Final Report

of AFRIQIYAH Airways Aircraft
Airbus A330-202, 5A-ONG Crash
Occurred at Tripoli (LIBYA)
on 12/05/2010

Published February 2013

Foreword

In accordance with Annex 13 to the Convention on International Civil Aviation and chapter 10 of Libyan Civil Aviation law No. 6 of 2005, Libyan Civil Aviation Authority as state of occurrence instituted the investigation of the Accident of AFRIQIYAH Airways Aircraft occurred on 12 May 2010 to the Airbus A330-202 registered 5A-ONG in landing phase final approach to runway 09 at Tripoli International Airport.

Libyan Civil Aviation Authorities has notified the relevant national and international concerned bodies.

The investigation has been conducted with an appreciated assistance and co-operation from BEA (France), NTSB and FAA (USA), DSB (The Netherland) and Accident and Incident Investigation Department (South Africa) as well as Airbus and General Electric.

The investigation committee is highly appreciated the full co-operation and assistance provided by BEA (France) and Airbus.

Contents

Glossary

A/F	Air Field
A/THR	Auto Thrust
ACARS	Aircraft Communications Addressing and Reporting System
ADF	Automatic Direction Finder
AFM	Aircraft Flight Manual
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
AP	Automatic pilot
APP	Approach
APU	Auxiliary Power Unit
APV	Approach Procedure with Vertical guidance
ARINC	Aeronautical Radio, Incorporated
ATC	Air Traffic Control
ATCT	Aviation Training Center of Tunisia
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot Licence
BEA	Bureau d'Enquêtes et d'Analyses
CAM	Cockpit Area Microphone
CCQ	Cross Crew Qualification
CDFA	Continuous Descent Final Approach
CONF	Configuration
CRM	Cockpit / Crew Resource Management
DA	Decision Altitude
DGAC	Direction Générale de l'Aviation Civile
DH	Decision Height
DME	Distance Measuring Equipment
ECAM	Electronic Centralized Aircraft Monitoring
ELT	Emergency Locator Transmitter
ETA	Estimated Time of Arrival
ETOPS	Extended range operations by twin-engined aircrafts
FAF	Final Approach Fix
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FCU	Flight Control Unit

FD	Flight Director
FIC	Flight Information Centre
FMA	Flight Mode Annunciator
FMGEC	Flight Management Guidance and Envelope Computer
FMS	Flight Management System
FMGS	Flight Management and Guidance System
FPA	Flight Path Angle
FPD	Flight Path Director
FPV	Flight Path Vector
FRMS	Fatigue Risk Management System
ft	Feet
GPWS	Ground Proximity Warning System
HDG	Heading
IAC	Instrument Approach Chart
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
kHz	kilohertz
KSS	Karolinska Sleepiness Scale
kt	Knot
LyCAA	Libyan Civil Aviation Authorities
LOSA	Line Operation Safety Audit
MAPt	Missed Approach Point
MCDU	Multipurpose Control and Display Unit
METAR	Aerodrome routine meteorological report
MDA	Minimum Descent Altitude
MLG	Main Landing Gear
ND	Navigation Display
NDB	Non Directional Beacon
NM	Nautical Mile
NOTAM	Notice To Airmen
OACI	Organisation de l’Aviation Civile Internationale
OCV	Organisme de Contrôle en Vol
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PFD	Primary Flight Display

PNF	Pilot Not Flying
QRH	Quick Reference Handbook
RNAV	Area Navigation
RVR	Runway Visual Range
SGS-RF	Système de Gestion de la Sécurité – Risque fatigue
SOP	Standard Operational Procedures
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
SWP	Sleep Wake Predictor
TAF	Terminal Aerodrome Forecast
TAWS	Terrain Awareness and Warning System
THS	Trimmable Horizontal Stabilizer
TMA	Terminal Control Area
TOGA	Take Off / Go Around
TPMA	Three Process Model of Alertness
TRK	Track
TRTO	Type Rating Training Organization
TWR	Tower
UTC	Universal Time coordinated
VDEV	Vertical Deviation
VNAV	Vertical Navigation
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
V/S	Vertical Speed
XTK	Lateral Deviation

Synopsis

Date and time
12 May 2010 at 04 h 01

Aircraft
Aircraft Airbus
A330-202
Registration number 5A-ONG

Place
Tripoli International Airport (Libya)

Owner
AFRIQIYAH Airways

Type of flight
Public transport of passengers
Scheduled flight 8U771
Johannesburg (South Africa) - Tripoli (Libya)

Operator
AFRIQIYAH Airways

Persons on board
3 Flight crew
8 cabin crew
93 passengers

Summary

Aircraft type A330-202 registration 5A-ONG was on schedule flight from O.R Tambo International Airport - Johannesburg (South Africa) to Tripoli international Airport (Libya).The Aircraft took off on May 11th 2010 at 19:25 UTC flight number (8U 771).

There were three cockpit crew, eight cabin crew, and 93 passengers on board, with fifty thousand Kgs of fuel during takeoff role and the Aircraft mass was 187,501 KGs.
During final approach towards runway 09 at Tripoli international Airport, the crew announced go-around and initiated the miss approach procedure with the knowledge and confirmation of Tripoli tower.

During the missed approach phase, the Aircraft responded to the crew's inputs, velocity and altitude increased above the MDA, then Aircraft descended dramatically until collided with the ground about 1200 meters from the threshold of the runway 09 and 150 meters right of the runway centre line, impact and post impact fire caused complete destruction to the Aircraft.
An investigation committee had been formed to investigate the case and to submit the final report including the required safety recommendations.

Consequences

	People			Equipment
	Killed	Injured	Uninjured	
Crew	11	-		Destroyed
Passengers	92	1		

1 - FACTUAL INFORMATION

1.1 History of the Flight

Unless otherwise specified, the times in this report are expressed in Universal Time Coordinated (UTC). Two hours should be added to obtain the standard time in Libya on the day of the event.

1.1.1 Fight 8U 770 Tripoli - Johannesburg

On May the 10th 2010 AFRIQIYAH Airways Aircraft type A330-202 registration 5A-ONG took off from Tripoli international Airport at 18:45UTC landed at O.R Tambo International Airport early morning at 02:45 UTC on May the 11th 2010 without any obstacles. The aircraft crew was consisted of a Captain and two first officers (one operating, the other as a relief pilot).

1.1.2 Fight 8U 771 Johannesburg - Tripoli

On Tuesday, May 11 2010 at 19 h 45, the A330-202, registered 5A-ONG, took off from Johannesburg (South Africa) to Tripoli (Libya) with (50,000) Kgs of fuel, ninety-three passengers and eleven crew members on board. This was the international scheduled flight 8U771 operated by AFRIQIYAH Airways. The flight crew consisted of a Captain who was Pilot Not Flying (PNF), a co-pilot who was Pilot Flying (PF) and a relief co-pilot.

The flight took place without any notable events until the approach.

At 02:18:58 first contact to Tripoli FIC, aircraft was at flight level 400 flying with NDJAMINA FIR expecting arrival TOMO (02:26), SEBHA (03:04), and TRIPOLI (03:59) UTC.

At 02:29:32 Aircraft made contact with Sebha control received weather report as (11 23 50 Z 310/04 7000 SKC 20/17 QNH 1008) and no abnormality had been reported.

At 03:29:43 Aircraft identified by Tripoli ACC controller Squak 4032 and cleared direct to Tripoli TW locator approach runway 09 Weather was (wind calm, visibility 6KM sky clear, temperature/ due point 19/17°C, QNH 1008).

At 03:30:11 Aircraft crew asked for latest weather and requested descent. ACC replied weather (wind calm, visibility 6KM sky clear, temperature/ due point 19/17°C, QNH 1008) , and aircraft cleared to descend to FL 90.

At 03:41:03 Crew informed AFRIQIYAH flight watch about estimated arrival at (04:05) with no remarks.

At 03:58:57 Aircraft transferred to Tripoli Tower on 118.1, with clear contact performed and aircraft was at (1200 ft) QNH.

At 03:59:19 Tripoli Tower notified the aircraft to continue approach and to report runway in sight, Crew confirmed the message.

At 03:59:35 missed approach altitude was selected (2000 ft) and FPA angle (-3) at the same time the aircraft received a message from (AAW721) which landed immediately informing the accident crew about fog patches noticed during short final.
At 04:00:01 Aircraft passed locator (TW) at (1000 ft) crew informed ATC that he will report when runway in sight request landing clearance if runway in sight, Tower agreed adding wind calm.

At 04:00:24 syntactic voice message generated (hundred above) and the Captain called out "Continue". The co-pilot responded by also calling "Continue", aircraft was approaching the MDA of 620 feet.

At 04:00:42 Aircraft was at altitude 490 ft (280 ft RA) syntactic voice generated (too low terrain) at which the captain requested go around, The co-pilot confirmed and the captain informed the Tower, then go around initiated and aircraft climbing to 670 ft.

At 04:00:59 Aircraft nosing down.

From 04: 01:10 to 04:01:12 Captain took priority over the flight controls by pushing on priority button and the aircraft was fully under the captain's control who applied a sharp nose down input.

At 04:01:14 Approximately aircraft impacted with ground near by Tripoli International Airport (N 32 39.696, E 013 06.878) at (262 ft) above mean sea level with (260 knots) Ground Speed and a vertical speed off (– 4400 ft / min).

1.2 Injuries to Persons

Injuries	Crew	Passenger	Others
Fatal	11	92	-
Serious	-	1	-
Minor/None	-	-	

Only one passenger survived, but was seriously injured during the accident. He remained in hospital in Tripoli for more than forty-eight hours before being transferred to the Netherlands.

The Survivor seat number in the aircraft in accordance with passenger manifest found to be 12D but Investigation Committee could not confirm the Survivor seat and his position in the aircraft at the time of accident.

1.3 Damage to Aircraft

The Aircraft was destroyed by direct impact with ground at (260 knots) ground speed and vertical speed of (4400 ft /min) down and post crash fire.

1.4 Other Damage

Several electricity poles, a step down transformer, shelter, a house and some trees received damage.

1.5 Personnel Information

1.5.1 Flight crew

With regard to the expected flight time and as per company operation manual. Aircraft crew was augmented, which was composed of members more than the minimum crew required by the Certificate of Airworthiness (AFM) so this crew was composed of one Pilot and two co-pilots.

From the cockpit voice recorder it was found that at 02:11:05 the Captain entered the cockpit came back from his rest during cruise, all three pilots were in the cockpit at the time of accident.

1.5.2 Captain

Male, 57 years old.

- Airline Transport Pilot License ATPL issued by Libya.
- Airbus A330 type rating obtained on 12 May 2009 after conversion training completed at the Type Rating Training Organization (TRTO) of the aircraft manufacturer Airbus in Toulouse.
- Other type ratings:
  - Fokker 28 obtained on 30 May 1978,
  - Boeing 727 obtained on 5 October 1988,
  - Airbus A320 obtained on 1 April 2005 in the Jordan Airlines TRTO in Jordan.
- Captain since 5 October 1988.
- Last proficiency check on 15 November 2009 at the Sabena TRTO in Brussels.
- Last Cockpit Resource Management (CRM) training: 12 October 2009.
- Unrestricted Class 1 medical certificate issued on 30 June 2009 valid until 29 June 2010.
- Experience:
  - Approximately 17,016 hours of flight, including 516 hours on type,
  - 216 hours in the previous three months, all on type,
  - 48 hours within the last 12 days, all on type.
- Flight duty time:
  - End of last flight duty period at Johannesburg before the accident flight: Tuesday 11 May 2010 at 03 h 15,
  - Beginning of flight duty period: Tuesday 11 May 2010 at 18 h 25.
  - Rest time in Johannesburg before the accident flight: 15 hours 10 minutes.

The Captain was hired by AFRIQIYAH Airways in 2007 as an A320 Captain. He first worked for Libyan Arab Airlines and then Nouvel Air with which he carried out non precision approaches only in selected mode (company instructions). He flew at the same time under contract for Nouvel Air and AFRIQIYAH Airways.

1.5.3 Co-pilot

Male, 42 years old.

- Airline Transport Pilot License ATPL issued by Libya.
- Airbus A330 type rating obtained on 14 May 2009 after conversion training completed at the Airbus TRTO in Toulouse.
- Other type ratings:
  - Twin Otter DHC6 obtained on 26 July 1997,
  - Airbus A320 obtained on 20 November 2006 at the TRTO Aviation Training Center of Tunisia (ATCT) in Tunis.
- Last proficiency check on 19 November 2009 at the Sabena TRTO in Brussels.
- Class 1 medical certificate issued on 25 October 2009, with restrictions to wear glasses and have spare glasses available.
- Experience:
  - 4,216 hours of flight, including 516 hours on type,
  - 163 hours in the previous three months, all on type,
  - 56 hours within the last 12 days, all on type.
- Flight duty time
  - End of last flight duty period at Johannesburg before the accident flight: Tuesday 11 May 2010 at 03 h 15,
  - Beginning of flight duty period: Tuesday 11 May 2010 at 18 h 25.
  - Rest time in Johannesburg before the accident flight: 15 hours 10 minutes.

1.5.4 Relief Co-pilot

Male, 37 years old.

- Commercial Pilot License CPL issued by Libya.
- Airbus A330 type rating obtained on 05 May 2009 after conversion training completed at the Airbus TRTO in Toulouse.
- Other type ratings:
  - Boeing 727 obtained on 22 October 2005,
  - Airbus A320 obtained on 03 December 2006 at the TRTO Aviation Training Center of Tunisia (ATCT) in Tunis.
- Last proficiency check on 01 May 2010 at the SIM Egypt Air in CAIRO.
- Unrestricted Class 1 medical certificate issued on 11 January 2010.
- Experience:
  - 1,866 hours of flight, including 516 hours on type,
  - 216 hours in the previous three months, all on type,
  - 56 hours within the last 12 days, all on type.
- Flight duty time
  - End of last flight duty period at Johannesburg before the accident flight: Tuesday 11 May 2010 at 03 h 15,
  - Beginning of flight duty period: Tuesday 11 May 2010 at 18 h 25.
  - Rest time in Johannesburg before the accident flight: 15 hours 10 minutes.

For all crew members:

- Tripoli – Johannesburg Flight was 07:37 hours.
- Johannesburg – Tripoli Flight was 08:36 hours.
- Rest time in Johannesburg before the accident flight: 15 hours 10 minutes.

1.5.5 Cabin Crew

There were 8 cabin crew Members onboard the Aircraft in its flight from Johannesburg to Tripoli and their information as follows:

- **Chief Cabin Crew (1)**

Male, 50 years old;

- Certificate of Security and Saving No. 73 valid until 23/02/2011.
- Class 2 medical certificate issued on 10 February 2009, valid until 09 February 2011.
- Type ratings: A330 / A320 /A310/ B727/F28/B707.

- **Cabin Crew Member (2)**

Male, 32 years old;

- Certificate of Security and Saving No. 1133 valid until 04/03/2011.
- Class 2 medical certificate issued on 12 March 2009, valid until 11 March 2011.
- Type ratings: A330 / A320.

- **Cabin Crew Member (3)**

Male, 27 years old;

- Certificate of Security and Saving No. 1147 valid until 09/03/2011.
- Class 2 medical certificate issued on 24 February 2009, valid until 23 February 2011.
- Type ratings: A330 / A320.

- **Cabin Crew Member (4)**

Female, 37 years old;

- Certificate of Security and Saving No. 997 valid until 06/08/2010.
- Class 2 medical certificate issued on 03 September 2008, valid until 02 September 2010.
- Type ratings: A330 / A320 /F27/ B727/F28.

- **Cabin Crew Member (5)**

Male, 20 years old;

- Certificate of Security and Saving No. 1173 valid until 16/03/2011.
- Class 2 medical certificate issued on 26 February 2009, valid until 25 February 2011.
- Type ratings: A330 / A320.

- **Cabin Crew Member (6)**

Male, 24 years old;

- Certificate of Security and Saving No. 879 valid until 04/03/2011.
- Class 2 medical certificate issued on 27 May 2008, valid until 26 May 2010.
- Type ratings: A330 / A320 /YAK40/ B727.

- **Cabin Crew Member (7)**

Female, 41 years old;

- Certificate of Security and Saving No. 1733 valid until 07/12/2010.
- Class 2 medical certificate issued on 29 December 2008, valid until 28 December 2010.
- Type ratings: A330/A320/A300 / F20 /GII/ B727/F28/F27.

- **Cabin Crew Member (8)**

Male, 31 years old;

- Certificate of Security and Saving No. 884 valid until 30/08/2010.
- Class 2 medical certificate issued on 07 September 2008, valid until 06 September 2010.
- Type ratings: A330 / A320 / B727.

1.5.6 Air Traffic Controllers

The ATC licensing unit is a subdivision of the air navigation department in which evaluation, issuing and renewal of individual ATC licensing carried out.
At the time of the accident there were 4 air traffic controllers who handled the case of AFRIQIYAH flight AAW 771 during its approach to runway 09. They were qualified and their information as follows:

- **Air Traffic Controller (1) Approach**

Male, 27 years old;

- Airtraffic Controller License No. 297 valid until 26/01/2014.
- Class 3 medical certificate, valid until 26/01/2014.
- Type ratings : Area / Approach
- Issue Date: 08/03/2010.

He was handling the flight during approach phase in the Area Control Centre (HLLL ACC).

- **Air Traffic Controller (2) Approach**

Male, 23 years old;

- Trainee Airtraffic Controller

He was an assistant controller in the approach sector responsible for the Telecommunication.

- **Air Traffic Controller (3) Tower**

Male, 48 years old;

- Airtraffic Controller License No. 164 valid until 10/06/2010.
- Class 3 medical certificate, valid until 10/06/2010.
- Type ratings : Tower
- Issue Date: 20/11/1989.

He was handling the Air Frequency (118.1) in the Tower during short final approach and Landing phase in Tripoli Tower (HLLT TWR).

- **Air Traffic Controller (4) Tower**

Male, 47 years old;

- Air traffic Controller License No. 211 valid until 13/09/2011.
- Class 3 medical certificate, valid until 13/09/2011.
- Type ratings : Tower
- Issue Date: 12/06/1996.

He was responsible for handling the Telecommunication in the Tower after the Accident.

1.6 Aircraft Information

1.6.1 General Information

Airframe

Manufacturer	Airbus
Type	A330-202
Serial number	1024
Registration	5A-ONG
Entry into service	15 September 2009
Certificate of airworthiness	No. 600, Category Transport, Valid until 14/09/2010
Hours flown until 12 May 2011	2,175 hours for 572 cycles
Last maintenance check	Check A02 at Lufthansa Technik Milano on 05/03/2010

Engines

	Engine (1)	Engine (2)
Manufacturer	General Electric	General Electric
Type	CF6 – 80E 1A4B	CF6 – 80E 1A4B
Serial number	811520	811519
Installation date	28/04/2009	29/04/2009
Total run time	2184:24 hours	2185:12 hours
Run time since installation	2184:24 hours	2185:12 hours
Cycles since installation	584	583

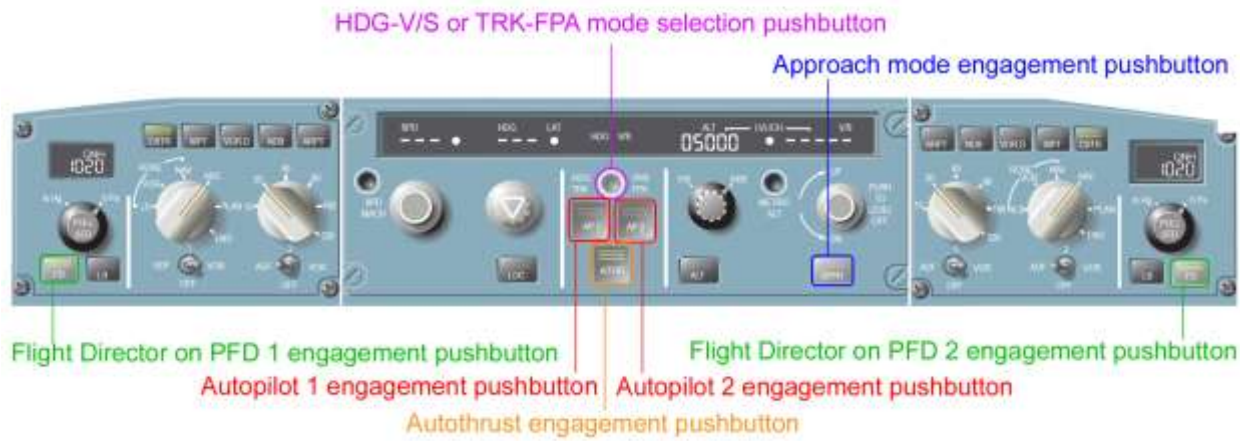
1.6.2 Autopilot, flight director and autothrust

The autopilot, flight director and autothrust functions are ensured by two Flight Management Guidance and Envelope Computers (FMGEC), controlled by the crew via the Flight Control Unit (FCU) and the Multipurpose Control and Display Unit (MCDU). Each of these two computers can perform these three functions.

The Flight Director (FD) displays the control orders from the FMGEC on the Primary Flight Display (PFD). In normal operation, with the FDs engaged (FD push buttons lit on the FCU), FD 1 displays the orders from FMGEC 1 on PFD 1 (left side) and FD 2 displays the orders from FMGEC 2 on PFD 2 (right side). It is possible to display only one FD at a time or none, although Airbus normal procedures recommend that both of them should be displayed. Furthermore, the autopilot 1 function is ensured by FMGEC 1 and the autopilot 2 function by FMGEC 2. The autothrust function (A/THR) can be ensured by the two FMGECs independently, but by priority is ensured by the FMGEC associated to the engaged autopilot.

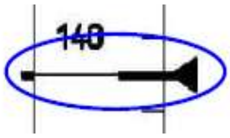
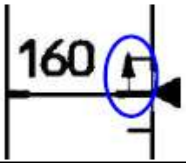
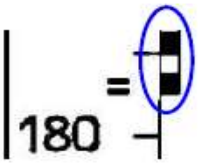
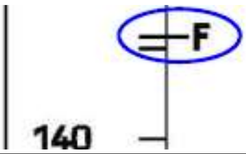
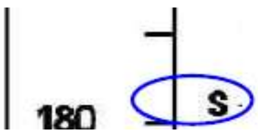
The display of the FD on the PFD depends on the mode selected with the HDG-V/S / TRK-FPA push-button on the FCU:

- In HDG-V/S mode, the FD is represented by two perpendicular trend bars and displays vertical and lateral deviations from the autopilot commands;
- In TRK-FPA mode, the Flight Path Vector (FPV) speed vector (or "bird") is displayed, it indicates the drift and slope. The associated flight director is called the FPD (Flight Path Director) and is represented by a symbol in which the pilot positions the FPV to follow the flight path elaborated by the FMGECs.



