.
- Pitch: +10°.
- Speed: 180 kts.

0007: 05.8: The Captain says: "Now we are getting into it" and the FO responds: "O.K".

0007:09.5: The FO calls: "I continue with heading?". The HDG SEL knob is moved right from 120 to 165°.

The FDR indicates:

- Pressure altitude: 2600 ft.
- Heading: 190°
- Pitch: +7°
- Speed: 190 kts.
- Bank angle: 24°, right.
- Flaps: down 5°

0007:12.2: The Captain says: "through here is OK, isn't it?" The FO responds; "OK".

0007:18.2: The Captain exclaims;

The FDR indicates:

- Pressure altitude: 2700 ft.
- Heading: 215°

- Pitch: +8°.
- Speed: 200 kts.
- Bank angle: 34° right.
- Flaps: down 5°.
- Flight Controls: in neutral position
- Autopilot: not engaged.
- HDG SEL: 165°.
- Flight Director roll command bar: at extreme left position.

0007:19: The bank angle aural warning sounds: “BANK ANGLE”. The roll control wheel is immediately turned 22° to the right, then 20° to the left, again 45° to the right and finally 11° to the left. The bank increases rapidly to the right.

0007:23: At 2770 ft, without any call, the “CMD A” mode of the autopilot (AP) is engaged; Action on the flight controls decreases.  
Some action on the right rudder pedal is perceptible.  
The bank angle, which reaches 50°, tends to stabilize.

0007:28: Intense action on the flight controls resumes; first roll movement to the right, then to the left and again to the right. Several bursts of rudder inputs are made to the right. The Captain announces “we are crashing”.

The FDR indicates:

- Altitude: 2800 ft.
- Pitch angle: +5°.
- Speed: 220 kts.
- Bank angle: 55° to the right and increasing rapidly.

0007:29: Uncoordinated movements of the flight controls increase, coupled with bursts of right rudder applications. The FO confirms: “right, yeah we are crashing right”. The bank angle reaches 70° to the right.

0007:31: Prolonged pressure on the right rudder pedal is perceptible while the roll control wheel is moved from left to right and then completely to the left.

The FDR indicates:

- Pressure altitude: 2900 ft and decreasing rapidly
- Heading: 290°
- Pitch angle: minus 3°
- Speed: 220 kts.
- Bank angle: 80° to the right, and increasing rapidly.

0007:33: The FO calls “Right Captain, Left, Left, Left...correction Left ### \*\*\*.

The DFDR indicates:

- Pressure altitude: 2700 ft, in a dive.
- Heading: 330°



- Bank angle: 90° to the right.

0007:35: The bank angle reaches 115°, then decreases towards 70°, following full left roll input on the control wheel.

The altitude is 2500 ft.

The heading reaches 360°.

Other bursts of left roll inputs on the control wheel and some pressure on the right rudder pedal are perceptible.

0007:40: The altitude is 1300 ft.

Bank angle is 70°

The speed is 270 kts

0007:42: The airplane crashes with speed of 287 kts, a pitch angle of minus 48°, heading 090°, and 60° right bank angle.

## 1.2- Injuries to person

Injuries	Flight crew	Cabin Crew	Passengers	Other Persons	Total
fatal	02	04	108	-	114
Serious	-	-	-	-	
Minor/None	-	-	-	-	
Total	02	04	108	-	114

*\* This passenger number includes one accompanying engineer and one positioning cabin crew member.*

The six crew members were all of Kenyan nationality. The passenger distribution according to nationality is as follows:

- 37 Cameroonians
- 15 Indians
- 07 South Africans
- 06 Ivoirians
- 06 Nigerians
- 05 Britons
- 05 Chinese
- 03 Kenyans
- 03 Niger Nationals
- 02 Central Africans
- 02 Congolese (DRC)
- 02 Equatorial Guineans

- 01 American
- 01 Burkinabe
- 02 Comorian
- 01 Congolese
- 01 South Korean
- 01 Egyptian
- 01 Ghanaian
- 01 Malian
- 01 Mauritian
- 01 Senegalese
- 01 Swedish
- 01 Swiss
- 01 Tanzanian
- 01 Togolese

### **1.3- Damages to Airplane:**

The airplane was completely destroyed.

### **1.4- Other Damages:**

The vegetation comprising essentially of mangrove trees is destroyed within the zone of impact.

### **1.5- Information on the Personnel**

#### **1.5.1. - Flight Crew**

The flight crew consisted of a captain and first officer. The accident occurred on the fifth day of a five-day pairing for the two pilots. The flight crew's recent schedule and their recent flight and duty time are shown in tables 1 and 2.

**Table 1**  
**Flight crew's work schedule in the days before the accident (UTC)**

<b>Date D/M/Y</b>	<b>Type of flight</b>	<b>Route</b>	<b>Showtime</b>	<b>Scheduled Departure</b>	<b>Scheduled Arrival</b>	<b>Block</b>	<b>Turn</b>
1/5/07	Line flight	NBO/COO	1030	1130	1640	5:10	
	Line flight	COO/ABJ		1740	1850	1:10	1:00
	Line flight	ABJ/COO		1950	2100	1:10	1:00
2/5/07	Day off						
3/5/07	Deadhead	COO/ABJ	1800	2000	2100		
4/5/07	Line flight	ABJ/DLA	1725	1825	2100	2:35	1:00
	Line flight	DLA/NBO		2200			
5/5/07					0220	4:30	

**Table 2**  
**Flight crew's flight and duty times in the days before the accident (UTC)**

<b>Date D/M/Y</b>	<b>Duty start</b>	<b>Duty End</b>	<b>Duty time</b>	<b>Flight time</b>	<b>Subsequent Rest period</b>
1/5/07	1030	2130	11/00	7:30	44:30
2/5/07	Day off				
3/5/07	1800	2130	3:30	0:00	20:00
4/5/07	1725				
5/5/07		0207*	5:42*	2:45*	N/A

#### **1.5.1.1- The Captain**

Male, 52 years old

Kenyan Commercial Pilot License (CPL) obtained on the 10<sup>th</sup> April 1991.

Kenyan Air Transport Pilot License (ATPL) No. YK-1949-AL.

Medical class 1 valid till 4<sup>th</sup> Nov. 2007.

Type Rating B737-300 obtained on the 12 November 1997

Conversion on B737-700 and 800 variant obtained.

Last proficiency check on type on the 24 February 2007

Other type qualifications: A310-300

Crew Resources Management (CRM) training: 30th November 2005

Professional Experience:

- 8682 flying hours total,
- total as Captain 3464
  - 665 hours and 20 minutes of flying time on B737-700 as Captain
  - 158 hours and 30 minutes of flying time on B737-800 as Captain
  - 160 hours and 46 minutes of flying time within the last 90 days
  - 125 hours and 57 minutes of flying time within the last 60 days
  - 62 hours and 48 minutes of flying time within the last 30 days
  - 4 hours 01 minute of flying time in the last 72 hours
  - 3 hours of flying time in the last 24 hours

On Route and Douala Aerodrome qualification: qualified for area/aerodrome certification on 18<sup>th</sup> November 2006. The Captain had operated severally into Douala with the last flight on April 7<sup>th</sup> 2007

Captain's last 48- Hours History

Post flight rest at Cotonou and Positioning at Abidjan: Arrival at Cotonou on the 1st of May at 2210 local time, after executing flight NBO-COO- ABJ-COO. Departure from COO on the 3rd of May at 2130 as passenger for ABJ. Resumes service at ABJ on the 04th May to effectuate flight KQA507 of 1825.

The Captain is the pilot flying

1.5.1.2- Copilot (First Officer (FO))

Male, 23 years of age

Kenyan Commercial Pilot License (CPL), No. YK-5371-CL obtained in October 2005.

Instruments Flight Rating and International Radio telephony Qualifications valid up to 8th January 2008

Medical class 1 valid up to 5th July 2007

Type rating B737-300 obtained on the 23 September 2006

Type Rating B737-700 obtained on the 15 February 2007

Type Rating B737-800 obtained on the 16 March 2007

Last proficiency check on type on the 13 February 2007

Crew resource management training undertaken on 26<sup>th</sup> November 2006

**Professional Experience:**

- 831 total flying hours
  - 113 hours and 26 minutes of flying time on B737-700
  - 57 hours and 01 minute of flying time on B737-800
  - 188 hours and 10 minutes of flying time within the last 90 days
  - 141 hours and 37 minutes of flying time within the last 60 days
  - 68 hours and 14 minutes of flying time within the last 30 days
  - 4 hours and 01 minute of flying time within the last 72 hours
  - 3 hours of flying time during the last 24 hours.

Qualification on Route and the Douala Aerodrome: Qualified for area/aerodrome certification on 16<sup>th</sup> March 2007. The FO had operated twice into Douala within the last 28 days.

Copilot's last 48 Hours History: Post flight rest at Cotonou and positioning at Abidjan. Arrived at Cotonou on the 1st of May at 2210 local time after executing flight NBO-COO-ABJ-COO. Departure from COO on the 3rd of May at 2130 as passenger for Abidjan. Resumes duty at ABJ on the 4th of May to execute flight KQA507 of 1825

**1.5.2- Cabin Crew:**

Personnel information not relevant to the accident.

**1.5.3. - Accompanying Engineer:** not relevant

Personnel information not relevant to the accident.

**1.5.4. Air Traffic Control Personnel:**

**1.5.4.1- Tower Controller**

Male, 54 years old

Works at the Douala ATS center since 7th July 1980

- Qualification as Aerodrome Controller: since 1982
- Approach Control Rating: since 1982



- Last refresher course (periodicity 6 months): from 26 April to 30 April 2007.

Proficiency in English Language: Underwent training for ICAO Level IV in accordance with ASECNA's procedures.

## **1.6- Information Concerning the Airplane**

The B737-800, serial number 35069 came out of the factory of manufacture in 2006, and was delivered to Singapore Leasing Enterprise. Leased to Kenyan Airways, it was issued the registration "5Y-KYA" by the Kenyan Civil Aviation Authority (KCAA) on the 27<sup>th</sup> of October 2006, and classified in the category of Public Passenger Transport.

On the 10<sup>th</sup> of April 2007, by letter No. EI/M.2./186/2007, Nissen Kauin Kabushiki Kaisha, KO-569-1 Kinoura Hakata-CHO, Imbari-City, Ehime- Prefecture, 794-2305, Japan, contacted KCAA for the transfer of ownership of this airplane to them.

The airplane is mortgaged to the benefit of Standard Chartered Bank.

### **1.6.1- Airplane**

#### **1.6.1.1- Airframe**

Manufacturer	Boeing Aircraft Company
Type	B737-800 (WL)
Serial Number	35069
Boeing Tabulation Number	YL301
Registration	5Y-KYA
Date of Manufacture	2006
Date of Registration	27 October 2006
Utilization since coming into service	2100 hours of flight and 734 cycles
Utilization since last "C" Check	Not applicable
Certificate of Navigability	Valid till 26 October 2007
Last type of maintenance	5A check done at 2002 hours and 700 cycles on 25 <sup>th</sup> April 2007
List of Airworthiness Directives	In conformity as of 05 May 2007
List of modifications	No major nor minor modification

The last programmed maintenance of type "5A" was effectively executed in compliance with approved maintenance program No. KA/B737-700/800/AMS.

The next maintenance check of type "6A" was scheduled at 2502 flight hours.



The “C” check was scheduled at 6000 flight hours or 18 months from the 28<sup>th</sup> of November 2006.

The last list of airworthiness directives was established on the 30<sup>th</sup> April 2007.

#### 1.6.1.2- Engines

	<b>Engine 1</b>	<b>Engine 2</b>
<b>Engine manufacturer</b>	CFM International	CFM International
<b>Type</b>	CFM56-7B26	CFM56-7B26
<b>Serial Number</b>	894251	894252
<b>Date of installation</b>	2006	2006
<b>Total Hours</b>	2100H27	2100H27
<b>Hours since installation</b>	2100H27	2100H27
<b>Cycles since installation</b>	734	734

#### 1.6.1.3- Fuel

Fuel used is “Jet A1”. It is approved by the FAA.

The crew requests 14200 kg of fuel in accordance with the operations flight plan.

The airplane uplifts 9500 kg of fuel at Douala distributed as follows:

<b>Left Tank</b>	<b>Center Tank</b>	<b>Right Tank</b>
1500 kg	6600 kg	1400 kg

The total fuel on Board at the time of departure is 14200 kg; distributed as follows:

<b>Left Tank</b>	<b>Center Tank</b>	<b>Right Tank</b>
3800 kg	6600 kg	3800 kg

#### 1.6.1.4- Technical Malfunctions:

The first flight after the “5A” check was on the 26<sup>th</sup> April 2006 (ATL No. 280482). From that day till the day of the accident, one technical malfunction is recorded in the ATL: “Cockpit door stiff to open when disarmed”. This malfunction is lifted on the 3 May 2007 (ATL No, 288185).

Note: From the 11<sup>th</sup> December 2006 to 27<sup>th</sup> February 2007, there are several entries on the ATL concerning malfunction of AP A. During the following subsequent hangar A checks (4A on 22/03/07 and 5A on 25/04/07) there were no defect entries on autopilot system.

#### 1.6.1.5 - Weight and Balance

MTOW Certified: 79015 kg  
MLW Certified: 66360 kg  
TOW: 69294 kg  
MAC Limits: Between 14 % and 28 % MAC at Take off: 17, 3 %

Total Weight in Cargo compartments: 2751 kg

Compartment 1: 300 kg  
Compartment 2: 1208 kg  
Compartment 3: 1149 kg  
Compartment 4: 94 kg

The calculation of weight and balance were done by KQA ground handling service using a computerized system, and this was manually confirmed using center of gravity charts.

Loading and security of the load entering the aircraft is done by KQA line station.

### **1.6.2- Description of Systems and Elements of the Aircraft Linked with the Accident:**

#### 1.6.2.1 The Boeing 737 Cockpit Displays

In their operations, Kenya Airways utilized three series of the Boeing 737: The Boeing 737 300, 700 and 800 series.

Apart from various system, engine and airframe differences, there was also a difference in the cockpit displays.

The 737-300 has, as primary displays, an Electronic Attitude Director Indicator (EADI) and an Electronic Horizontal Situation Indicator (EHSI) combination. These were projected on two cathode ray tube (CRT) displays.

The 737-700 had a Common Display System, comprising six flat panel Liquid Crystal Display (LCD) display units (DU's). These were configured in the traditional "T-panel" in combination with a partial map display. This was commonly referred to as the EFIS/MAP display format.

The 737-800, has a the same number and type of LCD screens as the 737-700, however these are configured to have a dedicated screen for the primary flight display (PFD) and a separate screen for the navigation display (ND).

Pilots at Kenya Airways, after qualification as per the Kenya Airways policies, were expected to competently fly all three versions of the 737 in their fleet.

The pilots on the accident flight, had been signed off by Kenya Airways instructors, and were cleared to operate any of the Boeing 737's in the Kenya Airways fleet.

For ease of reference, pictorial representations and system descriptions from the relevant chapters of the Boeing 737 flight crew operating manuals have been appended to this report.

#### 1.6.2.2 The Autopilot Flight Director System (AFDS) and the Auto-throttle (A/T) System

##### General Remarks

The Automatic Flight Control System (AFS) comprises of the autopilot and flight director system (AFDS), and the auto throttle (A/T) .The Flight Control Computer (FCC) provides the N1 limits and target N1 for the auto throttles, and command speeds for the A/T and the AFDS.

The different modes are activated by pressure on a pushbutton; the button lights up to indicate that the mode is selected.

Please note that: The lighting up of the pushbutton switch only confirms that the mode is selected. It is the indication on the FMA that confirms engagement.)

Luminous indications on Flight Mode Annunciators (FMA) confirm the status of:

- power control (A/T)
- roll engaged mode (HDG SEL/ VOR)
- pitch engaged mode (TOGA)
- The AFDS according to whether the FD or AP is selected.

**The automatic flight control system as a whole is described in the Boeing Operational Manual, volume 2, chapter 4.**

**The following summary is simply a guide, and as such cannot be considered as a substitute for the contents of the manual.**

##### Mode of Operation of the Flight Management Computers (FMC) During Take-Off:

The AFDS system comprises of 2 flight control computers (FCC A and B), and a Mode Control Panel (MCP).



During operation of the autopilot (AP), the FCC A and B send control signals to their respective hydraulic servo commands for roll and pitch, which then actuate the flight controls through separate hydraulic systems.

During operation of the Flight Director (FD), the FCC A sends steering commands to the command bars of the Captain's Attitude Director Indicator (ADI), and the FCC B does same to the co-pilots' ADI.

When both FD are engaged, the system functions in such a way that only one FCC (called the Master) is in control, and the indications on both the pilot's and co-pilot's ADI are identical.

When the autopilot (AP) is not engaged, the Master FCC is the one that was selected first; that is the case during the take off run.

When the autopilot (AP) is engaged by mode CMD, the Master FMC is the one corresponding to the AP that was engaged first in mode CMD.

### FD displays during Take HDG SEL Mode

The command bars of the FD generally operate with the same steering commands as those of the AP.

However the take-off mode is a flight director only mode.

With the airplane lined up for TO on the runway, and the 2 FD engaged, the mode TOGA is engaged by pressing on a pushbutton.

Depending on the model, pressing on TOGA commands either "maintaining wings level or heading selection (HDG SEL)".

On the airplane 5Y-KYA, the following sequence is engaged:

Before 60 kts

- pitch angle -10 degrees
- Wings level for TO
- A/T in mode N1
- The throttles advance till TO power is obtained
- The FMA displays the indications: N1 and TOGA
- No roll is displayed on the FMA
- FD indication is displayed on the FMA

At 60 kts, the FD commands +15 degrees nose up

At 84 kts the A/T mode annunciates Throttle Hold (THR HLD)

At Lift- Off, the FD commands +15 degrees nose up till a sufficient rate of climb is obtained.

From then the FD commands:

- pitch angle necessary to maintain the MCP speed (normally V2+20 kts).
- wings level attitude.

If in these conditions, without the AP engaged, the HDG SEL pushbutton is pushed in:

- The roll command of the FD maintains HDG SEL.
- HDG SEL indication appears on the FMA which previously displayed no indication of roll
- FD remains displayed on the FMA.

If in the same conditions, the AP is engaged using the CMD pushbutton:

- the roll mode of the AP engages in HDG SEL.
- the indication HDG SEL is displayed on the FMA
- the pitch angle control changes to LVL CHG mode and MCP speed is maintained
- the indication CMD replaces the indication FD on the FMA.

