FINAL INVESTIGATION REPORT

ACCIDENT OF PAKISTAN INTERNATIONAL AIRLINES FLIGHT PIA 8303 AIRBUS A320-214 AIRCRAFT REGISTRATION NUMBER AP-BLD CRASHED NEAR JINNAH INTERNATIONAL AIRPORT KARACHI ON 22ND MAY, 2020

Dated: 20th April, 2023

SCOPE

Aircraft Accident Investigation Board (AAIB), Pakistan conducts investigations in accordance with Annex-13 to Convention on International Civil Aviation and Civil Aviation Rules 1994 (CARs 94).

The sole objective of the investigation and the final report of an accident or incident under above stated regulations is the prevention of future accidents and incidents of similar nature. It is not the purpose of such an investigation to apportion blame or liability. Accordingly, it is inappropriate to use AAIB Pakistan investigation reports to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

This report contains facts which have been determined up to the time of publication. Such information is published to inform the aviation industry and the public about the general circumstances of civil aviation accidents and incidents.

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ABBREVIATIONS

A/SKID	Anti-Skid
A/THR	Auto Thrust
AAIB	Aircraft Accident Investigation Board
AAL	Above Aerodrome Level
AC	Alternating Current
ACC	Area Control Centre
ACCREP	Accredited Representative
ACP	Audio Control Panel
ADF	Automatic Direction Finding
ADIRS	Air Data Inertial Reference System
ADS	Automatic Dependent Surveillance
AFDAEL	Airbus Flight Data Analysis Event List
AFFF	Aqueous Film Forming Foam
AGB	Accessory Gear Box
AGL	Above Ground Level
AIIAP	Allama Iqbal International Airport
AIP	Aeronautical Information Publication
ALAR	Approach and Landing Accident Reduction
ALT	Altitude
ALTN LAW	Alternate Law
AMEX	Aviation Medical Examiner
AMI	Aero Medical Institute
AMSL	Above Mean Sea Level
ANO	Air Navigation Order
ANS	Air Navigation Services
AOC	Air Operator Certificate
AP	Auto Pilot
APM	Airport Manager
APPR	Approach
APS	Airport Services
APU	Auxiliary Power Unit
ASC	Air Safety Circular
ATC	Air Traffic Control
ATPL	Air Transport Pilot License
ATS	Air Traffic Services
AUTO BRK	Auto Break
BEA	Bureau of Enquiry and Analysis
BSI	Borescope Inspection
CAMB	Civil Aviation Medical Board
CAP	Corrective Action Plan
CARs 94	Civil Aviation Rules 1994
CAS	Calibrated Air Speed
CATI	Civil Aviation Training Institute
CCTV	Closed Circuit Television
CDS	Centralized Documentation System
CE	Critical Element
CEO	Chief Executive Officer
CG	Centre of Gravity
CL	Climb Detent
CMA	Continuous Monitoring Approach
CONF	Configuration
COO	Chief Operating Officer
COVID-19	Corona Virus Disease 2019
CPL	Commercial Pilot License
CRC	Continuous Repetitive Chime
CRM	Crew Resource Management
CSI	Cycle Since Installation

CSM / G	Constant Speed Motor / Generator
CSN	Cycle Since New
CSO	Cycle Since Overhaul
CU	Cockpit Unit
CVR	Cockpit Voice Recorder
DC	Direct Current
DES MODE	Descent Mode
DFDR	Digital Flight Data Recorder
DG	Director General
DGM - CQA	Deputy General Manager - Corporate Quality Assurance
DH	Decision Height
DNA	Deoxyribonucleic Acid
E/WD	Engine / Warning Display
EASA	European Aviation Safety Agency
ECAM	Electronic Centralized Aircraft Monitor
ECG	Electrocardiogram
ECP	ECAM Control Panel
ECU	Electronic Control Unit
EEG	Electroencephalogram
EFIS	Electronic Flight Instrument System
ELAC	Elevator Aileron Computer
ELT	Emergency Locator Transmitter
EMER CANC	Emergency Cancel
EMER ELEC CONFG	Emergency Electrical Configuration
ENT	Ear Nose and Throat
ESS	Essential
ETT	Exercise Tolerance Testing
FAA	Federal Aviation Administration
FAC	Flight Augmentation Computer
FAF	Final Approach Fix
FC	Flight Cycles
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Techniques Manual
FCU	Flight Control Unit
FD	Flight Director
FDA	Flight Data Analysis
FDM	Flight Data Monitoring
FDP	Flight Duty Period
FH	Flight Hours
FIR	Flight Information Region
FL	Flight Level
FMA	Flight Mode Annunciator
FMGS	Flight Management Guidance System
FMS	Flight Management System
FO	First Officer
FOQA	Flight Operational Quality Assurance
FPA	Flight Path Angle
FPM	Flight Path Monitoring
FSD	Flight Standards Directorate
FSF	Flight Safety Foundation
FSK	Frequency Shift Keying
ft	Feet
ft/min	Feet Per Minute
FWC	Flight Warning Computer
FWS	Flight Warning System
G/S	Glide Slope
GAT	General Aviation Trainer
GEN	Generator
GM	General Manager
GPS	Global Positioning System

GPWS	Ground Proximity Warning System
GS	Ground Speed
HDG	Heading
HF	High Frequency
hPa	Hectopascal
HQCAA	Headquarter Civil Aviation Authority
hrs	Hours
HSE	Health Safety Environment
Hz	Hertz
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organization
IDG	Integrated Drive Generator
IFSD	In-Flight Shutdown
IIC	Investigator In-charge
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
JIAP	Jinnah International Airport
JPMC	Jinnah Postgraduate Medical Centre
kts	Knots
KVA	Kilovolt-Ampere
L/H	Left Hand
LLP	Life Limited Part
LOC	Localizer
LSN	Life Since New
M.I.	Medical Inspection
MAPt	Missed Approach Point
MASTER CAUT	Master Caution
MCDU	Multi-function Control and Display Unit
MCL	Maximum Climb
MCT	Maximum Continuous Thrust
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MEL	Minimum Equipment List
MEM	Memory
METAR	Meteorological Aerodrome Reports
MHz	Megahertz
min	Minute(s)
MLG	Main Landing Gears
MOR	Mandatory Occurrence Report
ms	Millisecond
NAV	Navigation
NCD	Non Computed Data
ND	Navigation Display
NLG	Nose Landing Gear
NM	Nautical Mile
NTSB	National Transportation Safety Board
OEM	Original Equipment Manufacturer
OLD	Operational Landing Distance
OM	Outer Marker
OP CLB	Open Climb
OPEN DES	Open Descent
P/N	Part Number
PAF	Pakistan Air Force
PB	Push Button
PCAA	Pakistan Civil Aviation Authority
PEL	Personnel Licensing
PF	Pilot Flying
PFD	Primary Flight Display
PFSA	Punjab Forensic Science Agency
PIA	Pakistan International Airlines

PIC	Pilot In-Command
PM	Pilot Monitoring
PMA	Permanent Magnet Alternator
PPS	Point Per Second
QA	Quality Assurance
QT	Quart
R/H	Right Hand
R/T	Radio Telephony
R/W	Runway
RA	Radio Altimeter / Altitude
RAT	Ram Air Turbine
RCC	Rescue Coordination Centre
RFFS	Rescue and Fire Fighting Services
RPT	Regular Public Transport
s	Second
S/N	Serial Number
SAG	Safety Action Group
SAR	Search and Rescue
SARP	Standards and Recommended Practice
SATI	Station Air Traffic Instructions
SB	Satisfactory with Briefing
SD	System / Status Display
SDAC	System Data Acquisition Concentrator
SEC	Spoilers Elevator Computer
SEP	Safety Equipment and Procedure
SID	Standard Instrument Departure
SMS	Safety Management System
SOP	Standard Operating Procedure
SPD	Speed
SPECI	Special Report of Meteorological Conditions Issued
SPI	Safety Performance Indicator
SRS	Speed Reference System
SSP	State Safety Programme
STAR	Standard Terminal Arrival
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
TAF	Terminal Aerodrome Forecast
TCO	Third Country Operator
TGB	Transfer Gear Box
THS	Trimmable Horizontal Stabilizer
THSA	Trimmable Horizontal Stabilizer Actuator
TLA	Thrust Lever Angle
TLU	Travel Limitation Unit
TOGA	Take off / Go-Around
TR	Thrust Reverser
TRK	Track
TSI	Time Since Installation
TSN	Time Since New
TSO	Time Since Overhaul
USOAP	Universal Safety Oversight Audit Program
UTC	Universal Time Coordinated
V/S	Vertical Speed
VAPP	Final Approach Speed
VFE	Maximum Speed with Flaps Extended
VHF	Very High Frequency
VMC	Visual Meteorological Condition
VOR	Very High Frequency Omni-Directional Range
VREF	Reference Speed
Vsw	Stall Warning Speed
VTP	Vertical Tail Plane

INFORMATION ON NOTIFICATION

The accident was reported to Aircraft Accident Investigation Board (AAIB), Pakistan, by Airport Manager (APM) / Chief Operating Officer (COO) Pakistan Civil Aviation Authority (PCAA) Jinnah International Airport (JIAP) Karachi[1] and General Manager Safety and Quality Assurance Pakistan International Airlines (PIA)[2]. The accident was notified[3] in accordance with International Civil Aviation Organization (ICAO) Annex-13. Ministry of Aviation, Government of Pakistan issued Notification[4] to constitute an Investigation Team to investigate the accident. The investigation has been conducted by AAIB, Pakistan. Accredited Representatives (ACCREPs) from National Transportation Safety Board (NTSB), United States of America (USA) and Bureau of Enquiry and Analysis (BEA), France along with advisors have participated in the investigation.

[1] PCAA APM / COO, JIAP, Karachi Accident Report dated 22nd May, 2020
[2] PIA Mandatory Occurrence Report (MOR) dated 22nd May, 2020
[3] AAIB Notification to ICAO, BEA (France) and NTSB (USA) dated 22nd May, 2020
[4] Federal Government Notification dated 22nd May, 2020, Corrigendum dated 11th November, 2021

SYNOPSIS

On 22nd May, 2020 at 08:05:30 Universal Time Coordinated (UTC), PIA Airbus A320-214 aircraft Reg. No. AP-BLD, took off from Allama Iqbal International Airport (AIIAP) Lahore, Pakistan to perform a regular commercial passenger flight (PIA 8303) to JIAP Karachi, Pakistan with 08 crew members [Captain, First Officer (FO) and 06 flight attendants] and 91 passengers.

At 09:15:38 UTC, descent for Approach was initiated. Flight was cleared for an Instrument Landing System (ILS) Approach Runway (R/W) 25L. Aircraft altitude was around 9,000 feet (ft) instead of 3,000 ft at 15 Nautical Mile (NM) from touchdown. Speed Brakes and Landing Gears were extended. Aircraft was significantly above the published vertical approach path. Around 5 NM from the touchdown, both Speed Brakes and Landing Gears were retracted. Several Warnings, cockpit indications and Air Traffic Control (ATC) instructions were disregarded by flight crew and the Unstabilized Approach was continued.

At 09:34:28 UTC, aircraft touched almost 4,500 ft down the R/W 25L with Landing Gears retracted. Flight crew initiated a Go-Around. Both Engines were damaged during the contact with the R/W. The resultant loss of Engine oil and subsequent lack of lubrication resulted in failure of both Engines.

Around 2,000 ft, flight crew announced that they have lost Engines, followed by a MAYDAY call. Aircraft started to lose height and crashed at 09:40:18 UTC in a populated area 1,340 meters (m) short of R/W 25L. Out of 99 persons on-board, 97 were fatally injured whereas 02 passengers survived. On ground 04 persons were injured, out of them 01 expired later in the hospital.