1.6.3 Characteristic and limit speeds

A certain number of speeds are represented by specific symbols on the PFD's speed scale (protection or design speeds – "green dot", F, S, Vmax, Valpha prot, etc.).

Actual airspeed reference line and scale		A white scale on a grey background moves in front of a fixed yellow reference line next to a yellow triangle to show airspeed.
Speed trend		This yellow arrow starts at the speed symbol. The tip shows the speed the aircraft will reach in 10 seconds if its acceleration remains constant.
VMAX		The lower end of a red and black strip along the speed scale defines this speed. It is the lowest of the following : • VMO or the speed corresponding to MMO • VLE • VFE
Minimum flap retraction speed		This is a green symbol (letter F). It appears when the flap selector is in position 2 or 3.
Minimum slat retraction speed		This is a green symbol (letter S). It appears when flap selector is in position 1.

The positions and maximum speeds with slats and flaps extended are given in the table below:

MAXIMUM FLAPS/SLATS SPEEDS

Lever Position	SLATS	FLAPS	AILERONS	Ind. on ECAM	MAX SPD	FLIGHT PHASE
1	16	0	0	1	240	HOLDING
		8	5	1 + F	215	TAKEOFF
2	20	8	10	2 (a)	205	APPROACH
	20	14	10	2	196	TAKEOFF/APPROACH
3	23	22	10	3	186	TAKEOFF/APPR/LDG
FULL	23	32	10	FULL	180	LANDING
(a) This slats/flaps position corresponds to CONF 1*						

1.6.4 Autopilot modes

1.6.4.1 General philosophy

Guidance is provided by two kinds of AP/FD modes:

- **Managed modes**. Guidance according to the lateral and vertical profiles is developed by the FMGEC on the basis of the data inserted by the crew in the MCDU.
- **Selected modes**. Guidance is carried out on the basis of the flight parameters selected by the crew on the FCU.

The modes that provide guidance in the lateral and vertical plans aircraft can be armed, engaged or disengaged. When the modes are armed, it means they are ready to be engaged to provide guidance when the engagement criteria are met.

The Flight Mode Annunciator (FMA) on the upper part of the PFD indicates the status of the A/THR and AP/FD modes, and the landing capability. It reflects the inputs made by the crew via the MCDU on the FCU and the auto-throttle. According to the manufacturer's procedures the crew must verify and call out status changes for each mode. The FMA has five columns, each consisting of three lines. In the first three left columns the modes engaged are displayed in green on the first line while the armed modes are displayed in blue or magenta on the second line. Special messages relating to the flight controls and the Flight Management and Guidance System (FMGS) appear on the third line. In the fourth column, the landing capabilities are displayed in white on the first two lines while the Decision Height (DH) or the MDA is displayed in blue on the third line. In the fifth column, the engagement status of the AP, the FD and A/THR is displayed in white. The A/THR indication is displayed in blue when it is armed but inactive.

1.6.4.2 Non-precision approach

To perform a non-precision approach, three options are available:

1. Lateral and vertical guidance selected by the crew: TRK and FPA modes (HDG and V/S).
2. Lateral guidance managed by the FMGEC and vertical guidance selected by the crew: NAV and FPA modes (or NAV and V/S). The NAV mode can be used if the approach procedure is included in the navigation database and if its description, in the lateral and vertical plans, is validated by the crew).
3. Lateral and vertical guidance managed by FMGEC: FINAL APP mode.
   Pressing the APPR pushbutton on the FCU before reaching the FAF engages this approach mode. The crew must first verify that the APPR NAV mode is engaged and the FINAL vertical mode is armed and then, when the engagement conditions are met, that the common mode FINAL APP is engaged. This mode can be used in Instrument Meteorological Conditions (IMC) if:
   - The approach in the database has been validated and approved by the operator;
   - The crew does not change the final approach encoded in the database;
   - Before starting the approach, the crew checks the approach path from the navigation database as displayed on the MCDU or the Navigation Display (ND) against the published approach path;
   - the approach path is intercepted laterally and vertically before the FAF or an equivalent position, to ensure that the aircraft is correctly established before beginning the final approach;
   - the crew monitors the final approach path with appropriate facilities (radio navigation, distance to the runway threshold or Missed Approach Point (MAPt), altitude, FPV, etc.)

In all three cases, the reference displayed on the PFD must be the speed vector FPV ("bird"), which should be selected during the initial approach. The "bird" is selected by pressing the "HDG-V/S / TRK-FPA" pushbutton on the FCU.

1.6.4.3 Guidance modes

1.6.4.3.1 Lateral modes

TRK mode: provides lateral guidance to follow a route (TRK) selected by the crew. The required value is displayed in the HDG/TRK window on the FCU.

NAV mode: provides lateral control to follow the flight plan entered in the MCDU by the crew. When engaged, the altitude constraints associated with the turning points of the lateral flight plan are taken into account in the managed vertical guidance modes. Similarly, the speed constraints related to the turning points of the lateral flight path are taken into account in managed speed mode.

1.6.4.3.2 Vertical mode

FPA mode: is used to capture and maintain the flight path slope displayed in the V/S – FPA window on the FCU. The selected mode is engaged by pulling the V/S – FPA selector on the FCU.

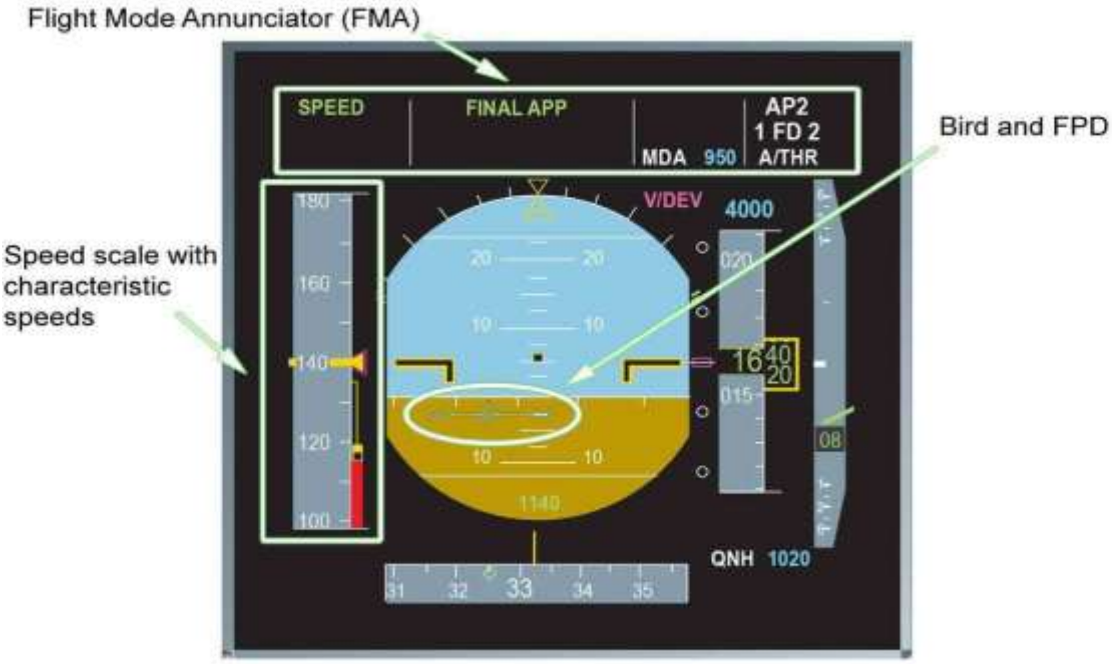
1.6.4.3.3 Common mode

FINAL APP mode: provides lateral and vertical guidance to follow a along a theoretical flight path developed by the FMGEC, for a non-precision approach entered in the MCDU. Guidance is provided as far as the MDA, at which point the pilot takes over manual control of the aircraft.

The MDA is selected on one of the pages of the MCDU (PERF APPROACH). By pressing the APPR button on the FCU when the aircraft is above 400 ft and a non-precision approach has been selected on the MCDU, the FINAL and APP NAV modes are armed and displayed on the FMA. If the NAV mode has already been engaged, the APP NAV mode engages immediately. As soon as the conditions for engaging the vertical mode are satisfied, the mode FINAL APP engages, to achieve and maintain zero deviation from this flight path. This mode is displayed on the first line and in second and third columns of the FMA. Guidance is provided to the MDA – 50 ft, at which altitude the AP, if used, is automatically disengaged. The common managed mode FINAL APP can then be used if the following conditions are met:

- The non-precision approach procedure is defined in the navigation database;
- The non-precision approach procedure defined in the navigation database has been checked by the crew against the published approach procedure;
- The crew has not altered the final approach in the flight plan page of the MCDU.

1.6.4.4 Presentation of information on the PFD



1.6.5 Aircraft Weight and balance

At take off from Johannesburg Aircraft total weight was 187,501 Kgs and centre of gravity was 27.2 MAC During flight to Tripoli Aircraft burned 43,000 Kgs fuel and the landing weight was 144,501 Kgs and centre of gravity was 28.2 MAC Aircraft weight and centre of gravity were not a factor in the Accident.

1.6.6 Aircraft Maintenance History

AFRIQIYAH Airways own a fleet of airbus A319/ A320 & A330; their maintenance is based at Tripoli International Airport. Line Maintenance activities on A330 is done by maintenance personnel employed by AFRIQIYAH Airways under LIBYAN CAA & company approval.

Training

AFRIQIYAH maintenance staff was trained on A319/A320 Aircraft at Airbus training center in HUMBERG and on the A330 at TOULOUSE Airbus training center, they had the theoretical and practical experience on Aircraft type in fulfillment of the company and LYCAA requirements.

Facilities

- **Maintenance facilities** at Tripoli is basically tools and equipment capable of doing preflight, transit, daily, weekly, Line replacement unit (LRU), and troubleshooting tasks.
- **Non routine work** requires high skills or special test equipment are usually out sourced from EASA approved companies.

- **Heavy maintenance** such as A, C checks, and Modifications are contracted with EASA and LYCAA approved repair stations under the supervision of AAW maintenance control.
- **Engineering and planning** are done in house by the use of electronic software called AMASIS, entries are made by maintenance control center, planning, engineering, and stores. Collected data on the Aircraft generated electronically as a work package and passed over to maintenance for performance.

Out stations maintenance services

AFRIQIYAH Airways signed a maintenance support contract with South Africa airways based in O.R Tambo (Johannesburg) International Airport, this technical support center has been approved by the Libyan authority (LYCAA) on February the 15th 2010 and authorized for line maintenance work such as Preflight and Transit checks and snag rectifications (Approval Number 11/10) valid until 14/02/2011.

Crashed Aircraft maintenance

5A-ONG A330-202 was delivered at Toulouse airport on 15/09/2009

From date of delivery Aircraft flying hours and cycles are counted, also technical follow up was carried out by AFRIQIYAH Airways AMASIS system including removals, installations, Ads, SBs, Modifications implementation. The technical history of the Aircraft is preserved in hard copies such as papers, manuals, and log books, also as an electronic format in the AMASIS server.

Checks:

Preflight: carried out before the first flight of the day.

Transit: Carried out between every two flights.

Daily: Carried out every day not exceeding 36HR.

Weekly: done once every week on fixed day.

Out of phase: maintenance work generated electronically and due by Aircraft hours or cycles.

A check: Work package generated every 800 hours including all maintenance tasks required by the maintenance schedule, and other technical follow up.

For this Aircraft **A1** was done at Air Algerie on 10/12/2009.

A2 was done at Lufthansa Milano on 05/03/2010.

C check: Work package generated every 20 calendar months including all maintenance tasks required by the maintenance schedule, and other technical follow up. In this case (crashed aircraft) the calendar time was less than 20 months.

Aircraft incident record:

Since date of delivery, only two incidents reported on this Aircraft.

- The upper ceiling of the aft cargo was damaged during cargo loading, damage classified as minor and repair was done to the panel.
- FOD damage to engine No.2 fan blades during Take off at Tripoli International Airport, Boroscope inspection carried out no damage found in the core of the engine, four blades replaced and balanced then Aircraft was released back to service on 17/04/2010.

48 hours before the crash

On 10/05/2010 Work at Tripoli after Flight 8U901 Paris (CDG) – Tripoli (TIP), technical log book page (**013303**) (*left nose wheel and number 3 main wheel replaced due to wear*), and Aircraft ETOPS check list was carried out but no snags recorded by flight crew (written ***Nil***).

On 11/05/2010 Work at Johannesburg after Flight 8U770 Tripoli – Johannesburg technical log book page (**013304**) no snags recorded by flight crew (written ***Nil***), ETOPS check list performed.

Repetitive Snags

During the past ninety days prior to the accident one repetitive snag related to aircraft controls recorded in the Aircraft technical log book, this snag indicates that the captain side stick priority push button had sticky operation and delay in returning to the off position.

First report was on 25/03/2010 stating (*AP1 disconnect button is some times stuck giving* ***priority left*** *call on disconnection*) as a reaction from the maintenance the button cleaned with contact cleaner and tested found OK.

Second report was on 29/03/2010 stating (*LH side stick AP / priority push button stays in for 4 sec before coming out*) as a reaction from the maintenance the button cleaned with contact cleaner and tested found OK.

When this snag occurred the Airbus maintenance manual did not cover the procedure for rectification and work carried out by the maintenance team was done according to common practices.

After the accident the investigation committee informed the Airbus about this matter and an amendment to the maintenance procedure was added by the Airbus according to Task Number 27-90-00-810-912-A issued on Jul 01/2011.

1.7 Meteorological Information

1.7.1 General

This chapter presents the TAF and METAR weather elements that were available in the accident date.

1.7.2 General Situation

The weather elements listed below reflect normal seasonal weather conditions and known by all the crews, especially with the possibility of mist or fog at sunrise, or sandstorm during the day.

Sunrise is at 04 h 11 and azimuth is at 067° 52'.

1.7.3 Meteorological situation in Tripoli

METAR

```
METAR HLLT 112030Z 36003KT 7000 HZ SKC 23/15 Q1008
METAR HLLT 112050Z 35001KT 7000 SKC 23/15 Q1008
METAR HLLT 112250Z 32005KT 7000 SKC 21/17
METAR HLLT 112350Z 31004KT 7000 SKC 20/17 Q1008
METAR HLLT 120250Z 35003KT 6000 SKC 19/17 Q1008
METAR HLLT 120350Z VRB01KT 6000 NSC 19/17 Q1008
METAR HLLT 120420Z 27007KT 5000 BR NSC 19/17 Q1009=
SPECI   HLLT 120425Z 27008KT 2000 BR NSC 19/17 Q1009=
METAR HLLT 120450Z 26007KT 2000 BR FEW003 19/17 Q1009=
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TAF

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HLLT 112300Z 1200/1224 36005KT 7000 NSC PROB40 1200/1206 5000 BR
BECMG 1206/1208 FEW025 SCT100 PROB30 TEMPO1209/1215 7000 – RA
BKN080 BECMG 1212/1214 03010KT NSC BECMG 1216/1218 22015KT=
```

ATIS

After listening to the SSCVR, two ATIS messages could be partially heard and are transcribed below. The recording quality of the SSCVR made it impossible to determine which ATIS is involved.

- At 03 h 21 min 00, "... *wind calm, visibility 7 km, sky clear, temperature 19°C, dew point 17°C, QNH 1008* ..."
- At 03 h 28 min 00, *"... visibility 8 km, temperature 22°C, dew point 21°C, QNH 1008* ...".

1.7.4 Weather information received in flight

The radio communications recorded as well as the SSCVR transcript indicates that the crew had received weather information relevant to the conduct of the flight. In particular, the crew received the above messages.

1.8 Aids to Navigation

Tripoli International Airport is equipped with the navigational aids equipment necessary for departure, approach and landing to the airport, Aircraft was approaching to runway 09.

Last calibration report of Tripoli International Airport Nav. Aids is contained in Appendix 3.

1.8.1 Navigation Aids serving Runway 09

- Locator TW located on the extended runway 09 centre line at 3.9 NM on frequency 301 kHz,
- Locator D located on the runway 09 centre line on frequency 435 kHz,
- TPI VOR/DME on frequency 114.500 MHz at (N 32:39.48 E 13:09.18) and used for departure and approach.

1.8.2 Navigation Aids serving Runway 27

- Locator PE located on the extended runway 27 centre line at 4.1 NM on frequency 390 kHz,
- Locator G located on the runway 09 centre line at 0.6 NM on frequency 365 kHz,
- ILS CAT II on frequency 109.500 MHz,
- TPI VOR/DME on frequency 114.500 MHz at (N **32:39.48** E **013:09.18**).

All navigational aids were operating normally except TPI VOR/DME which restricted since there was a possibility of deviation due to Tripoli International Airport working site equipment according to NOTAM A0033/10 (Appendix 3).

1.8.3 Radar Services

Tripoli ACC was equipped with a secondary radar serving area and approach control and was working normal before and during time of accident.

1.9 Communications

Communications were conducted normally between the aircraft and the air traffic controllers en-route as well as Tripoli FIC, ACC / Approach and Tripoli tower on all frequencies.

After aircraft entered Tripoli FIR, the flight crew had made the following contacts:

- Tripoli ACC on frequency 120.900 MHz,
- Tripoli TWR on frequency 118.100 MHz.

At the time of the accident, the ground frequency was not in use and both air and ground movements were consolidated on the same frequency 118.100.

The transcript of the exchanges between the controllers of the Libyan airspace and the crew during approach is presented in appendix 2 in the SSCVR transcript.

1.10 Aerodrome Information

1.10.1 Infrastructure

Tripoli International Airport is a controlled airport, open to public air traffic and located thirty kilometres south of Tripoli. Published Airport Information contained in Appendix 5.

The reference elevation of the airport is 266 ft. The airport has two paved runways:

- The 09/27 is 3,600 x 45 meters and its real direction is 089/269 and its elevation is 264/264.9 with 1.37 E, magnetic variation.
- The 18/36 is 2,600 x 45 meters and its real direction is 177/357 and its elevation is 241.5/267.4 with 1.37 E, magnetic variation (Not in use).

At the time of the accident, i.e. about ten minutes before sunrise, the active runway was the 09 whose threshold elevation is 264 feet. The lighting for this runway consists of:

- High-intensity approach lighting system with white lights, about 700 meters long;
- Runway lights;
- Precision Approach Path Indicator (PAPI) system.

Airport Information as follows:

- Airport Coordinates: N 32:39.48 E 013:09.18.
- Runway length: 3600m.
- Runway width: 45m.
- Runway surface: PCN100.
- Runway direction: 089/269.
- Aids to Navigation: (TW,D) Locators + TPI VOR / DME
- Elevation: 264 ft.

The level of protection of the safety, rescue and aircraft fire fighting services was nine (ICAO classification), which corresponds to six airport fire-fighters and a dispatcher, with three fire trucks.

The Air traffic Control Tower – the control tower listed as 28 m high, is located 450 m north of the middle runway 09/27, and 2025 m of threshold runway 09. The controllers have an unrestricted view of the runway and the taxiways leading to the runway. The distance between the tower and impact point was about 3200 m and there were 3 controllers at the tower in the accident time.

1.10.2 Arrival procedure

Generally, in the Tripoli Terminal Control Area (TMA), arrivals are carried out under radar vectoring until intercepting the extended centreline of the final approach segment.

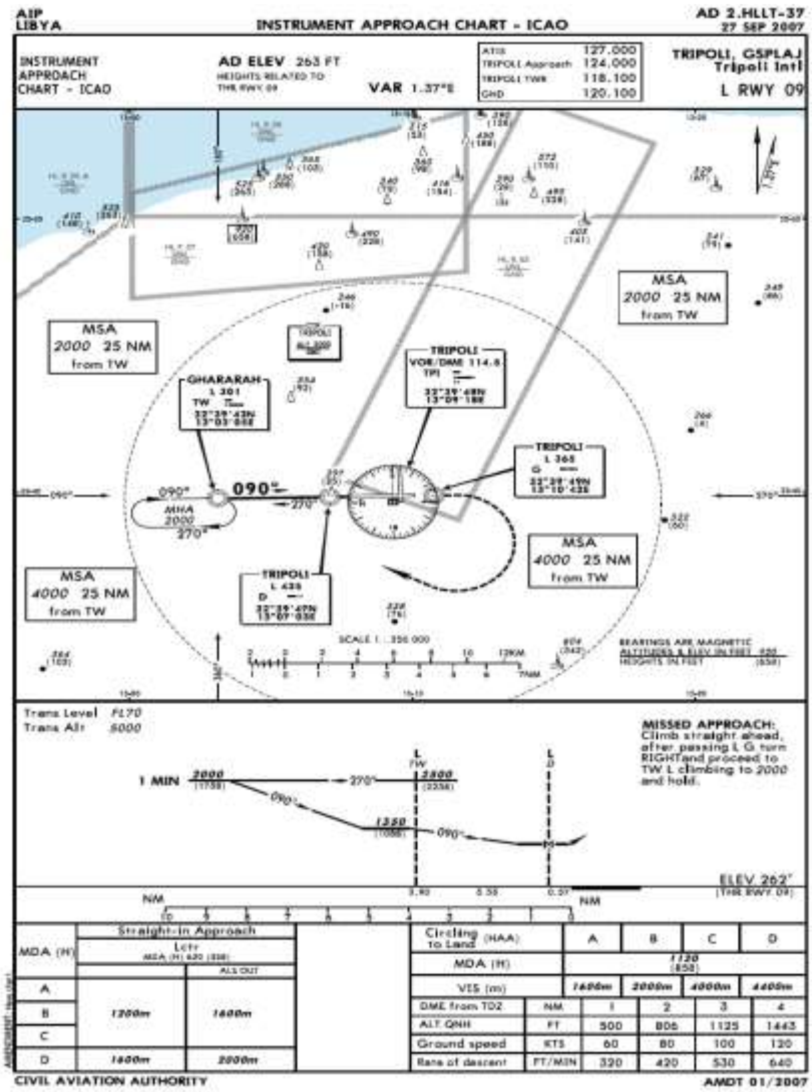
Vectoring ends 10 NM from TPI.

When runway 09 in use and before applying the approach procedure, the arrival is usually carried out by intercepting the inbound radial 270 of TPI VOR/DME without descending below 2,000 ft until 10 NM from this VOR/DME.

1.10.3 Approach procedure to runway 09

The approach procedure to Locator 09 of 27 September 2007 is detailed on the official Instrument Approach Chart (IAC) map, which is reproduced below. For the final approach, passing Locator TW at 3.9 NM from the runway 09 threshold and 5.2 NM from TPI VOR/DME is performed at 1,350 ft. The MDA is 620 ft and the minimum visibility is 1,600 meters for a category D aircraft such as the A330. The MAPt is Locator D at 0.57 NM from the 09 runway threshold.