### Engaging the Autopilot (AP):

The AP is engaged by pressing on a pushbutton CMD or CWS, after which the indication CMD or CWS is displayed on the FMA

The AP does not engage if force is exerted on the flight controls.

Only 1 AP can be engaged at a time, except in the approach (APP) mode during landing approach.

When the AP is engaged using CMD mode, the airplane responds to the preselected modes.

When the AP is engaged using the CWS mode, if pressure on the flight controls is removed with a bank angle of less than 6 degrees, the AP rolls back the wings to the horizontal position and maintains the existing heading.

When the AP is engaged using the CMD mode, strong pressure on the flight controls on the roll or pitch axis will engage either the partial roll (R) or pitch (P) mode of the CWS, and the corresponding indications will appear on the FMA.

During F/D only operations while pitch or roll commands are more than ½ scale from centre, pushing a CMD A or B switch engages the A/P in CWS for pitch and/or roll and the related F/D bar(s) retract.

## The Speed Trim System

The Speed trim system is conceived to improve speed stability and the flight characteristics during manual flight when the A/P is not engaged.

The speed trim moves the stabilizer trim position in the direction that will counter undesirable modification of speed.

The speed trim system uses the AP stabilizer trim motor elevator trim even though the AP itself is not engaged.

This system work anytime the AP is not engaged when the necessary action on the stabilizer trim to maintain appropriate speed has not been executed by the pilot.

### **1.6.3 Availability of Transponder, TCAS and EGPWS**

Transponder is available and working

SELCAL code is QS-AB

The airplane is equipped with TCAS and an EGPWS.

The onboard radar is working and is operating on both panels (pilot's and copilot's) at TO.

## **1.7- Meteorological Conditions**

### **1.7.1- General Meteorological Situation**

The day is characterized by the presence of cumulonimbus clouds around the Douala airport. These clouds developed storms from 1500 hours. The meteorological protection file handed to the crew contained the following elements:

- \*wind and temperature charts at various altitudes
- \*weather forecast charts at various altitudes.
- \*TAF and METAR of the aerodromes on route
- \*Forecast for winds, temperature and humidity in Douala and Nairobi up to FL 180.

Special meteorological reports were issued at 2324, 2330, 2342 and 0000 hours.

The pilots received a meteorological protection file before the flight and did not require verbal briefing.

The last weather observation at 2359 was as follows:

- visibility 800 m
- wind calm



- rain and moderate thunder storm
- clouds SCT 300 ft, BKN 1000 ft, CB 1600 ft all sectors,
- tempo visibility 1500m, moderate rain and thunder storm
- temperature 27; Dew point 26
- QNH. 1010

A radar weather observation message is issued every 3 hours; the last two were at 2100 and 0000. A satellite image was available on request.

No wind shear detector (LLWSAS) is available however the Cameroon AIP charts indicate that LLWSAS is available.

It is night time and very dark. The aircraft heading while parked at gate C7 was 118,8°, which is parallel to the heading of the take off runway (RWY12). This allowed the crew to use the airplane onboard weather radar system on the ground prior to start up to monitor the weather cells immediately after take off end of the runway.

## 1.7.2 General Situation and Evolution of the Weather on that Day

### 1.7.2.1 Before the accident

1600: Some cloud clusters are spotted on the satellite picture in the following areas:

- over the gulf of Guinea (SW sector from the station)
- over the SE sector of the station
- east of Yaoundé
- north of Yaoundé

1900: The clusters of clouds on the East and North of Yaoundé regroup into an active mass of clouds imbedded thunderstorms and moving in a SW direction at a speed of 15 kts.

2200: Clusters of clouds can still be observed over the station and at the same time the aforementioned thunderstorms from Yaoundé approaching the station. Radar observation at that time is as follows:

- Radar OBS FKKD 042100Z
  - Nr1 moderate echoes 010-050 degrees, 50-110 km MOV SW 20 kts NC
  - Nr2 weak to moderate grouped echoes, 150-240 degrees 120-300 km STNR NC
  - Nr3 grouped moderate echoes 320-020 degrees, 130-200 km MOV W 15 kts NC.

2230: Thunderstorms with moderate rain, reduced visibility, low ceiling expected over the station according to the trend in the meteorological report.

2324: Moderate thunderstorms and rain are observed over the station, with a visibility of 2500 m, low ceiling (SCT 300 ft, BKN 900 ft, SCT CB 1800ft) and wind 040/4 kts.

2342: Increase in the force of the surface wind is observed (050/10 kts) gusting to a maximum of 20 kts and a decrease of visibility to 800 m.

#### 1.7.2.2: At the Time of the Accident:

0000: An improvement of the meteorological situation is observed. The thunderstorms are observed moving south-South East to South west of Douala Airport leaving the weather improvement at the airport.

#### 1.7.2.3- After the Accident

0030: The improvement of the meteorological situation continues. The visibility increases to 4000 m, and reaches 8 km at 0000 Z on the 5<sup>th</sup>; meanwhile the thunderstorm continues to dissipate.

### 1.8- Navigation Aids

1.8.1- The Douala VOR/DME (112.9 MHz), the ILS DL (110.3 MHz) and all the lightings (runway and taxi ways) are all working.

The NDB YK is not working; a NOTAM was issued to that effect.

### 1.9- Telecommunications

The airplane is equipped with VHF radios; all are working.

The tower control is equipped with VHF radios, frequencies 119,7 and 129,5 MHz; all are working.

All flights have contact with the TWR on 119.7 for start up and departure.

The TWR has telephone and teletype contact with the Principal Meteorological Center.

The TWR has telephone and VHF contact with the airport fire and rescue service.

The TWR has telephone contact with the regional air traffic control center.

The radio telecommunications of the Douala TWR are recorded on tape, including the time of transmission in UTC. The transcript of the communications during the time of flight of KQA507 is attached as Appendix 4 to this report

## **1.10- Information on the Aerodrome**

### **1.10.1- Infrastructure**

The Douala international airport (FKKD), situated at 2.16 NM SSE of the city, is open to public air traffic; it has a runway of QFU: 12/30, and dimensions 2850/45 m, built of composite material.

The level of protection provided by the fire and rescue service is 8 (ICAO).

The reference altitude is 10 m (34 ft).

The coordinates of the reference point are: 04 00.48 N—009 43.35 E.

The reference temperature is 27 degrees C

The runway is equipped with high intensity border lightings (spacing 60 m), and an approach light system.

The landing aids are: a Cat II ILS but operated only in Cat I, an approach light system on runway 30, a PAPI for runway 12, and VOR/DME + NDB.

There exists only one taxi way between the apron and the runway; an airplane must backtrack and turn on the turning pad at the end of the runway.

Flight KQA507 took off from runway 12. For this runway the total TO run distance available (TORA) and take off distance available (TODA), are respectively 2850 m and 2950 m; that for acceleration stop (ASDA) is 2900 m

No inspection of the runway was done after the thunderstorm before the TO of KQA507

### **1.10.2- EDEBA 1E Departure Procedure**

The Douala airport has 02 standard instrument departure procedures (SID) for runway 12. The EDEBA 1E procedure which was the one used by flight KQA507 states: “follow runway heading to VOR/DME DLA, then intercept R-102 via EDEBA intersection up to VOR/DME NLY”.

## **1.11- Flight Data Recorders**

### **1.11.1- Characteristics of the Recorders:**

	<b>CVR</b>	<b>FDR</b>
Brand	Honeywell	Honeywell
Type	CVR 120	SSFDR
Type	980-6022-	980-4700-
Number	001	042
Serial	08675	12657
Number		
Number of parameters	4	1135
Duration of recording	2 hours	25 hours

The CVR records \$ parallel high quality tracks of 30 minutes and two 2 hours tracks consisting of combined radio channels and Cockpit Area Microphone (CAM).

### **1.11.2- Recovery of the Recorders**

The Flight Data Recorder (FDR) was retrieved on Monday 7<sup>th</sup> May 2007. On the 24<sup>th</sup> of May 2007, it was conveyed to the TSB Engineering laboratory in Ottawa (Canada) for analysis and recovery of data. The preliminary analysis took place on the 25<sup>th</sup> and 26<sup>th</sup> of May 2007.

The Cockpit Voice Recorder (CVR) was retrieved on the 15<sup>th</sup> of June 2007 in four separate parts as follows:

- the pinger (underwater locator beacon(ULB));
- the battery
- the motherboard, and;
- the CVR module memory.

Three separate parts (the chassis broke in two parts and the memory module ) were conveyed to the TSB Canada Engineering on the 17<sup>th</sup> of June 2007.

The analysis of the recorders was done by TSB Engineering Canada in the presence of the Members of the Commission of Inquiry, the accredited representatives of the States of Kenya and the USA, the FAA, Kenya Airways and Boeing Aircrafts Corporation.

The reading cable of the FDR having been damaged, another one was installed. The memory of the FDR contained 25 hours of recordings including the period of the accident.

No particular difficulty was encountered during the reading of the 2 recorders.



### 1.11.3 The FDR and CVR produced the following facts concerning this flight:

- Just after lift-off, the airplane has a roll tendency to the right, without any imbalance in the loading, fuel distribution or engines thrust.
- Several inputs of pitch trim for nose up attitude are made during initial climb
- Passing 1000 ft climbing, all action on the flight controls ceases; the airplane goes into a continuous roll to the right. Passing 34° of Bank Angle, action on the flight controls recommences; the bank angle increases up to 115° and then decreases to 60° on impact.
- Having departed with a heading of 118° after TO, from 1000 ft the airplane goes into a continuous turn to the right ending with a heading of 90° on impact.
- The airplane attains a maximum altitude of 2900 ft, and then descends rapidly at a rate that reaches 14000 ft per minute; at impact, it has a speed of 287 kts and a pitch angle of minus 48°.
- The engines run normally
- The flight controls work normally
- After the call "OK COMMAND" made by the Captain, the AP is not engaged
- When the AP "CMD A" push button on the MCP was selected at 2770 ft, the AP worked normally and engaged in CWS mode on both pitch and roll and in addition:
  - action on the control wheel ceases .
  - action on the control wheel recommences and that on the rudder pedals continues
  - the avionics work normally.

The CVR reveals the following information on the flight crew:

- the flight crew is concerned by the meteorological situation and the Captain seeks to reassure the FO.
- the flight crew analyses the meteorological situation using the airplane's radar while still on the apron, and does so again while aligned for TO; they choose a trajectory such as to avoid the storm after TO.
- the call for the reading of the check list, the heading selection, certain technical calls, the engaging of the AP as well as the distribution of tasks on board are not done in accordance with the SOPA; these deviations are not the subject of any briefing.
- after line up, the crew takes off without demanding or obtaining authorization to do so from the aerodrome control.

1.11.4 The data extracted from the FDR and CVR are attached to this report as Appendixes 5 and 4 respectively.

### **1.12- Wreckage and Impact Information**

**1.12.1-** The accident site is of very difficult access and is situated SSE of the Douala International Airport, in a mangrove swamp on the right bank of the Dibamba River. The nearest settlement to the site is called Mbanga Mpongo.

At impact the airplane has a pitch angle of minus 48°, 60° right bank angle and heading 90°. It opens a crater oriented South West/ North East, of a surface area of about 50 m<sup>2</sup> and 5 m deep. The crater is full of murky water.

A significant mass of overturned mud is found on the North West and South West borders of the crater. The vegetation all around is covered with mud up to 30 m away. The trees in the immediate vicinity of the crater are lying down because they were either uprooted or broken. The damage done to the vegetation extends over a surface area of about 2000 m<sup>2</sup>. The North West side of the crater is the most affected.

On crashing, the airplane disintegrated; the debris on the left side of the plane is concentrated in the direction of 30°, and that of the right side in the direction of 90°. The South West and North East sides have negligible amounts of debris.

The content of the airplane (flight deck, cabin and cargo compartment) is found concentrated in the 70° direction as follows: nearest to the crater-economic class (blue seats); next first class (red seats); and finally the front part of the plane.

The detailed plan of the distribution of the significant elements found, as well as aerial photographs of the site and its description are attached to this report as Appendixes 2 and 3.

**1.12.2-** The airplane, the engines, equipments and instruments were not subjected to any particular analysis.

### **1.13- Medical and Pathological information**

**1.13.1-** The remains of the technical crew were not identified.

**1.13.2-** DNA testing was carried out by the International Commission on Missing Person (ICPM) DNA laboratory in Sarajevo, Bosnia.

Eighty six (86) victims were positively identified by DNA with four (4) victims identified by fingerprints.



**1.13.3-** The medical records of the two pilots reveal some ocular problems (refraction problems):

- the Captain suffers of low vision acuity due to myopia, necessitating the constant wearing of corrective lenses.
- the first officer has diminishing visual acuity necessitating the permanent wearing of corrective lenses.

**1.13.4-** There is no indication that physiological factors or incapacity of any sort could hamper the performance of the technical crew.

## **1.14- Fire**

No indication of in flight fire. On impact an instant fireball was observed, which can be attributed to fuel burning.

## **1.15- Survival Aspects**

**1.15.1-** The accident occurred at about 0008 hours on the 5<sup>th</sup> of May 2007. The accident site was located at about 1730 hours the next day the 6<sup>th</sup> of May 2007.

No distress message was received from the crew.

The emergency locator beacon (406 MHz); PN: 453-6501, SN: 05812; did not emit any exploitable signal and was damaged on impact.

**1.15.2-** No survivor was found. The human remains recovered from the accident site were consisted with those of high speed impact.

## **1.16. Tests and Research**

### **1.16.1. Airplane Performance**

Under the authority of the NTSB in her premises in Washington, Boeing made a presentation of the performance of the airplane in September 2007.

#### **A) Simulation of the Accident**

A theoretical model was conceived for the simulation of the accident to:

- a. recreate the events representing the parameters of the FDR;
- b. Understand

- a) the trajectory of the flight (flight path)
- b) the behavior of the airplane according to FDR data
- c) influence of the actions on the flight controls and atmospheric disturbance
- d) the reasons for the actions on the flight controls
- e) the parameters and unrecorded data
  - inference from the actions on the flight controls
  - explore possible scenarios of the accident

It is established that:

- a. the simulation produces a faithful representation of the flight up to the point where the airplane attains 85 degrees bank angle.
- b. The airplane reacted in conformity with the recorded inputs on the flight controls.
- c. There is no indication of a sudden atmospheric phenomenon (winds) affecting the movement of the airplane.

It became necessary to create a slight asymmetry on the roll axis to respect the parameters (+0.0008).

#### B) Lateral Trim of the B737-800

The inclination of the control wheel in order to maintain the wings horizontal can be caused by:

- inherent asymmetry from construction
- thermal effect on the rudder
- the position of the rudder trim

##### Asymmetry from construction

For all its airplane models, Boeing fixes a maximum acceptable deviation of the trim to minimize excessive consumption of fuel due to drag, and to respect the criteria for flight with flaps extended.

##### Thermal Effect on the Rudder

When the plane changes altitude, the attendant change of ambient temperature affects the rudder.

The rudder deflects up to a maximum value of 0.75 degrees:

- a. to the left when the airplane gets colder (climb);
- b. to the right when the airplane gets warmer (descent).

This thermal displacement of the rudder can be read by the DFDR, but there is no return on the rudder pedals nor on the rudder trim.

The only indication for the pilot is a slight deviation of the roll control wheel to maintain the wings horizontal.

#### Position of the Rudder Trim During TO

The table below whose contents are from the DFDR, summarizes the position of the rudder trim at TO during the last 7 flights preceding the accident, and that of the accident (flight No. 8).

Flight No	City of Departure	Position of the rudder trim at TO
<u>1</u>	ABJ	0
<u>2</u>	DLA	0
<u>3</u>	NBO	0.50 R
<u>4</u>	LOS	0.13R
<u>5</u>	NBO	0.13R
<u>6</u>	DLA	0
<u>7</u>	ABJ	0.50
<u>8</u>	DLA	0.13R

#### Lateral Trim data during Flight KQA507

The table below summarizes the facts concerning the lateral trim for flight KQA507, as manifested by the amount of deviation of the roll control wheel from the central position that the pilot had to make in order to maintain the wings horizontal during TO from Douala:

Inherent asymmetry from construction	5-6 degrees of deviation of control wheel
Asymmetry due to Thermal effect on rudder	No thermal effect up to 1000 ft
Asymmetry due to position of rudder trim	2.5 degrees of deviation of control wheel

Consequently, it is established that at TO from Douala, the airplane has a tendency to roll to the right due to the combined effects of the inherent asymmetry from construction and the slightly right positioning of the rudder trim.

To counter this roll tendency, some effort should be exerted to maintain the control wheel turned about 8 degrees to the left.

#### **1.16.2- Human Factors**

##### Research done in Washington

The NTSB made a presentation on Spatial Disorientation in its premises in Washington DC in September 2007 describing the following accidents and incidents:



- accident involving USAir flight 1016 near Charlotte/Douglas International Airport on 2 July 1994
- accident involving Crossair flight 498 near Nasserwil/ZH on 10 January 2000
- incident involving delta Airlines flight 106 near new york, New York on 14 September 2000
- accident involving Gulf Air flight 72 near Muharraq, Bahraih on 23 August 2000
- accident involving Flash Airlines flight 604 near Sharm el Sheikh on 3 january 2004.

From this presentation, the following lessons were highlighted:

- Spatial disorientation is the divergence between the perceived orientation and the actual orientation in relation to the surface of the earth.
- Spatial disorientation:
  - is a normal consequence of the forces related to flying
  - is inevitable in case of the absence, or non-observance of precise visual references
  - may involve illusions in the pitch, roll or yaw axis.
  - is felt by most pilots at one moment or another
  - most often involves illusions of bank.

There exist 3 types of spatial disorientation:

- Type 1 : Non recognized or subtle
- Type 2 : Recognized
- Type 3 : Incapacitating.

### Recovery from Disorientation

It has been estimated that when a pilot is subjected to disorientation in an environnement that lacks external visual references, 10 to 35 seconds may be necessary for the pilot to recover completely from the situation.

### Aggravating Factors to Spatial Disorientation

- Distraction
- The to and fro movement of sight between the interior and exterior of the cockpit
- Flight maneuvers
- Fatigue
- Medical condition

### Research at Pensacola April 2008

Under the authority of the NTSB, the US Navy Medical Research Center at Pensacola Florida, made a complementary presentation on the 3<sup>rd</sup> of April 2008 on spatial disorientation with practical experimentation. This experimentation corroborated the conclusions of the Washington presentation.



### **1.16.3- Flight Simulation**

The commission traveled to Seattle in April 2008 to visualize flight KQA 507 as reconstituted by Boeing in the flight simulator using data from the DFDR.