SECTION 1 - FACTUAL INFORMATION

1.1. History of the Flight

1.1.1. History of flight has been reconstructed in six sequences based on significant events which took place during the event flight. The parameters mentioned in this report are based on Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR) analysis. Rate of Descent wherever mentioned is not a recorded DFDR parameter and is calculated using pressure altitude recorded at different time intervals. The table presents phase wise title of each sequence along with its start and end time. All Timings are mentioned in UTC. The communication in local language (Urdu) has been translated into English.

S/N	Title	Start	End
1.	From start of ground operations at AIIAP Lahore till ATC clearance descent to FL100 (Direct to MAKLI)	07:55:00	09:15:06
2.	From ATC clearance to Gears retraction	09:15:06	09:33:10
3.	From Gears locked-up to 1st impact with the R/W (Belly Landing)	09:33:10	09:34:28
4.	From 1st impact with the R/W to Go-Around	09:34:28	09:34:42
5.	From lift-off to Engine No. 1 spool down (End of DFDR Recording)	09:34:42	09:36:17
6.	From Engine No. 1 spool down to the end of flight (End of CVR Recording)	09:36:17	09:40:18

Table 1 – Phases of Event Flight

1.1.2. Navigation Display (ND), and Multi-function Control and Display Unit (MCDU) selections are not recorded parameters of DFDR. In addition to available DFDR and CVR extracts, simulations were conducted using the actual track and Navigation (NAV) profile followed by aircraft to determine the most probable scenario. The screenshots of ND and MCDU used in subsequent sections of this report are therefore based on most probable scenario to depict what view was most probably available to flight crew in the cockpit.

1.1.3. The reconstruction of event flight is based on multiple analysis reports and extensive analysis of DFDR, CVR, ATC, Closed Circuit Television (CCTV) and Radar Recordings. The tolerance of time markers mentioned against various events is approximated at around ± 2 seconds (s).

1.1.4. Phase 1: From Start of Ground Operations at AIIAP Lahore till ATC Clearance Descent to FL100 (Direct to MAKLI)

1.1.4.1. At 08:05:30, aircraft took off from AIIAP Lahore.

1.1.4.2. At 08:19:51, one of the cabin crew offered snacks which was politely refused by the flight crew[5].

1.1.4.3. At 08:24:24, aircraft came in contact with Area Control Karachi.

[5] CVR Transcript in Urdu by AAIB Pakistan

1.1.4.4. At 08:24:30, Area Control Karachi cleared PIA 8303 for NAWABSHAH 2A (NH 2A) arrival procedure [Standard Terminal Arrival (STAR) as published in Aeronautical Information Publication (AIP) of Pakistan and JEPPESEN] and advised to expect ILS Approach for R/W 25L.

1.1.4.5. At 09:15:00, prior to descent at the end of cruise FO was found to be Pilot Flying (PF), whereas Captain was found to be Pilot Monitoring (PM)[6]. FO requested for descent. Aircraft was in cruise at FL340, Calibrated Air Speed (CAS) 268 knots (kts) and Mach 0.77. Thrust Levers were in climb notch, SLATS were retracted (CONF0). The display of selected altitude on Flight Control Unit (FCU) was set to FL150. Auto-Pilot 2 (AP-2) and both Flight Directors (FD-1 and FD-2) were engaged, and Auto Thrust (A/THR) was active. In cruise phase, the MACH MODE was engaged. At 09:16:09, after initiation of descent it changed to SPEED MODE. Flight Mode Annunciator (FMA) display was as following: -

Figure 1 – FMA Display

1.1.5. Phase 2: From ATC Clearance to Gears Retraction

1.1.5.1. At 09:15:00, flight crew requested ATC for descent and ATC cleared (at 09:15:07) “Pakistan 8303 Descent FL100, pilot discretion proceed direct MAKLI”. The MAKLI waypoint is located 4 NM before SABEN at the end of NAWABSHAH 1C (NH 1C) STAR, 15.3 NM from the R/W 25L threshold. Initially the flight crew were given NH 2A STAR by Area Control Karachi, but was subsequently cleared for direct MAKLI 10,000 ft (pilot discretion). The track from NAWABSHAH to direct MAKLI resembles NH 1C STAR which is followed by a right turn for SABEN, as appended below: -

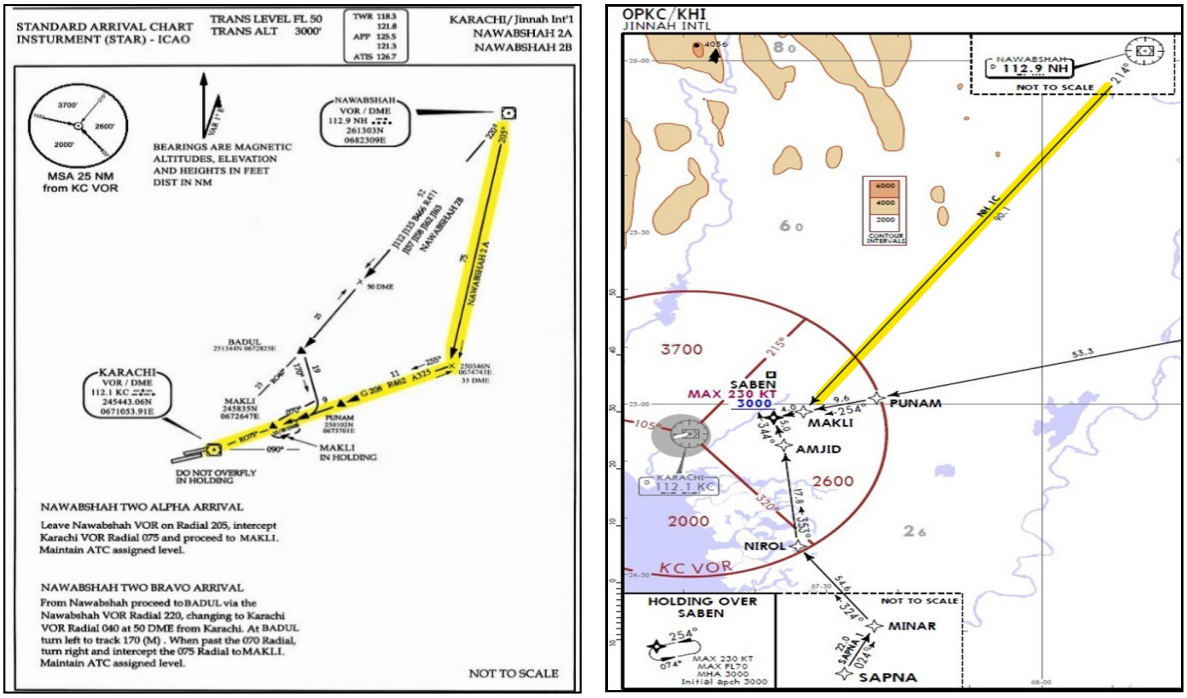


Figure 2 – Standard Arrival Charts

[6] BEA Contribution Report on Aircraft Systems dated 16th June, 2022, Pg – 29

1.1.5.2. Based on the Flight Management System (FMS) analysis[7] it is evident that ILS-Z Approach for R/W 25L was selected. As illustrated in the Approach chart below, the SABEN waypoint is at 11.4 NM from the R/W 25L threshold, and includes a Holding Pattern. After reaching SABEN, the aircraft are required to descent in left hand pattern to the initial Approach height of 3,000 ft.

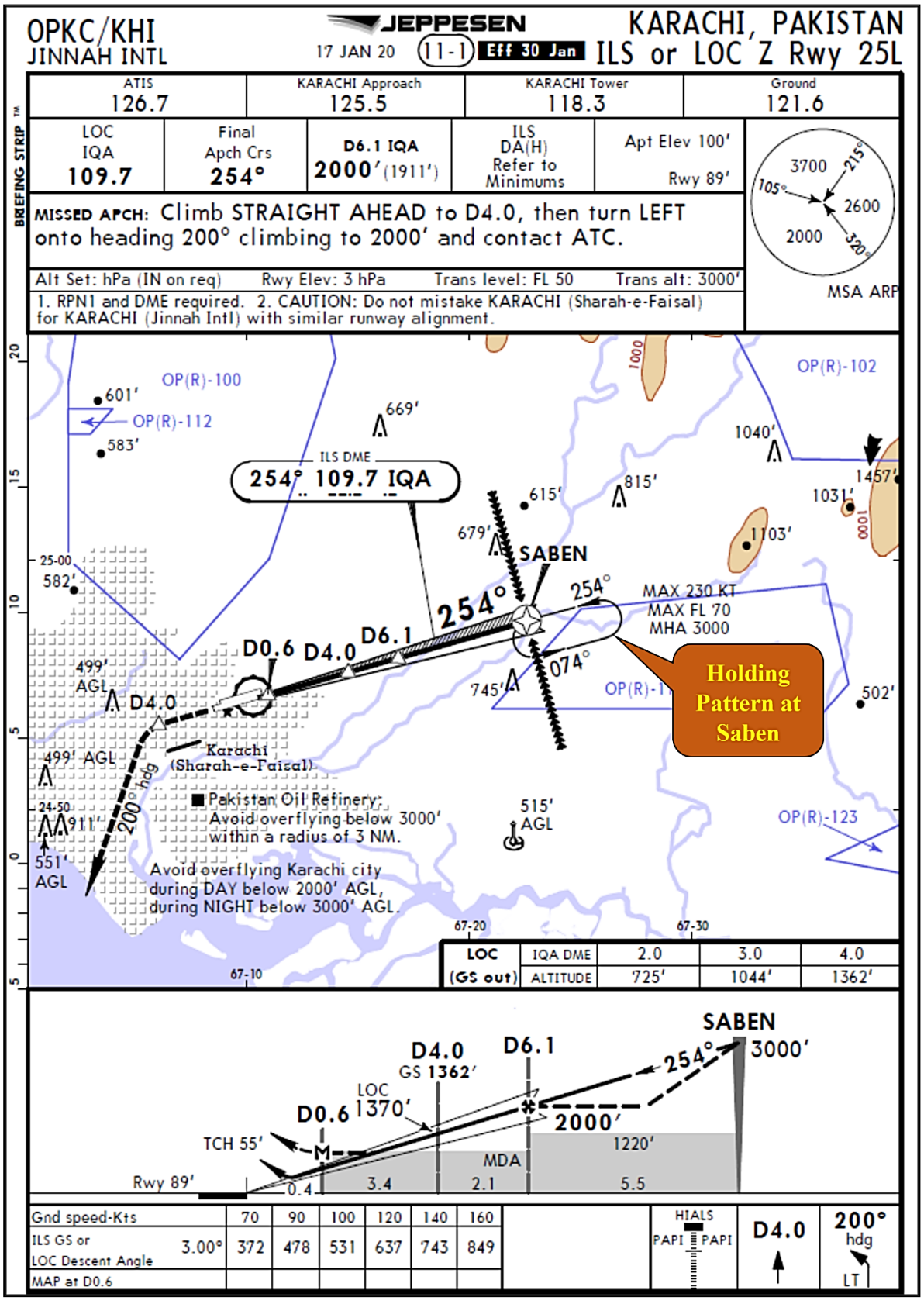


Figure 3 – ILS-Z R/W 25L Approach Chart

[7] Airbus Report dated 31st May, 2021, Pg – 34

1.1.5.3. At 09:15:38, flight crew initiated descent from FL340, the selected altitude on FCU was changed to FL100 and Descent MODE (DES MODE) was engaged (flight crew pushed the ALT knob on the FCU). The CAS was 268 kts (managed target speed). Rate of Descent was constant, around 1,000 ft/min, which indicated that aircraft was below the FMS descent profile [Refer section 1.16.3.6 “Descent (DES) MODE”].