The approach chart does not specify a glide slope from the Locator TW but shows a table of crossing altitudes against distance, called DME, from the 09 runway threshold. A rate-of-descent speed is also given as a function of the ground speed of the aircraft for the final approach.



1.10.4 Choice of the active runway

Runway 09 was active on the evening of 11/05/2010, the day before the accident, since weather conditions had not changed significantly, this configuration was retained on the morning of May 12, 2010. The observed weather conditions (METAR 1.7.3) at the time of the accident were not inconsistent with a Locator approach to runway 09.

1.11 Flight Recorders

In accordance with the regulations in force, the aircraft was equipped with a Cockpit Voice Recorder (SSCVR) and a Flight Data Recorder (SSFDR).

1.11.1 Cockpit voice recorder

The SSCVR was a protected recorder capable of reproducing at least the last two hours of recording:

- Model: L3Com FA2100
- Type number: 2100-1025-02
- Serial number: 596102.

The following tracks were recorded:

- VHF and headset microphone of the Captain (left seat) of two hours duration,
- VHF and headset microphone of the co-pilot (right seat), of two hours duration, public address, of two hours duration,
- Cockpit Area Microphone (CAM), of two hours duration.

1.11.2 Flight data recorder

The SSFDR was a protected recorder capable of reproducing at least the last twenty-five hours of recording:

- Model: L3Com FA2100
- Type number: 2100-4043-02
- Serial number: 580367.

1.11.3 Data readout

The SSCVR and the SSFDR were remitted to the BEA by the designated investigator on Thursday 20 May 2010 for analysis. The recordings were of good quality and the whole flight was included.

The graphs of the flight parameters are in appendix 10. An extract from the transcript of the SSCVR recording is given in appendix 2.

The recordings were synchronized in UTC based on the parameters UTC Hours, UTC Minutes, UTC Seconds, VHF1 manual radio transmitter and the alarms.

1.11.4 Events recorded

The following information comes from recordings of the two flight recorders. Throughout the flight, the flight control law was *normal* law.

Note: In the following sections, the modes recorded and displayed in green on the FMA are indicated as presented in section 1.6.3.1. As the armed vertical and lateral modes are not registered, these are not indicated.

The symbols ① (circled figure) are used to identify the important steps on the flight path.

The recorded value of the barometric setting of the Captain's and co-pilot's altimeters was 1008 hPa. The PA 2, the FD 1 and 2 and the A/THR were engaged.

At 03 h 29 min 50, the co-pilot called out "*runway 09 NDB approach, autobrake low*".

At 03 h 49 min 29, the crew called out *"1008, activate approach phase".*

At 03 h 54 min 42, the crew selected Flight Path Vector (FPV) on the FCU (push button HDG/VS – TRK/FPA on the FCU).

At 03 h 55 min 01, the FPV ("Bird") was selected by pressing the button "HDG/VS – TRK/FPA" on the FCU.

At 03 h 56 min 33, the selected altitude was 1,400 ft.

At 03 h 57 min 18, the aircraft was 10 NM from TPI at 1,920 ft. The configuration of the slats and flaps was a CONF 1.

At 03 h 57 min 35 ①, the Captain asked the co-pilot, who agreed, to carry out the approach in "*Nav approach"*.

Six seconds later, the approach controller gave the crew a clearance for a Locator approach to runway 09.

At 03 h 57 min 51 ②, the Captain called out "*Track FPA*" and the co-pilot replied "I *will do it [when] establish*".

At 03 h 58 min 24, the crew selected CONF 2 configuration.

At 03 h 58 min 25 ③, the aircraft altitude was 1,400 ft. NAV and ALT modes were engaged and the aircraft route was 089 degrees.

At 03 h 58 min 46 ④, the Captain asked the co-pilot "*Give it to the approach now or this*". A few seconds later, the crew engaged the APP NAV mode for lateral guidance and armed the FINAL mode for vertical guidance by a pressing the APPR button on the FCU. At 03 h 58 min 54, the common guidance mode FINAL APP was engaged. The aircraft was at a distance of about 8 NM from VOR TPI, its altitude was 1,400 feet and its speed 149 knots. Two seconds later, the co-pilot called out "*Final Approach*", displayed on the FMA:

A/THR MODE	AP/FD VERTICAL MODE	AP/FD LATERAL MODE	APPROACH CAPABILITIES	AP FD A/THR STATUS
SPEED	FINAL APP		MDA 620	AP2 1FD2 A/THR

At 03 h 59 min 03, the crew selected CONF 3 for the slats and flaps.

At 03 h 59 min 14 5, the aircraft was in landing configuration. Its speed was 144 knots and its altitude 1,400 feet. The co-pilot called for the landing checklist.

A 03 h 59 min 19, the approach controller told the crew to continue the approach and to call back when they had the runway in sight.

At 03 h 59 min 24 6, the FPA mode was engaged on the FMA after the crew had selected a descent angle of -3.0 degrees on the FCU. The aircraft was 6.5 NM from TPI VOR, i.e. 1.3 NM from the Locator TW, but still 5.2 NM from the runway threshold.

A/THR MODE	AP/FD VERTICAL MODE	AP/FD LATERAL MODE	APPROACH CAPABILITIES	AP FD A/THR STATUS
SPEED	FPA -3.0	NAV	MDA 620	AP2 1FD2 A/THR

At 03 h 59 min 32 7, the co-pilot called out "*Minus three degrees Sir*". At the same time, the Captain of the preceding aircraft that had just landed called the Captain by his first name on the approach frequency to warn him about the presence of low stratus cloud. The Captain replied and thanked him.

At 03 h 59 min 35, the selected altitude was 2,000 ft.

A 03 h 59 min 58, the aircraft passed over Locator TW at an altitude of 1,020 ft (QNH).

At 04 h 00 min 01 8, the co-pilot called out passage over Locator TW. The aircraft altitude was 980 feet and its speed 128 knots. One second later, the Captain told the approach controller that he was on final approach and would call again when they had the runway in sight.

At 04 h 00 min 10, the Captain contacted the approach controller to confirm that he was cleared to land if the runway was in sight. At 04 h 00 min 13, the approach controller gave him clearance to land.

At 04 h 00 min 24 9, when approaching the MDA of 620 feet, and following the "HUNDRED ABOVE" callout by the synthetic voice, the Captain called out "*Continue*". The co-pilot responded by also calling "*Continue*".

At 04 h 00 min 30, the aircraft was at the MDA, and 2 NM from MAPt.

At 04 h 00 min 36, the co-pilot asked the Captain whether he should abort the approach.

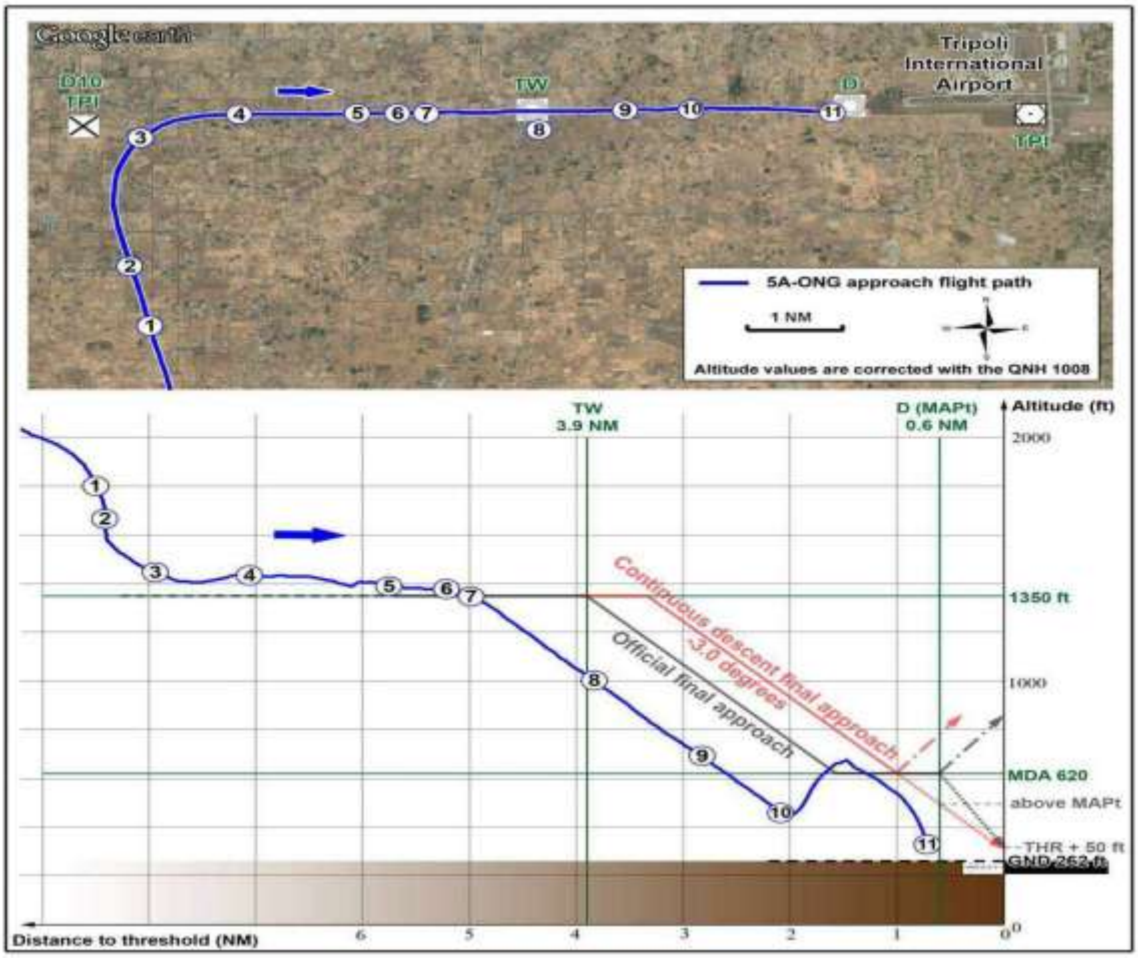
At 04 h 00 min 42 (10), at a height of 280 feet (AGL), the TAWS "TOO LOW TERRAIN" warning sounded and the Captain reacted by calling out "*Go around go around go around*". When the Captain's called to abort the approach, the autopilot was disengaged by pressing the "instinctive disconnect" push button. The co-pilot then made a nose-up input.

At 04 h 00 min 44, the thrust levers were positioned in TOGA. Nose-up inputs were applied on the co-pilot's side stick; the pitch attitude initially increased from 2.1 to 12.3 degrees nose-up and the altitude initially increased from 460 to 670 feet (QNH), The aircraft also switched from landing configuration to configuration 1 and the landing gear was in the retracted position, following the crew selection at 04 h 00 min 53.

From 04 h 00 min 47 onwards nose-down inputs were applied for 21 seconds. During this period, the pitch attitude and altitude reached 3.5 degrees nose-down and 524 feet (QNH), at 04 h 01 min 08.

From 04 h 01 min 07 onward, the TAWS "DON'T SINK", "TOO LOW TERRAIN" and "PULL UP" warnings respectively were recorded by the SSCVR.

The SSFDR recording ended at 04 h 01 min 13 (11) . Chronology of end of accident flight is shown in APPENDIX 11.



End of the flight path of 5A-ONG

1.12 Wreckage and Impact Information

1.12.1 Description of crash site

The impact site was located on a sandy plain dotted with trees, 1,200 m from the threshold of runway 09, at an altitude of about 260 feet, outside the airport. The wreckage was spread over a rectangular area of 800 m long and 90 m wide, oriented 94 degrees, and some debris was found within the airport.

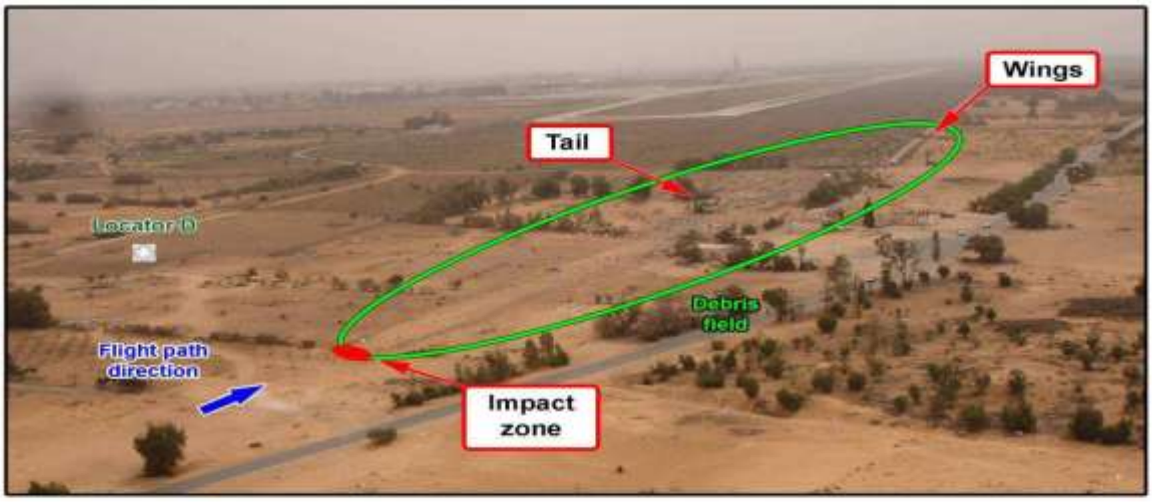
Location of crash site

Initial observations show that the aircraft struck the ground with high energy and high longitudinal velocity.

1.12.2 Wreckage distribution

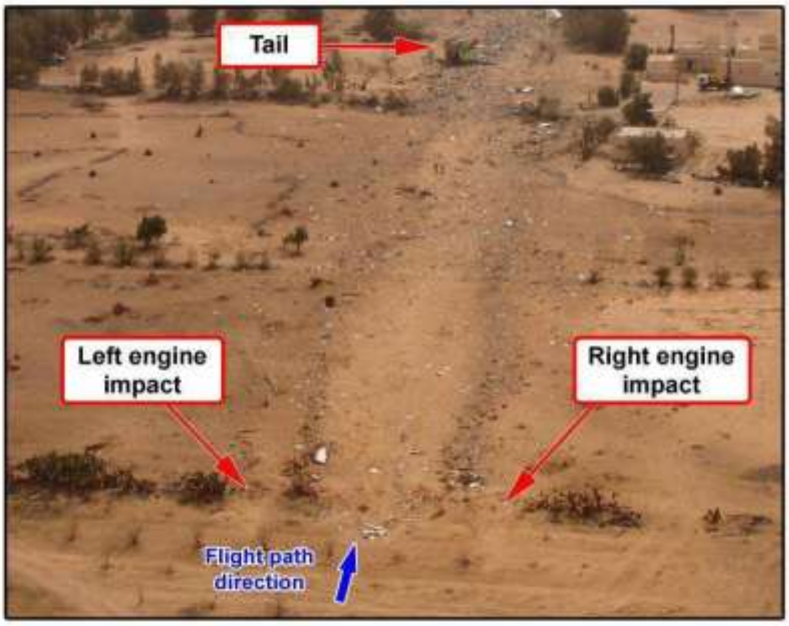
Tree-tops were broken over an area located a few meters before the impact zone; elements of the aircraft broke away as a result of these contacts.

The first debris found in the impact zone comes from the soft underbelly of the aircraft, the landing gear doors and the nacelles of the two engines. It should be noted that debris from these parts of the aircraft were scattered over several hundred meters from the point of impact. No trace of the landing gear was observed at this location.



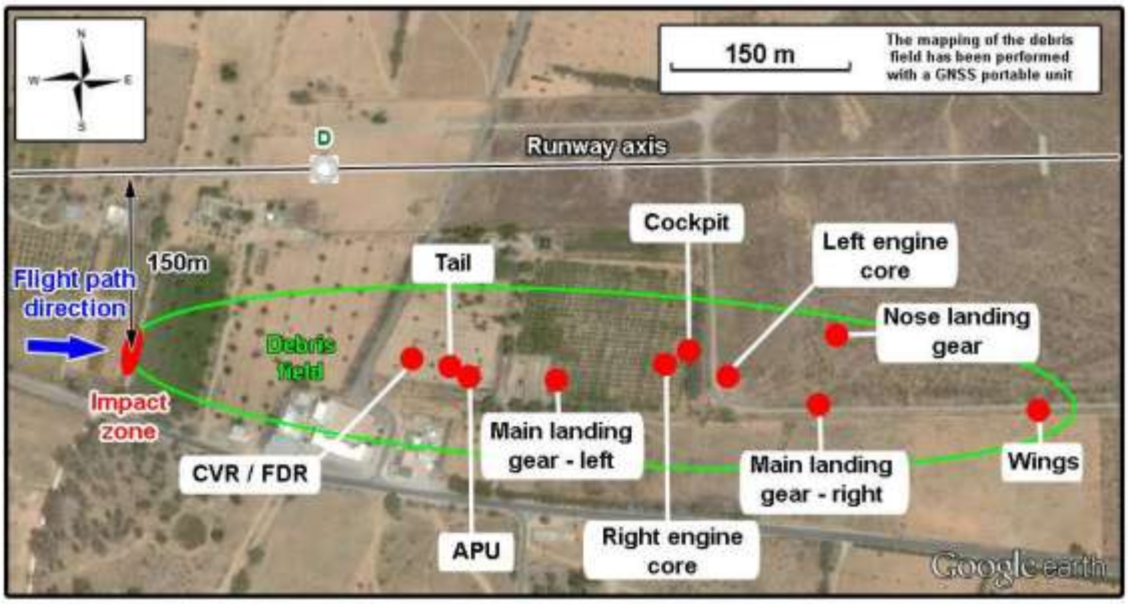
Aerial view of the debris field

Many small fragments belonging mainly to the mid and aft sections of the fuselage were distributed eastwards from the impact zone; pieces from the front section of the fuselage were found 180 m from the impact zone.



Aircraft ground impact

The first large items from the wreckage were distributed 270 m from the impact zone: the vertical stabilizer, the left Main Landing Gear (MLG), engine #1, the cockpit, engine #2, the right MLG, the nose gear, and finally the wings in the eastern part of the debris field. The latter bore significant fire marks.



Distribution of the debris field

The rear structure of the aircraft was located at about 275 m from the impact zone, comprising the tail section and the vertical stabilizer, with the main shaft of the Auxiliary Power Unit (APU) nearby. The adjusting screw of the Trimmable Horizontal Stabilizer (THS) was found broken. The nut was at a distance of 20.0 cm from the output bearing of the actuator.

This value corresponded to a 3° nose-up position of the THS.

The two flight recorders were found a few meters before the tail section.

1.12.3 Slats, flaps and landing gear

The flap control, found near the cockpit, was positioned on 0.

The position of the flap servo controls indicates that they were close to the "retracted" position. The observations made on the slat rails of the left wing indicate that slats were "extended". It should be noted however that the observed positions after impact may not accurately reflect the status before the impact, given the loads experienced.

The landing gear control was positioned on "retracted".

The landing gears were badly damaged. The locking mechanism of the left main gear was found locked in "retracted" position.

The position of the right gear could not be determined

The door closing mechanisms of the MLG were found to be "unlocked in retracted position."

1.12.4 Engines

Both engines were badly damaged. All the pieces of equipment attached to the periphery of the fan housing were torn off and scattered around the site.

On both engines, the housings of the fan, high pressure compressor, combustion chamber and high and low pressure turbines were deformed as a result of bottom- upwards compression loads.
All fan blades were damaged (broken or highly bent). The blades of the visible discs (low pressure turbine, fan, compressor, etc.) were broken.

The damage to the rotating assemblies of the engines indicated that the engine speeds were high at the time of impact.

The engines showed no evidence of pre-impact mechanical failure

The engines had no visible signs of a fire.

1.12.5 Emergency locator transmitter (ELT)

Libyan regulations as well as ICAO standard require Aircrafts to be equipped with emergency locator transmitter (ELT). The purpose of this equipment is mainly to send electromagnetic signals on 406MHz to identify the aircraft and its position in case of accident or emergency cases.

The aircraft was equipped with one fixed automatic Emergency Locator Transmitter (ELT) and two portable manually activated survival beacons. The fixed automatic emergency locator transmitter is normally secured on the upper part of the fuselage, between frames 66 and 67; it is connected to an antenna attached to the fuselage, and all of them had been recovered from the crash site, although the aircraft had been subjected to a very high vertical and longitudinal deceleration no ELT signal was transmitted by any of them.

1.12.6 Summary of wreckage examination

Examination of the accident site showed that the aircraft collided with the ground with its wings horizontal and a pitch attitude that was almost level. After the initial high-energy impact, the aircraft slid longitudinally over a distance of about 800 m, gradually disintegrating, as indicated by the scattering of debris.

Examination of the wreckage also made it possible to determine that the engine speed was high and the aircraft configuration was as follows:

- Landing gear retracted;
- Landing gear doors in transition;
- Flaps partially retracted and slats extended, which corresponds to position 1 of the slat and flap control lever;
- Position of the THS: 20.0 cm between the nut and the output bearing of the electric actuator. This value corresponded to a 3° nose-up position of the THS.

1.13 Medical and Pathological Information

1.13.1 Cockpit Crew Medical checks

According to ICAO Annex 1 and Libyan Civil Aviation Act No 6 of 2005, any flight crew must hold a valid medical certificate to practice the privileges of his/her license, in order to satisfy that requirement he/she has to pass through a medical check on preset bases to maintain his/her medical fitness with an approved medical examiner.

The medical records of both co-pilots were reviewed by the committee found free of any irregularities during their operational past.

By reviewing the Captain medical records, it was found that all checks were satisfactory except his blood pressure which was as follows:

Date	Blood pressure
07/2003	120/80
12/2003	120/80
06/2004	120/80
11/2004	120/80
05/2005	130/80
11/2005	130/80
05/2006	130/80
11/2006	120/80
06/2007	120/80
11/2007	130/80
05/2008	140/80
11/2008	130/80
29/06/2009	**180/100**
30/06/2009	**170/100**

As indicated on the table, on June 2009 the captain blood pressure was recorded as 180/100 on 29/06/2009 and the next day 30/06/2009 was 170/100 but his medical certificate was issued without any restrictions. A remark was found in his medical file (*for follow up periodically for B/PR check and later for ECG, Stress*).

Since the new regulations was amended to be in consistency with the current ICAO Requirement extends the validity of the medical certificate for 12 months, so the medical certificate held by the captain issued on 30/06/2009 assumed to be valid up to 29/06/2010.

Consequently, the Director General of Civil Aviation Authority of LIBYA has revoked the approval of the concerned medical examiner.