From this simulation the following facts emerged:

- the tendency of the airplane to roll to the right can easily be controlled by the pilot
- With a bank angle of 34 degrees, the airplane can easily be brought to wings level position with manual piloting, if the crew is not subjected to spatial disorientation
- With the airplane in a bank angle of 50 degrees, when the AP is engaged in mode “roll CWS”, the plane returns to 30 degrees bank angle by itself if no force is applied to the control wheel
- At the moment the airplane attains 50 degrees bank angle, a hard and sustained input to the right rudder pedal would make the nose of the aircraft to drop abruptly.

### **1.17- Organizational and Management Information**

#### **1.17.1- Information concerning Organizations and their Management whose activities could directly or indirectly have had influence in the operation of the airplane**

##### **1.17.1.1 Airplane Operator:**

The following activities were observed within Kenya Airways (KQA), who is the operator of the airplane:

- The commercial flights schedule of KQA had been modified. This modification took effect at the time the flight crew involved in the accident had been sojourning in Cotonou since the 1<sup>st</sup> of May 2007, from where they were scheduled to leave 4 days later for Nairobi as the crew on duty. On the 3<sup>rd</sup> of May, the flight crew was positioned at Abidjan to effectuate flight KQA 507 of the 4<sup>th</sup> of May 2007.
- From its position at stand C7, the flight crew, in the presence of the station manager, studied the meteorological situation on their route using the airplane’s radar.
- The procedure for engaging the AP as stated in the SOPA gives room for interpretations:  
According to the “Boeing B737 OPS Manual”, after TO, the AP is engaged after raising the flaps. The SOPA on the other hand prescribes the engaging of the AP as follows: “When above minimum altitude for AP”, without any other guidelines. From the declarations of Captains and Instructors interviewed on the subject, some of them state that the AP should be engaged after 3000 ft, during or after accelerating to raise the flaps; while others say that there is no minimum altitude,

or that this altitude, which was formerly 1000 ft, was lowered to 400 ft. (ref B737-700/800 FCOM Vol 1 Limitations Section).

- The requirement for 3 months of experience and 150 flying hours on the basic airplane (B-737-300), before advancing to the B 737-800 variant, as laid down in part D of the Flight Manual was not respected in the case of the First Officer. However it was established that a subsequent amendment of the applicable manual to remove this requirement was effected in February 2007. There is no other requirement in Part A which affected the status of the FO.
- The Operator had on several occasions introduced demands to KCAA for a waiver concerning the up-grade of First Officers to the B737-700/800, who had not yet attained the required experience as prescribed in part A and D of the Flight Manual;
- The Captain had been sanctioned and underwent a line re-training and proficiency check three years earlier. The check had been ordered because of the Captain's decision to initiate a diversion due to a standby ADI failure during a scheduled passenger flight. Management had considered that the diversion demonstrated a lack of understanding following failure of airplane systems and the redundancies that are designed into the system.
- Since successfully checking out as Captain on B737, KQA instructors and examiners have written several reports about him, making mention of several recurrent shortcomings, notably concerning: crew resource management (CRM), knowledge of systems, respect of SOP, cockpit scan and situation awareness, planning and decision making. These reports have each been treated individually with corresponding remedial recommendations made in each case.
- According to KQA management, the overall performance of the Captain is judged to be below the standard average, but "acceptable". The grading system used by KQA consists of 4 levels: "not acceptable"- "acceptable"- "standard" – "above standard".

A Line Proficiency Check (LPC) of the Captain done on the 1<sup>st</sup> August 2006 cited deficiencies in several areas. A consequent reply from the Manager of Product training stated: "A review of the entire training program will be carried out to see if complacency or incompetence is the issue".

The Captain's record contained a note from the manager of product training, dated 10 August 2006, which stated, "Reference your last LPC report of 1st August 2006 where we discussed your shortcomings. You will be given another check in three months." The Captain underwent another line check on 18 November 2006, which he passed. There is no evidence of any retraining or punitive action taken against him.

- Since checking out as Captain, he has been maintained on the 737.

#### 1.17.1.2- Air Traffic Management

The organization responsible for the management of air traffic is "L'Agence pour la Sécurité de la Navigation Aérienne en Afrique et Madagascar" (ASECNA), or (The Agency for Air Navigation Safety in Africa and Madagascar).

The following findings were made:

- The controller on duty uses the French language to transmit information concerning deteriorating meteorological conditions to flight RAM 287.
- The controller did not communicate the SPECI of 2342 to the flight crews; he did communicate it to RAM 287 at 2359 at the latter's request in French.
- The controller was not troubled by the state of the runway and the possible contamination of the whole terminal maneuvering area after the heavy rain that had fallen on the aerodrome.
- The air traffic controllers are not licensed but have certificates issued by ASECNA.

#### 1.17.1.3 Management of Airport Services and Ground Assistance

The management of airport terminal and ground handling is under the responsibility of "Aéroports du Cameroun" (ADC).

The following findings were made:

##### a) Aerodrome Services

No inspection of the runway was done to ascertain the absence of contamination on all maneuvering areas after the heavy rains that had just fallen on the station.

##### b) Ground Assistance

- The agreement, by which the ground handling service had been sub-contracted by ADC to the air transport company "Cameroon Airlines" (Camair), had just been terminated. ADC therefore had to provide that service by itself in Douala.
- ADC has the monopoly of ground handling services at the Douala terminal.
- ADC has not received any certification from the Cameroon Civil Aviation Authority for the exercise of such services.
- ADC made use of a Camair employee acting strictly on private basis to position the airplane on its arrival from Abidjan.
- ADC allows KQA to execute by itself, certain already contracted technical tasks like luggage security check, loading and offloading of the airplane, weight and balance, and boarding of passengers.

#### 1.17.1.4- Meteorological Services

Meteorological assistance to air navigation at the Douala airport is provided by ASECNA through The Principal Meteorological Center (PMC). The following findings were made:



- The meteorological radar in Douala is operational, and it is used to produce weather observation messages like METAR and SPECI;
- The PMC keeps in store information that is available to flight crews and operators on request.
- The PMC made no verbal briefing to the ADC agent when the latter signed out the meteorological protection file for KQA.

#### 1.17.1.5 The Airplane Manufacturer

The manufacturer of the airplane is the Boeing Aircraft Company. The following finding was made:

- Rudder trim modification due to thermal variations during climb and descent, are not sufficiently explained to pilots during their training.

#### 1.17.1.6 The Certification and licensing Authority

##### **KCAA**

The KCAA is the certification authority for the air transport company KQA..

- The KCAA issued AOC n° 20 to KQA on 27<sup>th</sup> November 2006 that expired ending November 2006; This AOC was renewed. The report of the inspection concerning this renewal was not available in the company file at KCAA.
- A waiver is granted to KQA concerning the utilization of FOs who do not fulfill the conditions of Parts A and D of the OPS Manual as concerns minimum experience required to flight on B737-700/800 NG variants. There is no proof that any pertinent studies were conducted to justify these waivers.
- KCAA failed to point out that KQA did not take into account the different appreciations of the captain and copilot during their evaluations by the company flight instructors;

##### **FAA**

The FAA is the certification authority of the type of aircraft.

Rudder trim modification due to thermal variations during climb and descent, are not sufficiently explained to pilots during their training.

Simulated test carried out at Boeing have confirmed that with the AP engaged in CWS roll at bank angles of up to 50 degrees, the airplane will roll back to 30 degrees angle of bank. This information should have been made available to pilots through the Boeing manuals.



The CCAA is the certification authority for aerodromes, airport terminals, ground handling services, and air navigation services. It is also the authority that issues licenses for air traffic controllers. It ensures that the administration in charge of meteorology certifies and insures continuous oversight of organizations responsible for providing meteorological assistance to air navigation.

a) Certification of aerodrome service providers:

CCAA did not ensure that:

- the limits of responsibilities between the airport ground handling service provider and the air traffic service provider, especially as concerns the maneuvering areas, are covered by any agreement or protocol.
- the management of the airport acts in conformity with the rule concerning the system of inspection of the runway after heavy rainfall

b) Certification of ground handling and airport terminal service provider.

The CCAA accepted that ADC should take up the responsibility of the supply of these services without ensuring that the latter possessed the necessary know-how to handle them with the required safety standards.

### 1.17.2 Career Evolution.

#### 1.17.2.1 The Captain

A significant number of documented records during his training for upgrade to captain, highlight recurrent performance deficiencies notably in: CRM, adherence to standard procedures, cockpit scan and situation awareness; these remarks are confirmed by similar reports made during his flight check-out as captain and also during his 5 years of duties in that capacity.

In 2002 in particular, a progress report during his training as captain underscores on the one hand, a satisfactory performance in aircraft handling, and on the other hand an over-bearing tendency towards his colleagues, a touch of arrogance and insufficient flight discipline, notably as concerns cockpit scan and situation awareness. This report also recommended the need for continuous monitoring of these character traits.

Summary of Captain's annual proficiency checks from 2002 to 2007:

- In November 2002, a route training assessment was converted to a training flight because the captain demonstrated inadequate knowledge of procedures and airplane systems, including FMA, AFDS and fuel management.

- In August 2003 the captain was urged during a recurrent training session to be more attentive to checks and aircraft limitations, be more systematic in responding to system failures, provide more consistent briefings and adhere to SOPs
- In February 2004, the captain was urged during a recurrent simulator training session to take time to analyze failures and discuss them with the FO.
- In July 2004, the captain underwent route proficiency training and check because of his decision to initiate a diversion due to an STANDBY ADI failure was judged to be an indication of “lack of understanding following airplane systems and redundancies that are designed into the systems”.
- In July 2005 a line proficiency check cited deficiencies in the captain’s familiarity with airplane systems and SOPs, command ability, and team work. It also stated that he was “overbearing”.
- In August 2006 an annual line check was judged to be below standard for a captain, leading to another check on the 18<sup>th</sup> of November 2006
- The captain’s last examination was an operations’ proficiency check conducted on 24<sup>th</sup> February 2007, which he passed. The report on this examination contained no examiner comments.

The Captain had been sanctioned and underwent a line re-training and proficiency check three years earlier. The check had been ordered because of the Captain's decision to initiate a diversion due to a standby ADI failure during a scheduled passenger flight. Management had considered that the diversion demonstrated a lack of understanding following failure of airplane systems and the redundancies that are designed into the system.

Since successfully checking out as Captain on B737, KQA instructors and examiners have written several reports about him, making mention of several recurrent shortcomings, notably concerning: crew resource management (CRM), knowledge of systems, respect of SOP, cockpit scan and situation awareness, planning and decision making. These reports have each been treated individually, with corresponding remedial recommendations made in each case.

#### 1.17.2.2 The FO

The FO was trained in South Africa where he obtained a CPL with twin engine and instrument rating qualifications.

His file at KCAA reveals that his first IFR test of 17<sup>th</sup> September 2005 had been unsatisfactory and he had to repeat it.

In like manner his radiotelephony test of 11<sup>th</sup> August 2003 had been unsatisfactory and he had to retake it.

Initial reports during his training as first officer make mention of the need to improve in certain areas, namely: situation awareness, R/T, to closely monitor and call out deviations of pilot flying, to monitor the AP when it is engaged, to be fast in flight deck preparation and to less tense in order to execute flight procedures properly. However his overall performance during training and flight checks was judged to be satisfactory.

During one of his last proficiency checks early 2007, the examiner confirms a satisfactory performance globally, but enjoins the following recommendations:

- monitor the deviations of pilot flying and call them out;
- monitor the performance of the AP when it is engaged.

There is no evidence that the FO did effectively undergo a CRM training for which he had been programmed in September 2006.

Type Rating on the B-737 300 and conversion on the B-737 700/800

The FO was hired by Kenya Airways on the 6<sup>th</sup> of June 2006 with a total of 557 flying hours, of which 300 were on the DHC 6-300.

On the 28<sup>th</sup> of July 2006 he obtained his type rating on the B737-300.

On the 15<sup>th</sup> of February 2007 he completed a line check on the B737-700

On the 16<sup>th</sup> of March 2007 he successfully checked out as FO on the B737-800.

## **1.18 Additional Information**

### **1.18.1 DFDR**

The DFDR is easily found on the surface uncovered by debris with slight external damages with the underwater locator beacon units detached.

### **1.18.2 CVR**

It is located at the impact crater filled with rain and raising sea/river water. A CVR pinger is used to locate the recorder from the water filled crater. Local men were hired to drain the crater using diesel water pumps. First the recorder mother board is found, search intensifies at the area the board is found, and then found next is the battery pack, then the underwater locator beacon and finally the CVR memory module.

The delay in recovering the module is because all the units of the recorder separated. This is attributed by two reasons namely:-

- Location of the recorder, i.e. aft cargo compartment The ULB missing caused the search for CVR using the Acoustic Pinger Receiver to be difficult as signals were being received from both (i.e. DFDR and CVR) ULB beacons. This made mapping of the CVR ULB location inside the crater to be difficult.
- The other reason which attributed to the delay was a logistical problem as the ULB tester initially available with the investigators could only be used on land and but not when the ULD was submerged in water. As a result, a CVR search

had to wait for an Acoustic Pinger Receiver from Boeing, USA. Shipment of the unit took some days to be delivered to the investigators





## **2 ANALYSES**

### **2.1 General**

Flight KQA 507 left Abidjan to Nairobi with a scheduled one hour stop in Douala. The scheduled departure from Douala was 2200. Departure was delayed for approximately one hour due to weather and eventually took off at 2306. The aircraft was serviceable for the flight. At the time of departure there was rain and some thunderstorms in the vicinity of the airport. On lift off there was a perceptible tendency of the aircraft to roll to the right, which was easily corrected by the pilot flying through a left aileron input which stopped at 1000 feet. The aircraft started a slow uncommanded roll to the right which was not checked by the crew. Control inputs resumed at 2700ft and 34 degrees of right bank. The pilot's inputs were erratic, leading to excessive bank angle and a rapid loss of height. The aircraft crashed after a spiral dive and was completely destroyed killing all on board.

### **2.2 Flight Operations**

#### **2.2.1 Crew Qualifications**

The Captain is up to date with his qualifications as concerns the flight executed.

The FO is type rated on the B 737-800; before 12 February 2007, he does not fulfill the conditions of experience for line flying on type as laid down in KQA Operational Manual Part D, i.e. 150 flight hours and 3 months of experience. A request for a waiver was filed with KCAA to that effect, together with a revision to the manual with an effective date of 12 February 2007. The FO was therefore appropriately qualified as per existing requirement.

The Captain is quite experienced as concerns the route and the Douala airport. This was the third flight on the route for the FO; he was therefore qualified in his capacity.

#### **2.2.2 Operational Procedures**

A number of Operational Procedures listed in the company's Operational Manual, were deviated from by the crew:

##### **2.2.2.1 Briefing before Departure and Check List Calls**

In the face of rather disquieting meteorological conditions, a special briefing on the weather was necessary before take off.

The "before taxi check list" was called by the Captain but the "before take-off" check list was initiated by the FO, the pilot monitoring without the call by the captain.

#### 2.2.2.2. Radio communications

Before start up, the Captain uses the call sign KQA504 instead of KQA507 according to the revised schedule. After a quarter of an hour, the confusion is clarified by the aerodrome controller.

After that, all communications with ATC are done by the FO, up to the point when he reads back that he will call back for take off authorization. Just before TO, the Captain intervenes in the communications to request a modification of the departure clearance, because of prevailing meteorological conditions on route. Then the airplane takes off without requesting or obtaining the TO clearance.

This intervention of communication by the captain may have affected the FOs flow of radio communication, and may have eventually led to aircraft taking off without TO clearance.

#### 2.2.2.3 Engaging of the Autopilot

The procedure for engaging the autopilot inscribed in the SOPA is less precise than that prescribed by Boeing in its “B 737 OPS manual”; it leaves room to diverse interpretations by flight crews as to when the autopilot can be engaged. This was confirmed in interviews with company’s Boeing 737 flight instructors. Besides that the procedure in use at time of accident recommends that the pilot flying do the engaging, and that the other pilot confirm the FMA indication.

When the Captain made the call “command”, the FO made no response because, either because he (a) did not hear the captain’s callout, (b) heard the captain’s callout but did not crosscheck the FMA, or (c) heard the captain’s callout and saw no changes in the FMA but chose not to inform the captain he, or because SOPA did not make verbal confirmation mandatory.

The SOPA’s deviations from the procedure recommended by Boeing, the lack of a require confirmatory announcement by the pilot monitoring, and the lack of standardization among flight crews with respect to the application of this procedure engendered confusion in the effective engaging of the autopilot. The confusion was further accentuated during the accident flight by the coming into action of the speed trim due to deteriorating manual piloting.

#### 2.2.2.4 Technical Calls

No technical call out was heard from the FO while there were variations of pitch from +15° to +8°, of speed from 150 kts to 200kts, and roll increasing beyond 25 degrees right.

As stated in the OPS Manual (part A), any voluntary deviation from standard procedure must be preceded by a briefing, except when it is justified by the need for immediate action for a safety reason.



Just one single announcement by the FO of the variations on the FMA, or of the excessively changing flight parameters, would have jolted the pilot flying unto an awareness of the deteriorating situation long before the Bank Angle warning alarm sounded.

## **2.2.3 The Piloting of the Airplane**

2.2.3.1 From lift-off up to about 1000 feet, the Captain controls the tendency of the airplane to roll to the right without any difficulty. He calls “HDG SEL”, and it is confirmed by the FO “SELECT CHECK”. The responses “CHECK” by the FO is an indication that the Captain performed the actual heading selection himself in accordance with SOPA procedures at the time of the accident. Then all action on the flight controls ceases for 55 seconds.

- During the first 18 seconds of this time period, the flight crew’s attention may have focused on the weather radar to avoid thunderstorms. The autopilot is not engaged, and the airplane is not manually piloted; in the absence of corrective action through the flight controls, the airplane rolls to the right, and the heading increases by itself, and more so in a direction that corresponds to the desired deviation from the route by the crew. Deviations of pitch and speed become excessive, but there is no call from the FO who is the pilot monitoring, and who limits his action to making heading selections on the HDG SEL to sort of accompany the aforementioned uncontrolled variations of the airplane’s heading.
- Then the Captain calls “OK CMD” to engage the AP; he then behaves as though the AP is effectively engaged, something which is neither confirmed by an announcement by the FO, nor by the FMA, nor by the behavior of the airplane itself. On the other hand, the automatic activation of the speed trim following excessive increase of speed could contribute to sustain his false impression of the AP being engaged.
- There is no evidence why the AP didn’t engage but the DFDR data indicates a slight control column pressure as “OK Command” call is made by the Captain. There is a possibility that the selection was made but the pressure on the column interfered with engagement of the autopilot. It should also be recalled that the AP “CMD A” had suffered recurrent breakdowns for a period of three months prior to this flight.
- The FO continues to effectuate heading selections on the HDG SEL which have no effect on the behavior of the airplane; he makes no announcement to the Captain concerning deviations on the FD roll command bar.
- The two pilots execute the change of altimeter setting without noticing or interpreting the deteriorating flight parameters, which are clearly visible on the EADI, on which, incidentally, they are reading the altimeter setting.