1.1.5.4. At 09:18:36, aircraft was passing through FL310. The Auto Thrust System (A/THR) Thrust MODE engaged and N1 speed was reduced to IDLE on both Engines, which indicated that the aircraft was starting to capture the FMS Descent profile. Rate of Descent increased to 2,400 ft/min. CAS increased to a maximum of 284 kts before reducing towards the managed target air speed of 269 kts. Auto-Thrust (A/THR) MODE changed to IDLE MODE to adjust the thrust while Auto-Pilot (AP) followed descent profile. The selected altitude became 5,000 ft.

1.1.5.5. At 09:23:16, Area Control Karachi gave call, “Pakistan 8303 contact Approach 125.5”. This call was not acknowledged by flight crew. Between 09:23:30 and 09:23:57 Area Control Karachi gave three calls to PIA 8303 and also tried to relay through another aircraft (PIA 8368) in air but there was no reply from the flight crew.

1.1.5.6. At 09:24:36, Karachi Approach called PIA 8303 on 125.5 Megahertz (MHz) which was not replied. Karachi Approach then gave three calls on Guard frequency. Third call on Guard was responded by the flight crew, “Strength 2 sir confirm changeover to 126.5”. Karachi Approach replied, “Contact 125.5”. Normal Radio Telephony (RT) contact was established between aircraft and Karachi Approach thereafter.

1.1.5.7. At 09:25:54, Karachi Approach called PIA 8303 to descent 3,000 ft baro altitude 1004 hectopascal (hPa) and cleared for ILS R/W 25L. The selected altitude became 3,000 ft at 09:26:00. Captain and FO altimeter were set at baro altitude 1004 hPa 15 s later. The aircraft was descending through 15,369 ft baro altitude.

1.1.5.8. At 09:29:53, Approach (APPR) guidance MODES were armed [Glide Slope (G/S) and Localizer (LOC) blue on FMA]. Auto-Pilot 1 (AP-1) was engaged in addition to AP-2. Between 09:29:53 and 09:30:39 CAS remained around 250 kts and A/THR MODE switched between SPEED and IDLE MODE.

1.1.5.9. At 09:30:22, at 16 NM from R/W 25L, LOC* (Localizer Capture) MODE was engaged. At 09:30:35, aircraft passed MAKLI with 9,363 ft baro altitude, 245 kts CAS, and FLAPS at 0°. 1 s later, Karachi Approach asked, “Pakistan 8303 confirm track mile comfortable for descent?” to which PIA 8303 replied, “Affirm”. Aircraft was still around 9,000 ft baro altitude at a distance of approximately 15 NM from R/W 25L threshold. In CVR recording, Captain exclaimed, “*What has happened?”, “Stop, Stop Oh No! Take out the Hold, take out the Hold, take out the Hold, take out the Hold*” (in Urdu). FO responded, “*Hold taken out, should we report this happening*?” (in Urdu). Captain replied, “*No, this could be due to Hold tell Karachi Approach that established on localizer”* (in Urdu).

1.1.5.10. At 09:30:44, Open Descent (OPEN DES) MODE was engaged with a target at 3,000 ft by pulling the ALT Knob on FCU. Aircraft was at 9,210 ft baro altitude, 245 kts CAS, Rate of Descent had reduced to 660 ft/min (feet per minute) and distance from threshold was approximately 14.8 NM. Speed Brakes were extended.

1.1.5.11. For a 3° G/S at 14.8 NM R/W 25L threshold, aircraft was required to be at 4,700 ft baro altitude. Aircraft was significantly above the published vertical Approach Path and was actually at flight path angle of almost 6° [8]. This was a scenario of G/S interception from above. FMA display was as follows: -

Figure 4 – FMA Display (OPEN DES MODE)

1.1.5.12. At 09:30:53, 14.1 NM from R/W threshold, AP / FD Vertical MODE changed to LOC track at 9,000 ft baro altitude and 245 kts CAS. 05 s later, target speed was selected to 255 kts (SPD knob was pulled on FCU).

1.1.5.13. At 09:31:13, Karachi Tower contacted Karachi Approach on hotline and shared its observation about incoming PIA 8303, "*Sir, it's too high*" (in Urdu). Karachi Approach responded, "*Yes, it is too high and I am observing it and will give orbit*" (in Urdu).

1.1.5.14. At 09:31:26, 11.4 NM from R/W 25L threshold, and 250 kts CAS, SABEN waypoint was overflown at 7,830 ft baro altitude. As per the ILS-Z R/W 25L Approach Chart (Refer Figure 3), target altitude for set course from SABEN is 3,000 ft. Therefore, aircraft was excessively high (4,830 ft in excess) above the desired G/S.

1.1.5.15. At 09:31:34, 7,440 ft baro altitude, 10.8 NM from R/W 25L threshold, and Rate of Descent 2,900 ft/min, target speed was changed to 248 kts. At 09:31:39, Gear Selector was set to DOWN position. Landing Gears were DOWN and Locked 13 s later at 7,239 ft baro altitude. Pitch started to decrease from 0° and 30 s later reached 7.4° nose down.

1.1.5.16. At 09:31:41, Karachi Approach called PIA 8303, "Sir, orbit is available if you want". PIA 8303 responded, "Negative sir, we are comfortable we can make it Insha-Allah".

1.1.5.17. At 09:32:03, Karachi Approach inquired about surface wind from Karachi Tower. Karachi Tower responded that surface wind 250° / 15 kts. Karachi Approach also obtained landing clearance from Karachi Tower.

1.1.5.18. At 09:32:09, Captain said, *"Hold was stuck, this is automatically built-in, I forgot".* (in Urdu).

1.1.5.19. At 09:32:12, baro altitude was 4,850 ft, pitch angle was -7.0° and still decreasing.

1.1.5.20. At 09:32:18, 4,817 ft baro altitude, 7.7 NM from R/W 25L threshold, AP Vertical MODE changed to Altitude Capture (ALT*), Rate of Descent was 4,115 ft/min. G/S signal was +50 µA (0.8 dot). 2 s later, selected speed target was reduced from 248 kts to 230 kts. 1 dot on the Primary Flight Display (PFD) corresponds to a deviation of 75 µA, a positive value indicates an aircraft above the G/S[9]. ILS trajectory deviation scale has two dots on either side of the zero deviation reference for both Localizer and G/S. One dot represents ±0.8° on LOC Scale and ±0.4° on G/S Scale[10].

[8] Airbus Report dated 31st May, 2021, Pg – 15
[9] Airbus Report dated 31st May, 2021, Pg –16
[10] Airbus FCOM, Trajectory Deviation, Pg – 1931

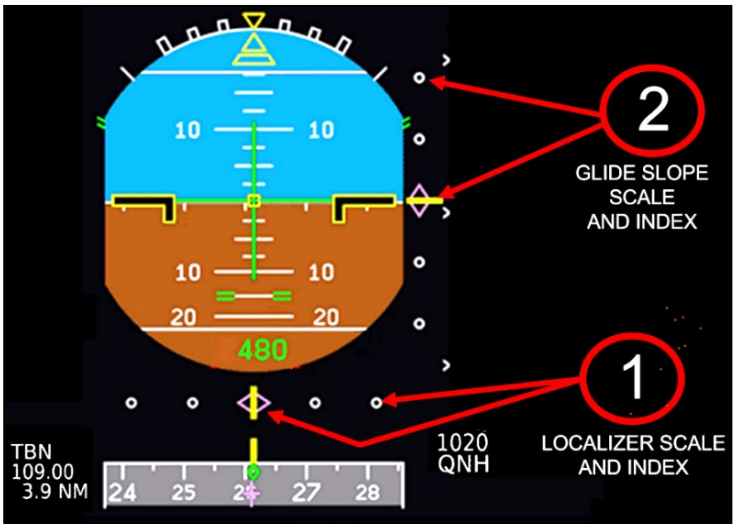


Figure 5 – G/S / Localizer Scale and Index

1.1.5.21. At 09:32:24, Captain said, "*He will be surprised what we have done*" (in Urdu).

1.1.5.22. At 09:32:25, Karachi Approach gave call, "Pakistan 8303 disregard turn left heading 180". PIA 8303 replied, "Sir, we are comfortable now and we are out of 3,500 for 3,000 established ILS 25L".

1.1.5.23. At 09:32:34, 3,830 ft baro altitude, 6.5 NM from R/W 25L threshold. AP Vertical MODE changed to Glide Slope Capture (G/S*). G/S signal was +205 µA (>2 dots). Descent Rate was 3,000 ft/min. 6 s later, the target speed was set to 225 kts. Despite being significantly above the desired G/S, the G/S* MODE was engaged due to perturbations.

SPEED	G/S*	LOC		AP1+2 1FD2 A/THR
SPEED	G/S*	LOC		AP1+2 1FD2 A/THR

Figure 6 – FMA Display G/S Engaged

1.1.5.24. At 09:32:38, Karachi Approach again called PIA 8303, "Negative turn left heading 180". PIA 8303 responded, "Sir, we are established on ILS 25L".

1.1.5.25. At 09:32:46, 3,090 ft baro altitude, 5.7 NM from R/W 25L threshold, CAS 242 kts, selected target speed CAS 225 kts and SLATS / FLAPS CONF1 was selected (VFE CONF1=230 kts). Pitch angle was -12.6° and still decreasing.

1.1.5.26. At 09:32:47, 2,730 ft baro altitude, 5.5 NM from R/W 25L threshold. Pitch attitude reached -13.7°. This led to AP disengagement due to excessive pitch down, as it exceeded 13° nose down. Descent Rate reached 6,800 ft/min. Both APs disconnected. FDs and A/THR remained engaged. Auto-Pilot OFF Warning triggered accordingly. Standard manner for flight crew to disengage AP is to press the takeover Push Button (PB) on the sidestick. But in this case, it was disengaged due to excessive negative pitch attitude (Refer section 1.16.8 for "AP disengagement conditions").

1.1.5.27. AP OFF is indicated by Master Warning Red light flashing, Cavalry Charge Aural Alert, AP OFF Red Warning on Electronic Centralized Aircraft Monitor (ECAM), AP status disappearing from FMA, and light on AP engagement PB on FCU going OFF. In this case all AP OFF indications except Cavalry Charge Aural Alert were available. The Flight Warning Computer (FWC) fitted in this aircraft was of standard F9D in which the "OVERSPEED" Warning [associated with a Continuous Repetitive Chime (CRC) Aural Alert] has a higher priority over the AP OFF WARNING (associated with the Cavalry Charge Aural Alert). Therefore, CRC was generated and not the Cavalry Charge (Refer section 1.16.5 "Aircraft Warning System and Warning Chronology").