1.13.2 Pathological Information

Post mortem examination of the victims indicated that all fatalities resulted from sever trauma.

Toxicological testing on tissue samples obtained posthumously from the captain and first officer was completed. The samples test result found negative of alcohol, major drugs abuse, prescription and offer the counter medication.

The rescue team did not properly indicate and label the exact position of all victims' bodies.

1.14 Fire

During crash site investigation, and the examination of the wreckage it revealed no sign of fire present in the Aircraft before the impact. From the examination of wreckage the aircraft caught fire after about 500 meters from the first impact and it was only limited signs of fire at the beginning, then huge fire at the area of the main wreckage where the wings and fuel tanks located.

At 04:02:32 Tripoli Tower controllers alerted the fire station of the airport and direct them to the crash site at the beginning of runway 09.

At 04:05:12 Tripoli Tower controller could not confirm the arrival of fire trucks to the crash site.

At 04:07:22 Tripoli Tower controllers informed search and rescue coordination centre, when the fire trucks arrived to the crash site the fire was in the bushes at the cockpit wreckage area, and wing fuel tanks.

During the whole action of firefighting there was no means of direct communications between the fire brigade and Airport control Tower.

1.15 Survival Aspects

Wreckage and debris distribution and the Electrical discharge of 11,000 volt due to Aircraft impact with the high tension power line then heavy impact with ground, minimised survival possibilities resulted in only 1 survivor as well as it was not possible to use any survival equipment on board the Aircraft.

1.16 Tests and Research

1.16.1 Study of spatial disorientation

A study of spatial disorientation was carried out. It is included entirety in appendix 6

1.16.2 Study of fatigue

An assessment of the crew's sleepiness was performed by a specialized laboratory. It is included entirety in appendix 7.

1.16.3 Captain's side stick Analysis and Examination

Reference to (1.6.6) with regard to Side Stick snag, investigation committee requested the examination of the side stick priority button on the left side. In fact, during two previous flights in March 2010, crews had reported that the button returned slowly to the neutral position after being pressed. Examination of the side stick unit was performed at Ratier Figeac plant in February 2011. Further analysis was carried out in June 2012 at Crouzet, manufacturer of the push-button. See Appendix 8.

Ratier Figeac Examination

Members from investigation committee attended the first examination that carried out in Ratier Figeac plant in February 2011 at which the physical examination was carried out and the force required to press the button was compared with a new side stick push button. The result was that the force required to push the crashed aircraft push button was almost twice the force required for the new one, as well as it has been noticed that a time delay for the button to return to the neutral position after depressed, also there were scratches due to friction in the push button. For further detailed analysis for the push buttons it was decided to take the unit to Crouzet, manufacturer for dismantling.

Crouzet Examination

Further test in the manufacture Crouzet was suppose to be conducted with in one month from Ratier Figeac plant visit but, because of the Revolution in Libya this visit was delayed till June 2012 in which the button was tested. The test results were as the following:

- Evidence of exposure to sand dust contamination
- The mechanical function is conform to the requirement
- Contact resistance is not conform on 2 contacts

Due to unknown contamination in the unit, it was decided to send the unit to DGA EP laboratory for chemical analysis.

DGA EP Lab Examination

A chemical analysis conducted in the DGA EP laboratory on the push button and revealed the following:

- Particles and deposits found inside and on the outer surface of the black sleeve are consisting of sand and calcium carbonate. These particles deposits may correspond to atmospheric dust or be caused by the ground where the accident took place.
- The particles found on the outer surface of the red button consist of sand.
- The greasy deposit found on the red button is similar to the deposit found on the contact pad. The infrared spectrum is similar to that of the (guar gum). The precise origin of this product is however identified. The laboratory rarely encountered this type of product. This Product is commonly used:
  - As flame retardant.
  - For the execution of works of hydraulic fracture.
  - Or, in the explosive industry.

  This product is also widely used in food industry.

Additional analyzes by GC / MS of fatty deposits located on the external surface of the red button:

Analysis by GC/MS (gazeuse couplée à la spectrométrie de masse) indicated the presence of phthalates and molecules with functions “ester”.
Phthalates are widely used as plasticizers in plastics. They could come from red plastic.

The ester-based products may be used in particular in lubricants. However, the small amount of product analyzed after extraction did not reveal the presence of an oil or fat known.

1.16.4 Analysis of ACARS Messages

For the reason of confirming the technical status during the flight, the investigation committee sent the down link data recorded by the ACARS just before the crash to the BEA for analysis and their answer was the analysis of ACARS messages didn’t reveal any evidence of aircraft system failure.

1.16.5 Simulator sessions

Two simulator sessions (one Fixed Base Simulator and one Full Flight Simulator) were organized at Airbus facilities in Toulouse to simulate the crash flight and to compare readings of flight recorders with the results of the simulator data.

Members of the investigation committee attended the two simulator sessions in the presence of BEA investigators and Airbus specialists and the tow sessions were as follows:

- The first simulator session was On February 2011 using the Fixed Base (development) Simulator where the event of the crash scenario of the Non Precession Approach (NPA) at Tripoli run way 09 locator approach simulated by two airbus pilots. The development simulator can be:
  - Configured with all system relevant to the crashed aircraft (5A-ONG).
  - Locator approach to Tripoli can be simulated using FMS data base DME10, TW, D, Runway.

- The approach to runway 09 with different visibility.
- High performance recording of parameters of aircraft and systems.

  - The second simulator session was performed on June 2012 using the training simulator with full flight simulator motion to further investigate the operational and human factor aspects”.

1.17 Information on Organisations and Management

1.17.1 Information on Airbus

Airbus is an aircraft manufacturer which is part of the EADS group, designs, builds (POA Production Organisation Approval), certifies (DOA Design Organisation Approval) and sells commercial aircraft from 107 to more than 520 seat range. As such Airbus has a large in-service fleet in operation (around 7000).

Airbus maintains a large Customers Services Function which provides all the necessary documentations, trainings and technical support to Airbus customers.

1.17.1.1 Monitoring flight parameters

Monitoring flight parameters is one of the tasks to be performed by the crew while carrying out a non-precision approach. This means that any change in mode displayed on the FMA must be called out by the PF. The PNF, in turn, must call out any deviation under the following conditions:

- Callout “SPEED” when the speed decreases more than 5 knots below the target speed, or increases more than 10 knots above this speed;
- Callout “SINK RATE” for any vertical speed greater than 1,000 ft/min in descent;
- Callout “BANK” when the bank angle is greater than 7 degrees;
- Callout “PITCH” when the pitch attitude is negative or greater than 10 degrees;
- Callout “COURSE” when the deviation from the final approach course is over half a point (dot), 2.5 degrees for a VOR or 5 degrees for an ADF;
- Altitude deviation callout “_ FT HIGH (LOW)” at the various checkpoints on the approach.

Upon receiving the PNF’s callouts, which he must read back, the PF must immediately make corrective inputs to control the observed deviation and then assess whether the conditions have stabilized.

In case of a go-around, the crew must also monitor any changes in mode displayed on the FMA. The PNF must also call out any deviation under the following conditions:

- “BANK” callout when the bank angle is greater than 7 degrees;
- “PITCH” callout when the pitch attitude is more than 20 degrees or less than 10 degrees;
- “SINK RATE” callout in the absence of rate of climb.

1.17.1.2 Conducting non-precision approaches

According to the Airbus A330 Flight Crew Training Manual (FCTM), the philosophy for conducting non-precision approaches is to have representation and procedures similar to those of a precision approach. Instead of the ILS signals, guidance on the lateral and vertical plans are performed from the FMGEC flight plan, controlled with conventional means (VOR, NDB, etc.). The crew must make sure that the FMGEC data are correct by checking their accuracy and the sequencing of the various approach segments.

The use of the autopilot is recommended for all non-precision approaches to reduce the workload of the crew and assist them in monitoring the approach path.

The final approach is carried out using either:

- The managed mode FINAL APP. The crew must check the start of descent on the ND, the modes displayed on the FMA, the flight path deviations in the vertical (VDEV) and lateral (XTK) plans on the ND. If the FINAL APP mode is not engaged, the crew must select a glide slope on the FCU and activate the FPA mode. The crew must then adjust the glide slope on the FCU to converge towards the approach plan and to achieve a zero vertical deviation (VDEV) in relation to the theoretical glide path.
- Using the selected modes (FPA and/or TRK mode). In this case, the crew must preselect a glide slope on the FCU 1 NM before reaching the FAF. To intercept the approach plan, the crew can pull the V/S – FPA button on the FCU 0.2 NM before the FAF and then adjust the glide slope on the FCU to converge towards the approach plan. The crew should in particular make sure that the vertical deviation (VDEV) from the theoretical glide path is zero.

After passing the FAF, and when the altitude is lower the go-around altitude, the Flight Crew Operating Manual (FCOM) states that it must be selected by the crew. The flight parameters should also be monitored (see 1.17.1.1) and the following actions must be carried out;

A330 AFRIQIYAH AIRWAYS FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.19	P 10
	NON PRECISION APPROACH	SEQ 001	REV 25

– A/THR . . . . CHECK IN SPEED MODE OR OFF

– WING ANTI ICE . . . . OFF

R Switch WING ANTI ICE ON, only in severe icing conditions.

– SLIDING TABLE . . . . STOW

– LDG MEMO . . . . CHECK NO BLUE LINE

– CABIN REPORT . . . . OBTAIN

– CABIN CREW . . . . ADVISE

– LANDING CHECKLIST . . . . COMPLETE

– FLIGHT PARAMETERS . . . . CHECK

Excerpt from Airbus FCOM provided to AFRIQIYAH Airways

On approaching the MDA, the PF's visual circuit must extend to the outside. Upon reaching the MDA, the synthetic voice issues the "MINIMUM" callout. The MDA must be checked or called out by the crew.

- If the conditions to continue for landing are not met, the crew must abort the approach and initiate a go-around. If the approach is carried out with vertical guidance in a selected mode, the distance to the runway threshold may not be easily evaluated and the crew must perform a step-down approach. Once at the MDA, in order to acquire visual references, the FCOM states that the crew can level off to the MAPt before initiating a go-around,
- If the conditions are met, the PF calls out "Continue". The AP must be disengaged (see FCOM extract below) and the approach continued as a visual approach. The FCTM states that FD should be disengaged.

A330 AFRIQIYAH AIRWAYS FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.19	P 11
	NON PRECISION APPROACH	SEQ 001	REV 26

R ● **AT ENTERED MINIMUM + 100 FT :**

– **ONE HUNDRED ABOVE** .... **MONITOR OR ANNOUNCE**

R ● **AT ENTERED MINIMUM :**

– **MINIMUM** .... **MONITOR OR ANNOUNCE**

● **If ground references are visible :**

– **CONTINUE** .... **ANNOUNCE**

– **AP** .... **OFF**
Continue, as with a visual approach (Refer to 3.03.20).

● **If ground references are not visible :**

– **GO AROUND** .... **ANNOUNCE**
Initiate a go-around.

R *Note : 1. When FINAL APP mode is engaged, the AP/FD will disengage under*
R *the following conditions, depending on which one comes first :*
R *– At minimum minus 50 feet (if entered) or at 400 feet AGL (if no*
R *minimum is entered), or*
R *– At the Missed Approach Point (MAP), depending on which one*
R *comes first.*
R *The FDs will revert to basic modes (HDG-V/S or TRK/FPA).*
2. In selected guidance, if ground references are not visible when the
R *aircraft reaches minimum, the flight crew should make an immediate go-around. However, if the distance to the runway is not properly assessed, a step descent approach may be considered, and a level-off*
R *at minimum may be performed while searching for visual references. If the flight crew has no visual reference at MAP, at the latest, they must begin a go-around.*

Excerpt from Airbus FCOM provided to AFRIQIYAH Airways

The normal procedures from the Quick Reference Handbook (QRH) for non- precision approaches performed with managed guidance are attached in appendix 9. Those relating to approaches conducted in selected modes are also in appendix 9.

According to the Airbus FCTM, the main objective of the approach briefing is for the PF to inform the PNF about his planned course of action for conducting the approach. It must be consistent with the expected weather conditions, as well as be concise and logical. The PF may especially mention the type of approach conducted the altitude and identification of the FAF, the glide slope on final approach, the MDA/DH and the missed approach procedure.

1.17.1.3 Missed approaches

The conduct of the flight during a missed approach is presented below:

During a missed approach, the PNF should make a callout as soon as the pitch attitude is more than 20 degrees or less than 10 degrees nose-up or if the aircraft does not climb.

A330 AFRIQIYAH AIRWAYS FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.23	P 1
	GO AROUND	SEQ 001	REV 26

GO AROUND

Apply the following three actions simultaneously :

– **THRUST LEVERS** . . . . **TOGA**

– **ROTATION** . . . . **PERFORM**
· Rotate the aircraft to achieve a positive rate of climb, and establish the required pitch attitude, as directed by SRS pitch command bar.

– **GO AROUND** . . . . **ANNOUNCE**

Note : The MCDU PERF page automatically switches to the GO AROUND phase.

– **FLAPS** . . . . **RETRACT ONE STEP**

– **FMA** . . . . **CHECK AND ANNOUNCE**
Check the FMA on the PFD. The following modes are displayed : MAN TOGA/SRS/GA TRK/A/THR (in blue).

– **POSITIVE CLIMB** . . . . **ANNOUNCE**

– **LDG GEAR UP** . . . . **ORDER**

– **LDG GEAR** . . . . **SELECT UP**

R – **NAV or HDG mode** . . . . **AS RQRD**

Note : Go-around may be achieved with both AP engaged. Whenever any other mode engages AP 2 disengages.

● **At go-around thrust reduction altitude (LVR CLB flashing on FMA) :**

– **THRUST LEVERS** . . . . **CL**

Excerpt from Airbus FCOM provided to AFRIQIYAH Airways

A330 AFRIQIYAH AIRWAYS FLIGHT CREW OPERATING MANUAL	STANDARD OPERATING PROCEDURES	3.03.23	P 2
	GO AROUND	SEQ 001	REV 20

- **At go-around acceleration altitude :**
  - **Monitor that the target speed increases to green dot.**
  - **If the target speed does not increase to green dot :**
    - **FCU ALT . . . . CHECK and PULL**
  - **Retract flaps on schedule.**

  Note : Consider the next step :
  - *Engage NAV mode, to follow the published missed approach procedure, or*
  - *Prepare for a second approach by selecting the ACTIVATE APP PHASE, and CONFIRM on the PERF page.*

Excerpt from Airbus FCOM provided to AFRIQIYAH Airways

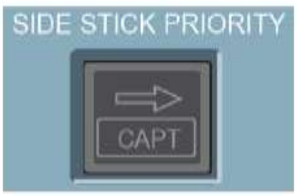
1.17.1.4 Taking over control

The side sticks, on the Captain's and co-pilot's side, are used for manual control of the aircraft in pitch and roll.

Each side stick has, among other things, a push button used to disengage the autopilot and/or take precedence over the other side stick.

When a pilot makes an input on the side stick, his orders are sent to flight control computers. When both pilots make inputs on their side stick, whether in the same or in opposite directions, the orders are algebraically added and sent to the computers.

Simultaneous control is detected when deflections of more than 2° are applied on each of the two side sticks. In this case, the two lights "SIDE STICK PRIORITY" light up green on the glare shield and the voice message "DUAL INPUT" is generated.



By pressing the button on the side stick, the pilot takes over control as long as he maintains the pressure.

When the Captain takes over control, announces (*I have control*) and the Co-pilot replies (*You have control*) , the light "SIDE STICK PRIORITY" lights up green in front of him, and the arrow of the same light turns red in front of the co-pilot. The voice message "PRIORITY LEFT" is generated.

When the co-pilot takes over control, the reverse logic is generated.

Voice messages relating to any control take-over have a lower precedence than TAWS warnings.

TAWS is a system that its primary goal is to alert a collision with the ground or terrain.

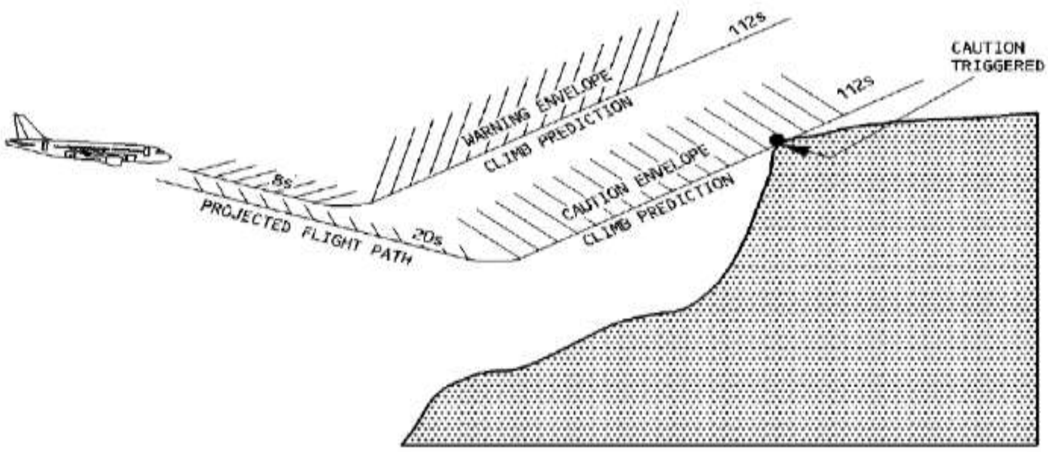
Depending on the system installed, different operating modes are available:

Reactive mode 1	Excessive descent rate
Reactive mode 2	Excessive terrain closure rate
Reactive mode 3	Altitude loss after takeoff or during missed approach
Reactive mode 4	Unsafe terrain clearance when not in the landing configuration
Reactive mode 5	Descent below Glide Slope
Predictive mode	Safety envelope calculated on the basis of the aircraft performance and the terrain database

Multiple warnings and messages can be generated by the system according to the configuration of the aircraft, its position and the terrain database intrinsic to the system.

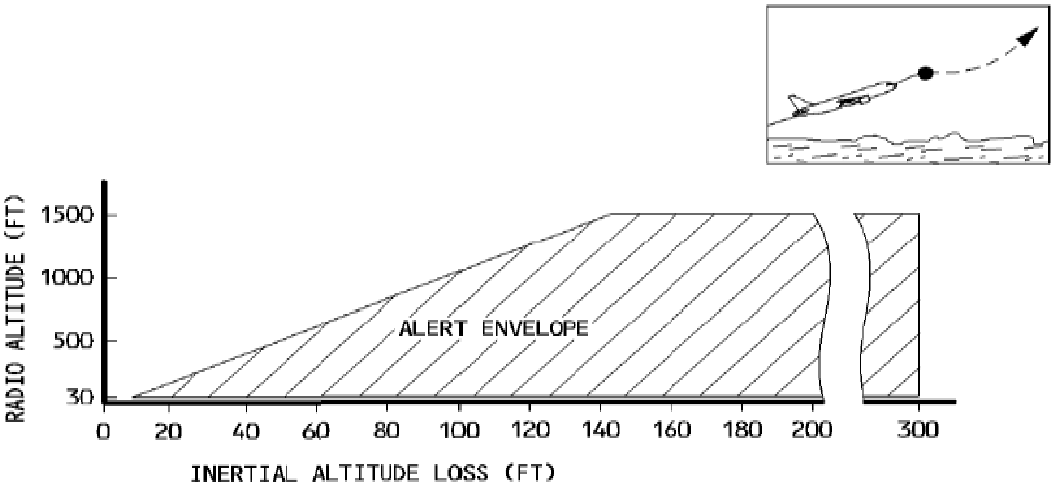
Among the aural warnings, those relevant for the understanding of the event are detailed below:

- “TOO LOW TERRAIN” can be generated by the system in predictive mode when it detects a conflict between the safety envelope calculated around the aircraft and the terrain database programmed on the aircraft:



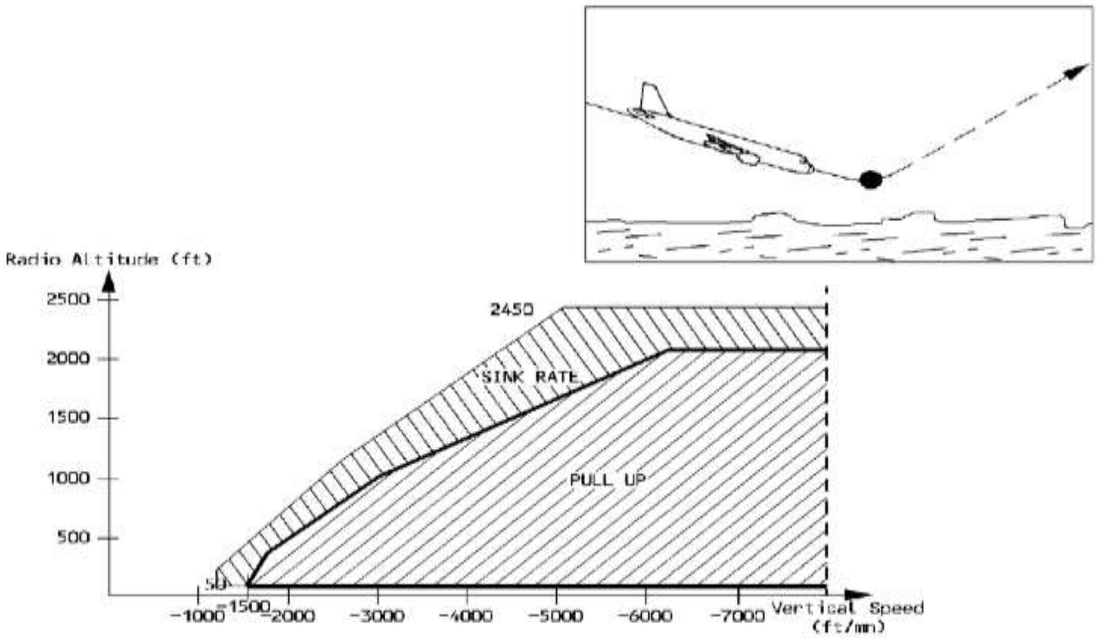
In this case, in addition to the aural message, the GPWS LEDs light up amber in front of each pilot.

- “DON’T SINK DON’T SINK” can be generated in reactive mode 3, when an altitude loss is detected including during takeoff or a missed approach;



In this case, in addition to the voice message, the Ground Proximity Warning System (GPWS) LEDs light up amber in front of each pilot.

- “PULL UP PULL UP” can be generated in reactive mode 1 when the rate of descent of the aircraft is excessive;



The TAWS warnings are also displayed on the ND.