The behavior of the flight crew during these 55 seconds demonstrates a lack of rigor in piloting, non-respect of the repartition of tasks on board, confusion in the use of the AFDS, and poor situation awareness.

2.2.3.2 As the airplane's right bank slowly increases, the captain appears unaware of the airplane's changing attitude. As the bank angle increases beyond 35 degrees right, the captain utters an expression of surprise and the Bank Angle warning alarm sounds. The captain resumes control activity and suddenly turns the roll wheel first to the right, aggravating the bank angle. The AP "CMD A" is selected most likely by the Captain, and the AP engages in CWS roll and LVL CHG without a call. Confused movements of the control wheel diminish during 5 seconds, and the bank angle stabilizes at 50 degrees.

The Captain is not apprehending the rate of correction by the AP in mode CMD, and resumes his confused movements of the flight controls, forcing the AP to switch to mode CWS Pitch. These inputs are mostly to the right on both the roll wheel and the rudder, which accordingly aggravates the situation. Since he does not apprehend the reactions of the airplane, he thinks he has lost control of the airplane and cries out "we are crashing"; the FO confirms "Right, yeah, we are crashing, right"; the Captain then aggravates the situation further notably by a prolonged input of right rudder.

The bank angle reaches 90 degrees to the right and is increasing further, the pitch decreases suddenly and the airplane enters into a spiral dive. The FO tells the Captain to level the wings by the right, then quickly corrects himself and says with insistence "Left, Left, Left Captain".

The FDR indicates conflicting actions on the flight controls at this moment, with the captain applying right wheel and nose up column while the FO counters with left wheel and nose down column. The FO's action is corrective while the captain's action is aggravating, but the situation is already beyond redemption.

The reaction of the captain indicates a case of spatial disorientation (non recognized or subtle type), resulting from a long slow turn without monitoring of the EADI, with no exterior visual reference in a dark night transitioning to a case of recognized spatial disorientation as the airplane's right bank angle increased beyond 35 degrees.

The Captain's conduct of the flight where he occasionally intervenes in the copilot's flow of duties coupled with the poor weather conditions may have eventually led to the copilot lagging behind the aircraft. He was therefore unable to perceive that the virtually uncontrolled flying is due to the captain's confusion; he consequently agrees that the aircraft is out of control.

The consequences of the disorientation are further aggravated by poor repartition of tasks on board and non-application of the recovery procedure as stated in the company QRH approved by KCAA.



The procedures call for the following:

• <i>Recognize and confirm the situation</i>	• <i>On noticing the excessive right bank angle the pilot flying exclaimed and then proceeded to apply a right wheel thereby increasing the bank angle</i>
• <i>Disconnect autopilot and autothrottle</i>	• <i>Autopilot was engaged when the bank angle was beyond 45 degrees.</i> • <i>Autothrottle was not disconnected</i>
• <i>Roll in shortest direction to wings level</i>	• <i>Application of elevator with bank angle in excess of 90 degrees.</i>
• <i>Recover to level flight</i> ○ <i>Apply nose up elevator</i> ○ <i>Apply nose up trim if required</i> ○ <i>Adjust thrust and drag as required</i>	• <i>Sustained application of right rudder during the upset.</i>
<i>The pilot monitoring is supposed to call out any deviations and any omissions throughout the recovery.</i>	<i>The pilot monitoring did not call any deviations until very late into the upset</i>

*There is a warning stating: **EXCESSIVE USE OF PITCH TRIM OR RUDDER MAY AGGRAVATE AN UPSET SITUATION OR MAY RESULT IN LOSS OF CONTROL AND/OR STRUCTURAL LOADS.***

It is clear that the crew did not properly assess and respond to the upset as stipulated in the procedures. The circumstances surrounding this flight suggest reasons for failure to recover from the upset would be either lack of training and/or lack of situational awareness due to spatial disorientation

#### 2.2.4 Meteorology

The prevailing meteorological situation in the vicinity of the aerodrome is characterized by thunderstorms. On that day, apart from the messages of regular meteorological observation, the PMC of the Douala Airport also did issue messages of special local meteorological observations at: 2324; 2330; 2342; and at 0000. These messages were all transmitted to the TWR.

In spite this prevailing situation and the messages received from PMC, the aerodrome controller only transmitted the special observation of 2342 in response to a request from RAM at 2359, and more so, in French. This last special report was therefore not formally brought to the knowledge of KQA507.

The crew receives a meteorological protection file on board their airplane, but does not request a verbal briefing. Company procedures did not call for a verbal briefing but expected the crew to study the meteorological documents before departure. They proceeded to start up 33 minutes after the reception of start up data. This start up was cancelled because of heavy

rainfall on the station. A new start up is made using data received 1 hour and 40 minutes earlier.

However the crew is preoccupied by the prevailing meteorological situation; they make use of the aircraft's radar to analyze the meteorological situation on their route while still on the apron, and even while taxiing before TO. Aligned on the runway before TO, again using the aircraft's radar, they take time to choose an avoidance trajectory after being airborne.

The crew therefore took off in full awareness of the prevailing meteorological situation at the aerodrome and on the initial section of their route. From available weather data however it is clear that the weather had improved sufficiently for a safe departure of the aircraft and met the prescribed company and airport departure minimums.

### **2.2.5 Aerodrome Services**

The controller advises the crew to taxi to stand C7, while the airplane is awaited by the KQA line station staff at stand C5. This lack of coordination is due to the inexistence of defined procedures for the management of traffic on the apron, or the absence of an appropriate coordination agreement between the operator of the aerodrome and the supplier of air navigation services at the airport.

In addition, no information was given by the operator of the aerodrome to the air traffic control concerning the level of contamination of the airport maneuvering areas after a heavy downpour. The controller limits himself to announcing "runway wet" to flight crews whenever he notices that rain has fallen on the runway. Whereas the operations manual of the ATS center prescribes that an inspection of the runway be done after heavy rain, and to advise flight crews not to take off if the thickness of the water on the runway surface is more than 1.25 cm.

No information on the state of the runway was given to the crew.

### **2.2.6 Ground Handling Service**

The ADC Company has the monopoly of supply of ground handling services at the Douala. ADC used an employee of Cameroon Airlines acting in his own private capacity to park the airplane on its arrival from Abidjan. Besides that, loading of the aircraft is executed by KQA line station staff.

ADC allows airlines to accomplish by themselves certain already contracted tasks.

### **2.2.7 Air traffic Services**

The controller did not broadcast the special weathers report as required. Secondly, on the request of RAM 287 in French, he in like manner transmitted the information in French.

## 2.2.8 Oversight

### 2.2.8.1 Oversight of Kenya Airways

A waiver for requirement for utilization of FOs had been introduced by KQA to satisfy operational demands. These waivers were systematically granted without adequate study on its safety implication.

The system described in Operations manual part D para 2.3.9 which addresses handling weak pilots appears robust enough but its application on the Captain's performance was not aggressive enough. As a result of poor implementation, the Captain remained at the acceptable level although his weaknesses were regularly reported by KQA examiners.

KCAA should have identified the problem during oversight inspections and directed appropriate corrections.

KCAA should have capitalized on the conclusions of KQA examiners to ask for corrective action in the follow up of technical flight crews.

Factors influencing the inability of KCAA to conduct effective oversight of KQA operations were determined to be lack of regular inspections and of personnel qualified to oversee operations of an operator such as KQA.

### 2.2.8.2. Oversight of Aerodrome Services and Ground Assistance

Despite the pertinent regulatory provisions, some loopholes were apparent as concerns certain organs in charge of aviation safety at the Douala airport, notably:

- the absence of coordination between the operator of the aerodrome and the supplier of air navigation services in the management of the maneuvering areas;
- information of flight crews concerning poor meteorological conditions;
- absence of runway water level measuring equipment ;
- non respect of contractual clauses concerning ground assistance.

This state of affairs portrays inefficiency of the CCAA in the oversight of safety in this aerodrome due to the lack of sufficient qualified personnel for inspections.

### 2.2.8.3 Oversight of Air Traffic Services

Despite the pertinent regulatory provisions, some loopholes were apparent as concerns Air traffic services notably

- the absence of the controller's licenses;
- the absence of the certification of English language proficiency;

This inefficiency of the CCAA in the oversight of Air traffic services is due to the lack of certification procedures and qualified personnel.



## **2.3 The Airplane**

### **2.3.1 Maintenance of the Airplane**

Maintenance records show that the airplane was equipped in conformity with the Kenyan civil aviation regulations, and that maintenance was carried out in conformity with the KCAA approved maintenance program.

### **2.3.2 Weight and Balance**

The weight and balance were within the prescribed limits.

### **2.3.3 Systems and Airframe**

There is no indication of any of the airplane's system malfunction, nor a failure in the airframe structure before the accident.

It is noteworthy that some differences existed between b737-700 and b737-800 flight instrument displays, as the pilots were flying the -700 and -800 concurrently as one variant, these differences could have affected the interpretation of information during instrument scan. It is also significant that the position of the autopilot command (CMD) indication in the -700 was different from that in the -800.

### **2.3.4 Airplane Performance**

The airplane's performances during take off and initial climb are in conformity with the FAA approved manufacturer's performance data.

## **2.4 Human Factors**

### **2.4.1 Training**

#### **2.4.1.1 The Captain**

The Captain exercised duties as FO on the B737-300 from 1997 to 1999. During his assessment flight of 8-10 November 2002 prior to his initial B737-300 command check, the check pilot considered the assessment unsatisfactory because of poor knowledge of systems including the AP, and insufficient monitoring of the FMA. His initial B737-300 command check on 20 November 2002 was inconclusive, calling for a second flight o, 21 November 2002 where he passed. A final command check by a different check pilot was conducted on 25 November which he passed.

A study of the pilot's training for B737-300 command indicates a slow progress but finally passing the checkout for command.



His training reports make mention of recurring difficulties in CRM, adherence to standard procedures and cockpit scanning.

Some of these proficiency checks were unsatisfactory requiring retraining before another check.

In February 2007, the Captain did his last operations proficiency check, which he passed.

In February 2007, the Captain did a last operations proficiency check, which he passed.

The analysis of flight KQA507 in paragraphs 2.2.2 and 2.2.3 above reveals the following deficiencies that are of about the same nature as those highlighted during his various flight checks:

- no briefing
- interference in the task of ground air communications on the apron and before take-off
- non adherence to SOP's in: engaging the AP, check list calls, repartition of tasks
- poor cockpit scanning
- poor situation awareness
- poor reaction in the face of an abnormal situation.

#### 2.4.1.2 The FO

The FO was trained in South Africa where he obtained a CPL with instrument and multi-engine rating. He failed his initial instrument rating flight test conducted by KCAA, but was successful on the second attempt. The same thing happened in his radiotelephony test.

During his training for type rating qualification for the B737-300, he did equally receive instruction on crew coordination as prescribed in the KQA operations manual (part D).

Different progress reports during his line training on the B737 reveal certain recurrent shortcomings as expressed by the instructors, notably:

- Should closely monitor and call out deviations of pilot flying; equally monitor when AP engaged.
- Situation awareness and radiotelephony still need to be improved on.
- Lagging behind aircraft during approaches; got disorientated during approach. He needs to practice incapacitations to boost confidence.

The analysis of flight KQ507, paragraphs 2.2.2 and 2.2.3 above reveal the following shortcomings similar to the ones made in his progress reports

- Failed to request authorization for TO clearance
- Did not call out the deteriorating flight parameters
- No reaction after the call "OK CMD" during the engaging of the AP

### **2.4.1.3 CRM Training**

The Captain underwent CRM training courses; however various proficiency checks reveal in a recurrent manner, that he had difficulty in crew coordination. The analysis of flight KQ507 reveals that he hardly associated the FO in decision-making.

The FO underwent CRM training course on 25-26<sup>th</sup> September 2006 but during flight KQA507 does not participate in the monitoring of the piloting.

In the light of these facts, the two pilots did not function as a team.

## **2.5 Organization of KQA**

The control of KQA operations is adequately organized: there is a safety program, a quality control program and an operations manual approved by KCAA.

Line proficiency checks are executed in a regular manner as stipulated in the operations manual and the results are kept on record.

As concerns the crew of flight KQA507, the results of these checks were recorded without any leniency and appropriate recommendations made.

In the light of these successive recommendations, which are by the way, largely confirmed by the findings of this investigation, the management of KQA should have taken the necessary measures to avoid pairing up this type of crew.

## **2.6 Medical and Psychological Aspects**

### **2.6.1 Medical Aspects**

Not relevant for analysis.

### **2.6.2 Psychological Aspects**

#### **2.6.2.1 The Captain**

The Captain has a strong character and a heightened ego, authoritative and domineering on subordinates which sometimes manifest itself as excessive confidence and a touch of arrogance. However his colleagues considered him friendly.

He seems to have been affected by the slow progress of his career and the fact that he had remained on the 737.

During flight KQA507 he put up a paternalistic attitude towards his FO.

#### 2.6.2.2 The FO

The FO is by nature reserved, and from testimonies and various checks he underwent he was not assertive.

During flight KQA507, he seems to be intimidated by the meteorological situation to the point that the Captain feels the need to reassure him thus: he gently and wittingly calls on him (the FO) to put on his wipers in order to see clearly during taxi; he again admonishes him to wait until line up on the runway before scrutinizing his radar screen; and finally he doles out some words of encouragement to him. His message to the cabin crew just before TO confirms his anxiety concerning the prevailing stormy weather.

He appears subdued by the strong personality of his Captain. After TO, he does not call out the clearly visible and important lapses of piloting, and seems to completely place his confidence with the Captain.



### 3- CONCLUSIONS

#### 3.1 Established Facts

The following facts were established from the investigation:

1. It is night- time.
2. The airplane had a valid C of A; no malfunction is recorded in the ATL.
3. The FDR indicates the aircraft and engines were operating normally.
4. Some differences existed between B737-700 and B737-800 flight instrument displays.
5. The weight and balance are within prescribed limits.
6. The crew had valid licenses and all other required qualifications.
7. Medical factors had no influence on the flight
8. The crew had been adequately rested.
9. Adequate safety oversight capacity was lacking.
10. There was a steep authority gradient in the cockpit.
11. The crew took off in full awareness of the prevailing meteorological condition on the station and the initial leg of their route.
12. The Principal Meteorological Center at Douala Airport issued Special weather reports covering the departure period for KQA507.
13. Air Traffic Control did not broadcast these special weather reports to KQA507
14. Air Traffic Control used the French language to transmit a SPECI to another carrier following a request that was also done in French by the subject carrier.
15. The captain is the pilot flying; he doesn't adhere to SOPs; does no cockpit-scan, has poor situation awareness and reacted inappropriately in the face of the abnormal situation.
16. The airplane took off without authorization from air traffic control.
17. The airplane has a tendency to roll to the right from lift off; this tendency is easily brought under control by the pilot up to 1000 ft.
18. At 1000 feet climbing, the pilot flying releases the flight controls for 55 seconds without having engaged the AP.
19. The AP is not effectively engaged when the Captain announces "OK COMMAND".
20. The aircraft speed trim comes into action automatically when speed variation between actual and commanded becomes excessive.
21. The FO is by nature a reserved person and does not call out the lapses in piloting.
22. There were shortcomings in the way the crew worked as a team.
23. The bank angle of the airplane increases continuously by itself very slowly up to 34 degrees right and the captain appears unaware of the airplane's changing attitude.
24. Just before the "Bank Angle" warning sounds, the Captain grabs the controls, appears confused about the attitude of the airplane, and makes corrections in a erratic manner increasing the bank angle to 50 degrees right;
25. At about 50 degrees bank angle, the AP is engaged and the inclination tends to stabilize; then movements of the flight controls by the pilot resume and the bank



- angle increases towards 70 degrees right. The Captain states “We are crashing” and the FO confirms.
26. A prolonged right rudder input brings the bank angle to beyond 90 degrees. The airplane descends in spiral dive.
  27. The FO calls out to the Captain to level the wings by the right, then quickly correct himself and says with insistence “Left, Left, Left captain”..
  28. The bank angle is reduced to 70 degrees and the airplane hits the ground.
  29. No information is given to the crew concerning the state of the runway.
  30. The supplier of ground handling services allowed KQA line station staff to perform some already contracted tasks.
  31. A waiver granted for the utilization of technical flight personnel with a request for the modification of the operations’ manual in part D was submitted
  32. The results of flight checks for technical flight personnel are reported without any complacency, but are not sufficiently exploited by the operator.
  33. The ELT broke up on impact and therefore no useful signal was emitted to assist in locating the airplane after the accident.
  34. Information to crews was missing on the rolling tendency of the airplane during climb and descent and the elements that induce it including:
    - a. Rudder thermal effect
    - b. Manufacturing asymmetry
  35. Full information in the capability of the Autopilot CWS roll mode including ability to roll the airplane from bank angles of 50 degrees and above back to 30 degrees bank is not explained in the Boeing flight manual.
  36. The shortcomings highlighted in the investigation of this flight, are among those reported during previous flight checks for the two pilots.
  37. Even though visibility is adequate, it is dark night with mangrove swamps and no cultural lights or other night visible cues off the takeoff end of the runway. This results in no external visual references outside the windshield after takeoff, which is one of the necessary factors for spatial disorientation.

### **3.2 Probable Causes**

The airplane crashed after loss of control by the crew as a result of spatial disorientation (non recognized or subtle type transitioning to recognized spatial disorientation), after a long slow roll, during which no instrument scanning was done, and in the absence of external visual references in a dark night.

Inadequate operational control, lack of crew coordination, coupled with the non-adherence to procedures of flight monitoring, confusion in the utilization of the AP, have also contributed to cause this situation.

## **4 SAFETY RECOMMENDATIONS**

### **4.1 Oversight of Operators**

The investigation has brought to light the need for rigor in:

- The putting into practice of the accident prevention system for an air carrier; and
- The continuous oversight that the civil aviation administration exercises over aviation operators, who are often, better equipped thanks to international commercial partnerships.