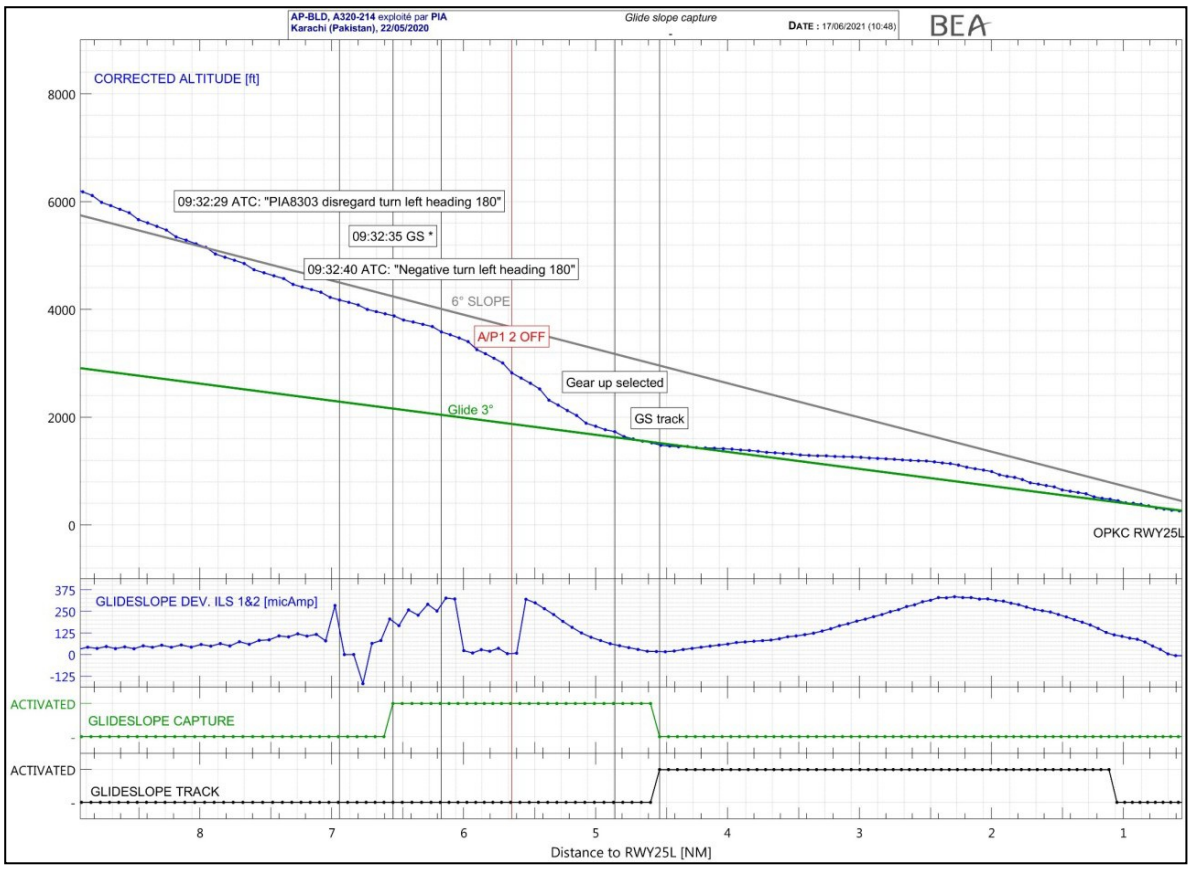


Figure 7 – G/S Capture and Auto-Pilot Disengagement at JIAP, Karachi[11]

1.1.5.28. 4 s later, almost simultaneous with the AP disconnection, "OVERSPEED" Maximum Speed with FLAPS Extended (VFE) Warning triggered Master Warning along with CRC Aural Alert. The triggering condition for VFE Warning is VFE +4 kts with SLATS and / or FLAPS extended. VFE for different configuration is mentioned in table: -

CONF	VFE
FULL	177
3	185
2	200
1+F	215
1	230

Table 2 – VFE for Different Configurations[12]

[11] BEA Contribution Report on Aircraft Systems dated 16th June, 2022, Pg – 09
[12] Airbus FCOM, Overspeed, Pg – 3625

1.1.5.29. At 09:32:52, 2,230 ft baro altitude, 5.2 NM from R/W 25L threshold, Ground Proximity Warning System (GPWS) Alerts triggered for 4 s (first sequence out of three sequence recorded during the event flight). CAS was 255 kts, Descent Rate was 7,400 ft/min. Due to disengagement of APs, spoilers were extended to full deflection[13]. Nose-up inputs were globally applied on FO (PF) sidestick up to 2/3 full back stick for 10 s. Aircraft pitch increased towards 0° and Descent Rate decreased towards 2,000 ft/min. During first sequence of GPWS synthetic voice Alerts (one "SINK RATE" Amber Caution and two "PULL UP" Red Warnings) were triggered.

1.1.5.30. At 09:32:56, 1,780 ft baro altitude, 4.9 NM from R/W 25L threshold, maximum CAS reached 261 kts (VFE CONF1 +31 kts, "OVERSPEED" Warning active), Descent Rate was 5,300 ft/min. G/S signal was corresponding to ~ 4° G/S and decreasing. 1 s later, Landing Gears were selected UP, and 3 s later Speed Brakes were retracted. 14 s later, Landing Gears were recorded Uplocked. 13 s interval between Landing Gears UP selection and Gears Uplocked is consistent with a nominal retraction sequence. Almost simultaneously (at 09:32:58) Karachi Approach cleared PIA 8303 for landing at R/W 25L.

1.1.6. **Phase 3: From Gears Locked-Up to 1st Impact with the R/W (Belly Landing)**

1.1.6.1. At 09:33:04, 1,400 ft baro altitude, 4.3 NM from R/W 25L threshold aircraft reached the desired G/S of 3° and FD Vertical MODE changed to G/S track, but the deviation started to increase again towards positive values. Descent Rate was 1,600 ft/min and pitch angle was close to 0°. CAS 247 kts (VFE CONF1 +17 kts) and decreasing.

1.1.6.2. At 09:33:22, 1,200 ft baro altitude, 3.1 NM from R/W 25L threshold CAS decreased close to the VFE CONF1 (230 kts). As the aircraft CAS reduced below the "OVERSPEED" Warning threshold of 234 kts (VFE CONF1+4 kts) the "OVERSPEED" Warning stopped for 2 s. G/S signal was +136 µA (~1.8 dot corresponding ~4.5° G/S) and increasing.

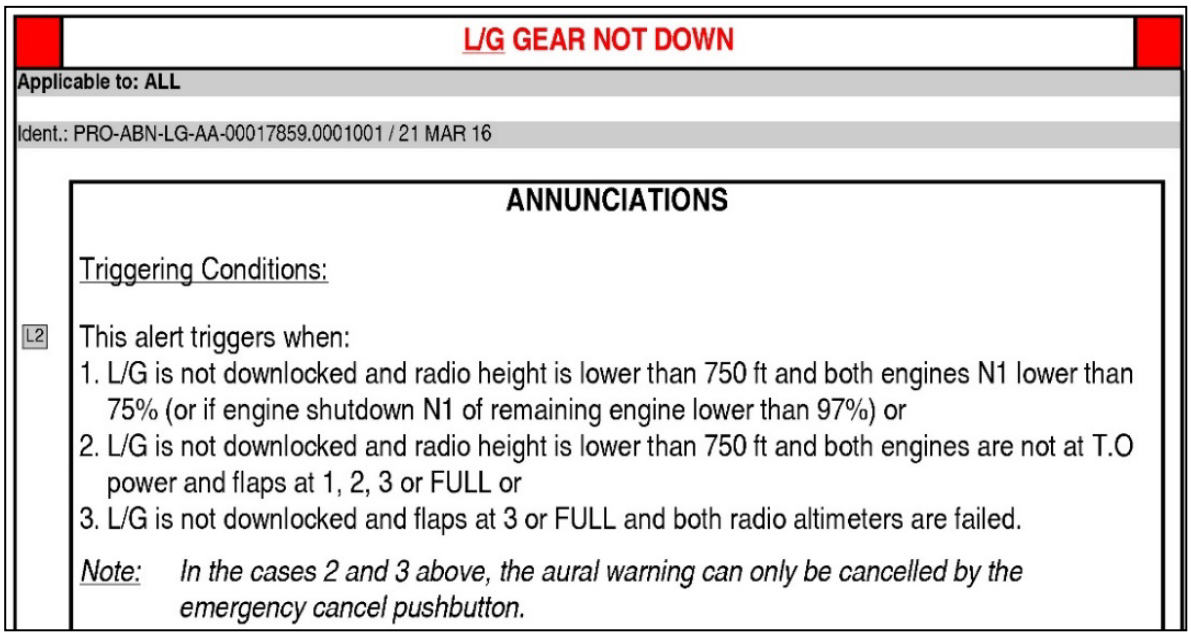
1.1.6.3. At 09:33:25, 1,180 ft baro altitude, 2.9 NM from R/W 25L threshold CONF2 was selected (VFE CONF2=200 kts) at CAS 232 kts (VFE CONF2 +32 kts). The "OVERSPEED" VFE Warning was triggered again and remained ON till first contact with the R/W. G/S signal was +178 µA (>2 dot corresponding >4.6° G/S) and increasing. 2 s later CONF3 was selected (VFE CONF3=185 kts). Transient CRC related with "OVERSPEED" was triggered (due to SLATS / FLAPS change). Once SLATS / FLAPS surfaces reached CONF3 position the CRC associated with "OVERSPEED" became permanent as the actual CAS was greater than VFE threshold for CONF3 (189 kts). It is confirmed that transient interruptions of the CRC may occur during the SLATS / FLAPS extension in "OVERSPEED" situation[14].

[13] Airbus FCOM, Speed Brakes and Ground Spoilers, Pg – 1630
[14] BEA Contribution Report on Aircraft Systems dated 16th June, 2022, Pg – 11

1.1.6.4. At 09:33:33, 1,110 ft baro altitude, 2.4 NM from R/W 25L threshold, Pitch was 0º, CAS was 227 kts (VFE CONF3 + 42 kts) and CRC was active. Aircraft was still well above the G/S (recorded deviation +287 µA, >2 dots) and increasing; the maximum of +334 µA was reached 5 s later. FO was heard saying *"Should we do the Orbit?"* (in Urdu) to which Captain replied *"No-No"*, followed by *"Leave it"* (both in Urdu). Captain took over controls by applying pitch down inputs, and pressed for 0.5 s on its instinctive sidestick PB. Small dual inputs were recorded during 4 s. However, analysis of DFDR recording indicate that from this moment onwards, Captain was the PF till R/W contact with Landing Gears UP.

1.1.6.5. Soon after, at 1.9 NM from R/W 25L threshold, aircraft crossed 1,000 ft Radio Altitude (RA). This is Stabilization Gate for Instrument Meteorological Conditions (IMC) as per stabilization criteria provided in Airbus Flight Crew Operating Manual (FCOM). The aircraft parameters deviation was more than the call out threshold mentioned in FCOM. (Refer section 1.16.15.3 – "Stabilized Approach Criteria recommended by Airbus").

1.1.6.6. At 09:33:48, aircraft was passing below 750 ft RA, 1.5 NM from R/W 25L threshold, CAS 217 kts (VFE CONF3 + 32 kts), Rate of Descent 2,100 ft/min, and Pitch attitude -5º. ECAM Red Warning "L/G GEAR NOT DOWN" and illumination of Red Arrow beside the Landing Gears Lever were triggered. The CRC and Master Warning Red light flashing were already active due to continued triggering of "OVERSPEED" VFE Alert.



L/G GEAR NOT DOWN

Applicable to: ALL

Ident.: PRO-ABN-LG-AA-00017859.0001001 / 21 MAR 16

ANNUNCIATIONS

Triggering Conditions:

L2

This alert triggers when:

1. L/G is not downlocked and radio height is lower than 750 ft and both engines N1 lower than 75% (or if engine shutdown N1 of remaining engine lower than 97%) or
2. L/G is not downlocked and radio height is lower than 750 ft and both engines are not at T.O power and flaps at 1, 2, 3 or FULL or
3. L/G is not downlocked and flaps at 3 or FULL and both radio altimeters are failed.

Note: *In the cases 2 and 3 above, the aural warning can only be cancelled by the emergency cancel pushbutton.*

Figure 8 – "L/G GEARS NOT DOWN" Triggering Conditions

1.1.6.7. At 09:33:51, Captain was heard saying "*Cancel it*" (in Urdu). Emergency Cancel (EMER CANC) PB on ECAM Control Panel (ECP) was pressed, which caused an interruption of CRC audio Warning in the CVR; the CRC relative to the "OVERSPEED" Warning was cancelled. 3 s later, the CRC associated to the "L/G GEAR NOT DOWN" was triggered. The EMER CANC PB cancels the present Aural Warning for as long as the failure continues and extinguish the Master Warning lights, but ECAM message display and Landing Gears Red Arrow light are not affected by this action. This mean that both VFE "OVERSPEED" and "L/G GEAR NOT DOWN" messages were still displayed in the cockpit.