If these TAWS warnings are activated, according to the FCOM the crew must do the following:

- “TOO LOW TERRAIN” warning: adjust the flight path of the aircraft or carry out a missed approach;
- “DON’T SINK” warning: adjust the pitch attitude and thrust to stop the warning;
- “PULL UP” warning: simultaneously disconnect the AP, apply and maintain a full nose-up input on the side stick, set the thrust levers to TOGA, check that the spoilers are retracted and keep the wings level. The PF must also inform the PNF of his manoeuvre by calling out “TOGA PULL UP”.

A330 AFRIQIYAH AIRWAYS FLIGHT CREW OPERATING MANUAL	ABNORMAL AND EMERGENCY	3.02.34	P 12a
	NAVIGATION	SEQ 105	REV 24

GPWS ALERTS (CONT’D)

■ **“PULL UP” - “TERRAIN TERRAIN PULL UP” - “TERRAIN AHEAD PULL UP”**

Simultaneously :

- AP . . . . OFF
- PITCH . . . . PULL UP

R *Pull to full backstick, and maintain in that position.*

- THRUST LEVERS . . . . TOGA
- SPEEDBRAKE lever . . . . CHECK RETRACTED
- BANK . . . . WINGS LEVEL or ADJUST

Best climb performance is obtained when close to wings level. Then, for "TERRAIN AHEAD PULL UP" only, and if the flight crew concludes that turning is the safest way of action, a turning maneuver can be initiated.

● **When the flight path is safe, and the warning stops :**
Decrease pitch attitude and accelerate.

● **When speed is above VLS, and vertical speed is positive :**
Clean up aircraft, as required.

■ **“TERRAIN TERRAIN” “TOO LOW TERRAIN” :**
Adjust the flight path, or initiate a go-around.

■ **“TERRAIN AHEAD” :**
Adjust the flight path. Stop descent. Climb and/or turn, as necessary, based on analysis of all available instruments and information.

■ **”SINK RATE” “DON’T SINK” :**
Adjust pitch attitude and thrust to silence the alert.

■ **“TOO LOW GEAR” – “TOO LOW FLAPS” :**
Perform a go-around.

■ **“GLIDE SLOPE” :**
Establish the aircraft on the glide slope, or switch OFF the G/S mode pushbutton, if flight below the glide slope is intentional (Non Precision Approach (NPA)).

1.17.1.6 Approach and Landing Checklists

The following show the approach checklist to be performed at the end of the descent, and landing checklist, to be performed when the aircraft is configured before reaching the stabilization altitude.

APPROACH	
BRIEFING	CONFIRMED
ECAM STATUS	CHECKED
SEAT BELTS	ON
BARO . . . . .______	SET (BOTH)
MDA/DH . . . . .______	SET (BOTH)
ENG START SEL	AS RQRD

LANDING	
CABIN CREW	ADVISED
A/THR	SPEED/OFF
ECAM MEMO	LDG NO BLUE
. SIGNS ON	. FLAPS LDG
. CABIN READY	. SPLRS ARM
. LDG GEAR DN	

1.17.1.7 DME distance information

All the DME distance information is output by the SSFDR.

The crew had selected the frequency of the TPI VOR/DME although a NOTAM message had been issued concerning the use of the VOR (*TPI VOR should be used with caution*).

1.17.2 Information on AFRIQIYAH Airways

At the time of the accident AFRIQIYAH Airways had 3 Airbus A330 and 6 Airbus A319/A320 aircrafts which are all operated by AFRIQIYAH Airways staff. The Airbus 330 (CCQ) training conducted by Airbus training Center TOULOUSE, the proficiency checks were performed at Sabena Technics (Brussels) in 2009 and at Egypt air (Cairo) in 2010. Given the dates of crew training on type and the dates of receipt of the A330 fleet (see 1.5), the first recurrent training and periodic checks were conducted in November 2009.

AFRIQIYAH Airways uses Airbus documentation to operate its Airbus fleet. In addition, training during operation adopting Airbus FCTP as reference as well as flight instructors and examiners were ex- Airbus staff. The ground and flight simulator training were conducted at approved EASA 147 training organization.

Quality office at AFRQIYAH Airways had conducted an internal audit during the first quarter of

2010 where no significant findings were observed especially on Training and Flight Operation.

The Libyan CAA Audit was carried out in August 2009 for AOC Renewal, in which the Audit findings were submitted to AFRIQIYAH Airways, corrective action was taken and subsequently AOC was renewed.

AFRIQIYAH Airways was going under IOSA audit during May 2010 including the day of the Accident and no major findings found on training, safety and operation. IOSA findings Report was submitted to AFRIQIYAH Airways where corrective action was carried out and IOSA Certificate had been renewed for a further period up to 06/10/2012.

1.17.2.1 Operations Manual of AFRIQIYAH Airways

In general, it is common practice within AFRIQIYAH Airways to designate the co-pilot as PF when weather conditions do not result in difficulty in handling the aircraft.

Reportable events

AFRIQIYAH Airways has its accident prevention and flight safety programme, the objectives of this programme is to address and control both real and potential hazards associated with aircraft technical operation and any human errors, and failures.

- **Go around**

Go around is a reportable event as per Afriqiyah operations manual.

- **TAWS Alerts**

GPWS warning is also a reportable event in Afriqiyah operations manual.

1.17.2.1.1 Non-precision approach

The AFRIQIYAH Airways operations manual states that all the A330s and A320s in its fleet have databases enabling use of the FINAL APP mode and that these databases are validated by AFRIQIYAH Airways for the various destinations of the network, in addition to those checks carried out by the database providers and Flight Management System (FMS) manufacturers.

It further states that guidance during Area Navigation (RNAV) approaches must be carried out in FINAL APP mode. NAV and FPA modes should be used only when altitude corrections are necessary due to the excessively low outside temperature or if an incorrect vertical encoding is detected in the navigation database. All RNAV approaches should be conducted with the AP and the FDs connected down to the MDA or (Decision Altitude) DA.

Regarding training, crews are trained extensively to use the FMGS as of their type rating. No specific training is required to use the FMGS during RNAV approaches. In practice, the first proficiency checks performed in 2009 by the AFRIQIYAH Airways flight crews qualified on A330 provided them with an opportunity to learn about the different ways to carry out non-precision approaches, especially in FINAL APP mode.

The Airbus FCOM should be the crew's reference in terms of description of the systems and procedures to follow for non-precision approaches and approach briefings.

According to the operations manual, as soon as the APPR button is pressed on the FCU during the approach, the crew should check the following:

- the correct display on the FMA (APP NAV in green and FINAL in cyan),
- the next waypoint on the ND,
- the lateral deviation (XTK) in relation to the flight path in the flight plan,
- the correct indication of the vertical deviation (VDEV),
- the blue arrow at descent point, the FAF,
- when passing the FAF, the correct indication of altitude, the FINAL APP mode displayed in green, the next waypoint,
- stabilized during the final approach, the lateral and vertical deviations, as well as FPV and the altitude in relation to the distance to the runway.

1.17.2.1.2 Augmented Flight Crew

Libyan CAA Regulations Part 1 stated that Augmented Crew on the Aircraft is the crew members other than the minimum crew required to operate the Aircraft according to its certification. AFRIQIYAH Airways operation manual part A section 7.5 states that each flight crew member can leave his post and replaced by another appropriately qualified flight crew member.

AFRIQIYAH Airways operation manual part A section 5.2.2.4 also states that a relief pilot can be scheduled on a flight especially long haul flights and wide body Aircraft provided that he went through all the required training qualification for these duties and so for this flight there was a relief pilot scheduled to relief any of the pilots during cruise phases.

The roles of the relief pilot mainly in the cruise phase in order to relief any of the operating pilots from their duties during cruise for a period of time to reduce the work load upon pilots in long haul flights. During the approach phase the relief pilot was in the cockpit but no direct role assigned to him.

The relief pilot had passed the (Relief Pilot above FL200 Cruise Check Program) Training, which was conducted at Toulouse on 21/11/2009 by Airbus.

1.17.2.1.3 Task sharing

The FCU and MCDU must be used, in accordance with the rules outlined below, in order to ensure:

• Safe operation (correct entries made)
• Effective inter-pilot communication (knowing each other's intentions)
• Comfortable operations (use "available hands", as appropriate)

MCDU entries are performed by the PF, during a temporary transfer of command to the PNF. A crosscheck must be performed. Time-consuming entries should be avoided below 10000 feet. Entries should be restricted to those that have an operational benefit. (PERF APPR, DIR TO, DIR TO INTERCEPT, RAD NAV, LATE CHANGE OF RUNWAY, ACTIVATE SEC F-PLN, ENABLE ALTN)	FCU entries are performed by: - The PF, with the AP on. - The PNF (upon PF request), with the AP off. FCU entries must be announced. Upon FCU entries: The PF must check and announce the corresponding PFD/FMA target and mode. The PNF must crosscheck and announce "CHECKED".

AP/FD MONITORING

The FMA indicates the status of the AP, FD, and A/THR, and their corresponding operating modes.

The PF must monitor the FMA, and announce any FMA changes. The flight crew uses the FCU or MCDU to give orders to the AP/FD. The aircraft is expected to fly in accordance with these orders.

The main concern for the flight crew should be:

WHAT IS THE AIRCRAFT EXPECTED TO FLY NEXT?

If the aircraft does not fly as expected or, disengage the AP, and fly the aircraft manually.

AFRIQIYAH Airways applies the Airbus SOP and Task sharing for all flight crew members through out all the phases of the flight in normal and abnormal operation.

1.17.2.1.4 Briefings

The approach briefing provided by AFRIQIYAH Airways is given below and is included in section “Supplements / Standard Operating Procedures” of the operations manual:

Afriqiyah	**PF** APPROACH BRIEFING	A319/A320/A330

Miscellaneous

Aircraft Type__ Tech STS___ MEL/CDL/OEB (if any)__NOTAM____
WX_____WX RADAR____ANTI ICE____

FRPPFS

FLT PLN: TOD__STAR__ MORA__MSA__ APP Type__ ALT/SPD__ GA__
RAD/NAV: Set for APP__ ILS Ident & Course__ VOR/ADF Switches___
PROG: GPS Primary_____ Accuracy High____ LND RWY inserted____
PERF: LND RWY____DEST DATA____MDA/DH___CONF__ VAPP__
FUEL PRED: ____ LND WT____EFOB at DEST/ALT____ EXTRA______
SEC FLT PLN: Other APP/RWY______ Diversion or Copy Active______

Landing/Taxi/Parking

RWY AIDS___ Length __ Usable Length__ Lighting__ Condition___
ENG REV__ A/BRK__ TAXI Routing___ Parking Guidance__ APU__

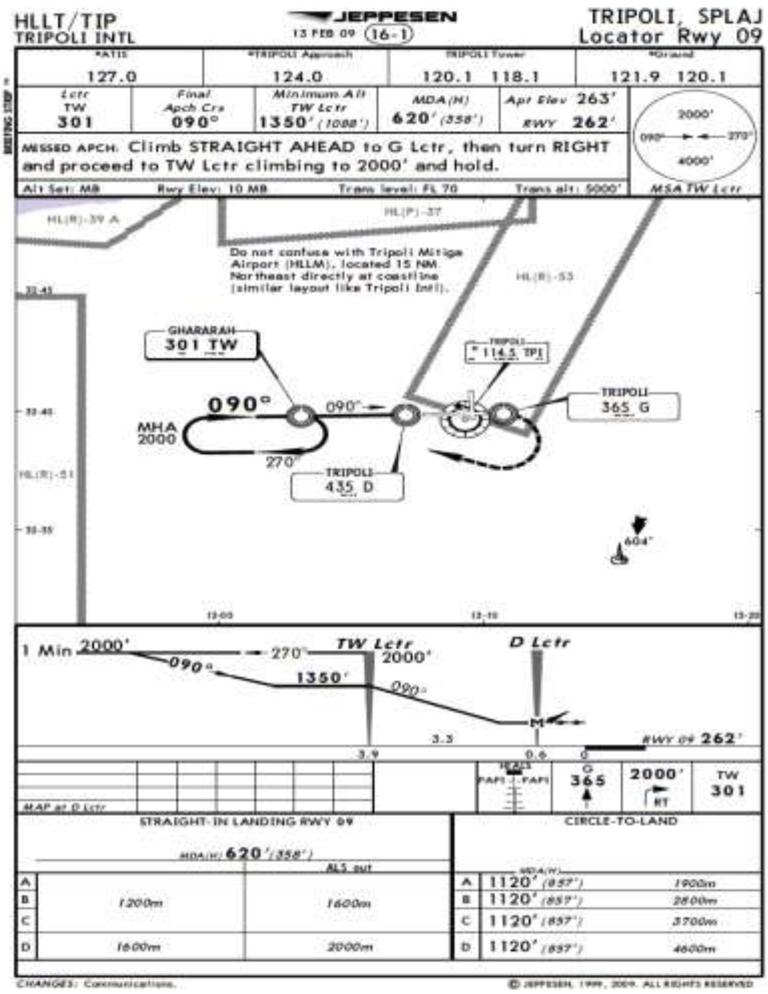
Approach briefing should be cross referenced checked with Jeppesen charts

AAW Approach briefing rev 02/April 2010

This briefing should be made by the PF. A common practice for the approach briefing is to make a "short" briefing when arriving at a known airport, such as Tripoli International Airport, provided the elements available to the crew present no special characteristics (wet runway, low visibility, etc.).

1.17.2.1.5 Documentation on board

AFRIQIYAH Airways crews used Jeppesen documentation. The Locator 09 approach chart is shown below.



The Jeppesen chart did not provide any glide path after the FAF and did not include the table in the official map identifying crossing altitudes in relation the distance to the runway threshold 09 and rates of descent in relation the speed of the aircraft.

Contrary to the fifth edition of Libyan Aeronautical Information Publication (AIP) (2007) made available as part of the investigation, a VOR/DME procedure to runway 09 was also published by Jeppesen. This VOR/DME procedure indicated a distance of 5.2 NM between the Locator TW and the TPI VOR/DME. The MDA for the VOR/DME approach was 550 ft and that for an approach using only the VOR and the two locators was 600 ft.

1.17.2.2 Crew Resource Management (CRM) training

CRM is normally defined as a management system which makes optimum use of all available resources, including equipment, procedures and people, to promote safety and enhance the efficiency of flight operations. CRM focuses on international communication leadership and decision making in the cockpit.

CRM can be defined as a management system which makes optimum user of all available resources.

AFRIQIYAH Airways ensures that CRM element and courses are integrated into all phases of the recurrent training program.

Reference to AFRIQIYAH Airways training manual 6.1 for crew resource management (CRM) is the effective utilisation of all available recourses to ensure safe and effective flight operations. AFRIQIYAH Airways (CRM) training programme for flight crew consists of five different training courses as follows:

- Initial CRM training.
- Conversion course CRM.
- New hire CRM training (for pilots joining AFRIQIYAH).
- Command CRM training course.
- Recurrent CRM training.

Whenever possible CRM training conducted in a group session outside AFRIQIYAH Airways premises, so the opportunity is provided for participants to interact and communicate away from the pressures of their usual working environment (at Egypt Air training centre).

Elements of CRM training shall also be integrated into all conversion courses, recurrent simulator training and assessed during proficiency checks and line checks (Reference Table 6.1.5 of AFRIQIYAH Training Manual).

TRAINING MANUAL	SUPPLEMENTARY TRAINING	AUG 07 Page 6-7

6.1.5. Crew Resource Management (CRM) Training Requirements

<table>
<tr><th></th><th>Initial CRM Training</th><th>Conversion CRM Course</th><th>New-Hire CRM Course</th><th>Command CRM Course</th><th>Recurrent CRM Training</th></tr>
<tr><th>(a)</th><th>(b)</th><th>(c)</th><th>(d)</th><th>(e)</th><th>(f)</th></tr>
<tr><td>Human error and reliability, error prevention and detection</td><td rowspan="6">In depth</td><td>In depth</td><td>Overview</td><td>Overview</td><td rowspan="6">Overview</td></tr>
<tr><td>Company safety culture, SOP's, organisational Factors</td><td rowspan="2">Not required</td><td>In depth</td><td rowspan="5">In depth</td></tr>
<tr><td>Stress, stress management, fatigue & vigilance</td><td rowspan="2">Not required</td></tr>
<tr><td>Information acquisition and processing Situation awareness, workload management Decision making</td><td rowspan="3">Overview</td></tr>
<tr><td>Communication and co-ordination inside and outside the cockpit</td><td rowspan="2">Overview</td></tr>
<tr><td>Leadership and team behaviour, synergy</td></tr>
<tr><td>Automation, philosophy of the use of automation</td><td rowspan="2">As required</td><td rowspan="2">In depth</td><td>In depth</td><td rowspan="2">As required</td><td rowspan="2">As required</td></tr>
<tr><td>Specific type-related differences</td><td>Not required</td></tr>
<tr><td>Case based studies</td><td>In depth</td><td>In depth</td><td>In depth</td><td>In depth</td><td>In depth</td></tr>
</table>

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1.17.2.3 Simultaneous control inputs

It is not accepted as common practice within AFRIQIYAH Airways that Captains, as PNF, could apply inputs on their side stick in parallel to those applied by co-pilots, as PF.

Dual input can be performed on this aircraft in which the response of the aircraft is the algebraic some of the two inputs, syntactic voice (SV) generated (DUAL INPUT).

1.17.2.4 Flight analysis

The regulations in force in Libya require systematic flight analysis from operators. However, AFRIQIYAH Airways had acquired flight analysis equipment and systems that were not fully operational. While the Operations Manual calls for the analysis of crew reports, this lack of systematic flight analysis can be compared with the limited internal feedback. The systematic analysis of flight data would not only help detect deviations and thus implement corrective actions following the detection of deviations, but would also enhance flight crew safety awareness.

During an interview with AFRIQIYAH flight safety engineer, the investigation committee was informed that, as a normal procedure in AFRIQIYAH Airways flight safety office, the Quick access recorder (QAR) tape should be removed from the aircraft every three days and sent to flight safety office to be analyzed immediately for deviation corrections, but on the case of flight April 28 2010 the tape received late and no analysis was carried out until late after the accident.

1.18 Additional Information

1.18.1 Non-precision approaches

1.18.1.1 Regulatory Aspects

Flight path control in the vertical plan during conventional approach procedures

In general, control of the flight path in the vertical plan during non-precision approach procedures is carried out using one of the three following methods:

- The Continuous Descent Final Approach (CDFA) is the preferred technique. Operators should use the CDFA technique where possible, because it enhances approach safety by reducing the pilot’s workload and the possibility of errors in carrying out the approach,
- The constant angle descent,
- The step-down descent.

- *Continuous Descent Final Approach (CDFA)*

Many contracting States require the use of the CDFA technique and apply more stringent requirements in terms of visibility or Runway Visual Range (RVR) when this technique is not used. This technique includes a continuous descent, carried out either with Vertical Navigation (VNAV) guidance calculated by the onboard equipment or based on a manual calculation of the descent rate required, without level-off.

The descent rate is chosen and adjusted to achieve a continuous descent to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre should begin for the type of aircraft flown. The descent will be calculated and carried out to cross that point at or above the minimum altitude of any published approach fix.

If the visual reference points for landing are not identified while approaching the MDA/H, the vertical segment (climb) of the missed approach is initiated at an altitude sufficiently high above the MDA/H for the aircraft to cross the MDA/H while on descent. The aircraft must never fly level at MDA/H or at an altitude close to MDA/H. Turns in the missed approach procedure are not to be initiated until the aircraft has reached the MAPt. Similarly, if the aircraft reaches the MAPt before descending to an altitude close to the MDA/H, the missed approach is to be initiated at MAPt.

The operator may require an increment to the MDA/H to set the altitude/height at which the vertical component of the missed approach is initiated in order to avoid a descent below the MDA/H. In such cases, it is not necessary to increase the RVR or visibility values prescribed for the approach. The RVR or visibility values published for the initial MDA/H should be used.

When approaching the MDA/H, the crew has only two options: continue the descent below the MDA/H and land with the visual reference points required in sight, or execute a missed approach. There is no level flight segment once the MDA/H has been reached.

The CDFA technique simplifies the final segment of the classical approach by incorporating techniques similar to those used for a precision approach procedure or an Approach Procedure with Vertical guidance (APV). This technique improves situational awareness in the pilot and is fully in line with all the criteria for a stabilized approach.

- *Constant angle descent*

For the second technique, a constant angle must be maintained, without interruption, from the FAF, or the optimal point in procedures without FAF, to the reference datum above the runway threshold, e.g. 15 m (50 ft). When the aircraft approaches the MDA/H, the decision will be taken either to maintain a constant angle flight path or to level off at or above MDA/H, depending on visibility.

If visibility is satisfactory, the aircraft continues the descent to the runway, without any intermediate level-off.

If visibility does not allow the descent to continue, the aircraft will level off at or above the MDA/H and will hold the inbound course until visibility allows it to glide below the MDA/H to the runway, or until it reaches the published MAPt and performs the missed approach procedure.

- ***Step-down descent***

The third technique involves a rapid descent and consists in an immediate descent to an altitude/height no less than the minimum altitude/height of the step-down fix or the MDA/H, as applicable. This technique is acceptable provided that the glide slope remains below 15% and the missed approach is initiated at or before the MAPt. With this technique, close attention should be given to attitude control given the high descent rates before reaching the MDA/H and, subsequently, the increased time of exposure to obstacles once the minimum descent altitude is reached.

Whatever the above technique chosen by the operator, a specific and appropriate training to this technique is necessary.