That is why the commission of inquiry recommends that:

- 1- KCAA and all State Administrations that issue licenses for aviation operations should ensure that they harness the necessary structures and means to approve and follow up amendments and revisions of manuals.
- 2- KCAA and all State Administrations that issue licenses for aviation operations, ensure that companies put in place an organization that enhance the application of manuals, and decision making in matters of safety especially as concerns technical flight crews.

### **4.2 Training**

It is strongly recommended that all flight crew receive formalized upset recovery training.

## APPENDIX 1

**PlanePicture.net**

1 2 3 4 5





## APPENDIX 2

**Aerial photo of crash site**





# APPENDIX 3

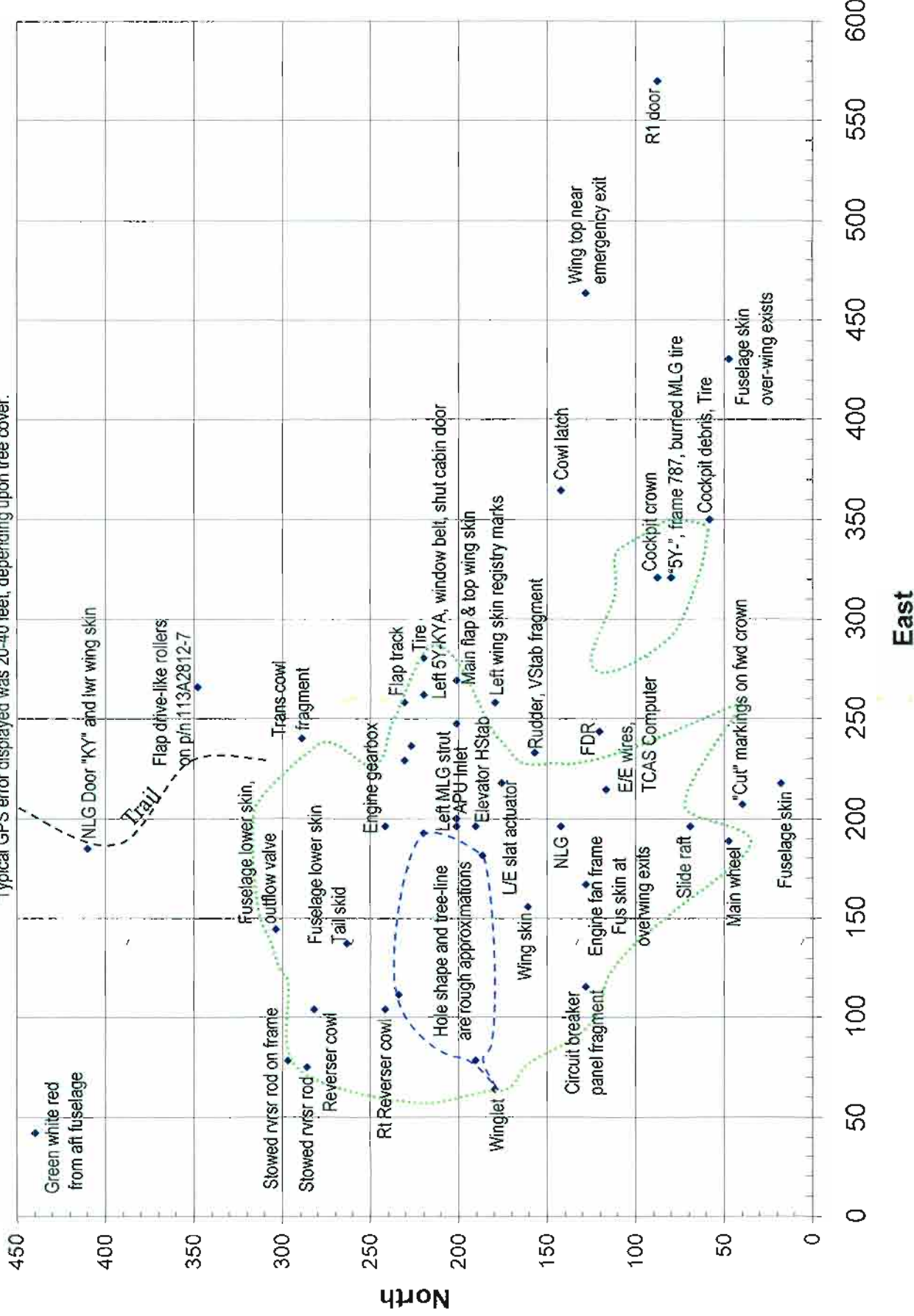
**KA507 Debris Coordinates**



**KA507 Debris Coordinates**  
In approximate feet from an arbitrary reference point  
(Using 3.666 ft = .00001 degree)

Revision of 17 May 2007

Typical GPS error displayed was 20-40 feet, depending upon tree cover.





## APPENDIX 4

**KenyaAirways\_b737\_CVR**

SPEAKER	TC	FDR UTC	FLIGHT CREW CONVERSATIONS [start of 30 minute recording]	RADIO COMMUNICATIONS
Comment	0:00:00			
Comment	0:19:19.9	#VALEUR!	[Start of Recording]	
P1	0:19:28.2		Starting one	One is clear
Grd Eng				
P1			Start one	
P1	0:19:34.8		Valve open	
P2			Open	
P1			{and did you see that oil pressure}	
P2			{Yes I have seen it}	
P2			N(two) Rotation	
P2	0:19:45.2		*** percent, N ***rotation, *** percent, Fuel flow , EGT	
P2	0:20:02.		Oil pressure ... fifty, two, four, starter cut out, start valve closed, (cutback), thirty eight seconds	
P1			OK flaps five	
P2	0:20:19.7		Five selected	
P2	0:20:32		**forward ... *left right	
P1	0:20:43		We have had two good engines	
Grd Eng	0:20:47		OK Blocks at what time	
P1	0:20:49		What do you want	
Grd Eng	0:20:51		I don't know. I don't have a watch with me	
P1	0:20:51.5		Hey ?	I don't have a watch with me
Grd Eng	0:20:54			
P1	0:20:56.8		So we say five five?	OK five five
Grd Eng	0:20:57.2			
P1	0:21:00		OK go ahead	
FA	0:21:02		I have 106 passengers on board. Ship's papers on board. All doors locked and armed. All passengers seated and ready for departure.	
P1	0:21:12		Ok four hours and thirty seven thousand, lots of turbulence out there if you don't go above cloud. OK go ahead.	
P2	0:21:30		OK Before taxi check. Generators ON, Probe heat ON, Anti-ice OFF, Isolation valve AUTO. Engine start switches CONTINUOUS. Recall checked, Autobrake RTO. Engine start levers	
P1	0:21:37.6		IDLE Detent.	
P2	0:21:38.5		Flight Controls	
P1	0:21:38.8		Checked	
P2	0:21:39.9		Ground Equipment	
P1	0:21:40		Removed	
P2	0:21:41		OK clear on the right. Before taxi checks complete.	

SPEAKER	TC	FDR UTC	FLIGHT CREW CONVERSATIONS	RADIO COMMUNICATIONS
P1	0:21:44		{OK} Request taxi clearance	
P2	0:21:46			Kenya 507 request taxi
P2	0:21:55			Tower Kenya 507
P2	0:21:58			Standby
P2	0:22:00		Standby	
P1	0:22:07.7		{this thing is moving}	
P2	0:22:08		{Yes}	
P1	0:22:16.5		{there is no way here}	
Tower	0:22:17.7			Kenya 507
P2	0:22:19.4			507 request taxi clearance
Tower	0:22:24.6			Taxi runway 12 backtrack
P2	0:22:27.3			Taxi runway 12 backtrack Kenya 507
P1	0:22:29.8		Alright ***	
P2	0:22:30		Right is clear	
P2	0:22:57			Kenya 507 we have 106 passengers, eight crew, 0545 fuel endurance
P1	0:23:09		Put on your wiper {man}	
P1	0:23:13.9		[sound - wipers]	
P1	0:23:16.8		you're struggling to look {and you got} wipers.	
P1	0:23:20.7		{Leave it alone} Leave him alone ***	
P2	0:23:25.9		OK	
P1	0:23:44.6		Clear left	
P2	0:23:45		Right is clear	
P1	0:23:53		Yes thank you	
P1	0:24:00		*** (sound of laugh)	
Tower	0:24:03.2			Kenya 507, after take-off runway 12 EDEBA 1E departure you are cleared level three seven zero clearance limit DEREP level three seven zero to JOMO Kenyatta
P2	0:24:20		{did he say three seven zero}	
P2	0:24:23.7			Cleared, after departure runway 12 cleared to Nairobi flight level three seven zero EDEBA 1E departure Kenya 507
Tower	0:24:34.9			Correct, call ready
P2	0:24:37.2			Call you ready next 507
P1	0:25:00		{wait first}	
P2			***	
P1	0:25:09		No, I mean {wait till we line up}	
P2	0:25:13.5		OK things usually happen in a hurry, that's why	
P1	0:25:15.9		(laugh) OK you're keeping up with it eh! ?	
P2	0:25:18.9		Yes I'm trying to keep up	
P1	0:25:28		First here we look at it.	
P2	0:25:29		OK	



SPEAKER	TC	FDR UTC	FLIGHT CREW CONVERSATIONS	RADIO COMMUNICATIONS
P1	0:25:30		We see the best way to {go through}	
P2	0:25:30.5		{OK}	
P2	0:25:39		Final Checks?	
P1	0:25:40		Yup	
FA	0:25:53.1		[Cabin announcement ]	
P2	0:26:21		I go to weather?	
P1	0:26:23		***	
P2	0:26:36.5		Before take-off checks Flaps	
P1	0:26:38.7		five indicated green light	
P2			stabilizer trim	
P1			we have six point ... ?	
P2			six point four *** six point four three	
P1	00:26:56		OK	
P2	0:26:56.3		Before take-off checks complete	
FA	0:27:01.6		Secure for departure	
FA	0:27:03.2		[laughing]	
P1			Why are you laughing?	
FA	0:27:06.6		It's nothing to do with this Swahili *** cabin secure for departure	
P1	0:27:15.9			And ahh tower from Kenya five-zero-seven, after departure we would like to maintain ahh slightly left of runway heading due weather ahead,
P2	0:27:27.5		Right	ahh sorry slightly right
P1	0:27:27.8			Approved
TWR	0:27:31.1			
	0:27:32.7		Right	
	0:27:33.4		OK, all done	
P2	0:27:39.7			[PA announcement] Ladies and gentlemen from the flight deck, your first officer, here is a kind reminder please ensure that your safety belt are well fastened for takeoff please your safety belts are well fastened for takeoff, attention cabin crew your seats
	0:28:03.7		Stable, N1, TOGA	
P2	0:28:15.7		OK takeoff thrust is set speed building on both	
P1	0:28:18.3		check	
P2	0:28:19.2		eighty knots throttle hold	
P1	0:28:21.2		Check	
AWS	0:28:30.0		[V1 auto call]	
P2	0:28:30.8		V1	
P2	0:28:33.2		Rotate	
P1	0:28:37.6		Gear up	
P2	0:28:38.5		OK	

SPEAKER	TC	FDR UTC	FLIGHT CREW CONVERSATIONS	RADIO COMMUNICATIONS
Comment	0:28:46.4		[sound of gear retraction]	
Comment	0:28:38.6		[First of multiple bursts of trim]	
P2	0:29:02.4		thousand feet	
P1	0:29:03.6		Heading select	
P2	0:29:05.0		Selected check	
P1	0:29:06.1		I will (keep) somewhere around here	
P2	0:29:07.7		All right	
P2	0:29:18.1	23:41:39.8	N1	
P1	0:29:19.1	23:41:40.8	OK command	
P2	0:29:22.4	23:41:44.1	I remain on legs?	
P1	0:29:23.7	23:41:45.4	Yup	
P2	0:29:36.2	23:41:57.9	***	
P2	0:29:36.8	23:41:58.5	Standard	
P1	0:29:38.1	23:41:59.8	Check	
P2	0:29:38.9	23:42:00.6	Two-four climbing	
P1	0:29:40.5	23:42:02.2	Checks	
P1	0:29:43.1	23:42:04.8	Now we are getting into it	
P2	0:29:44.8	23:07:06.5	OK	
P2	0:29:46.8	23:07:08.5	I continue with the heading	
P1	0:29:49.5	23:07:11.2	{Through here is OK isnt it}	
P2	0:29:51.3	23:07:13.0	OK	
P1	0:29:55.5	23:07:17.2	{Exclamation}	
AWS	0:29:56.3	23:07:18.0	[Bank angle Bank angle] Auto call out	
P1	0:30:06.0		We are crashing	
P2	0:30:06.7		Right, yeah we are crashing, right	
P2	0:30:10.0		Right captain, ... Left, Left, Left ... correction Left, ### ***	
Comment	0:30:19.3		[Sound of warning tone\buzzer]	

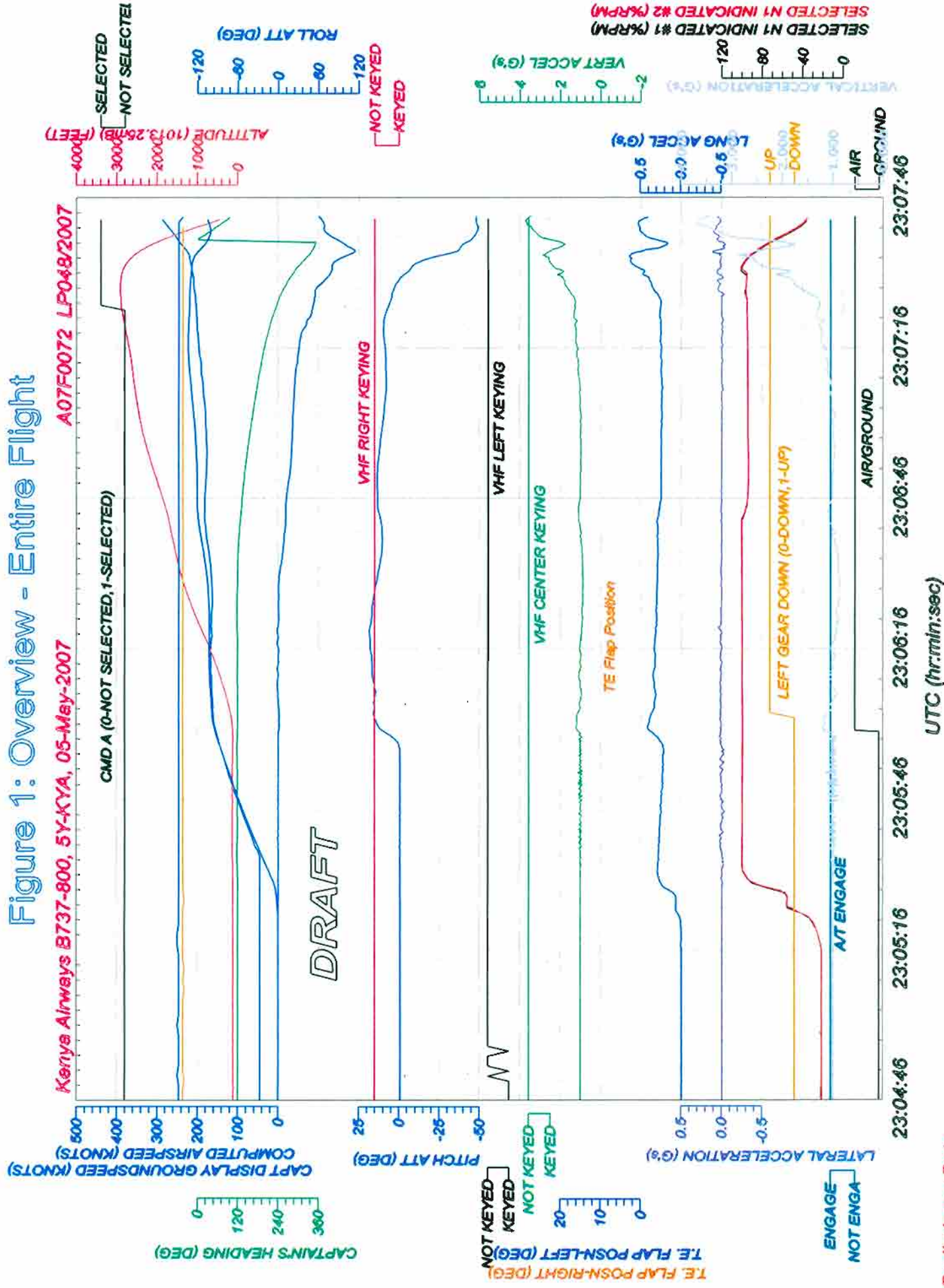
# APPENDIX 5

TSB Plots KEN 5Y-KYA

Figure 1: Overview - Entire Flight

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007





# Figure 2: Hydraulics

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007

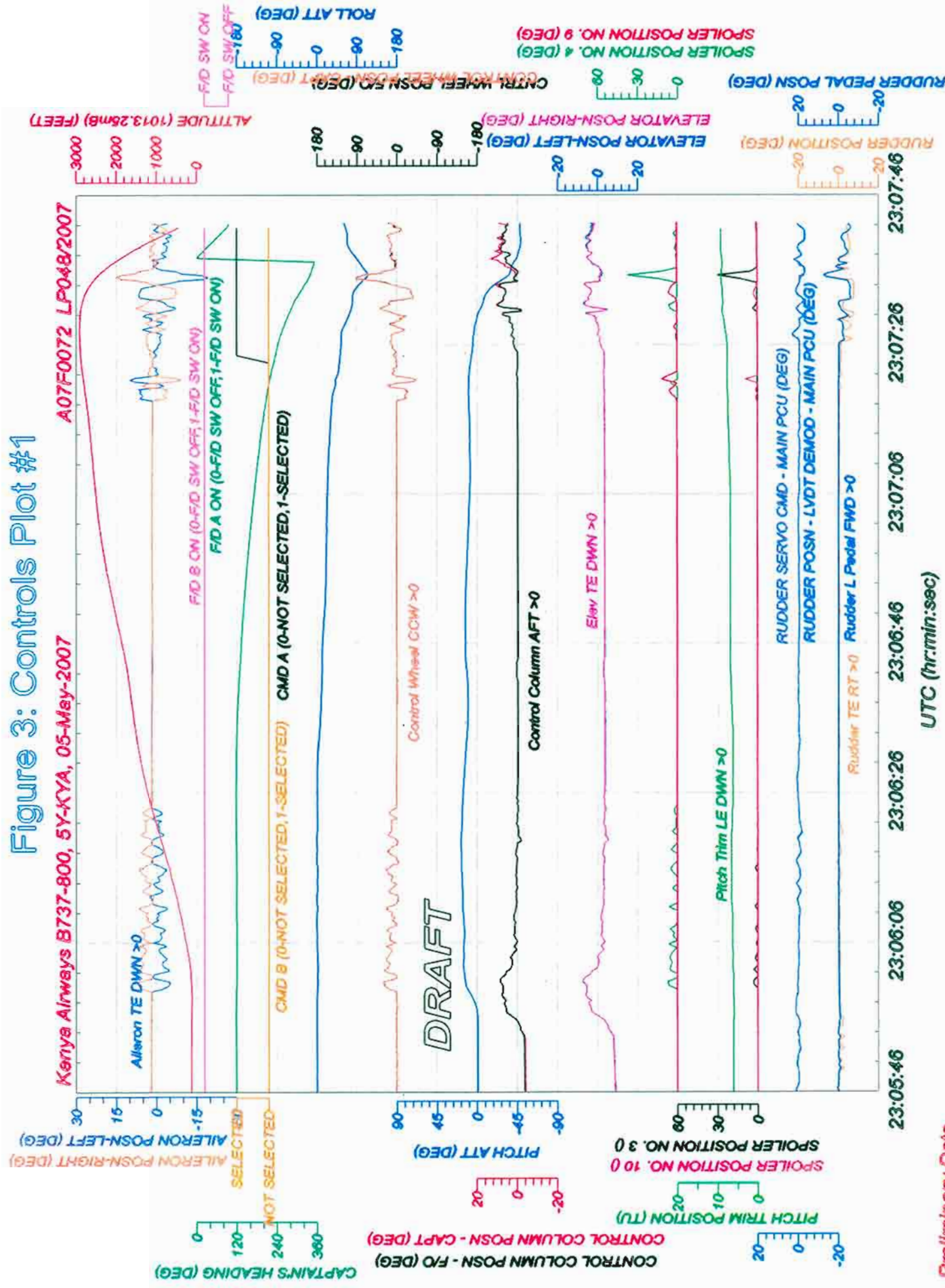


UTC (hr:min:sec)