1.1.6.8. At 09:33:54, 500 ft RA, 1.2 NM from R/W 25L threshold. CAS 220 kts (VFE CONF3 + 35 kts). Rate of Descent was 2,000 ft/min, Pitch attitude was -5.6°. G/S deviation was +202 µA (>2 dots). 1 s later, second sequence (out of three sequence) of GPWS Alerts triggered continuously until 09:34:16 (24 ft RA). The CVR transcript indicates that during this sequence a total of 13 Alerts were triggered: ten "TOO LOW TERRAIN" Amber Cautions, one "SINK RATE" Amber Caution, and two "PULL UP" Red Warnings. GPWS synthetic voices are superposed to the sounds generated by the Flight Warning System (FWS) (CRC in this case).

1.1.6.9. The height reference of 500 ft RA is also the Approach stabilization gate in Visual Meteorological Condition (VMC) as per stabilization criteria provided in Airbus FCOM. Aircraft parameters deviation was more than the call out threshold mentioned in FCOM **(**Refer section 1.16.15.3 – "Stabilized Approach Criteria recommended by Airbus"). Flight crew instead of Going-Around as per SOP, continued Unstabilized Approach (Refer section 1.16.15.5 – "Stabilized Approach Criteria by PIA").

1.1.6.10. At 09:33:58, 365 ft RA, 0.9 NM from R/W 25L threshold, at CAS of 215 kts (VFE CONF3 + 30 kts), EMER CANC PB was pressed again. "L/G GEAR NOT DOWN" related CRC also stopped. "OVERSPEED" Warning and Landing Gears Not DOWN Warning conditions were still met and related ECAM messages were still displayed in the cockpit.

1.1.6.11. At 09:34:04, 200 ft RA, 0.6 NM from R/W 25L threshold and with Rate of Descent of 1,500 ft/min, FCU selected speed target reduced from 225 kts to 152 kts.

1.1.6.12. At 09:34:16, crossing 24 ft RA, CAS was 205 kts (VFE CONF3 + 20 kts), GPWS Alerts stopped. Both Thrust Levers were retarded to IDLE and 2 s later A/THR, disconnected accordingly. GPWS Alerts stopped because the GPWS incorporates a "cut-out" threshold at 30 ft RA, below which GPWS Alerts are inhibited[15].

1.1.6.13. At 09:34:23, crossing 07 ft RA, 200 kts CAS (VFE CONF3 + 15 kts), full Reverse Thrust was selected on both Engines. Thrust remained at IDLE, but Thrust Reversers (TR) remained locked and did not deploy as aircraft was airborne (no ground condition detected by the ECU). ENG REV SET ECAM Alert associated with selection of Reverse Thrust in air was triggered along with a Single Chime Aural Alert and Master Caution Amber light.

1.1.7. **Phase 4: From 1st Impact with R/W to Go-Around**

1.1.7.1. On the CVR recording, a sound similar to ground impact was recorded at 09:34:28, corresponding to the belly landing which was also verified through vertical load factor and longitudinal deceleration. Both Engines' nacelles contacted with R/W almost 4,500 ft down the R/W 25L.

[15] Airbus Report dated 31st May, 2021, Pg – 25

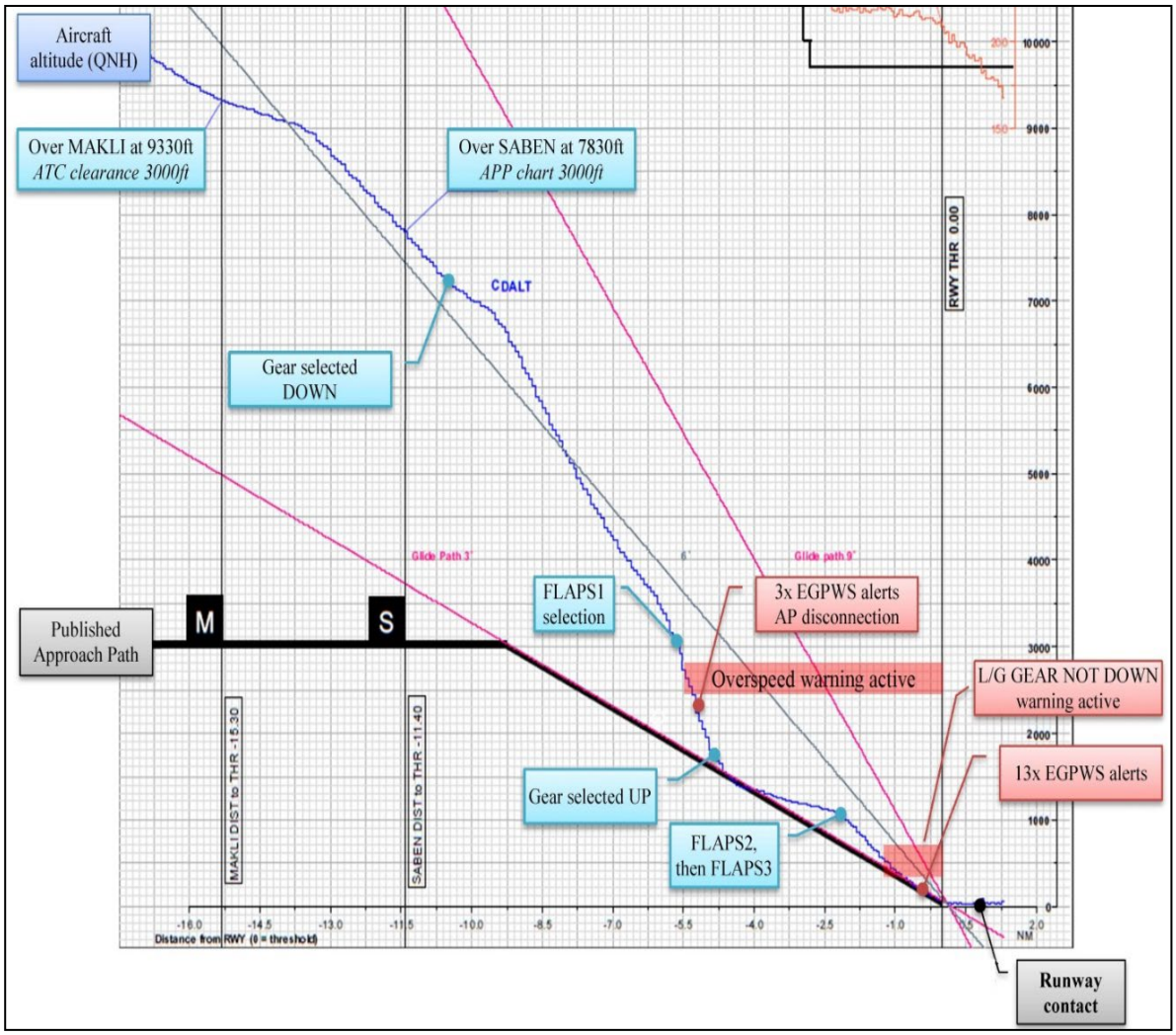


Figure 9 – Overview of Events till First Touchdown on the R/W 25L

1.1.7.2. At 09:34:30, maximum brake pedal inputs were recorded and it remained for next 14 s.

1.1.7.3. From 09:34:28 till 09:34:46, aircraft remained in intermittent contact with R/W surface. Both flight crew gave opposite sidestick inputs. Captain (PF) sidestick inputs reached up to full nose down, whereas FO (PM) applied up to 2/3 of full back sidestick input. The resultant elevator positions were on average mainly to nose down with pitch attitude reaching -4º within 2 s of R/W contact. Both Engines' N1 vibrations started to increase.

1.1.7.4. Both Engines touched the R/W at four different locations and left scratch marks of varying length and width. The R/W surface being concrete pavement remained intact; however, the surface got severely abraded due to scrubbing of both Engines at high speed. The Engines drag occurred almost symmetrical about R/W centre line. Engine No. 2 remained in contact with the R/W significantly longer than Engine No. 1. The total length of scratch marks including all segments was 2,194 ft for Engine No. 2 and 583 ft for Engine No. 1 (Refer section 1.16.17 – "Runway Inspection Report").

Figure 10 – Screenshots of Security / CCTV Cameras Footages Confirming Contact of both Engines' Nacelles

1.1.7.5. At 09:34:33, while aircraft was still on ground, CAS reduced to 178 kts (Below VFE threshold for CONF3) and "OVERSPEED" VFE Warning stopped.

1.1.7.6. At 9:34:37, both Thrust Lever Angle (TLA) were physically set to MAX REV detent. Engine No. 2 reduced towards IDLE Thrust and several Engine No. 2 parameters showed invalid variations for 4 s. Those invalid variations were probably due to channel reconfiguration in the ECU 2. Engine No. 2 Fire Warning triggered during 7 s. This included an ECAM Alert, Master Warning Red light flashing, and CRC Aural Alert. There were N1 vibration on Engine No. 2 above 5 Cockpit Unit (CU). After invalid variations, the Engine No. 2 N2 speed stayed below the minimum Alternating Current (AC) generation speed [(i.e. 56.3% with a persistence time of 500 millisecond (ms)] until 09:34:54 (reached 101% at 09:35:08). Engine No. 1 N2 speed stayed above the minimum AC generation speed.

1.1.7.7. Thus, between 09:34:36 and 09:34:54, Engine No. 2 generator was no longer providing AC power and there was an electrical reconfiguration i.e. Engine No. 1 generator supplying both AC 1 and AC 2 buses. It is not possible to determine if after 09:34:54, Engine No. 2 generator resumed powering to AC 2 bus. However, at the time of the DFDR loss, only Engine No. 1 generator powered both AC buses, given the damage observed on Engine No. 2 generator. It is likely that the GEN2 was lost during the phase where the aircraft nacelles were in contact with the R/W (Refer section 2.3.1 – "Electrical System").

1.1.7.8. At 09:34:42, FO said "*Take off Sir, Take off*" (in Urdu), and 2 s later at 160 kts CAS, both TLA were advanced to Take off / Go-Around (TOGA). 1 s later, A/THR was engaged and Engine No. 2 OIL LOW PRESSURE Warning was recorded during 6 s. This OIL LOW PRESSURE Warning was due to Engine No. 2 going into Restart MODE (N2 went below 47%). In Restart MODE, the oil circuit is not pressurized. The triggered ENG OIL LOW PRESSURE is recorded in DFDR but not displayed in the cockpit as it is a normal consequence of the low N2 rotation speed. Longitudinal and Lateral Go-Around MODES were automatically engaged.

1.1.7.9. Analysis of DFDR read out plots indicate that Engine No. 2 most probably stalled at 09:34:41.

1.1.7.10. Following the TLA being pushed to TOGA, Engine No. 1 N1 command increased to 94%, Engine No. 2 N1 command decreased to 16% and the "L/G GEAR NOT DOWN" Warning stopped, as ENG 1 N1 increased above 75% (Refer Figure 11). As the Engine No. 2 N2 was below 47%, Engine No. 2 status changed to "START" and it waited for N2 to increase above 53.9% to command the increase of N1. This is coherent with the DFDR parameters showing the Engine No. 2 N1 command at IDLE during this period.

1.1.7.11. Most probably there was a transient loss of Electronic Control Unit 2 (ECU) power supply, due to the failure of the Permanent Magnet Alternator (PMA) following Accessory Gear Box (AGB) contact with the R/W. Backup power and ECU initialization takes approximately 4 s after which normal Engine behaviour is restored. This is also consistent with loss of ECU 2 parameters for around 4 s in DFDR data.

1.1.8. **Phase 5: From Lift-Off to Engine No. 1 Spool Down (end of DFDR Recording)**

1.1.8.1. At 09:34:43, dual input commands on sidestick stopped. Captain was PF until the end of the DFDR recording.

1.1.8.2. At 09:34:44, both brake pedals were released. 1 s later, RA started to increase indicating that aircraft was no longer on the R/W. Engine No. 1 N1 reached 94%, while Engine No. 2 was still in "START" status.

1.1.8.3. At 09:34:49 Karachi Tower informed Karachi Approach on landline that aircraft touched the R/W without Landing Gears DOWN. Karachi Approach asked about latest position of the aircraft. Karachi Tower informed Karachi Approach that aircraft is crossing the stop way.