1.18.1.2 ARINC specifications for continuous descent final approaches

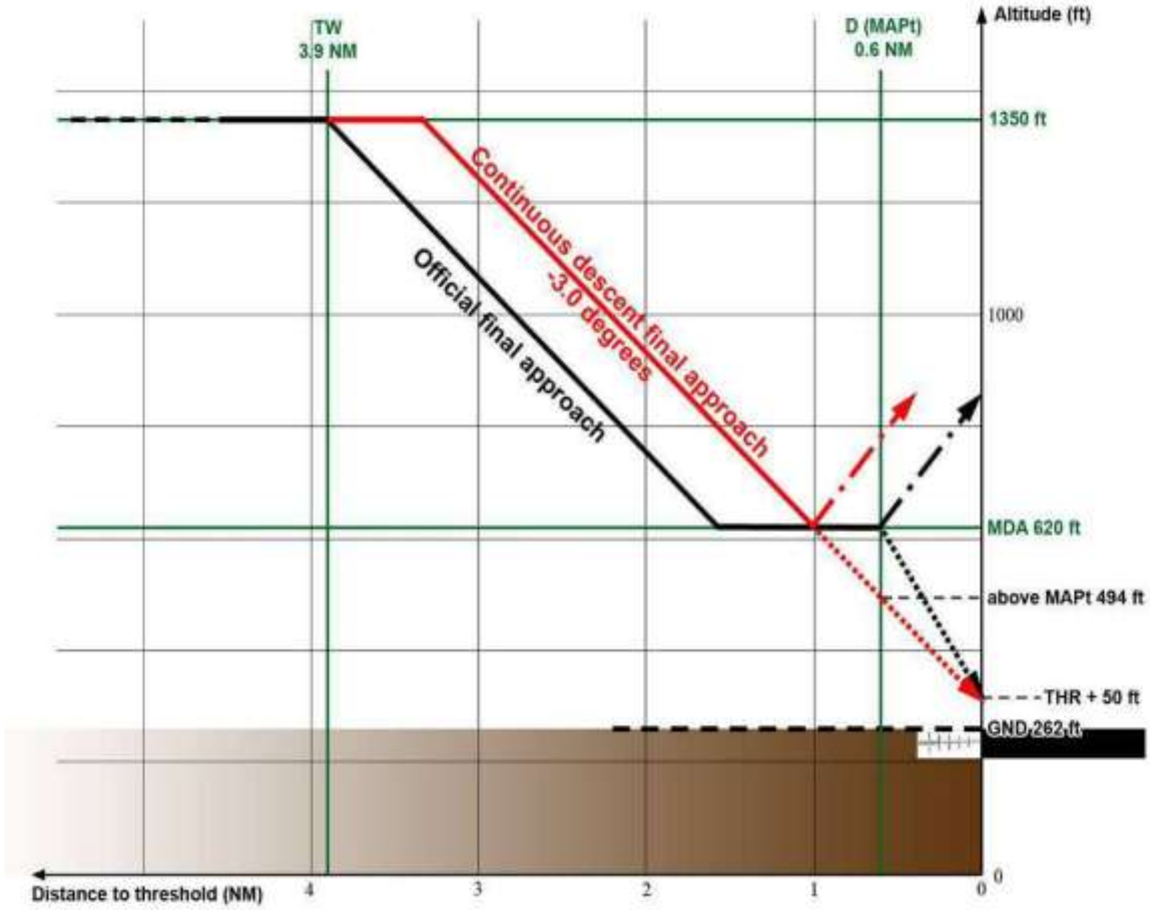
ARINC (Aeronautical Radio, Incorporated) document on navigation system databases provides specifications for preparing data files for onboard navigation systems.

For a non-precision approach with a FAF and a MAPt before the runway threshold and with certain alignment criteria as is the case for the approach procedure Locator 09 in Tripoli:

- The threshold is not included in the coding of the approach procedure in the database,
- The glide slope is calculated by considering the threshold elevation increased by fifty feet and the crossing altitude the FAF. If the calculated slope is less than three degrees, the glide slope is increased to three degrees. The actual point at which final descent will begin is shifted accordingly,
- The procedure coding takes the MAPt into account. An altitude is specified for the MAPt and corresponds to the crossing altitude of the MAPt during descent.

Thus, for the runway 09 Locator approach procedure at Tripoli, the calculated glide slope for on final approach for a continuous descent final approach is three degrees. Contrary to what is published, the descent begins after crossing TW. The continuous descent approach for runway 09 Locator approach has the following features:

- Descent to an altitude of 2,000 ft;
- Level at 2,000 ft to a distance of 10 NM from TPI VOR/DME;
- Descent from 10 NM from TPI VOR/DME to an altitude of 1,350 ft;
- Level at 1,350 ft after crossing TW to the intercept with the 3-degree glide path 50 ft above the runway threshold;
- Descent on a 3-degree glide path ;
- MAPt crossing on a 3-degree glide path at an altitude of 494 ft.



1.18.2 Flight on 28 April 2010

On April 28, 2010 in the afternoon around 15 h 50, i.e. fourteen days before the accident, the Captain and co-pilot carried out the same approach (Locator to runway 09) at Tripoli with the same aircraft. The METAR and SPECI messages below show the weather conditions in Tripoli at the time of the event.

METAR and SPECI for HLLT

METAR HLLT 281450Z 01009KT 9999 FEW020 SCT030 BKN080 20/13 Q1009 SPECI HLLT 281545Z 34007KT 8000 –RA FEW020 SCT030 BKN080 19/14 Q1020 SPECI HLLT 281552Z 34008KT 320V202 8000 –RA FEW013CB SCT020TCU OVC080 19/14 Q1020 SPECI HLLT 281605Z 03012KT 5000 TSRA FEW013CB SCT020 OVC080 18/15 Q1019

The SSCVR recording was not preserved and therefore could not be processed.

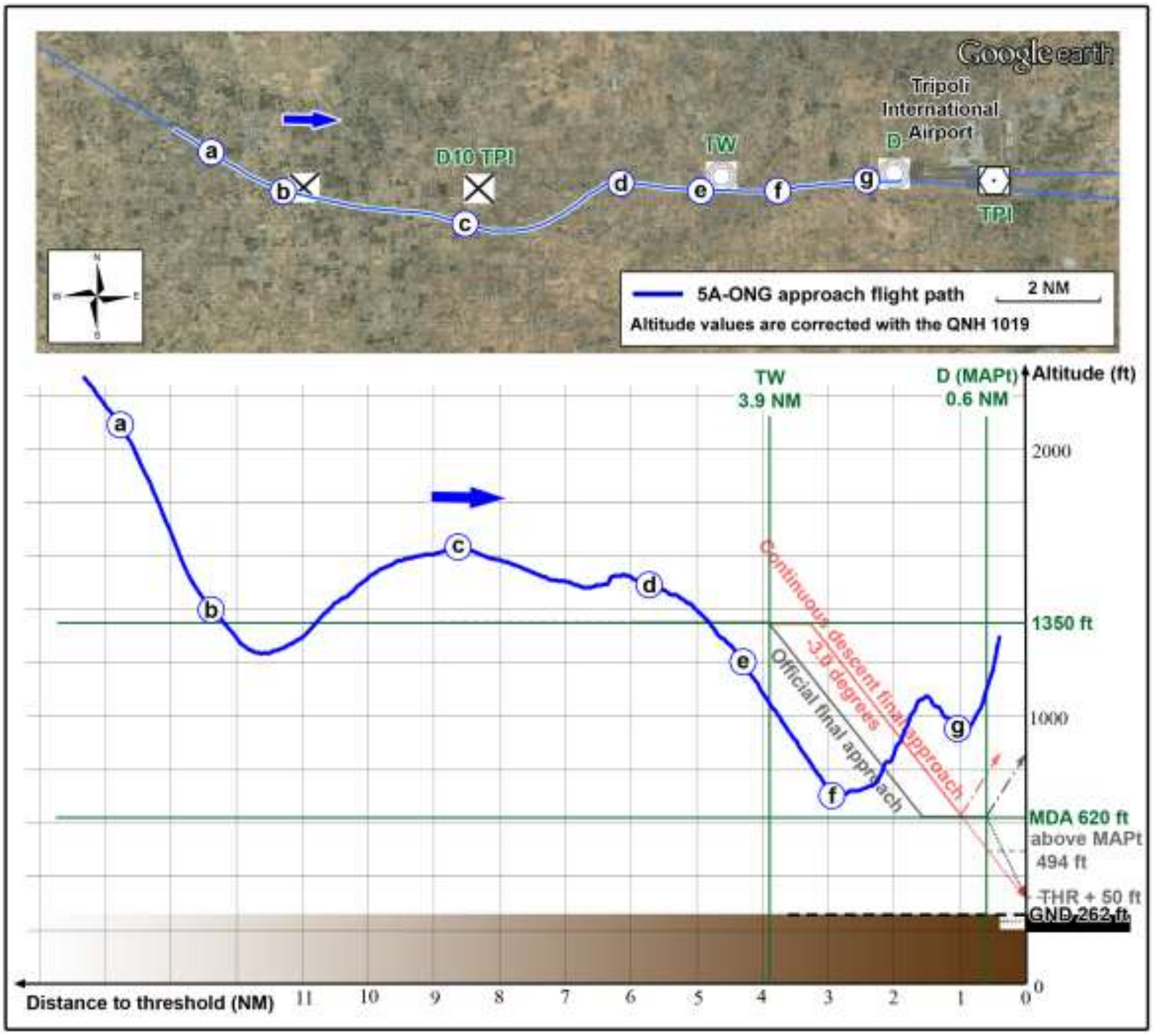
The analysis of the SSFDR recording highlighted the following:

- The initial approach was carried out on manual control with the flight directors engaged and lateral mode NAV and the following vertical modes FPA a, DES then

OP DES. The thrust levers were set to CLIMB.

- Around 1,400 ft, which corresponds to the altitude selected on the FCU to level off at the intermediate segment, while the aircraft was overshooting the centreline of the approach segment, the flight directors were disengaged (b)
- The aircraft passed under the altitude of 1,400 ft selected on the FCU.
- The altitude of the aircraft increased thereafter to reach 1,620 ft (c).
- The crew configured the aircraft for landing.
- The final descent was started about 2 NM before TW (d).
- The autopilot was engaged about 0.5 NM before TW, with modes TRK (track angle close to 090°) and FPA -3.3° (e).
- The aircraft flew over TW at an altitude of about 1,050 ft.
- At about 70 ft above the MDA, the autopilot was disengaged; the thrust levers were set to TOGA (which engaged the flight directors in SRS and GA TRK modes) (f) .
- Following the autopilot disconnect, and for a period of 40 seconds:
    - The altitude increased to 1,060 ft and then decreased to 940 ft (TAWS warning “DON’T SINK” generated) before increasing again (g).
    - The pitch attitude which was +3 degrees successively changed as follows:
        - initially increased to reach +7 degrees,
        - then decreased to +2 degrees,
        - then increased again up to +7 degrees,
        - decreased to -2 degrees,
        - increased to reach +25 degrees,
    - dual inputs were recorded on seven occasions times, generating “DUAL INPUT” warnings,
    - inputs on the thrust levers were recorded,
    - the VFE was exceeded twice.
- The crew then stabilized the flight path of the aircraft and landed a few minutes later on runway 27.

Overall, the approach was never stabilized, from the intermediate approach segment to the missed approach. Parameters from the 28 April 2010 flight are presented in Appendix 12**.**



A comparison with the information on the accident flight highlights certain similarities:

- Final approach carried out in FPA vertical guidance mode before flying over TW;
- TW over flown at an altitude lower than specified in Locator approach procedure to runway 09;
- Lack of control and stabilization of pitch attitude during go around;
- Lack of adjustment of the thrust during go-around.

However, the comparison also highlights the following differences:

- Approach aborted at an altitude higher than the MDA;
- Appropriate response to the TAWS warning “DON’T SINK”;
- Failure to select the managed APP FINAL common guidance mode by pressing the APPR pushbutton on the FCU.

AFRIQIYAH Airways did not receive any report from the crew and therefore was not able to analyse the event as part of the flight safety procedures.

1.18.3 Testimony of the Captain of AAW721

The Captain of flight AAW721 that landed on runway 09 four minutes before the accident indicated that when he initiated the final descent, he could see the airport and the runway lights through the mist. He then passed through a more or less dense cloud layer that he considered to be low stratus cloud. Close to the minimum descent altitude, he regained sight of the ground and landed.

After informing the Captain of the accident flight of the presence of fog banks, by a direct call on the frequency of the control tower, he suggested the air traffic controller on duty to change the runway QFU, once parked. He says he heard the callout of the missed approach, and thought this manoeuvre was due to his message about the weather conditions.

1.18.4 Report of ALITALIA Flight AZ871 Captain

Note: ***<u>This report was reprinted as it was introduced to the investigation committee</u>.***

Flight AZ871 operated as a daily scheduled passenger flight from TIP to FCO.

The crew left the hotel in town at 04:40 LT and soon noticed that top of taller buildings were invisible due to low clouds.

Once on board the crew realized that the ATIS time report was 21:30Z, i.e. the evening before.

About 05:50 LT AZ871 was cleared to taxi (taxiway S) to takeoff from runway 09. Again the crew noticed that weather conditions were different from what reported by ATIS. They estimated the ceiling to be lower than reported and visibility to be about 2-3 km.

During taxi AZ crew heard AAW771 flight reporting TW beacon inbound and, at that moment, switched on the TCAS in order to identify the position of AAW771 flight.

AZ871 was taxing to runway 09 heading 270° when spotted the AAW771 on the TCAS at 300ft AGL.

At that moment AAW771 reported to the tower they were unable to see the runway and requested to make a go around then clearance for ILS27.

AZ871 crew saw the A330 appearing below the clouds, in a low-nose attitude and almost wing level. Few seconds later the A330 impacted the ground slightly south of the runway and burned into flames. Tail section of the aircraft separated almost immediately and bounced on the ground several times.

AZ871 reported the crash to the TWR.

Crew noticed first rescue truck arriving on the spot about eight minutes after crash.

Few minutes later TWR cleared AZ871 for takeoff.

AZ871 took off at 6.15LT.

1.18.5 Air Traffic Control (ATC)

The flight got first contact with Tripoli FIC on HF 11300 at **02:18:58** on flight level 400 when it was within NDJAMINA FIR expecting position TOMO at **02:26**, SEBHA **03:04**, and arrival TRIPOLI **03:59** UTC.

At **03:15:47** Tripoli ACC Controller contacted the Tripoli tower controller on hot line giving the sequence of traffic which will be transferred to the tower in series including the crashed aircraft which was expected Tripoli ETA at **03:58**. Tripoli ACC has confirmed with Tripoli tower about wind which was calm, and asked the tower controller to confirm ILS is out and the tower controller confirmed that ILS is out. After that Tripoli ACC confirmed to continue using the runway 09 accordingly and suggested the runway change may be afterward.

At **03:29:05** the aircraft made the first contact with Tripoli ACC on 120.9 at FL 400 under radar. Aircraft position was 55 NM south of GRT reporting point; Controller passed all the available information to the flight concerning approach ATC Clearance and Tripoli weather.

The approach clearance was 10 miles to TW Locator for runway 09 (TW locator position at 3.9 miles from touch down runway 09).

At **03:51:22** Tripoli tower controller contacted ACC Controller on hot line requesting ATC clearance to Alitalia flight AZ871, ACC gave AZ871 ATC clearance and confirmed the ETA for the first 4 flights.

At **03:55:47** Tripoli ACC Controller answered Tripoli tower controller on hot line after 45 seconds of calling while AAW771 was more than 10 miles from runway 09 threshold on altitude 2500 ft, 3minutes before transfer the flight to tower. Tower was asking the ACC about the runway change from 09 to 27 and the ACC answered it is impossible to change runway to 27 since there were 6 or 7 flights in sequence, Tower informed the ACC that wind was 240/10 Kts. Tower tried to convince ACC to change the runway but could not, and the final answer of the ACC was there is no way to change the active runway adding the nearest traffic was 10 miles away. The call was ended by the ACC Controller that he is busy and will call tower later.

At **03:58:59** AAW771 transferred to tower with positive contact on 118.1. Tower controller asked AAW771 to continue his approach and to report when runway 09 in sight.

At **03:59:28** Tower controller was calling the ATC controller on hot line, while the phone was ringing it was clearly to hear the captain of AAW721 was passing the weather information to the captain of crashed aircraft, then the ATC answered the phone and the tower informed him that Alitalia flight AZ871 is ready, and the ACC answered him to hold position.

At **04:00:10** AAW771 asked for landing clearance if he got runway in sight and the tower controller approved his request.

From time **04:00:01** to **04:00:30** there was a discussion between tower and AWW721 on frequency 118.1 about the weather. AAW721 suggested changing runway in use to be 27.

At **04:00:52** Tower controller was calling the ATC controller, ATC answered after 30 seconds of calling. During this period the crash had occurred and tower controller changed his mind and informed the ACC controller about the crash, ACC was surprised. Clear panic was observed in the behavior of ATC and Tower controllers.

2 – ANALYSIS

The flight AAW 771 Johannesburg – Tripoli took place ON 11-12/05/2010 without any particular problem until the descent phase. The Captain returned from his rest at 02:10 hours as PNF as the crew was augmented.

2.1 Scenario

2.1.1 Approach preparation

To prepare for the approach, the crew had the ATIS elements available and had contact with Tripoli controllers. The active runway was runway 09, the wind was calm and the visibility announced by the controllers and stated in the METAR messages was 6 km. The crew was informed that the procedure in force was Locator 09.

From these elements, the crew conducted a “short” approach briefing. During this briefing, the PF only mentioned some of the items provided in the Operations Manual: active runway (09), pending proceedings (Locator 09) and autobrake level (“AUTOBRAKE LOW”). A common practice for the approach briefing was to make this type of briefing when arriving at a known airport, such as Tripoli International Airport, the home base of AFRIQIYAH Airways, provided the elements available to the crew presented no special characteristics (wet runway, low visibility, etc.). The course of action for the approach was not discussed, although several options were available to the crew for a non-precision approach (managed or selected guidance modes). While the SOP of AFRIQIYAH Airways requires all crew to perform approach briefing as stated in the SOP explaining type of approach and the strategy of the remaining flight, but the fact that the approach briefing was incomplete indicates that at this period of the flight, it is very likely that the crew did not anticipate any special difficulty in the conduct and management of the approach. However, in spite of the time gained, the crew did not spend more time on discussing and sharpening focus on the essential points of the approach to be flown after the briefing.

Following this, the crew continued the approach preparation and the approach checklist seemed to be performed, but without any formal callouts: the only item called out by the crew was the altimeter setting. It is not possible to determine whether the crew completed this checklist. However, the crew may have called out only the item that had not been addressed during the approach preparation, in this particular case the altimeter setting: the switch to QNH setting was performed on both sides at the same time as the callout.

2.1.2 Initial and intermediate approach segments

From 03: 57: 35 onwards, the aircraft was at an altitude of 1800 ft QNH. It was not yet aligned with the approach extended runway centerline and was 8.5 NM from the runway threshold. The Captain’s words *(“[Let us do it what is the name... it is better] Nav Approach, It’s approved as you know”*) probably invited the co-pilot to fly the approach in managed common mode. This terminology was non standard, or even ambiguous and could be a sign of a partial miss understanding of this guidance mode. No mention was made about this in the approach briefing. The co-pilot's response *("[Yes ok]")* suggests that he had understood the Captain's intention to carry out the approach in common managed guidance mode or laterally managed "NAV" vertically selected.

About fifteen seconds later, the Captain's callout "*Track FPA*" can probably be explained as a check that the "bird" was displayed on the PFD, as is the rule for non-precision approaches. This callout could however be interpreted by the co-pilot as an intention to carry out the approach in selected guidance modes. The co-pilot's callout "*[Established let us say now ok ok]*" at the same time as the Captain's callout suggests that he may have been monitoring other parameters, such as the flight path. In fact, the flight path shows that the aircraft was flying in lateral guidance NAV mode to the point located 10 NM on final, as requested by the approach controller, and turned to intercept the approach runway extended centerline. While monitoring the flight path, or other parameters, the co-pilot's response *"I will do it [when] established"* can be explained by a misinterpretation of the meaning of the callout "*Track FPA*". He probably considered it as a change in strategy by the Captain rather than a verification of the "bird" display on the PFD.

At 03: 58: 46, the Captain's callout *("[Give it to the approach now]" it was said in Arabic*) which properly means the Captain asked the co-pilot to engage the approach mode. The aircraft was established on the approach extended runway centerline, about 7 NM from the runway threshold and at the altitude of 1,400 ft selected on the FCU to match the altitude of the intermediate approach segment. It is very likely that the co-pilot, as PF, pressed the APPR button on the FCU. The FINAL APP mode was engaged a few seconds later and the co-pilot called out the change in mode displayed on the FMA "*Final approach*". The exchanges between the Captain and the co-pilot, as well as the selection made, the callouts and the guidance modes displayed on the FMA suggest that at this stage of the flight, both crew members shared the same approach strategy. About twenty seconds after switching to FINAL APP mode, the crew finished configuring the aircraft for landing.

2.1.3 Final approach

After configuration of the aircraft, the PF requested the landing checklist that could not be applied at this moment in time due to exchanges between the PNF and the Tower controller. Then at 03: 59: 24, the PF selected a glide slope of -3.0 degrees and engaged the FPA mode on the FCU. It is not possible to determine with certainty the factor that triggered this decision. However, this can be explained as follows:

- Misunderstanding of the managed approach procedure, and or
- The co-pilot could have interpreted the Captain's "*Track FPA*" callout at 03: 57: 51 as a change in strategy with regard to the guidance modes selected for the final approach (switching from common managed guidance mode to selected guidance mode in the vertical plan and managed guidance mode in the lateral plan).

In fact, the co-pilot replied "*I will do it [when] established*", which may indicate his intention to change guidance modes once the aircraft was established for the final approach. This interpretation by the co-pilot (PF) is supported by the fact that the choice of the guidance modes for conducting the approach had been discussed for the first time only a few seconds before (*"[Let us do it what is the name... it is better] Nav Approach. It's approved as you know"* at 03: 57: 35). It is likely that the engagement of the common managed guidance mode by the co-pilot (PF) on one hand, and the engagement of the FPA mode with a slope of -

3.0 degrees on the other, met the Captain's expectations with regard to conducting the approach, The fact that the co-pilot changed the guidance mode for the descent resulted in a top of descent for the final approach at 5.2 NM from the runway threshold, It is possible that:

- The PF confused the DME distance with the distance to the runway threshold displayed on the PROG page of the MCDU, the distance of 5.2 NM being identical to the distance between TW and the VOR/DME indicated on the VOR/DME approach chart to runway 09 and probably memorized by crews based in Tripoli.
- This confusion can be explained by a misinterpretation of the distance displayed on the MCDU. In this case, the co-pilot associated the distance of 5.2 NM with the FAF, i.e. the top of descent for the final approach regardless of TW Locator.
- The co-pilot probably wanted to select the slope of -3.0 degrees at about 1 NM from the TW beacon, as provided in the manufacturer's documentation used by AFRIQIYAH Airways, and unintentionally engaged the FPA mode without waiting to be 0.2 NM from the beacon, contrary to the instructions in that same documentation (see 1.17.1.2).

After engaging the FPA mode, the co-pilot's (PF) callouts *"Go around altitude"* and "*Minus three degrees Sir"* indicate that he was aware that the final approach had started and may suggest that he believed they had crossed TW. The callout "*Minus three degrees Sir*" can also be interpreted as a desire to inform the Captain of the change in guidance mode and to confirm they were following a slope of -3.0 degrees in selected mode for the final approach. However, simultaneously with this callout, the Captain was called by his first name by the Captain of flight AAW721 who wanted to warn him about the presence of low stratus cloud in the vicinity of the runway. Concerning the co-pilot's callout, either the Captain:

- May have heard it and associated it with the identical descent angle of the managed approach (FMS), or
- He may not have heard it, since the Captain of flight AAW721 just called him by his first name.