# Figure 3: Controls Plot #1

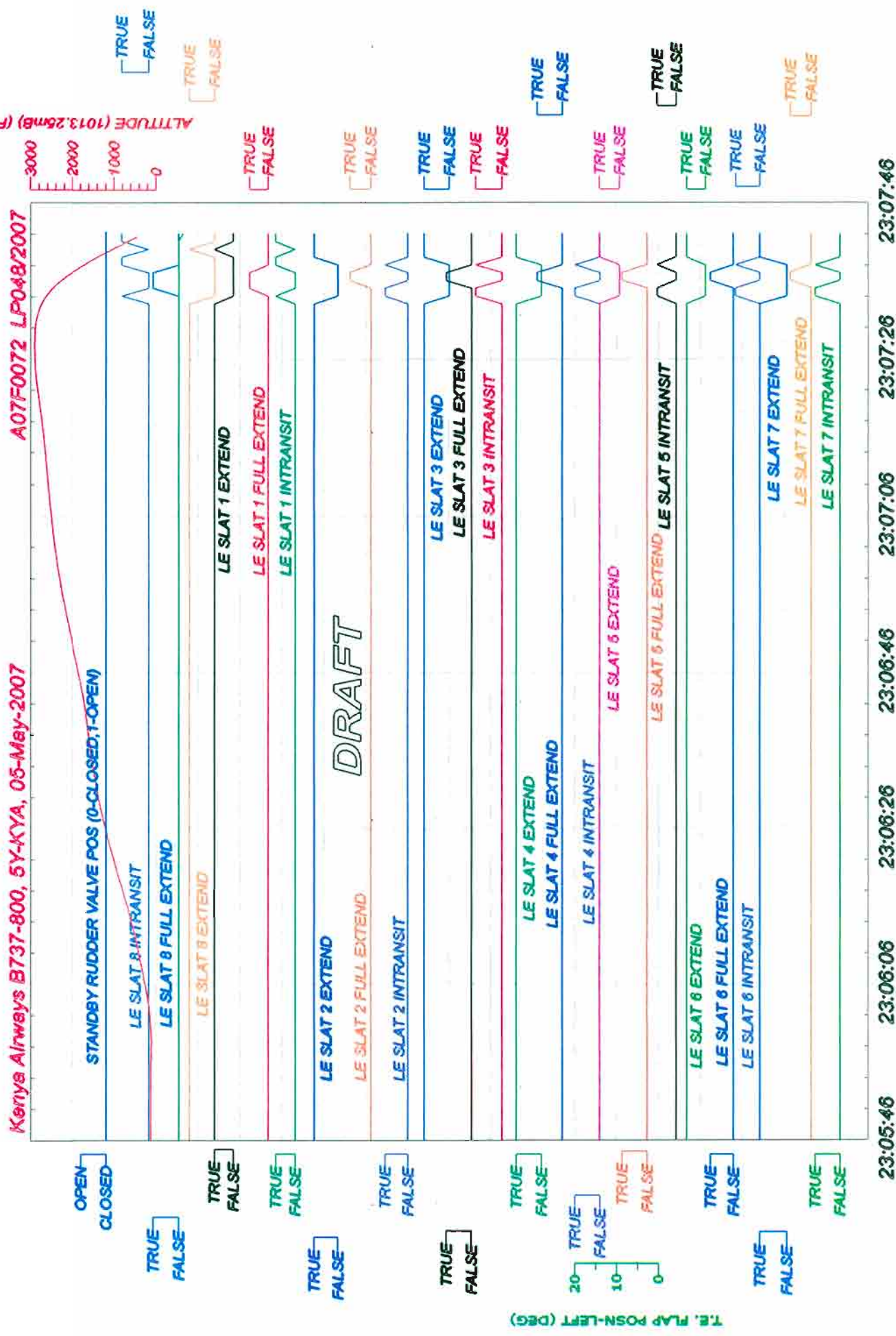
Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007





**Kenya Always B737-800, 5Y-KYA, 05-May-2007 A07F0072 LP0482007**



Recorders & Vehicle Performance Division - TBSC

# Figure 5: Fuel

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007

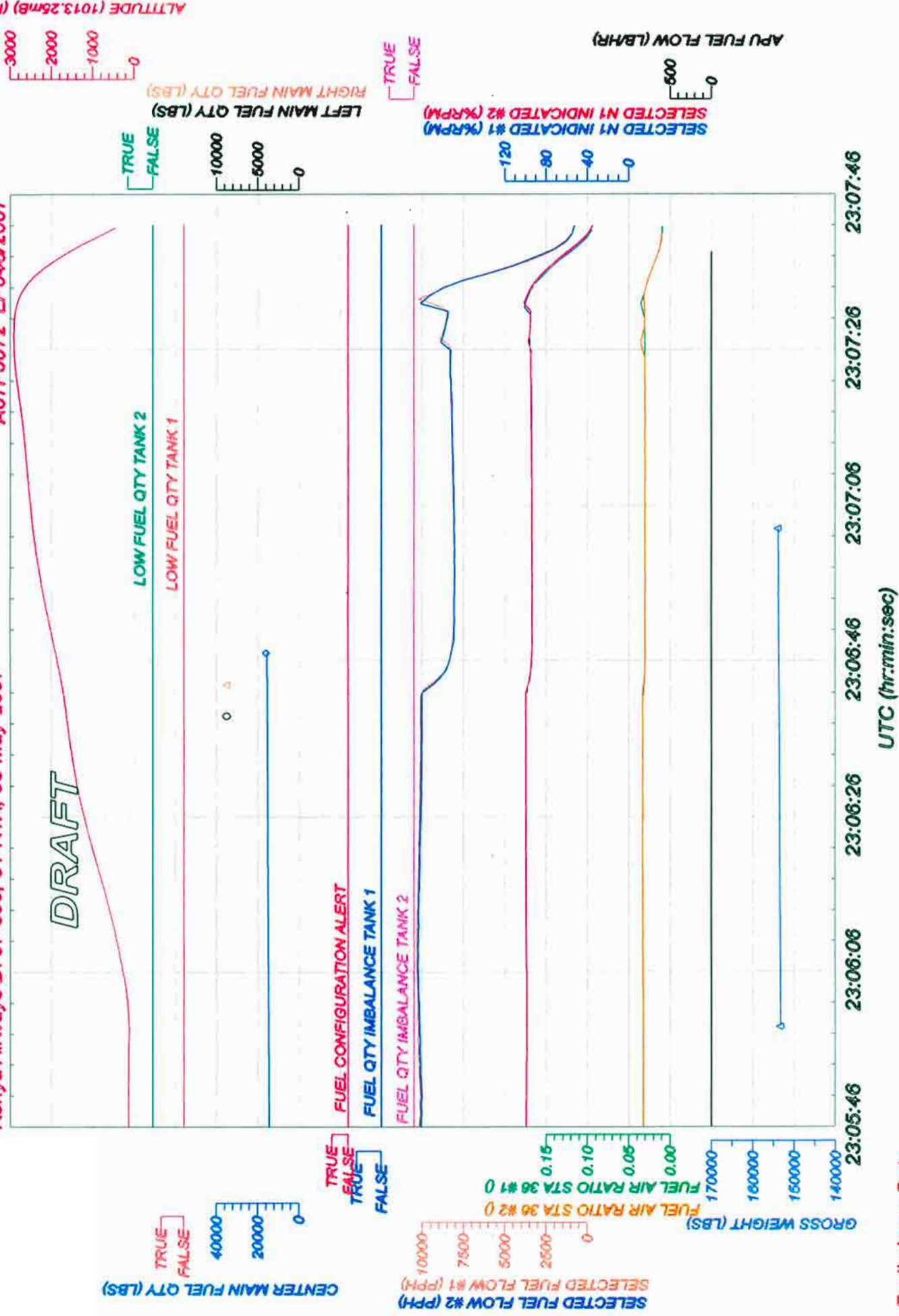




Figure 6: Engines #1

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007

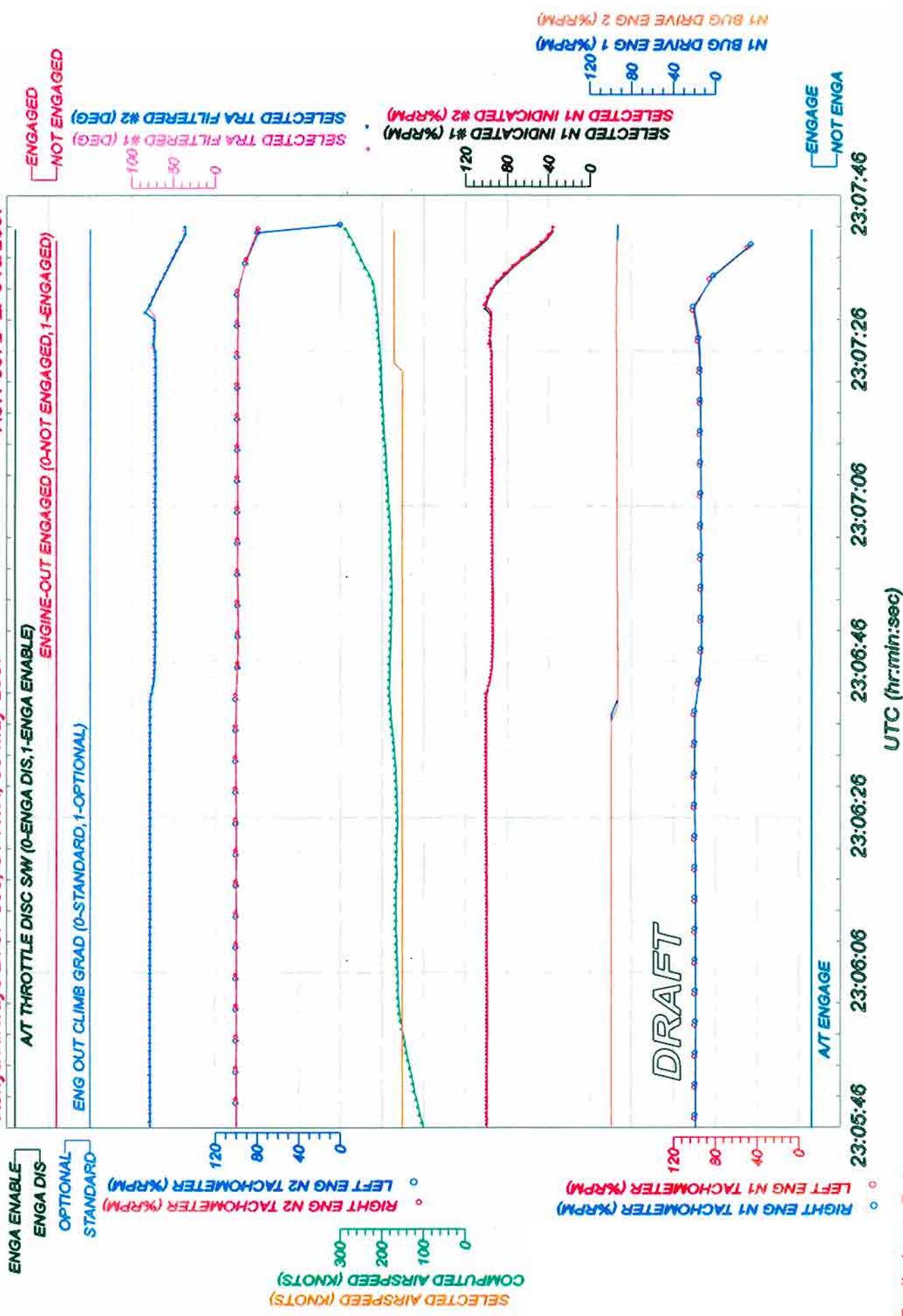


Figure 7: Engines #2

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007

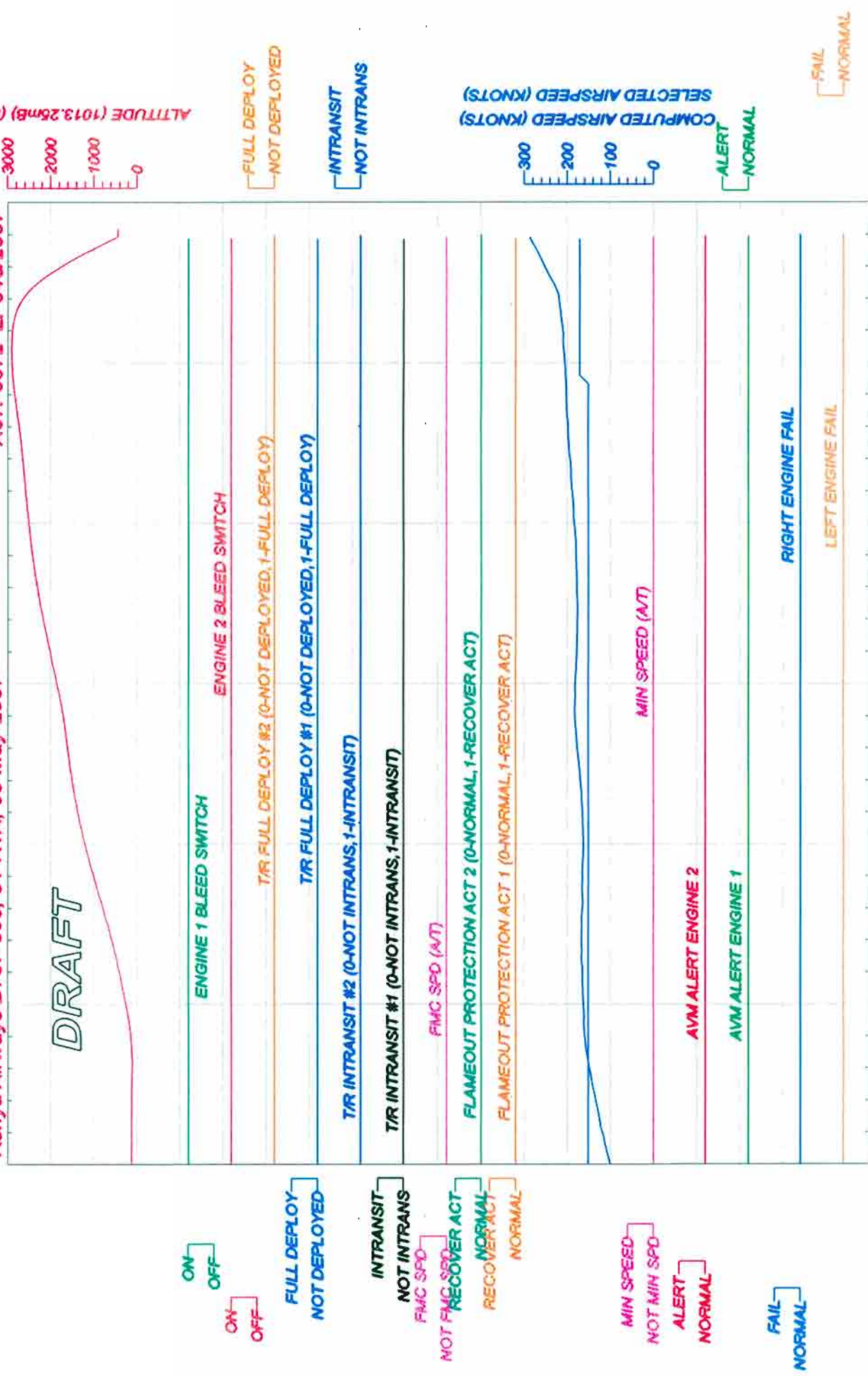
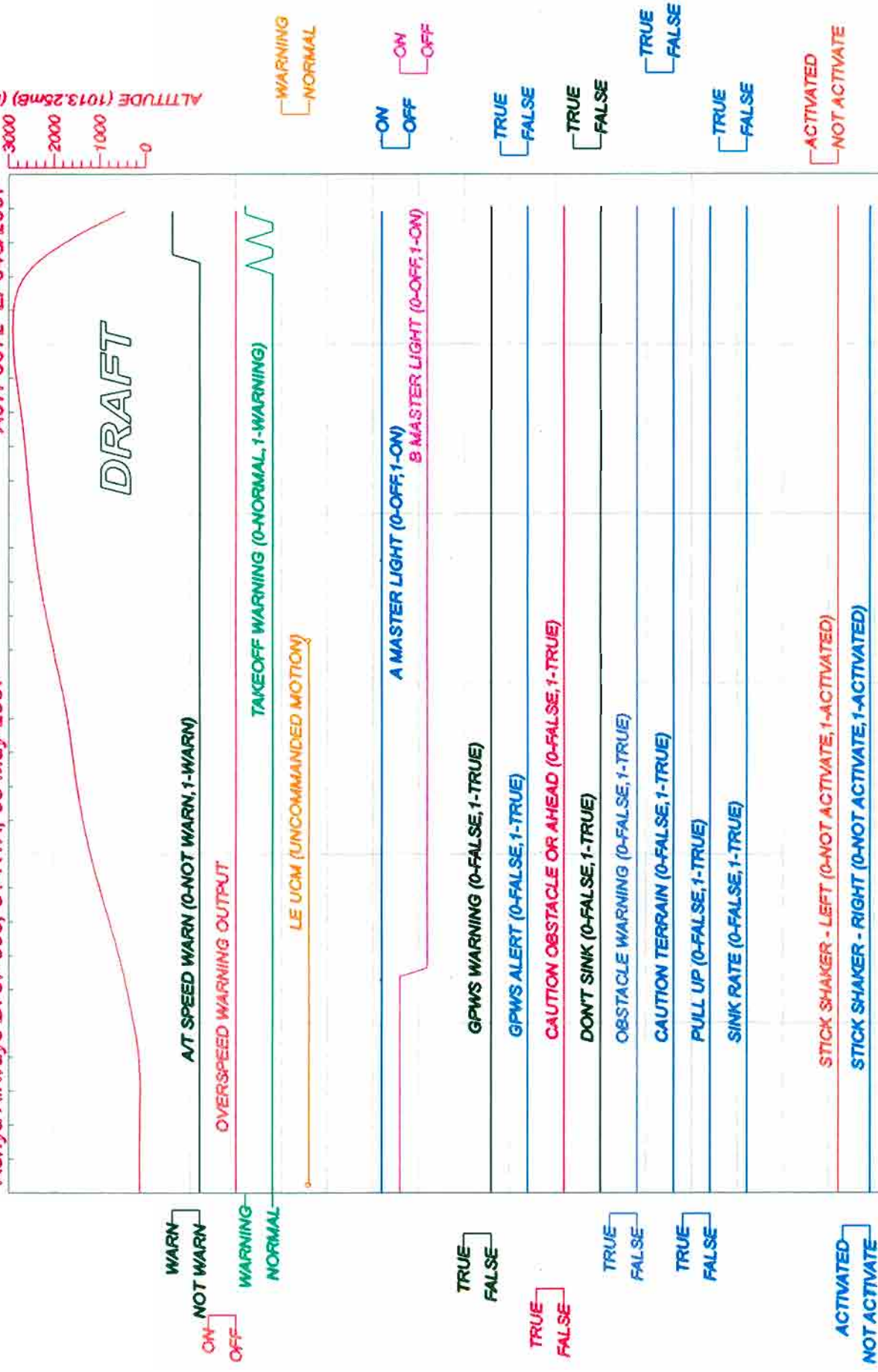