1.1.8.4. At 09:34:50, N1 vibration on Engine No. 1 reached maximum recorded value 9.8 CU and remained at this value for next 45 s. The OIL LOW PRESSURE Warning of Engine No. 2 stopped.

1.1.8.5. At 09:34:52, 59 ft RA, CONF2 was selected, and third sequence of GPWS Alert initiated in which one "TOO LOW GEAR" Amber Caution was triggered. The conditions for triggering of this Caution were consistent with GPWS MODE-4A triggering conditions [Refer section 1.16.9 – "Ground Proximity Warning System (GPWS)"].

1.1.8.6. At 09:34:57, 140 ft RA, Landing Gears were selected DOWN and then UP, FDs Lateral MODE changed to NAV. During the transient selection of the Landing Gears to the DOWN position, no change in Landing Gears Uplock / Downlock status was recorded in DFDR. Most probable that this transient selection did not generate a Landing Gears movement.

1.1.8.7. At 09:35:00, PIA 8303 called Karachi Approach, “Going Around”. Karachi Tower declared full scale emergency at the airport.

1.1.8.8. At 09:35:07, 356 ft RA, Engine No. 2 vibrations increased again up to 8.8 CU in 6 s.

1.1.8.9. At 09:35:10, 442 ft RA, 182 kts CAS, both Engines’ N1 actual reached 94%. CONF1 was selected and 2 s later clean configuration (CONF0) was selected.

1.1.8.10. At 9:35:11, Oil quantity of Engine No. 1 dropped from 16 Quart (QT) to 4 QT in 64 s and at 9:35:15, Oil quantity of Engine No. 2 dropped from 15 QT to 5 QT in 64 s (DFDR sampling rate of Engine Oil quantity is 64 s). This is coherent with the Engine No. 2 examination, which showed that the bottom part of Engine No. 2 was rubbed with the R/W at the AGB and Transfer Gear Box (TGB) level.

1.1.8.11. At 09:35:16, 567 ft RA and 200 kts CAS, Thrust Levers were reduced to Maximum Continuous Thrust (MCT) for 3 s and then pushed back to TOGA. Both Engines responded accordingly. Graph of Engine speed from lift off till end of flight is as follows: -

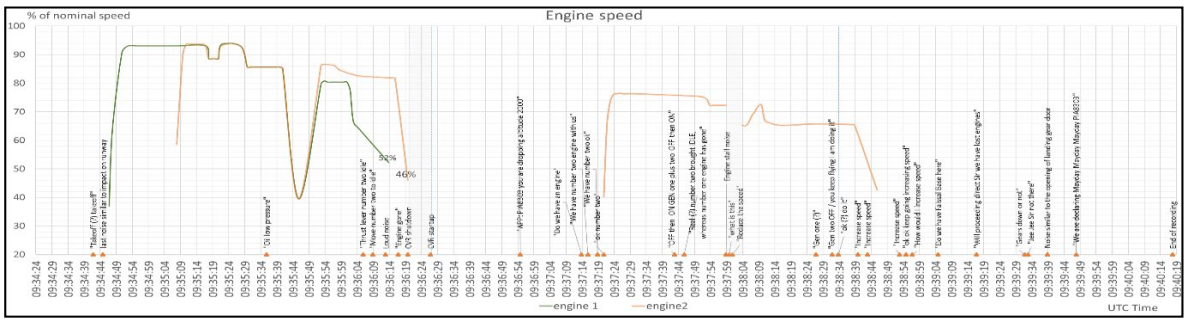


Figure 11 – Engine Speed from Lift-off till End of Flight

1.1.8.12. At 09:35:22, 677 ft RA and 215 kts CAS, selected speed was changed to 212 kts, and FDs Vertical MODE changed to Open Climb (OP CLB). This FD MODE reversion is nominal following speed selection when in Speed Reference System (SRS) MODE, and was indicated by an Aural “Triple Click”.

1.1.8.13. At 09:35:25, 790 ft RA and 223 kts CAS. 1 s later, Thrust Levers were reduced from TOGA to Climb Detent (CL) and A/THR engaged in Thrust Climb (THR CLB) MODE accordingly. N1 vibration on Engine No. 1 decreased from maximum recorded value to 0 CU. It was not possible to determine, because of the multiple failures after the R/W contact, why Engine No. 1 N1 vibrations switched from 0 to Non Computed Data (NCD), and then stayed at 0 until the end of DFDR recording. Recording of this parameter is considered invalid from that moment until the end of recording[16]. 1 s later, the N2 vibration on Engine No. 2 also became invalid (parameter value at NCD). The values of both Engines’ N1 vibrations is therefore considered invalid till end of recording.

[16] BEA Contribution Report on Aircraft Systems dated 16th June, 2022, Pg – 15

1.1.8.14. At 9:35:33, Engine No. 1 OIL LOW PRESSURE Warning activated, and stayed ON until end of DFDR recording. Related CRC Aural Alert was also activated. MASTER WARNING was cancelled by flight crew within 5 s.

1.1.8.15. At 09:35:38, 1,270 ft RA, CONF1 was transiently selected (only one sample), 1 s later, both FDs were disengaged, A/THR reverted to SPEED MODE accordingly. CAS was 243 kts while target speed was 212 kts. Both Engines' N1 reduced to 40%. Engine No. 2 OIL LOW PRESSURE Warning triggered and remained until end of DFDR recording. Associated Master Warning was also triggered but was cancelled 7 s later.

1.1.8.16. At 09:35:52, 2,160 ft RA, AP-1 was engaged, which stayed until the end of DFDR recording. PIA 8303 requested for heading and ILS R/W 25L. Karachi Approach cleared for left heading 110° and climb to 3,000 ft. HDG MODE (selected heading was 259°) and ALT* MODE (selected altitude was 3,000 ft) were engaged. Selected heading was changed to 110° within next 13 s.

1.1.8.17. At 09:35:56, 2,470 ft RA, aircraft started to turn left.

1.1.8.18. At 09:36:00, 2,670 ft RA, Engine No. 1 N1 actual started to decrease whereas N1 command remained constant at ~86%. This decrease of Engine No. 1 N1 actual with a constant N1 command corresponds to the start of Engine spool down and un-commanded In-Flight Shutdown (IFSD) of Engine No. 1. Engine No. 1 N2 rotation speed started to decrease (last recorded value in the DFDR was 59%), whereas Engine No. 2 N2 rotation speed was 93.8%. After this moment, Engine No. 1 generator stopped providing AC power as the N2 rotation speed went below 56.3% which is the cut-off value for generator.

1.1.8.19. Between 09:36:06 and 09:36:09, FO (PM) said, "*Thrust Lever number two IDLE, move number two to IDLE*" (in Urdu).

1.1.8.20. At 09:36:12, 3,100 ft RA, Engine No. 2 Thrust Lever was reduced to IDLE, whereas Engine No. 1 Thrust Lever was kept to Maximum Climb (MCL). Engine No. 2 N1 command reduced from 82% to 46% accordingly and Engine No. 2 N1 actual reduced accordingly from 82% to 71%.

1.1.8.21. At 09:36:17, 3,140 ft RA and 199 kts CAS, DFDR end of recording was caused as Engine No. 1 AC generator was no more providing AC power, and Engine No. 2 AC generator was also not providing AC power either. The normal flight control law (i.e. with all flight envelope protections) remained active until end of DFDR recording.

1.1.8.22. At 09:36:26 Karachi Tower asked Karachi Approach to ask the flight crew whether Gears were DOWN?

1.1.9. **Phase 6: From Engine No. 1 Spool Down to the End of Flight (End of CVR Recording)**

1.1.9.1. The CVR stopped recording at 09:36:19, due to loss of power, and resumed recording 8 s later. The dual loss of AC generation led to the automatic deployment of Ram Air Turbine (RAT). At that moment batteries supplied power to the emergency network. The CVR being powered by AC SHED ESS bus stopped recording, whereas DFDR had already completely stopped recording. Once RAT was

online, it started supplying power to emergency network and allowed AC SHED ESS bus to resume power. Thereafter only CVR recording resumed until end of the flight.

1.1.9.2. The events mentioned after 09:36:27 are only based on the analysis of the CVR (recording and spectral analysis). The Engine No. 1 N1 frequency could not be heard on CVR and was therefore could not be analysed.

1.1.9.3. From 09:36:28 to 09:36:47, a sequence of six Cavalry Charge Alerts separated by 4 s from each other were heard in CVR. Alongside with this sequence, five synthetic voice callouts {two times "DUAL INPUT", then "STALL STALL" (no associated Cricket), and two more "DUAL INPUT"} were heard between 09:36:31 and 09:37:02. As per radar data, aircraft altitude was 1,900 ft Above Mean Sea Level (AMSL), Ground Speed (GS) 222 kts, and track 103° at 09:37:02.

1.1.9.4. At 09:36:45, Captain (PF) asked about location of the R/W to which FO (PM) mentioned the physical location of R/W.

1.1.9.5. From 09:36:51 to 09:37:04, a C-Chord audio was heard on the CVR recording corresponding to an Altitude Alert.

1.1.9.6. At 09:36:55, Karachi Approach gave call, "Pakistan 8303 you are dropping altitude 2,000", to which FO requested 2,000 ft clearance, which was cleared by the Karachi Approach.

1.1.9.7. At 09:37:05, a CRC was heard. 6 s later Captain asked, "*Close it*" (in Urdu) and 2 s later CRC Alert was stopped.

1.1.9.8. From 09:37:13 to 09:37:21, in a short discussion the flight crew wondered about the status of Engine No. 2 and confirmed Engine No. 2 was running.

1.1.9.9. At 09:37:17, second C-Chord audio was heard. 20 s later, Captain said, "*Close it"* (in Urdu) and at 09:37:39 the audio Alert stopped.

1.1.9.10. From 09:37:21, the spectral analysis of CVR showed that the Engine No. 2 N1 speed was increasing from 40% nominal speed to reach 76% at 09:37:24.

1.1.9.11. From 09:37:21, Karachi Approach gave call that the MODE-C radar was showing 1,800 ft altitude and descending. At 09:37:27, FO replied, "Copied we are maintaining, trying to maintain".

1.1.9.12. At 09:37:33, FO informed Captain that the RAT minimum speed was 140 kts. 5 s later FO asked Captain to maintain 140 kts.

1.1.9.13. At 09:37:43, FO mentioned a GEN procedure "GEN 1+2 OFF then ON". At the same time, Captain said that *"you had selected Engine No. 2 to IDLE, whereas Engine No. 1 was gone"* (in Urdu), to which FO replied, "*Yes*" (in Urdu).

1.1.9.14. Between 09:37:59 and 09:38:01, three noises similar to an Engine stall were recorded. N1 was 72% before Engine No. 2 stall sounds. Engine No. 2 N1 cannot be determined from the spectral analysis of CVR during that period of time. Captain's reaction was to ask what these noises were? FO replied, "*Reduce the speed*" (in Urdu).

1.1.9.15. After Engine stall sound, Engine No. 2 N1 was 65%, then it increased back to 72% 5 s later, before reducing again and maintaining 65% from 09:38:12.

1.1.9.16. At 09:38:10, Captain said "*Select FLAPS1*" (in Urdu). At 09:38:14, a Single Chime (Master Caution Alert) triggered.

1.1.9.17. Engine No. 2 N1 speed decreased from 65% at 09:38:39 and from 09:38:46 the Engine sound could no longer be detected from the CVR spectral analysis. The minimum Engine No. 2 N1 speed was 42 % from CVR spectral analysis. A single "Stall" synthetic callout followed 1 s later by a Master Warning (Single Chime) was heard at 09:38:42.

1.1.9.18. From 09:38:50 to 09:38:54, a sequence of Stall Warnings was heard in the CVR. When the Stall Alerts started, FO asked Captain to increase the speed.