For his part, in the absence of any reaction from the Captain, who was busy managing radio communications, the co-pilot may have taken it for granted that the Captain had actually received the information about the change in guidance mode. He therefore naturally continued conducting the approach by asking for the checklist. He then called out flying over TW, perhaps by observing the ND. At this callout, neither crew member mentioned the top of descent before TW nor crossing this beacon at an altitude lower than that provided for in the procedure, i.e. 1,350 ft.

Within thirty seconds after the co-pilot's callout "*Minus three degrees Sir*", the sequence thus included exchanges with the crew of AAW721, the landing checklist and the callout relating to passing over TW. The distraction that may have resulted from this sequence did not prompt the Captain to possibly reconsider the interpretation of the slope called out by the co-pilot nor to notice the switch from managed common mode to selected mode or passing over TW in descent at an altitude lower than provided for in the approach procedure. His answer "*2,000 set*" to the co-pilot's callout "*Go around altitude*", which should coincide with the reading of the altitude window on the FCU, confirms this idea of momentarily diverted attention from monitoring the flight path as the altitude selection was initiated on the FCU two seconds after the "*2,000 set*" callout.

The intervention of the Captain of flight AAW721 (which may indicate that he went through a weather condition during approach and landing other than reported by ATC, visibility and cloud base), who the Captain knew, probably surprised him. Being called on the frequency by his first name perhaps naturally caused him to give priority to this intervention. It is possible that the consideration and use of the information provided by the latter led the Captain to focus his attention on the outside to acquire visual reference points rather than on coordinating with the co-pilot (PF) and monitoring the flight parameters. Under these conditions, it is probably that, the Captain could not imagine that his approach strategy might be wrong.

Thus, the change in guidance mode for the final approach by the co-pilot was not formally coordinated and no longer corresponded to the Captain's strategy, which was to carry out the approach in common managed guidance mode. The pilots no longer seemed to share the same strategy for conducting the final approach:

- The Captain's strategy was to carry out the final approach in common managed guidance mode, which involved a continuous descent final approach down to the MDA (about 1 NM from the runway threshold for the approach procedure to Locator 09) and then to the runway threshold, at an altitude of 50 ft.
- The co-pilot intended to carry out the approach in selected vertical guidance mode, which involved a final approach with a possible level at MDA until the MAPt.

The co-pilot's (PF) callout at 04: 00: 01 about crossing TW could be interpreted by the Captain as an invitation to advise the Tower controller when passing the FAF in order to obtain landing clearance. It did not lead him, as PNF, to check the flight parameters, the flight path and any possible deviations from it. On final approach to Tripoli, the Captain, who may have believed they were in common managed guidance mode, probably had no doubt about the automated management of the approach in this mode and consequently about the final path.

The callout "HUNDRED ABOVE" issued by the synthetic voice was heard and validated by the crew. When approaching the MDA, by calling out "*Continue*" probably in response to the co-pilot's question about visual reference acquisition "*[You see?]*", the Captain decided to continue the final approach and the co-pilot agreed. The Captain announced "Continue" probably in response to the co-pilot word "[You see?]" which could have been perceived either as a question about the visual reference acquisition by the Captain, or as an indication to the Captain that the co-pilot had acquired visual references to continue the approach or it may be explained by different weather exist from the weather report they already had. However, it is almost certain that the weather conditions (as indicated by the previous crew), the lighting conditions and the actual position of the aircraft in relation to the runway threshold when approaching the minima (2.6 NM and an altitude of 420 ft when "*Continue*" was called out) did not enable acquisition of the external visual references required to continue the approach below the MDA. The factors that may have led the Captain to decide to continue the approach are:

- An incorrect representation of the guidance mode. The Captain probably thought the aircraft would be positioned on the final approach path and he probably hoped to obtain visual references in the next few seconds given the optimal flight path he thought the aircraft was flying,
- The intervention of the Captain of flight AAW721, which had landed despite the weather conditions described, suggesting to the Captain that they were, however, adequate for a safe landing,

- Being back in Tripoli, the home base of the airline, for a crew familiar with the aerodrome, the procedure, the environment and probably the specific weather characteristics of the morning,
- And a situation where aborting the landing would have meant making a new plan of action, a costly process from a cognitive point of view after a long night flight.

On the Captain's "*Continue*" callout, which seems to demonstrate the latter's awareness of the MDA approach, the co-pilot (PF) probably assumed that the Captain had acquired outside visual references. He therefore continued the approach below the MDA, without disconnecting the autopilot for landing and probably looked for outside visual references. As this search probably turned out to be unsuccessful after the "MINIMUM" synthetic voice warning, he asked the Captain whether he should abort the approach or not. It should be noted that during the ten second period between the "*Continue*" callout and the co-pilot's question about whether the approach should be aborted, there was no verbal intervention of the two crew members and this can be explained by:

- The attention given by the crew to the communications with the crew of AAW721, taxiing in, and the Tower controller (about the weather conditions and a possible change in runway configuration) or,
- The search for outside visual references.

Having asked the Captain if the approach should be aborted, the co-pilot repeated the "THREE HUNDRED" computer callout. In the same second, the TAWS "TOO LOW TERRAIN" warning sounded and triggered the Captain's decision to abort the approach. Without outside visual references to continue the approach, the activation of this warning might took the Captain by surprise, and he repeated "*Go-around*" three times. The tone and speed of the co-pilot's answer "*Go-around Flaps*" and his last two interventions ("*I'll go-around Captain*" and "THREE HUNDRED") suggest that he expected this decision by the Captain. Although, the AFRIQIYAH Airways and Airbus SOP requires the PF to follow the standard procedures and initiate the go- around with out waiting the captain's approval.

The co-pilot's (as PF) hesitation in conducting a go around without explicit approval from the captain might indicate that the CRM principles had not been fully implemented. One of these principles is that although the captain is the superior and has ultimate responsibility in the cockpit, the other crew members should feel at liberty to contribute their own opinions, suggestions and to show initiative.

2.1.4 Missed approach

All the indications show that the co-pilot, by his repeated callouts below the MDA, was willing to abort the final approach. Indeed, on the Captain's callout to abort the approach, it is likely that it was the co-pilot who disconnected the autopilot by pressing the "instinctive disconnect" button on his side stick before applying a short pitch-up input. While the go around can be performed either by autopilot engaged or manually, the disconnection of the autopilot may be explained as a response to an emergency (as required by the TAWS procedure on the PULL UP warning while the actual warning they had was TOO LOW TERRAIN). The PF had requested go-around and called out "three hundred", The go-around was initiated without undue haste. At this stage, the actions of the two crew members indicate that they shared a common goal, but within a very short period of time some items of the go-around procedure were not called out (the "positive climb" and "FMA" callouts). The Captain, as PNF, did not make the appropriate callouts (deviation detection) and the co-pilot questioned him on several occasions, indicating the need for a more active participation of the PNF in a dynamic flight phase to apply the go-around procedure. It is likely that the Captain did not expect to have to abort the final approach and the "TOO LOW TERRAIN" warning destabilized him.

After switching from FULL configuration to configuration 3 onwards, i.e. four seconds after the autopilot disconnection, the co-pilot began to apply nose-down inputs on his side stick, resulting in a decrease in the pitch attitude of the aircraft to a negative pitch. These inputs are consistent with the high pitch attitude he could have perceived (see 1.16.1), typical of a somatogravic perceptual illusion occurring in the absence of outside visual references and monitoring of the artificial horizon. The co-pilot would have maintained nose-down inputs as long as he was feeling this effect, the pitch attitude perceived being relatively constant and greater than the theoretical pitch attitude during a go-around. The co-pilot's successive callouts "*Flaps*" were probably due to the detection of the red and black strip on the speed tape and the very high speed trend due to acceleration. They indicate that the co-pilot's attention was focused on the speed tape. He probably wanted to avoid reproducing what had happened during the flight of 28 April, during which the over speed warning was activated at the go-around. The processing of the airspeed information may have led the co-pilot to fail to monitor the actual aircraft attitude on the PFD during this phase, or even the vertical speed indicator. At no time was the go-around pitch attitude controlled, nor did the co-pilot follow the instructions from the flight director. The focus on the speed tape can be explained not only by a desire to avoid exceeding the VFE, but also by a state of fatigue (see 1.16.2) which can lead naturally to focus on a single point, especially if it is red. The aircraft started its descent at 450 ft AGL (670 QNH), the maximum height reached during the go- around and neither a crew member seemed to be aware of the flight path of the aircraft. For his part, the Captain responded to the co-pilot's callouts "*Flaps*" by changing the configuration. At the same time, he informed the Tower controller about the missed approach maneuver but did not effectively play his role as a PNF, e.g. by monitoring flying deviations.

Moreover, since the autopilot disconnection, the Captain applied inputs on his side stick in the same direction as the co-pilot, whether pitch-up or pitch-down. This suggests that not only did he perceive the same attitudes as the co-pilot but he also wished to adjust the co-pilot's inputs on the side stick without mentioning it. The amplitude of the Captain's inputs was such that it did not trigger the voice message "DUAL INPUT" at any time or the illumination of the SIDE STICK PRIORITY lights. This action appears to be intended to provide assistance without the Captain intending to fly the aircraft by himself without showing a lack of trust in co-pilot. The inputs applied are low enough not to trigger the simultaneous control "DUAL INPUT" warnings. However Investigation Committee found this type of simultaneous action contrary to the SOP.

This distracted the captain from his task of monitoring the flight data and also that it led to ambiguity about who was in control of the aircraft. Loss of control over the flight path after the go around may have been the inadvertent result of the absence of clarity about who was flying the aircraft.

Like the PF, the Captain's attention appeared to be focused on the speed tape. Indeed, at 04: 01: 03, with his callout "*Speed*" and his role as PNF, he certainly pulled the Speed/Mach button on the FCU to select the current speed. This action by the Captain occurred when the speed was 176 kt and the speed trend was mainly in the red band. It is possible that the Captain wanted to avoid triggering the over speed warning as was the case during the flight on 28 April 2010. He probably also tried to stabilize the speed simply by using the A/THR, although this was not possible as the levers were still on TOGA.

Three seconds after having selected the speed on the FCU and during the seven seconds before the aircraft struck the ground, a succession of TAWS warnings: "DON'T SINK", "TOO LOW TERRAIN" and "PULL UP", with increasing levels of severity was recorded. When the TAWS "DON'T SINK" alert was triggered, the Captain applied a sharp nose-down input on his side stick, which could be explained either by:

- The persistence of the somatogravic perceptual illusion. In this case, when selecting the speed on the FCU and CONF 1 the Captain necessarily moved his eyes, which may have affected his perception of the situation;
- Or through a reaction to the black and red strip scrolling down on the speed tape, leaving "virtually" the yellow horizontal line materializing the current speed under the lower part of the black and red strip.

The Captain made no callout regarding his taking over control. It is not possible to determine whether the Captain's nose-down input was related to the TAWS "DON'T SINK" alert, unlike the co-pilot's pitch-up input that was initiated one second after the alert was triggered. The co-pilot's pitch-up input can be interpreted as an action to stop the aircraft's descent following the triggering of the "DON'T SINK" and "TOO LOW TERRAIN" TAWS alerts or as a reaction by the co-pilot to the Captain's nose- down input. However, the co-pilot's simultaneous callout "*activate approach phase*" suggests that he was unaware of the real situation; he probably wanted either:

- to prepare for a second approach, or
- to try again to reduce the speed (in managed speed and SPEED mode of the A/THR, activating the approach phase helps to reduce speed).

Less than a second after his sharp nose-down input, the Captain pressed the side stick priority button for a period of about three seconds, without any callout by him nor a syntactic voice (priority left) generated, probably to take priority and avoid a dual input situation. In this critical situation, it is also conceivable that this action could have been caused either by a spasm on the side stick, which can be corroborated by the fact that he also pressed the radio button a few moments later or a defective push button which had been reported in the aircraft Technical Flight Log (See 2.12).

The Captain maintained his nose-down input on the side stick after taking over priority. At this time the co-pilot's input on the side stick was to the pitch-up stop. It indicates that the co-pilot at this stage aware of the aircraft flight path but did not know that his input on the side stick was inhibited by the Captain who had taken over control. During this one-second delay, the "DUAL INPUT" voice message was probably issued but masked by the higher-priority sequence of TAWS alerts ("TOO LOW TERRAIN"). Similarly, when the Captain took over control, the "PRIORITY LEFT" message may be also masked by the TAWS alerts. In addition, it should be noted that there was no reaction when the synthetic voice issued a callout on reaching minima during the aircraft's descent from the maximum height of 450 ft AGL that was reached during the go-around.

At a height of about 180 ft (AGL), i.e. less than two seconds before SSFDR and SSCVR end of recording and one second after the last TAWS "PULL UP" warning was triggered, the Captain applied a pitch-up input to the stop, and the priority side stick push button released. At this time the co-pilot's input on the side stick was also to the pitch-up stop. Both inputs probably indicate that the two crew members were aware of the aircraft path and ground proximity. Nevertheless, one second before the collision with the ground, the Captain released his pitch-up input to apply a pitch-down input.

These last actions associated with the lack of an appropriate response from the crew, adjusting the flight path when the TAWS warnings were activated, did not make it possible to avoid the collision with the ground.

2.2 CRM

The sequence of events leading to the accident (see 2.1) shows a lack of coordination, a lack of cross-checking and deviations from procedures. For example, right from the approach preparation, the fact that the approach checklist was not carried out formally and rigorously by calling out all the items indicates a typical procedural drift that results from one or more of the following:

- The routine nature of the return flight to Tripoli International Airport that could lead the crew not to carry out the checklist in a formalized way,
- The routine nature of this deviation without any immediate negative impact on flight safety,
- A saving in time and reduction in workload for the crew,
- Possible crew fatigue at the end of flight, resulting from sleep deprivation related to night flight and rest period at daytime during the stopover in Johannesburg.

These factors adversely impacted flight path management and flight strategy. The Captain, PNF, did not seem to have monitored the flight path. For example, it is possible he was not aware of the selection of the glide path on the FCU before crossing TW. Similarly, the PF's callout "*overhead TW*" did not prompt the Captain to monitor the altitude, which would have helped him to detect the aircraft, was flying at an altitude lower than specified in the procedure. Later, during the go- around, he did not call out any deviations of flight parameters. This lack of monitoring of the flight path by the PNF can be explained by an attention initially focused on the communications with the crew of AAW721 then on the outside conditions. The approach to a familiar airport may have also created an environment conductive to a lack of monitoring of the flight path. The element of surprise which may have resulted from the lack of visual references from the time when the aircraft reached the MDA to the activation of the "TOO LOW TERRAIN" warning did not enable the PNF to return to the control loop during the missed approach. Overall, the management of tasks during the approach deteriorated very quickly.

The return of the crew to their home base may have led them naturally to have a minimal basic CRM, coupled with a state of fatigue which is known to degrade communications and crew performance. The weather information at their disposal and the probable fatigue also confirmed this trend in the crew. The callouts for the approach briefing and the checks (checklist) seem to only cover those items that had not previously been addressed by the crew. The communication between the two crew members was limited from the initial approach onwards, which seemed that; they no longer sharing the same action plan. Inaccuracies in the terms used to define the approach strategy (managed or selected common guidance mode) were at the root of the loss of coordination. The interventions by the Captain of flight AAW721 also drew the Captain's attention away and deprived the crew of the opportunity to notice this loss or at least clear up doubts about sharing the same action plan. This lack of verification can also be explained by the fatigue of both pilots.

When the "TOO LOW TERRAIN" warning was triggered, the Captain ordered the missed approach. It is highly probable that he was very surprised to hear this warning and to have no visual reference after carrying out the approach in common managed guidance mode, which normally takes the aircraft to about 1 NM from the runway threshold. Despite the information from the Captain of flight AAW721 about the presence of low stratus cloud in the vicinity of the runway, the fact that the AAW721 had landed, this probably led the crew to be confident in being able to do the same. The Captain's callouts and answers to the co-pilot suggest that the activation of the "TOO LOW TERRAIN" warning destabilized him. His interventions did not correspond to what is expected in the management of such a situation. For his part, on several occasions the co-pilot had to urge the Captain to perform the tasks normally assigned to the PNF.

While it was confirmed that the 3 pilots were in the cockpit at the time of accident and the relief pilot has no assigned duty below FL200, However if he was occupying the third crew member seat, he would have access to monitor the flight instrument but investigation committee did not find any evidence of the relief pilot announcement or any notice made by him to the flight crew of the deviation from the assigned approach path probably he was looking out side for a visual ground reference.

In general, the crew's CRM was limited during the approach, further weakened after the decision to abort the approach. It seems unlikely that the crew's shortcomings that have been noted with regard to the CRM were caused by the current situation, as was demonstrated by the discussion about go-around between the PF and the relief co-pilot during cruise. The information on the operator's training programme aimed in developing knowledge and skills in the field of human performance and crew resource management is stated in (1.17.2.2).

2.3 Conducting Non-Precision Approaches

An analysis by the Flight Safety Foundation (*Flight Safety Digest Document, November 1998 – February 1999*) used in ICAO document 8168 (*PANS-OPS ICAO Doc8168 Operations of aircraft Section 4, Chapter 1*), shows that the risk of accidents during a non-precision approach is higher than during a precision approach. Although non-precision approach procedures are not inherently dangerous, errors are possible in the conduct of the approach especially in the flight path control.

Several methods were available to carry out the final approach. The Captain had opted for management based on the common managed guidance mode. This technique involved a continuous descent, the top of descent calculated by the onboard equipment being beyond the Locator TW, to a point approximately 50 ft above the landing runway threshold. The imprecise communications between the two crew members led to a loss of coordination, characterized by a change in the approach technique by the co-pilot, who chose a glide slope to carry out the final approach. The ambiguities and inaccuracies in verbal exchanges can be a potential indicator of the lack of familiarity with the different methods of approach about which the crew had recently been informed (see 1.17.2.1.1).

The various options available to a crew to perform a non-precision approach, combined with the crew's weak CRM and the lack of specific callouts to manage the non-precision approach during the briefing, increased the risk of errors and misunderstanding.

Analysis of the April 28 flight showed similarities to the accident flight, the same crew experiencing the same scenario of un-stabilized approach and a loss of situational awareness during go-around. These two events probably indicate a systemic weakness in the flight operation analysis method (procedures, training, practice or in the selection or matching of the crew roster if we consider that this was the only crew to recently have an accident) which cannot necessarily be precisely characterized. The investigation committee confirmed that the analysis of April 28 flight was not performed before the crash and the crew had not reviewed and fully understood what had happened during the April 28 flight.

2.4 Loss of Flight Path Control in Approach Phase during Go-around

The go-around on 28 April 2010 and the accident flight reveal some apprehension on the part of PF with regard to the go-around maneuver. Both flights also tend to show that the Captain was not necessarily comfortable with this procedure either. Even though the crew had to abort two approaches within two weeks, the go-around was still a flight phase rarely encountered during operations. In addition, training programs provide mainly type-ratings and go-around training sessions with one engine inoperative. This raises questions about the low exposure of crews to go-around maneuvers with all engines operating and with an aircraft becoming lighter at the end of a flight. From these findings, it is certainly not possible to make generalizations but many accidents that occurred during missed approaches show the risk associated with this approach phase.

In addition, during the go-around, it should be noted that neither pilot made callouts in relation to any deviation of flight parameters. It is likely that neither of them carried out a complete monitoring of flight parameters such as a pitch attitude of less than 10 degrees or a negative vertical speed and that their attention was focused on other elements (e.g. the aircraft configuration).

The approach was conducted with the autopilot connected, the latter being disengaged when the go-around was initiated, as during the April 28 flight. While it is possible to perform go-around with the autopilot engaged, investigation committee could not determine whether this behavior is related to crew or to the practices taught, as well as to understand the origin of these difficulties in controlling the aircraft trajectory during the go-around.

2.5 Flight Safety

2.5.1 General

The regulations in force in Libya require systematic flight analysis from operators. However, AFRIQIYAH Airways had acquired flight analysis equipment and systems, also Operations Manual calls for the analysis of crew reports but they were not fully implemented. This lack of systematic flight analysis can be explained by the limited internal feedback. The systematic analysis of flight data would not only help detect deviations and thus implement corrective actions following the detection of deviations, but would also enhance flight crew safety awareness.

During an interview with AFRIQIYAH Airways flight safety engineer, the investigation committee was informed that, as a normal procedure in AFRIQIYAH Airways flight safety office, the Quick access recorder (QAR) tape should be removed from the aircraft every three days and sent to flight safety office to be analyzed immediately for deviation corrections, but on the case of flight April 28 2010 the tape received late and no analysis was carried out until late after the accident.

The investigation committee concludes that AFRIQIYAH Airways safety policy had not been followed properly, which could be a very good factor to prevent such accident if that data has been processed on due time.

2.5.2 Reportable Events

Although go around and TAWS alerts are reportable events but the execution of GO-AROUND and TAWS alerts on April 28 2010 flight were not reported by the crew to the ATC nor to the company accident prevention advisor (APA).

The investigation committee was not able to determine why flight crew had not reported these events and therefore, if these events have been reported it could have been possible to analyze this flight in due time and make the flight crew aware of their mistakes.

2.5.3 AFRIQIYAH Airways Audits

Reference to 1.17.2 Information on AFRIQIYAH Airways the company had been subjected to regular audits carried out by three different means one as an internal audit performed by the quality system within the company, the other by the LYCAA and the third by international body (IOSA). The Investigation Committee had reviewed the three audit reports, and could not find deviations recorded in the areas of training, safety and operation. The IOSA on AFRIQIYAH Airways was going on during the time of accident, but no findings were recorded on the entities of training or safety, this was contrary with the practice conducted by the crew on 28 April 2010 flight which was not analysed on time.

Subsequently, the failure to discover deviations on safety and operation by the audits performed can be explained by:-

- Weakness in the way of conducting audit check list (quality in AFRIQIYAH, LYCAA, and IOSA) or,
- Check lists used during audits were more generic and did not pinpoint on certain items in safety area and flight analysis.

2.6 Crew Fatigue

According to the information gathered from Johannesburg, AFRIQIYAH Airways crashed aircraft crew rested for a period of more than 15 hours which was formally complied with LYCAA regulations, and in this matter the investigation committee confirm that none of the flight crew had left the hotel during their rest,

The flight departed O.R Tambo International Airport on 11/05/2010 evening and it is assumed that the two co-pilots had their rest during cruise some time before the captain took his rest, but the investigation committee could not find any documented material within AFRIQIYAH Airways to manage and control the rotation of the crew rest in long haul flights.