Figure 8: Discretes #1

**Kenya Airways B737-800, 5Y-KYA, 05-May-2007**

A07F0072 LP048/2007



23:05:46

23:08:08

23:06:26

23:06:46

23:07:06

23:07:26

23:07:46

UTC (hr:min:sec)

Preliminary Data  
Revised: 25 May, 2007

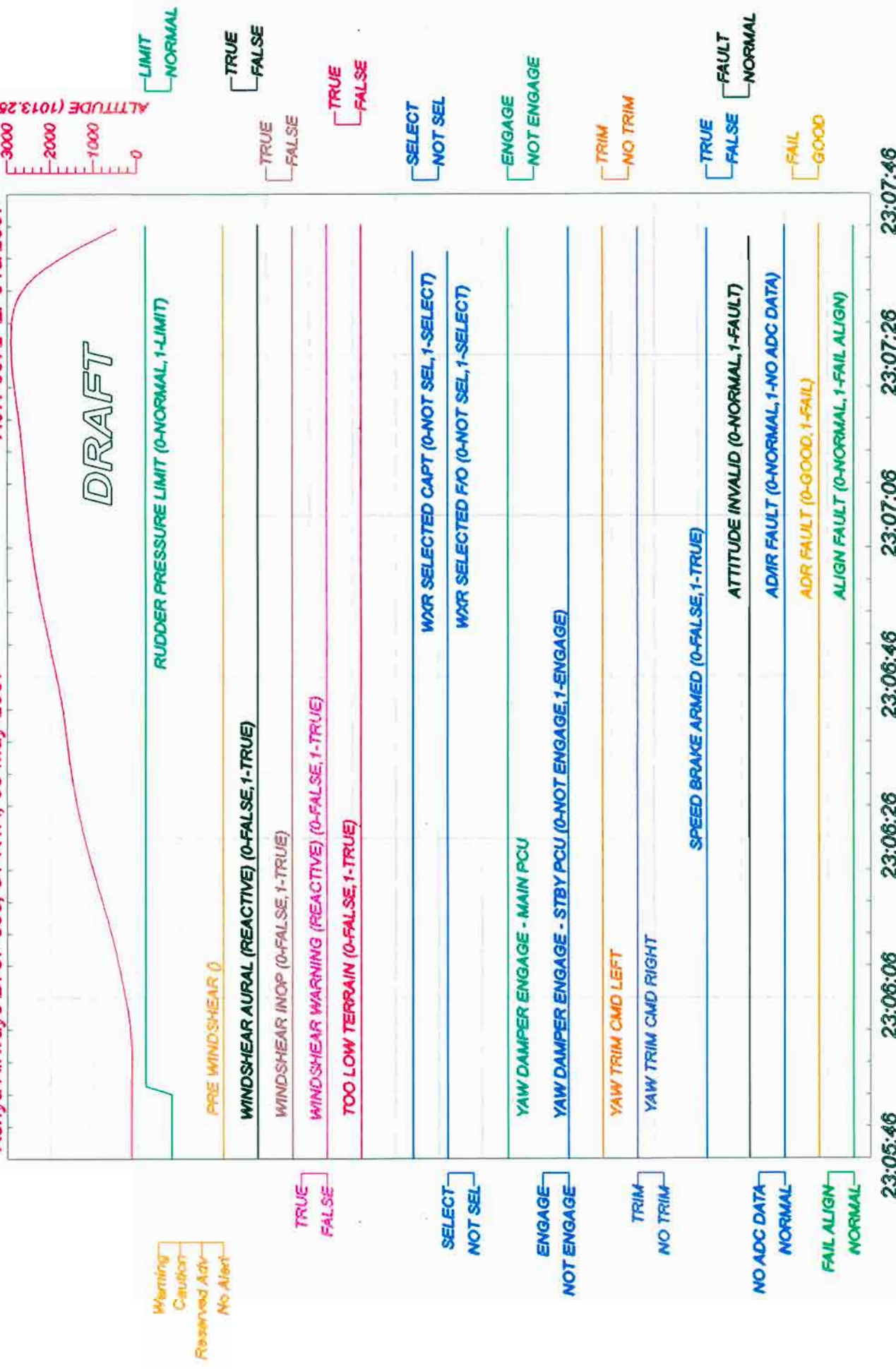
**Recorders & Vehicle Performance Division - TBSC**



## Figure 9: Discretes #2

**Kenya Airways B737-800, 5Y-KYA, 05-May-2007**

A07F0072 LP048/2007



UTC (hr:min:sec)

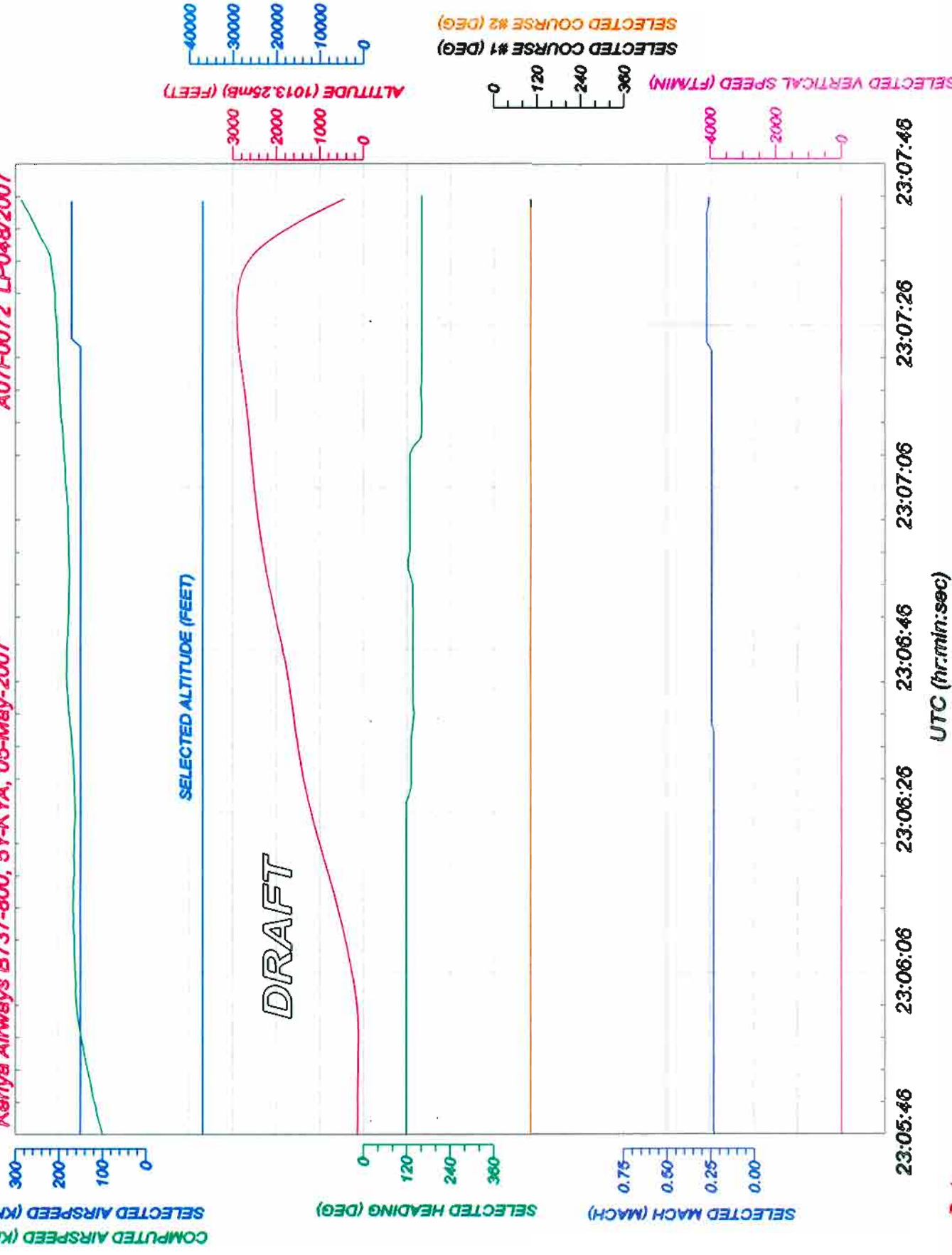
Preliminary Data  
Revised: 25 May, 2007