1.1.9.19. Just after the end of the stall Warning, FO asked Captain to continue to keep increasing speed. Captain replied, "*How would I increase speed*?" (in Urdu). It was followed by a third C-Chord Aural Warning, which lasted up to 09:39:47.

1.1.9.20. At 09:39:02, FO asked, "*Do we have Faisal Base* (Military airfield in the close vicinity of JIAP, Karachi) *here*?" (in Urdu).

1.1.9.21. At 09:39:10, Karachi Approach gave call to PIA 8303, "Appears to be turning left". FO replied, "We will be proceeding direct Sir we have lost Engines". At this time a "Dual Input" synthetic callout was heard. As per radar data, aircraft altitude was 1,500 ft AMSL, GS 177 kts, track 004° (turning left) at 09:39:12.

1.1.9.22. At 09:39:20, Karachi Approach gave call, "Confirm you are carrying out belly landing?". FO replied, "Negative Sir".

1.1.9.23. At 09:39:31, Captain asked FO whether Landing Gears were extended? FO confirmed that Landing Gears were not extended.

1.1.9.24. At 09:39:39, a noise similar to the Landing Gears extension was heard in the CVR. 3 s later, Captain asked FO, *"Cabin crew to be seated"* (In Urdu). Cabin crew were addressed at 09:39:44 by FO saying, "Cabin crew to your station for landing". As per radar data, aircraft altitude was 700 ft AMSL, GS 169 kts, track 349° (turning left) at 09:39:42.

1.1.9.25. At 09:39:46, Captain said "MAYDAY MAYDAY MAYDAY" and soon after a MAYDAY call was transmitted on RT by FO. At the same time a sequence of "Stall" synthetic callouts could be heard in the CVR recording. Both synthetic voice and cricket remained active until the end of the recording. As per radar data, at 09:39:49, aircraft altitude was 600 ft AMSL, GS 170 kts, track 333° (turning left).

1.1.9.26. At 09:39:51, Karachi Approach gave call to PIA 8303 that both R/W are available for landing.

1.1.9.27. At 09:39:54, Captain said, "*Don't take FLAPS, don't take FLAPS*" (in Urdu).

1.1.9.28. At 09:40:01, a Single Chime was heard.. As per radar data, aircraft altitude was 400 ft AMSL, GS 142 kts, track 285° (turning left) at 09:40:07.

1.1.9.29. At 09:40:18, sound similar to aircraft impact was heard. This also marked the end of CVR recording.

1.2. Injuries to Person(s)

1.2.1. Out of 99 souls on-board, 97 were fatally injured and 02 passengers sustained serious injuries. On ground 01 person was fatally injured and 03 persons sustained serious injuries. All passengers and crew were Pakistani nationals. Table below summarizes injuries to persons: -

Injuries	Crew	Passengers	Total in the Aircraft	Others
Fatal	08	89	97	01
Serious	-	02	02	03
Minor	-	-	-	-
None	-	-	-	-
Total	08	91	99	04

Table 3 **–** Injuries to Persons

1.3. Damage to Aircraft

1.3.1. The aircraft was completely destroyed as a result of the accident. There was no evidence (including terrorist activity, sabotage, in-flight fire, in-flight breakup, loss of control, and bird hit etc) of any other cause of destruction of the aircraft.

1.4. Other Damage

1.4.1. Aircraft crash caused damage to several houses due to impact and intense post-crash fire. Various vehicles parked in the street were also destroyed / burnt.

1.5. Personnel Information

1.5.1. **Flight Crew Personnel Information –** There were two pilots in the cockpit during the entire period of the flight. Captain on the left seat and FO on the right seat. Salient details of experience and qualification of both flight crew are as under: -

Captain **Pilot In-Command (PIC) (PF at the time of Accident)**			
Date of Birth: 1st April, 1962			**Male**
License Type: Air Transport Pilot License (ATPL) 7th March, 2007			
Last Medical Examination: 5th May, 2020 valid till 31st October, 2020			
Medical limitation: Advised to wear spectacles			
Last CRM Training: 23rd January, 2020 valid till 23rd January, 2022			
Date of Joining PIA: 3rd March, 1996			
Flight experience (flight hours)			
	Last 24 hours	Last 72 hours	Total
All Types	3:15 hrs	10:30 hrs	17252:27 hrs
Accident Type	3:15 hrs	10:30 hrs	4783:46 hrs
Dates of transition			
Captain Position	8th March, 2013 (on ATR aircraft)		
Captain Position on Accident Type	27th May, 2015		
Pilot in Command time (flight hours)			
All Types	7044:18 hrs		
Accident Type	4783:46 hrs		
Second in Command time (flight hours)			
All Types	10208:09 hrs		
Accident Type	NIL		
Grand Total (flight hours)			
All Types	17252:27 hrs		
Type Ratings			
A320	25th May, 2015 (valid at the time of accident)		
Instrument Rating			
Date Issued	11th June, 2019		
Validity	31st May, 2020		
Trainings and Checks			
Recurrent Ground Training	5th October, 2017		
Proficiency Check	14th July, 2016		
Line Check	10th August, 2018 (Northern Area Route Training / Check)		

Table 4 **–** Personnel Information Captain

1.5.1.1. Captain gained his initial medical fitness from Civil Aviation Medical Board (CAMB) Lahore on 15th April, 1987. Subsequently, he underwent regular medical renewals as per the procedures defined by PCAA with no exception except wearing glasses. In 2003, during medical examination, his Electrocardiogram (ECG) showed some changes in T-waves. He was advised Exercise Tolerance Testing (ETT) which appeared to be normal. In 2006 his ETT again highlighted similar changes. This time he was advised Thallium Scan which was normal and did not show any abnormality. After that, all his medical examinations remained unremarkable. His last Class-I medical certificate was issued from Lahore on 5th May, 2020 which was valid till 10th October, 2020.

First Officer (FO) (PM at the time of Accident)			
Date of Birth: 27th January, 1987			**Male**
License Type: Commercial Pilot License (CPL) 21st May, 2007			
Last Medical Examination: 23rd September, 2019 valid till 30th September, 2020			
Medical limitation: Advised to wear spectacles			
Last CRM Training: 30th August, 2018 valid till 30th August, 2020			
Date of Joining: 9th August, 2010			
Flight experience (flight hours)			
	Last 24 hours	Last 72 hours	Total
All Types	1:45 hrs	1:45 hrs	2291:15 hrs
Accident Type	1:45 hrs	1:45 hrs	1504:58 hrs
Dates of transition			
First Officer Position	3rd January, 2015		
First Officer Position on Accident Type	24th December, 2016		
Pilot in Command time (flight hours)			
All Types	158:40 hrs		
Accident Type	NIL		
Second in Command time (flight hours)			
All Types	2132:35 hrs		
Accident Type	1504:58 hrs		
Grand Total (flight hours)			
All Types	2291:15 hrs		
Type Ratings			
A320	23rd December, 2016 (valid at the time of accident)		
Instrument rating			
Date Issued	27th February, 2020		
Validity	28th February, 2021		
Trainings and checks			
Recurrent Ground Training	18th December, 2015		
Proficiency Check	27th February, 2020		
Line Check	24th March, 2019 (Route Check for Lahore to Muscat)		

Table 5 **–** Personnel Information First Officer

1.5.1.2. FO gained his initial medical fitness from CAMB Lahore on 6th September, 2005. Subsequently, he underwent regular medical renewals as per the procedures defined by PCAA with no exception except wearing glasses. His last Class-I medical certificate was issued from CAMB Karachi on 23rd September, 2019 which was valid till 30th September, 2020.

1.5.1.3. PCAA initiated scrutiny of flight crew licensing records during the year 2019 to address dubious pilot's licenses. The licenses of both flight crew were found to be valid and clear of all suspicions[17].

[17] PCAA PEL Directorate letter No. HQCAA/1136/225/RGLC/444 dated 26th April, 2021

1.5.2. **ATC Personnel Information –** Tables below summarize experience and qualification of Approach and Aerodrome Controllers: -

Approach Controller / Team Leader	
Date of Birth	22nd November, 1985
Date of Joining PCAA	3rd July, 2010
Type of License and Validity	Air Traffic Controller License (ATCL)
	April, 2021
Class and Validity of Medical	III
	31st December, 2020
ATC Unit Rating	- Aerodrome Control since 2011 - Area Control since 2013 - Area Radar since 2014 - Approach Radar Control since 2017 - Approach Control since 2019 - OJTI Aerodrome since 2015 - OJTI Area Control since 2015 - OJTI Area Radar since 2018
Aerodrome Controller	
Date of Birth	2nd April, 1992
Date of Joining PCAA	27th May, 2017
Type of License and Validity	Air Traffic Controller License (ATCL)
	April, 2022
Class and Validity of Medical	III
	31st December, 2020
ATC Unit Rating	- Aerodrome Control since 2018

Table 6 – Personnel Information Approach Controller (Team Leader) and Aerodrome Controller

1.6. **Aircraft Information**

1.6.1. The mishap aircraft was being maintained by PIA in accordance with the regulations of PCAA. Pertinent aircraft information is as follows: -

Aircraft	
Aircraft Make and Model	Airbus A320-214
Registration Marking	AP-BLD
Year of Manufacture	2004
Manufacturer Serial No.	2274
Owner / Lessor	GE Capital Aviation Services (GECAS)
Operator	Pakistan International Airlines
Date of Induction in PIA	30th October, 2014 (Dry Lease)
Maximum Take-off Weight	77,000 Kg
Maximum Landing Weight	64,500 Kg
Maximum Fuel Capacity	18,730 Kg
Total Aircraft Flight Hours (FH) / Flight Cycles (FC) prior to event flight	47124:32 FH / 25866 FC
Total Aircraft FH / FC done in PIA prior to event flight	18632 FH / 8353 FC
Certificate of Airworthiness (S/N, expiry date)	806, 5th November, 2020
Certificate of Maintenance Review prior to event flight (expiry date)	25th October, 2020
Last weighing carried out	October, 2019
Last Daily inspection prior to event flight	22nd May, 2020
Last Weekly Check prior to event flight	14th May, 2020
Last Check A	21st March, 2020
Last Major Check	Check 2C, dated 19th October, 2018
COVID-19 Pandemic Grounding (Location, date)	AIIAP Lahore, from 22nd March, 2020 to 7th May, 2020
Total Flight Since Check A	11 Flights
Last Operated Flight (Prior to event)	PIA 8232 (Muscat – Lahore) 21st May, 2020
Auxiliary Power Unit (APU)	APS 3200 (S/N P-2489) Serviceable

Table 7 **–** Aircraft Information

Engine No. 1	
Engine S/N	577-534
Manufacturer	CFM International
Engine Type	CFM56-5B4
Date of Installation	25th February, 2019
Time Since New (TSN) / Cycle Since New (CSN)	39189:11 / 18627
Time Since Installation (TSI) / Time Since Overhaul (TSO)	4022:50 / 4022:50
Cycle Since Installation (CSI) / Cycle Since Overhaul (CSO)	1749 / 1749
Engine Trend / Health	Satisfactory
Last Borescope Inspection (BSI)	22nd February, 2020

Table 8 – Aircraft Engine No. 1 Information

Engine No. 2	
Engine S/N	697-502
Manufacturer	CFM International
Engine Type	CFM56-5B4
Date of Installation	27th May, 2019
TSN / CSN	19497:32 / 11281
TSI / TSO	3440:32 / 3440:32
CSI / CSO	1487 / 1487
Engine Trend / Health	Satisfactory
Last BSI	14th November, 2019

Table 9 – Aircraft Engine No. 2 Information

Landing Gears			
Position	**Main Landing Gears (MLG)**		**Nose Landing Gear (NLG)**
	Left Hand (L/H)	**Right Hand (R/H)**	
P/N	201582001-010	201582002-010	D23589520-12
S/N	M-DG-2233	M-DG-2234	B1559
Installation date	18th October, 2014	18th October, 2014	18th October, 2014
Next overhaul date	17th October, 2024	17th October, 2024	17th October, 2024
1st Life Limited Part (LLP) due at Life Since New (LSN)	56480	56480	49046
LSN current	25583	25583	25583
Remaining LLP	30897	30897	23463

Table 10 – Aircraft Landing Gears Information

1.6.2. **Fuel -** Aircraft was last refuelled with JET A-1 fuel from AIIAP Lahore (departure Aerodrome) total quantity of fuel onboard was 7,740 kg[18]. The samples of the fuel taken from the refuelling source were tested for contamination. The fuel test reports did not reveal any abnormality[19].