According to study of fatigue on night oriented persons made in coordination with BEA (see 1.16.2) the crew flew two consecutive night flights; this would impose a certain amount of fatigue which might degraded the performance of the flight crew and increased the effect of somatogravic illusions.

Investigation Committee concluded that the pilots' performance was likely impaired because of fatigue, but the extent of their impairment and the degree to which it contributed to the performance deficiencies that occurred during the flight cannot be conclusively determined

2.7 Report of ALITALIA Flight AZ871 Captain

From the Report of ALITALIA Flight AZ871 Captain (See 1.18.4) it was mentioned that the ALITALIA Captain heard the AAW771 Crew (***reported to the tower they were unable to see the runway and requested to make a go around then clearance for ILS27***).

From the SSCVR and ATC tape Records, Investigation Committee found that the sequence of the go around phase was not as reported by the ALITALIA Captain since the AAW771 Crew did not give any information about their inability to see the runway and requested to make a go around but the fact that the AAW771 Crew initiate the go around even before they inform the Tower. In addition it was not found at all that the crew of AAW771 requested clearance for using runway 27 and in this case Investigation Committee found that the report of the ALITALIA Captain was not accurate in reporting this event.

2.8 Air Traffic Control (ATC)

2.8.1 Selection of Active Runway and Instrument Approach

The active runway means the runway considered by ATC as that best suited for crews about to land or takeoff. In addition to the direction and speed of the surface wind, the criteria for selecting the active runway depend on such factors as the available approach, landing aids, and specific instructions concerning the airport. If the active runway is not satisfactory to a crew, the later may request to use another runway.

On the day of the accident, the wind reported to the crew by the Tower controller was calm and the METARs information was wind variable at 1 kts (METAR HLLT 120350Z VRB01KT

6000 NSC 19/17 Q1008). The maximum authorized landing tailwind component for Airbus A330 is 10 knots, however as the ILS was available on runway 27 to carry out a precision approach, thus considering the wind, and the presence of stratus clouds in the vicinity of the runway 09, an ILS approach on runway 27 would probably have reduced the risk of confusion between the two crew members, and would have facilitated the acquisition of the visual references required to continue the approach through to full landing.

It was also found that the tower controller gave landing clearance to AAW721 without reporting runway in sight as well as the conditioned landing clearance (AAW771 Asked "*Confirm clear to land if we have the runway in sight*" and the Tower answered "Affirmative clear to land wind calm") which was given to the crashed aircraft in contrary with the standard working procedures. Those clearances were not in consistency with the operating standard as well as local regulations.

2.8.2 Hot Line Discussion between Tower and ACC

Reference to Hot Line Records it had been found that the ACC controller asked Tower controller to confirm that ILS was out, Tower answered ILS is out. The investigation committee found in the technical log of ACC and Tower that, it was clearly stated during the shift hand over, communications and Nav. Aids were working normally. This gave an indication that both controllers in the Tower and ACC were not aware of the ILS serviceability, and could be a factor in selecting the active runway which was based on incorrect information since both controllers believed in the un-serviceability of the ILS.

Tower controller contacted the ACC on hot line giving wind 240/10 Kts and asking for runway change. The change of active runway was rejected at the beginning by the assistant air traffic controller at the ACC, which is a strategic issue has to be decided by the rated air traffic controller or the chief of the shift. The investigation committee could not confirm if this decision which was taken by the assistant controller him self or after coordination with the rated controller, although it had been agreed by the rated controller later but it was clear that the chief of ACC shift has no roll what so ever in this issue since he was on rest at the time of accident.

It had been found that from the ATC Records, the assistant controller informed the Tower controller the reason for not changing the active runway was because of the too close inbound traffic to the Airport. In fact investigation committee found at that time the nearest traffic was 10 miles away as mentioned by the ACC Controller which is considered to be enough to change the active runway from 09 to 27 and benefit from the better approach facilities.

2.8.3 Tripoli Tower

After the accident, Tower controller could not see the crashed aircraft and he had to confirm with Alitalia AZ871 crew the situation of the crash and how far from the runway, Alitalia crew answered, the crash was less than one mile south of the runway, added that the runway is free of any FOD due to the crash. Tower controller inspected the runway surface found clear and free of any debris. Tripoli Tower gave take off clearance to Alitalia AZ871 while the fire category of the airport was downgraded dramatically due to engagement of the fire brigades in the crash site. The performance of the Tower controllers was below standard; this can be explained by state of panic during this emergency situation.

2.8.4 ATC Incident Report

In general cockpit crew should report to ATC any technical abnormality or deviation from flight plan during flight (such as Flight Return, divert, Go around, miss approach, Incident or fire on board……etc), further processing such reports will not only enhance safety measures but also contribute in avoiding re-occurrence of incidents. The investigation committee could not find any evidence of reporting April 28 flight either by the fight crew to the ATC or by the ATC which properly had a good contribution in avoiding the accident on 12/05/2010.

In this case investigation Committee concludes that reporting and processing of such occurrences have great roles in enhancing aviation safety and both Air Crew and ATC staff are encouraged to report them in due time.

2.9 Weather

Weather information is one of the most basic and essential information that the Crew must have before commencing flight. The Crew of this flight had all weather information and forecast required before departure from O.R Tambo International Airport (Takeoff, en-route, destination, alternate Airports, .. etc) .

By tracking meteorological observations reports that issued by the national meteorological centre we found the following:

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METAR HLLT 120250Z 35003KT 6000 SKC 19/17 Q1008
METAR HLLT 120350Z VRB01KT 6000 NSC 19/17 Q1008
METAR HLLT 120420Z 27007KT 5000 BR NSC 19/17 Q1009
METAR HLLT 120450Z 26007KT 2000 BR FEW003 19/17 Q1009
METAR HLLT 120520Z VRB 03KT 2000 BR BRK003 19/17 Q1009
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Previous observations show atmospheric conditions prevailing Tripoli International Airport at day of the accident and at 03:29:43 the Area Control Centre (ACC) passed the following weather report (METAR) to the crashed aircraft (wind calm, visibility 6KM sky clear, temperature/ due point 19/17°C, QNH 1008) when the aircraft location was 55 miles south of GRT reporting point.

Tripoli International Airport weather forecast (TAF) was as follows:

TAF HLLT 112300Z 1200/1224 36005KT 7000 NSC PROB40 1200/1206 5000 BR BECMG 1206/1208 FEW025 SCT100 PROB30 TEMPO1209/1215 7000 –RA BKN080 BECMG 1212/1214 03010KT NSC BECMG 1216/1218 22015KT=

TAF HLLT 111700Z 1118/1218 35005KT 8000 NSC PROB40 1200/1206 5000 BR PROB30 TEMBO 1212/1216 –RA FEW050 BKN100 BECMG 1215/1217 09010KT=

TAF HLLT 111100Z 1112/1212 30015KT 8000 SKC BECMG 1118/1120 30005 KT NSC PROB40 1200/1206 5000 BR BECMG 1210/1212 02010KT=

TAF HLLT 110500Z 1106/1206 22015KT 8000 NSC BECMG 1112/1114 29015 KT CAVOK BECMG 1121/1123 35010KT 8000 NSC=

From the previous forecasts we notice that the data does not impede air traffic moving, but noticed that wind mostly coming from west and north west (300/15 – 350/05 – 360/05 – 220/15) and during the crashed aircraft approached for landing received a warning from one of AFRIQIYAH aircraft in specific flight AAW721 which refers to the presence of low clouds on the short final – and this warning was at 03:59:32 (Approximately 90 seconds before the accident).

At 05:28 (1 hour and 17 minutes after accident time) weather warnings was issued, valid from 04:00 to 07:00 and was as follows:

HLLT LOC WARN1 VALID 120400Z – 120700Z BR OBS AND FCST OVER HLLT A/F RED V/S TO 2000 OR LESS AT TIME=

Tripoli International Airport equipped with sensor to measure cloud base (CEILOMETER). This sensor which located at the beginning of runway 27 has the ability to measure cloud base from 0 up to 7500 meter.

At 04:12 the sensor recorded low altitude cloud base (60-110 meter), when wind speed and direction was (270/10 kts – SSFDR reading) after making some calculations to determine the clouds location at the time of the accident based on ceilometer recordings and taking into account the time of the accident which was at 04:01:13 we found time difference 04:12 – 04:01:13 = 10 min 47 sec (10.78 min).

Wind speed 10 Kts (1NM = 1852 meter).

The clouds away from the sensor 10.78 min × 310 meter/min = 3341 meter

As the sensor away from the beginning of the runway 09 a distance of 3215 meter, so the clouds will be at 3341 – 3215 = 126 meter west of runway 09 threshold. In this case the low light patches clouds were covering the final approach segment moving to cover the beginning of runway 09.

Conclusion:

- As atmospheric humidity increases, the air temperature and the dew point became closer, this resulted in (MIST) or fog which leads to reducing visibility.
- Weather warning No. 1 was released after the accident more than one hour, and this warning valid from 04:00 to 07:00, states MIST covers Tripoli International Airport, with low visibility reaching 2000 meter or less.
- Direction of wind mostly coming from the west, speed variable from calm to 10 Kts. Wind speed recorded by the aircraft flight recorder SSFDR from 7 to 12 Kts, coming from the west, and attributed the difference in wind speed to the presence of the aircraft at an altitude of relatively high and measure surface wind.
- Reading recorded by the (ceilometer) device – and with wind speed of 10 Kts, clouds were at the beginning of the runway 09.
- Warning issued from flight AAW721 and its proposal to change runway direction to the Tower confirms the presence of clouds beginning of the runway 09, and there was a difficulty in approaching for landing.
- Approach to the runway by crashed aircraft was not successful, and the crew not reported runway in sight, which confirms that visibility was not good.
- Sunrise was at 04:11 almost 9 minutes after the accident.
- According to maps of the British meteorological office which was tracking the movement of volcanic ash as a result of the eruption of Iceland volcano. The volcanic ash was 3200 Kilometres to the west of Tripoli international Airport.

2.10 Cockpit Crew Medical checks

With regard to the Captain blood pressure records especially on 29 – 30/06/2009 which found high with a remark to follow up, the Captain may not had been informed about this remark, knowing that his medical file was kept by the medical center. In addition the investigation committee could not find any evidence of any other medical follow up check to the captain afterward (Refer to 1.13.1).
After the crash the medical report says that captain and both co-pilots bodies were free of drugs, alcohols and the death was caused due to multiple serious injuries.

2.11 Crew training

Reference to (1.18.2) for 28 April, 2010 and the crashed flights, it seems that on both cases the behavior of the crew was built on misunderstanding and/or mishandling of procedures, this may indicate insufficient or weak syllabus in the training and/or inadequate evaluation process at the end of such training.

As we know the aim of training is to improve behaviors and skills, the method of updating training programme is by studying feedbacks given from trainees and operators, but this update could lead sometimes to exaggeration and complications in the process, to the point that some pilots put their means of explanation between the lines and build up their understanding on their old experience. The investigation committee concluded that the training received by the crew may not enable them to demonstrate enough go around particularities and for this issue the committee would like to point out that shortly after the accident the Airbus initiated a special training scission on go around to overcome any of misunderstanding, misuse procedure or mishandling. In addition an article under the go around handling title came out in the Airbus safety magazine issue 10 august, 2010.

2.12 Fuel

A330-202 is a modern aircraft equipped with sophisticated computerized fuel system assisting and reducing crew work load. The aircraft has total fuel capacity of 111272 Kg but, it is not necessary to carry this entire quantity in the fuel tanks, the fuel quantity needed can be calculated as per the distance to the destination, alternative airport, takeoff and landing weight, contingency fuel and others.

At take off time of the aircraft from Tripoli airport, the fuel quantity was 97400 Kg, which was enough for a return flight (Tripoli-Johannesburg-Tripoli) without refueling.

At arrival to O.R Tambo (Johannesburg) International Airport the remaining fuel was about 51000 Kg and it was enough to fly back to Tripoli International Airport. The aircraft reached the destination airport Tripoli without any problems in the fuel or its systems;

As per Technical Flight Logbook (TFL) all the fuel quantities for all previous flights of the same route was nearly the same. In addition during the crash site investigation a fuel smell was noticed and fire broke off especially at the wing wreckage area where the fuel tanks located, also a solidified molten aluminum of the aircraft wings and structure had been found, this proves that there was fuel in the aircraft before the accident.

By recalculating the fuel consumed during this flight which was about 43000 Kg and from the FDR reading, the fuel onboard at the crash time was about 7200 Kg.

From the above the investigation committee confirms there were no short of fuel, fuel system malfunction, and contamination or system deficiency.

2.13 Aircraft Power-plant and Systems

All the available information indicates that aircraft systems at time of accident were working normally. According to the SSFDR, SSCVR readout data and the crash site investigation, no system malfunction was recorded or observed.

Aircraft engines were working normally; this had been confirmed by the read out of the SSFDR as well as by the engines wreckage examinations at the crash site.

It had been confirmed that both engines were working at high power setting at time of impact.

2.14 Captain Side Stick Analysis and Examinations

With regard to repetitive push button snag that reported in the aircraft Technical Flight Log (See 1.6.6), the captain side stick has been taken for special test in three places (See 1.16.3). The difference in force required to press the push button between the results in Ratier Figeac plant and Crouzet manufacturer can be explained by:

- long storage conditions during liberation war and or,
- Successive manipulation as subsequence to the Ratier Figeac plant examination and the period after until the Crouzet manufacturer examination.

For these reasons the investigation committee thought, the Ratier Figeac examination results were more close to the condition of the press button at the time of accident.

The fact that delay in returning to the off position was noticed during the test in Ratier Figeac plant as well as reported as a snag in the aircraft technical logbook means the button takes over priority for some time without the intention of the pilot, this could explain why the captain did not call out (I have control) because he was not aware of taking over priority.

From the laboratory result it seems that the contamination on the push button was sand which had come from the crash site and the gummy substance may be comes from the fire extinguishing agent, but because the problem of late release of the button was existing even before the crash, also the result of the DGA EP laboratory indicates signs of friction on the red button and remains of phthalates, this may be explained by a tight tolerance during manufacturing causing friction on the button after time of use in operation.

2.15 Explosives

From the crash site investigation it had been found that the overall shape of wreckage distribution almost longitudinally in line with the aircraft direction from the first clear impact point with the ground.

No debris was found before the first impact point, this indicates that the aircraft was intact when impacted with the ground and no explosion occurred before and after impact.

Also it was confirmed that when SSFDR and SSCVR units were transported to France, the airport security had checked the units for the presence of signs of explosive material using particles test and the result was negative. These confirmed that there was no explosion before and after the impact and no traces of any explosive material in the crash site.

3 – CONCLUSIONS

3.1 Findings

1) The flight crew was certified and qualified for the flight.
2) The flight crew had a rest period in Johannesburg: 15 hours 10 minutes before the accident flight.
3) The aircraft had a valid Certificate of Airworthiness and was maintained in accordance with existing regulations.
4) The aircraft's weight and balance was within the limits prescribed by the manufacturer.
5) At take off from Johannesburg, the aircraft technical log book was clear from snags or deferment ; fuel onboard was about 50 tons, and there were no short of fuel, or fuel system malfunction during the whole flight and at the time of accident.
6) The aircraft took off from O.R Tambo International Airport without any known technical problems. The analysis of the recorded parameters did not identify any failure of the aircraft, engines or its systems.
7) The composition of the crew was in accordance with the operator's procedures and the applicable regulations.
8) The Captain took his rest during the cruise and returned as PNF about 1 hour 50 minutes before the crash.
9) The weather conditions known to the crew at the time of the approach preparation presented no difficulties threatening the plan to land in Tripoli.
10) The weather information available to the Crew was not reflecting the actual Tripoli International Airport weather conditions at the time of Accident.
11) An aircraft landed a few minutes before the accident flight noted the presence of low stratus cloud around Tripoli International Airport, while the crashed aircraft was approaching.
12) Approach briefing and checklist were not carried out formally and rigorously by the Crew who was not sharing a common approach strategy.
13) The final approach initially was in managed guidance mode then changed to selected vertical guidance mode under an angle of -3 degrees.
14) The final approach in selected vertical guidance mode was initiated before flying over TW Locator.
15) The Crew did not respond to aircraft call out (SV: MINIMUM) during the approach.
16) The aircraft flew below the MDA, without acquired ground visual references.
17) The PF (Co-pilot) hesitated to initiate the go-around in due time.

18) The co-pilot began the missed approach upon the Captain's callout "*go around*" following the TAWS warning "TOO LOW TERRAIN".

19) The autopilot was disconnected for go-around.

20) After disconnecting the autopilot, the co-pilot applied nose-up inputs and then nose-down inputs on his side stick, resulting in a decrease in the pitch attitude of the aircraft to a negative pitch.

21) The aircraft started its descent at 450 ft AGL (670 QNH), the maximum height reached during the go- around.

22) The Crew's CRM was limited during approach, further weakened at go around.

23) The co-pilot's nose-down inputs caused the aircraft to descend below the MDA again,

24) Following the TAWS "DON'T SINK", "TOO LOW TERRAIN" and "PULL UP" warnings, the co-pilot applied pitch-up inputs on his side stick, while the Captain was applying a nose-down input.

25) During that nose-down input, the Captain took over control by an input on his side stick, and then applied a pitch-up and a pitch-down input before the impact with the ground.

26) The Captain did not announce (*I have control*) when he took over the control.

27) Simultaneous dual inputs were not in accordance with the SOPs.

28) On the 28 April 2010, the crew performed an un-stabilized approach and carried out a missed approach maneuver during a Locator approach for runway 09 at Tripoli.

29) The analysis of April 28 flight was not performed before the crash and the crew had not reviewed and fully understood what had happened during that flight.

30) Flight analysis system within AFRIQIYAH Airways was not properly implemented.

31) The Captain Side stick priority push button had technical defect record and there was no maintenance procedure for that defect from Airbus before the Accident.

32) The 3 pilots (Captain, Co-pilot and Relief pilot) were in the cockpit during the crash.

33) Pathology report did not show any sign of drugs, alcohol, and toxic particles in the flight crew bodies.

34) Neither of the Automatic ELT,s had been activated due to Aircraft impact.

3.2 Probable Cause

A final approach carried out in common managed guidance mode should have relieved the crew of their tasks. The limited coordination and cooperation between the two crew members, especially the change into vertical selected guidance mode by the PF, probably led to a lack of a common action plan.

The lack of feedback from the 28 April 2010 flight, flown by the same crew on the same aircraft, did not allow them to anticipate the potential risks associated with managing non-precision approaches.

The pilots' performance was likely impaired because of fatigue, but the extent of their impairment and the degree to which it contributed to the performance deficiencies that occurred during the flight cannot be conclusively determined.

During the go-around, the crew was surprised not to acquire visual references. On one hand the crew feared exceeding the aircraft's speed limits in relation to its configuration, and on the other hand they were feeling the effects of somatogravic illusion due to the aircraft acceleration. This probably explains the aircraft handling inputs, mainly nose-down inputs, applied during the go-around. These inputs were not consistent with what is expected in this flight phase. The degraded CRM did not make it possible for either crew member to identify and recover from the situation before the collision with the ground, even when the TAWS warnings were activated close to the ground.

Based on elements from the investigation, the accident resulted from:

- The lack of common action plan during the approach and a final approach continued below the MDA, without ground visual reference acquired.
- The inappropriate application of flight control inputs during a go- around and on the activation of TAWS warnings,
- The lack of monitoring and controlling of the flight path.

These events can be explained by the following factors:

- Limited CRM on approach that degraded during the missed approach. This degradation was probably amplified by numerous radio-communications during the final approach and the crew's state of fatigue,
- Aircraft control inputs typical in the occurrence of somatogravic perceptual illusions,
- Inappropriate systematic analysis of flight data and feedback mechanism within the AFRIQIYAH Airways.
- Non adherence to the company operation manual, SOP and standard terminology.

In addition, the investigation committee found the following as contributing factors to the accident:

- Weather available to the crew did not reflect the actual weather situation in the final approach segment at Tripoli International Airport.
- In adequacy of training received by the crew.
- Occupancy of tower frequency by both air and ground movements control.

4 – SAFETY RECOMMENDATIONS

1. All Flight Crews are required to comply with company operations manual in regard to reportable events despite of the Crew member position.
2. Flight Crews should strictly adhere to company SOPs.
3. Airlines have to comply with the current regulation related to flight analysis programme and to create an environment of safety awareness.
4. Aircraft maintenance personnel must not perform any maintenance work if it is not covered by the manufacturer's documents and subsequently consultation with the manufacture is recommended.
5. Air traffic control personnel have to comply with the national and international standard in performing their duties as well as to stick with the standard phraseology used in the field.
6. Air traffic control personnel have to take much care about runway selection taking in consideration wind speed, direction and runway facilities as main factor.
7. Air Navigation Department within Civil Aviation Authority of Libya should distinguish the ground and the air as will as approach and area movements communication knowing that facilities are available.
8. Airports Authority should upgrade Runway 09 in Tripoli International Airport to be equipped with precision approach facilities.
9. Civil Aviation Authority of Libya and National Safety Board should make available and use of radio communications facilities between airports tower and fire fighting trucks.
10. Airbus has to review its training courses syllabus emphasising on go around, emergency procedures and taking into account low visibility and somatogravic illusion.
11. Civil Aviation Authority of Libya should develop a system for the supervision and control of medical examiners, including action to be taken in the event that sufficient evidence exists to demonstrate that a medical examiner has not performed his or her duties in accordance with the prescribed procedures.
12. Flight Crew must immediately after landing report to ATC occurrences such as go around, and to the Company safety division before next flight. Also ATC staff are encouraged to report such event in due time.
13. ATC should report any abnormal occurrences associated with the operation of Aircrafts to the concerned entities within the Civil Aviation Authority.
14. Entities conducting audits on AFRIQIYAH Airways (including company quality system, LYCAA, and IOSA) should pay more attention to areas related to safety, operation, and flight analysis during their audits.

15. AFRIQIYAH Airways should make available and use of a clear crew rest programme for augmented crew in long haul flights.

16. AFRIQIYAH Airways should make sure that somatogravic illusion phenomena is covered in pilot recurrent trainings.

17. AFRIQIYAH airways should make a regular follow up and control on pilot performance emphasising on Crew CRM (make use of LOSA) and in particular to review the CRM training in order to minimize the gap between the CRM as prescribed in the manuals and how it is practiced during scheduled flights.

18. ATC Tower should consider downgrading of the airport fire category whenever the fire brigades or part of are engaged with an airport emergency.

19. National Safety Board should properly train the rescue team to indicate and label the injured and victims in the crash site.

20. ICAO should review the requirement and the principles of the ELT.

21. The National Meteorological Centre should upgrade weather services at Tripoli International Airport as well as meteorological warnings have to be issued in due time in case of significant weather change.