Recorders & Vehicle Performance Division - TBSC

Figure 10: Selections

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

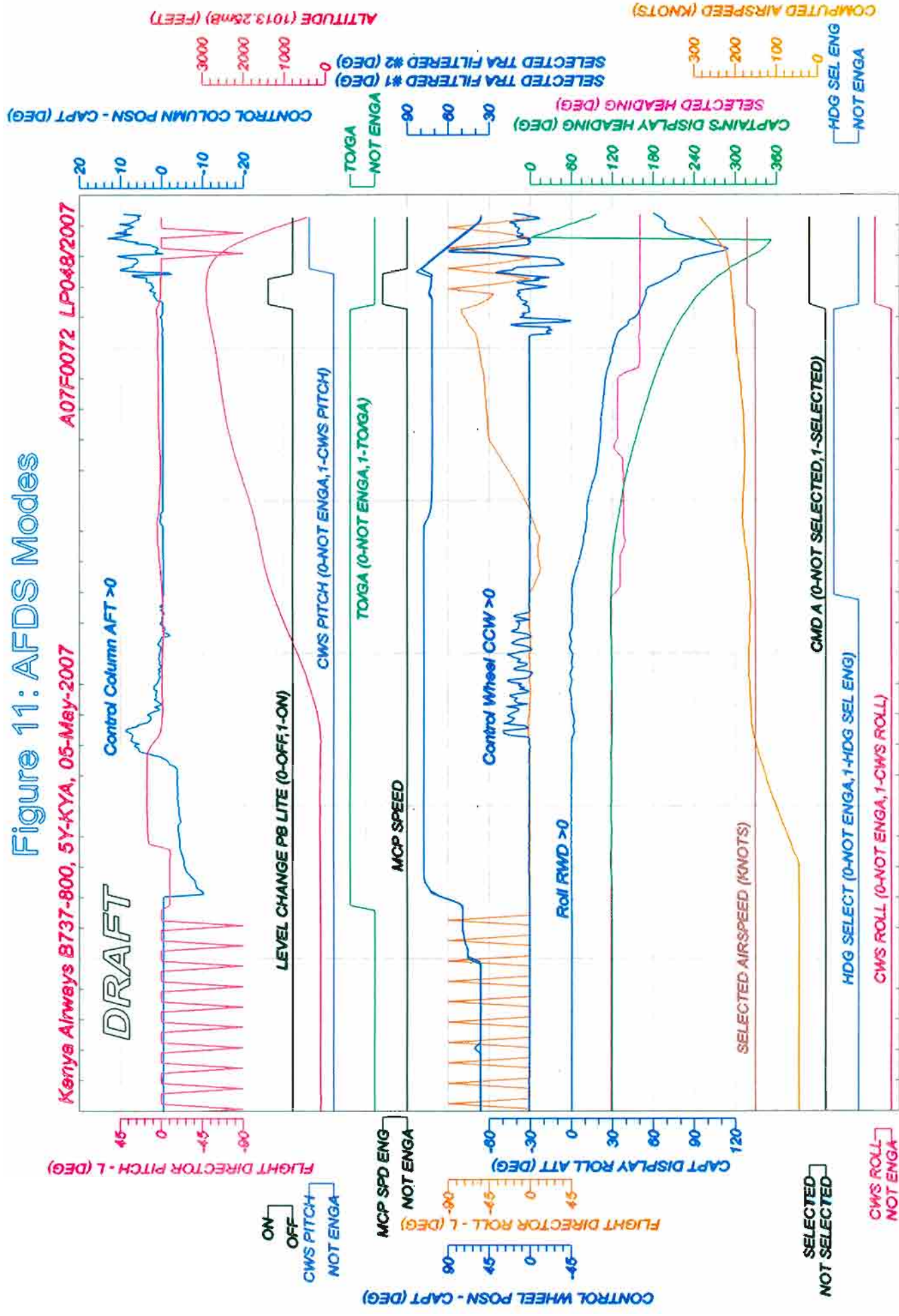
A07F0072 LP048/2007



# Figure 11: AFDS Modes

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007

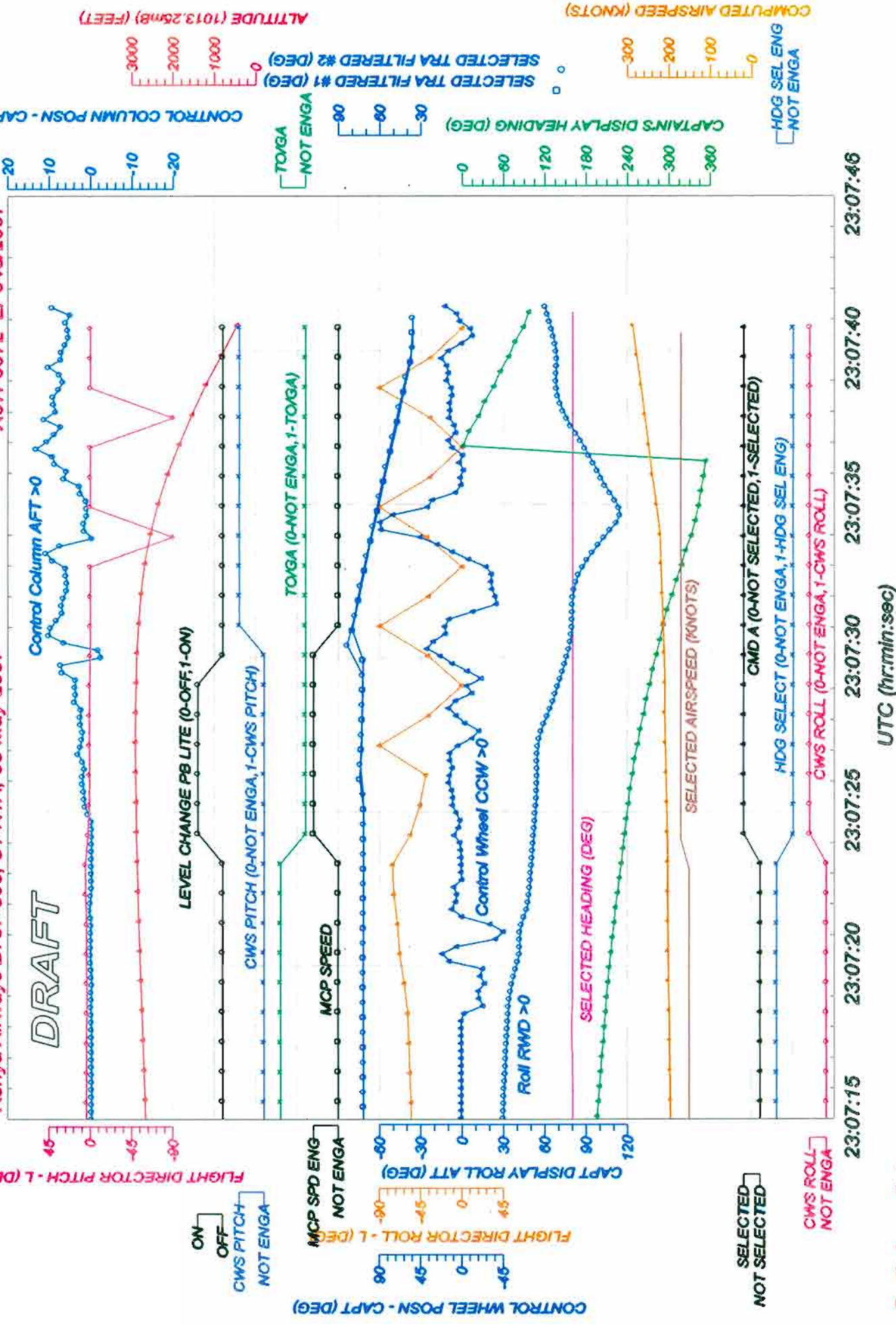




# Figure 11a: AFDS Modes Close-Up

Kenya Airways B737-800, 5Y-KYA, 05-May-2007

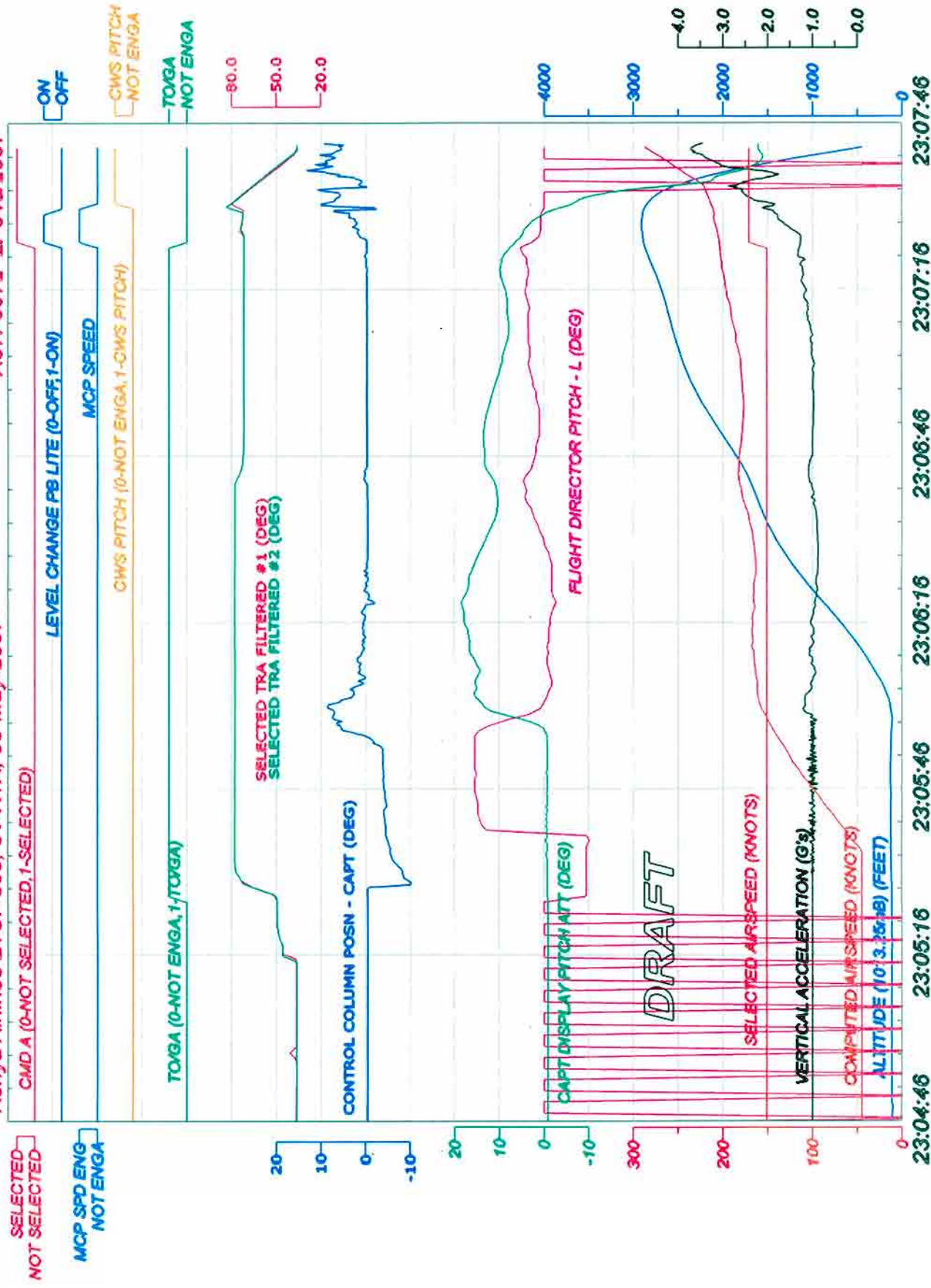
A07F0072 LP048/2007



# Figure 12: AFDS Pitch

Kenya Airlines B737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007



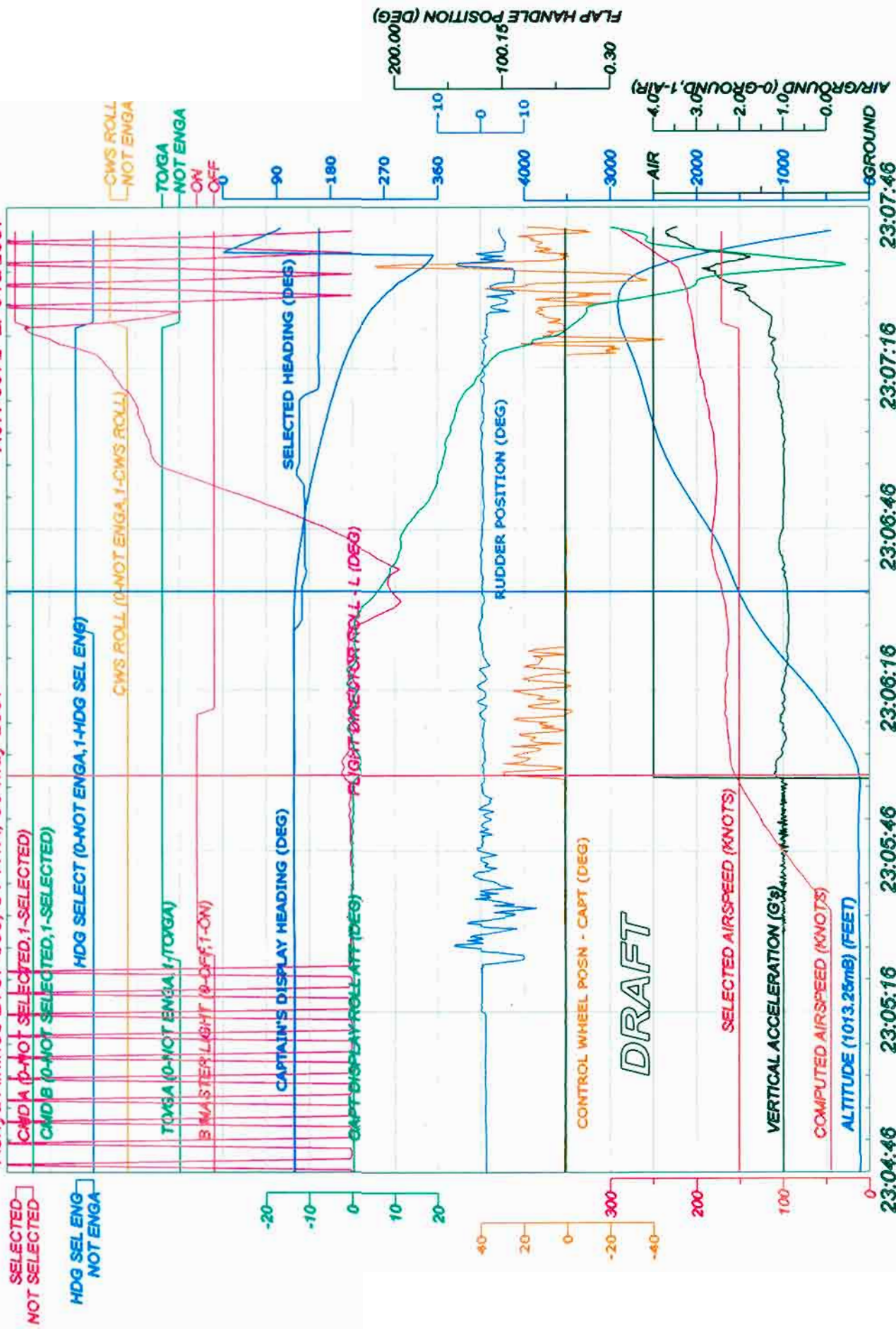
Subframe Reference Number (seconds)



# Figure 13: AFDS Roll

Kenya Airlines 8737-800, 5Y-KYA, 05-May-2007

A07F0072 LP048/2007



Subframe Reference Number (seconds)



## APPENDIX 6

Radio band transcript

❖ Fréquence : 118.1 MHZ (Tour)

HEURE	DE	A	CONVERSATIONS
17 h 59' 45"	KQA 507	TWR	Abidjan KQA 507.
17 h 59' 47"	TWR	KQA 507	KQA 507 Abidjan.
17 h 59' 50"	KQA 507	TWR	Abidjan KQA 507, request latest weather condition.
17 h 59' 53"	TWR	KQA 507	Wind 230°/ 05 kts, T° 26 QNH 1009 RWY 21 in use go ahead.
18 h 00' 00"	KQA 507	TWR	Copied, 1009, RWY 21 in use KQA 507.
18 h 07' 14"	FLYCO	TWR	Abidjan Tour, de FLYCO, bonsoir.
18 h 07' 18"	TWR	FLYCO	FLYCO la Tour bonsoir.
18 h 07' 21"	FLYCO	TWR	Bonsoir, nous souhaitons faire la visite de piste maintenant.
18 h 07' 28"	TWR	FLYCO	Reçu faites la visite.
18 h 14' 17"	TUTIW	TWR	Abidjan de TUTIW, bonsoir.
18 h 14' 23"	T-IW	TWR	T-IW bonsoir. Parking SAMA nous demandons l'autorisation de tracter l'avion jusqu'au parking AIR IVOIRE.
18 h 14' 35"	TWR	T-IW	Reçu, tractez.
18 h 14' 41"	TWR	T-IW	Vous êtes au SAMA et vous voulez tracter pour quel poste ?
18 h 14' 47"	T-IW	TWR	Pour la piste AIR IVOIRE.
18 h 15' 18"	FLYCO	TWR	Abidjan Tour de FLYCO.
18 h 15' 20"	TWR	FLYCO	FLYCO la Tour.
18 h 15' 22"	FLYCO	TWR	La piste est dégagée et comme observation rien à signaler, merci.
18 h 15' 26"	TWR	FLYCO	Reçu.
18 h 15' 33"	T-IW	TWR	T-IW Abidjan.
18 h 15' 35"	TWR	T-IW	T-IW écoute.
18 h 15' 51"	T-IW	TWR	Bon l'avion décolle à 20 H à 20 H 50'
18 h 15' 56"	TWR	T-IW	Reçu tractez, je vous rappelle pour un numéro de parking.
18 h 15' 59"	T-WR	TWR	OK.
18 h 17' 24"	T-IW	TWR	IW Abidjan.
18 h 17' 26"	TWR	T-IW	IW écoute.
18 h 17' 29"	TWR	T-IW	Tractez pour la position 8 A.
18 h 17' 32"	T-IW	TWR	8 A.
18 h 17' 33"	TWR	T-IW	C'est exact.
18 h 26' 17"	AFR 702	TWR	La Tour d'Abidjan bonsoir AFR 702.
18 h 26' 27"	TWR	AFR 702	Appelant Abidjan.
18 h 26' 29"	AFR 702	TWR	Euh c'est AFR 702.
18 h 26' 31"	TWR	AFR 702	AFR 702 bonsoir j'écoute.
18 h 26' 35"	AFR 702	TWR	Bonsoir pour info je vous reçois fort 5 clair 2, on est en interception localiser 21 on passe 3500' vers 2700' à 20 NM.
18 h 26' 50"	TWR	AFR 702	AFR 702 bien reçu, descendez à 2200' au QNH.
18 h 26' 59"	AFR 702	TWR	On rappelle 5 NM en finale et on est autorisé 2200' AFR 702
18 h 27' 27"	KQA 507	TWR	Abidjan KQA 507.
18 h 27' 31"	TWR	KQA 507	507 Go.
18 h 31' 33"	KQA 507	TWR	KQA 507 request start, level 370 registration 5 YKYA.

HEURE	DE	A	CONVERSATIONS
18 h 31' 43"	TWR	KQA 507	Start up approved, time check 18 H 31' QNH one zero one zero report ready to taxi.
18 h 31' 51"	KQA 507	TWR	We are cleared for start up level 370, and we call you next ready for taxi and QNH one zero one zero KQA 507
18 h 31' 59"	TWR	AFR 702	AFR 702, cleared to land wind 230°/06 kts.
18 h 32' 04"	AFR 702	TWR	AFR 702 on passe 4 NM en finale
18 h 32' 09"	TWR	AFR 702	Autorisé, à l'atterrissage vent 230°/06 kts.
18 h 32' 15"	AFR 702	TWR	Autorisé à l'atterrissage AFR 702.
18 h 34' 44"	AFR 702	TWR	(illisible) AFR 702.
18 h 34' 48"	TWR	AFR 702	AFR affirme, dégagez par la centrale pour le poste 06 rappelez placeur en vue.
18 h 34' 54"	AFR 702	TWR	Euh ok pour info vous avez une mauvaise radio, on ne comprend pas très bien.
18 h 35' 03"	TWR	AFR 702	Bien reçu, le quotidien les contrôleurs.
18 h 35' 10"	AFR 702	TWR	Je rappelle le placeur en vue AFR 702.
18 h 37' 29"	TWR	KQA 507	You are cleared to taxi to backtrack RWY 21 report ready to copy your ATC.
18 h 37' 34"	KQA 507	TWR	Cleared to taxi to hold point RWY 21 cleared to backtrack RWY 21 KQA 507
18 h 42' 21"	TWR	KQA 507	Level 230 initially when airborne RWY 21 left turn.
18 h 42' 32"	KQA 507	TWR	Say again for 507
18 h 42' 43"	TWR	KQA 507	KQA 507 How do you ready?
18 h 42' 49"	KQA 507	TWR	Cleared to go level 230 initially VIA AFO
18 h 42' 54"	TWR	KQA 507	Read back is correct how do you read
18 h 42' 56"	KQA 507	TWR	Your illisible.
18 h 43' 02"	TWR	KQA 507	Report line-up ready to take off.
18 h 43' 06"	KQA 507	TWR	Unreadable, unreadable
18 h 43' 10"	TWR	KQA 507	KQA 507 how do you ready now?
18 h 43' 13"	KQA 507	TWR	Five by five
18 h 43' 15"	TWR	KQA 507	KQA 507 cleared for take off RWY 21 wind 220/06 report 40 climbing.
18 h 43' 21"	KQA 507	TWR	Cleared for take off KQA 507
18 h 49' 03"	TWR	KQA 507	KQA 507, airborne time 18 H 45' say level passing.
18 h 49' 07"	KQA 507	TWR	(illisible) KQA 507.
18 h 49' 14"	TWR	KQA 507	Level passing.
18 h 49' 16"	KQA 507	TWR	40
18 h 49' 17"	TWR	KQA 507	40, airborne time 45 contact immediately 121.1
18 h 49' 21"	KQA 507	TWR	Immediately 121.1 good evening.



✧ **Frequence** 121.1 MHZ (APP)

HEURE	DE	A	CONVERSATIONS
18 h 00 00	APP	KQJA 507	KQJA 507 say your outbound RDL now
18 h 00 15	KQJA 507	APP	We are now established and estimate AFQ at 18 h 57 TEMBE 15 H 00 and Descent at 20 H 55 go ahead
18 h 00 30	APP	KQJA 507	Roger you climb initially 230 to AFQ report contact with Accra
18 h 00 35	KQJA 507	APP	Wilco
18 h 00 38	APP	KQJA 507	You confirm established on your route
18 h 00 42	KQJA 507	APP	YES
18 h 00 43	APP	KQJA 507	Roger
18 h 00 49	APP	SAA 052	0152 Descend to 50 to report leaving crossing 240 maintain RDL two one two zero
18 h 01 01	SAA 052	APP	OK we understand F1 050 and the rest
18 h 01 06	SAA 052	APP	inbound RDL 152
18 h 01 14	APP	SAA 052	Roger report crossing 240
18 h 01 19	SAA 052	APP	We'll call you passing F1 240 next SAA 052
18 h 02 18	ZSOYE	APP	Abidjan approach ZSOYE request descent
18 h 02 20	APP	ZSOYE	Say your DME
18 h 02 22	ZSOYE	APP	We are 09 DME A1
18 h 02 27	APP	ZSOYE	05 DME descend to F1 60 request leaving 230
18 h 02 34	ZSOYE	APP	We descend F1 60 and we're leaving now 230 YE
18 h 03 00	APP	ZSOYE	Heath ZSOYE say estimate OPR1
18 h 03 08	ZSOYE	APP	1910
18 h 03 09	APP	ZSOYE	1940 Roger
18 h 03 15	ZSOYE	APP	And any delay expected for ZSOYE
18 h 03 20	APP	ZSOYE	Atten your expected approach time will be 1917 1917
18 h 03 21	ZSOYE	APP	Expected approach time 1917 ZSOYE
18 h 03 30	APP	ZSOYE	Your traffic is SAA 052 AIRBUS 342 from FAUS to Abidjan estimating OPR1 1917 and he will be number one
18 h 03 44	ZSOYE	APP	copied RF
18 h 04 32	SAA 052	APP	SAA 052 passing F1 240 07 DME and 156 RDL
18 h 04 37	APP	SAA 052	Roger report passing 100
18 h 04 42	SAA 052	APP	Report passing 100 SAA 052
18 h 05 58	KQJA 507	APP	Accra KQJA 410 K KQJA 507
18 h 06 06	APP	KQJA 507	KQJA 507 this is Abidjan go ahead
18 h 06 09	APP	KQJA 507	KQJA 507 your position
18 h 06 12	KQJA 507	APP	Roger KQJA 507 go ahead check AFQ and we are cleared F1 370 by Accra we are in Africa
18 h 06 21	APP	KQJA 507	Roger say crossing again
18 h 06 23	KQJA 507	APP	We are maintaining 230 we are now cleared 230
18 h 06 24	APP	KQJA 507	191000 191000 191000 191000 191000

Retranscription de la conversation  
Téléphonique relative à l'incident de  
KQA 507 du 04 Mai 2007.

✧ Fréquence : ATS / ACCRA

HEURE	DE	A	CONVERSATIONS
18 h 53' 01"	Accra	Abidjan	KQA euh, confirm KQA euh, KQA 507 correct.
18 h 53' 06"	Abidjan	Accra	I confirm.
18 h 53' 08"	Accra	Abidjan	OK au niveau 230, 230, c'est correct.
18 h 53' 14"	Abidjan	Accra	Correct.
18 h 53' 16"	Accra	Abidjan	OK c'est bien copié pour KQA 507.
18 h 53' 20"	Abidjan	Accra	OK.