1.7. Meteorological Information

1.7.1. Weather information of Meteorological Office JIAP, Karachi issued before flight on 22nd May, 2020 is as follows: -

S/N	Station	Time (UTC)	Terminal Aerodrome Forecast (TAF) (Departure / Destination)
1	Lahore	220345Z	2206/2312 34008KT 5000 HZ NSC TX41/2210Z TN23 / 2300Z TEMPO 2215 / 2220 34015G40KT 1500 TSRA FEW030CB SCT040 BKN100 BECMG 2308 / 2312 32010G20KT
2	Karachi	220330Z	2206/2312 24010G22KT 6000 NSC BECMG 2219 / 2221 26010KT 5000 FU SCT025 FM230400 23010G20KT 6000 NSC=
S/N	**Station**	**Time (UTC)**	**Meteorological Aerodrome Reports (METAR) / Special Report of Meteorological Conditions Issued (SPECI) (Destination)**
1	Karachi	220925Z	220925Z 24011KT 7000 NSC 35/24 Q1004 NOSIG=
2	Karachi	220955Z	220955Z 24011KT 7000 NSC 35/24 Q1004 NOSIG=

Table 11 – Pre-Flight Weather Details

1.7.1.1. **Description of TAF Lahore –** Lahore 220345Z 2206 / 2312 34008KT 5000 HZ NSC TX41 / 2210Z TN23 / 2300Z TEMPO 2215 / 2220 34015G40KT 1500 TSRA FEW030CB SCT040 BKN100 BECMG 2308 / 2312 32010G20KT.

Description of TAF – Lahore	
220345Z	22 0345 UTC (Date and time of origin)
2206/2312	22 0600 UTC / 23 1200 UTC
34008KT	Wind 340° 08 kts
5000	Visibility 5000 m
HZ	Weather Haze
NSC	No significant clouds
TX41 / 2210Z	Maximum Temp 41° C at 22 1000 UTC
TN23 / 2300Z	Minimum Temp 23° C at 23 0000 UTC
TEMPO 2215 / 2220	Temporary changes between 22 1500 to 22 2000 UTC
34015G40KT	Wind 340° 15 kts Gust 40 kts
1500	Visibility 1500 m
TSRA	Thunderstorm Rain
FEW030CB SCT040 BKN100	Clouds Few CB 3000 SCATTERED 4000 Broken 10000
BECMG 2308 / 2312	Becoming from 23 0800 UTC to 23 1200 UTC
32010G20KT	Wind 320° 10 kts Gust 20 kts

Table 12 – TAF – Lahore

[18] PIA Fuel Indent Loading Instructions Form No. 9-22-47E
[19] PSO Fuel Jet A-1 Test Reports dated 30th & 31st May, 2020

1.7.1.2. **Description of TAF Karachi –** Karachi 220330Z 2206 / 2312 24010G22KT 6000 NSC BECMG 2219 / 2221 26010KT 5000 FU SCT025 FM230400 23010G20KT 6000 NSC.

Description of TAF – Karachi	
220330Z	22 0330 UTC (Date and time of origin)
2206/2312	22 0600 UTC/ 23 1200 UTC
24010G22KT	Wind 240° 10 kts Gust 22 kts
6000	Visibility 6000 m
NSC	No significant cloud
BECMG 2219 / 2221	Becoming group from 22 1900 UTC to 22 2100 UTC
26010KT	Wind 260° 10 kts
5000	Visibility 5000 m
FU	FU (smoke)
SCT025	Clouds SCT 25
FM230400	From 23 0400 UTC
23010G20KT	Wind 230° 10 kts Gust 20 kts
6000	Visibility 6000 m
NSC	No significant cloud

Table 13 – TAF – Karachi

1.7.2. **Description of METAR Karachi**

1.7.2.1. METAR OPKC **220925Z** 24011KT 7000 NSC 35 / 24 Q1004 NOSIG

Description of METAR – Karachi	
220925Z	22 0925 UTC
24011KT	Wind 240° 11 kts
7000	Visibility 7000 m
NSC	no significant clouds are observed below 5,000 ft or below the minimum sector altitude (whichever is higher)
35/24	Temp 35° C / Dewpoint 24° C
Q1004	QNH 1004 hPa
NOSIG	Next 2 hours no significant changes

Table 14 – Meteorological Aerodrome Report JIAP, Karachi at 0925 UTC

1.7.2.2. METAR OPKC **220955Z** 24011KT 7000 NSC 35 / 24 Q1004 NOSIG

Description of METAR – Karachi	
220955Z	22 0955 UTC
24011KT	Wind 240° 11 kts
7000	Visibility 7000 m
NSC	No significant clouds are observed below 5,000 ft or below the minimum sector altitude (whichever is higher)
35/24	Temp 35° C / Dewpoint 24° C
Q1004	QNH 1004 hPa
NOSIG	Next 2 hours no significant changes

Table 15 – Meteorological Aerodrome Report JIAP, Karachi at 0955 UTC

1.8. **Aids to Navigation**

1.8.1. The aircraft was equipped with Navigation Equipment [Air Data Inertial Reference System (ADIRS), Global Positioning System (GPS), Very High Frequency Omni-Directional Range (VOR), Marker Beacon, Instrument Landing System (ILS), Automatic Direction Finding (ADF), Radio Altimeters (RA), Automatic Dependent Surveillance (ADS) etc]. The said systems were serviceable and no technical anomaly / failure was documented before the accident.

1.8.2. Navigation facilities at the departure and destination Aerodromes are as follows: -

1.8.2.1. **AIIAP, Lahore –** Aids to Navigation of AIIAP, Lahore as per AIP of Pakistan are appended below: -

OPLA AD 2.19 RADIO NAVIGATION AND LANDING AIDS

TYPE OF AID	ID	Frequency	Hours of operation	Site of transmitting antenna coordinates	Elevation of DME transmitting antenna	Remarks
1	2	3	4	5	6	7
ILS/LOC CAT I 36L	ILO	109.7 MHz	H24	313223.66N 0742410.53E	-	-
ILS/LOC CAT III 36R	ILA	109.9 MHz	H24	313224.49N 0742417.66E	-	Coverage 20 NM
NDB	LA	268.0 kHz	H24	313123.41N 0742348.18E	-	-
VOR/DME (2.1/2020)	LA	112.7 MHz CH74X	H24	313109.66N 0742400.05E	222.70M	200NM
DME	LA	CH74X	NIL	312959.00N 0742400.07E	222.70M	Coverage 200 NM
MM	LO	75.0 MHz	H24	312949.99N 0742414.91E	-	-
OM	LO	338.0 kHz	H24	312641.15N 0742404.47E	-	-
OM	O36R	75.0 MHz	H24	312641.50N 0742404.51E	-	-
GP/TDME 36L	DOTS/DASHES	333.2 MHz CH34X	H24	313042.70N 0742403.86E	-	-
GP/TDME 36R	DOTS/DASHES	333.8 MHz CH36X	H24	313033.31N 0742412.14E	230.00M	-

Table 16 – Aids to Navigation AIIAP, Lahore

1.8.2.2. **JIAP, Karachi –** Aids to Navigation of JIAP, Karachi as per AIP of Pakistan are appended below: -

OPKC AD 2.19 RADIO NAVIGATION AND LANDING AIDS

TYPE OF AID	ID	Frequency	Hours of operation	Site of transmitting antenna coordinates	Elevation of DME transmitting antenna	Remarks
1	2	3	4	5	6	7
ILS/LOC CAT I 25R	IKC	110.1 MHz	H24	245413.64N 0670837.68E	-	-
ILS/LOC CAT I 25L	IQA	109.7 MHz	H24	245359.09N 0670820.43E	-	-
NDB	KC	271.0 kHz	H24	245523.80N 0670936.29E	-	Coverage 500NM
VOR/DME (0/2016)	KC	112.1 MHz CH58X	H24	245443.06N 0671053.91E	40.84M	Coverage 200 NM Radial 300 Un-Reliable
MM	KO	235.0 kHz	H24	312949.99N 0742414.91E	-	3.9 NM FM THRRWY 25R
MM	KO	75.0 MHz	H24	245454.06N 0671117.40E	-	0.43 NM FM THRRWY 25R
GP/TDME 25R	IKC-DOTS/ DASHES	334.4 MHz	H24	245448.11N 0671029.32E	-	-
GP/TDME 25L	IQA-DOTS/ DASHES	333.2 MHz CH34X	H24	245433.50N 0671017.88E	30.90M	2.98° RDH 55 FT

Table 17 – Aids to Navigation JIAP, Karachi

1.8.2.3. Navigation facilities at the Departure and Destination Aerodromes were fully functional during the event flight.

1.9. Communications

1.9.1. **Onboard Communications –** Communication equipment for communication on Very High Frequency (VHF) and High Frequency (HF), in accordance with the aircraft certification requirements. The said systems were serviceable and no technical anomaly / failure was documented before the accident.

1.9.2. **Ground Based Communications –** Communication facilities at the departure and destination Aerodromes are as follows: -

1.9.2.1. **AIIAP, Lahore –** Communications of AIIAP, Lahore as per AIP of Pakistan are appended below: -

OPLA AD 2.18 ATS COMMUNICATION FACILITIES

Service designation	Call sign	Frequency	Hours of operation	Remarks
1	2	3	4	5
APP	Lahore APP	121.300 MHZ	H24	Primary
APP	Lahore APP	121.500 MHZ	H24	Emergency
APP	Lahore APP	125.300 MHZ	H24	Secondary
ATIS	ATIS	126.300 MHZ	H24	-
BS	Radio Pakistan	630.000 KHZ	HX	0130 --1900 HR
BS	Radio Pakistan	1090.000 KHZ	HX	Variable SKED
GCA	Lahore Ground	118.400 MHZ	H24	Primary
GCA	Lahore Ground	121.800 MHZ	H24	Secondary
TWR	Lahore Tower	118.100 MHZ	H24	Primary
TWR	Lahore Tower	118.875 MHZ	H24	Secondary

Table 18 – ATS Communication Facilities AIIAP, Lahore

1.9.2.2. **JIAP, Karachi –** Communications of JIAP, Karachi as per AIP of Pakistan are appended below: -

OPKC AD 2.18 ATS COMMUNICATION FACILITIES				
Service designation	**Call sign**	**Frequency**	**Hours of operation**	**Remarks**
1	2	3	4	5
APP	Karachi APP	121.300 MHZ	H24	Secondary
APP	Karachi APP	121.500 MHZ	H24	Emergency
APP	Karachi APP	125.500 MHZ	H24	Primary
ATIS	ATIS	126.700 MHZ	H24	-
BS	Radio Pakistan	830.000 KHZ	HX	0130-1900 HR
BS	Radio Pakistan	1450.000 KHZ	HX	Variable SKED
GCA	Karachi Ground	118.400 MHZ	H24	Secondary
GCA	Karachi Ground	121.600 MHZ	H24	Primary
GCA	Karachi Ground	121.800 MHZ	H24	Vehicle
GCA	Karachi Ground	123.000 MHZ	H24	-
TWR	KARACHI Tower	118.300 MHZ	H24	Primary
TWR	KARACHI Tower	118.800 MHZ	H24	Secondary
TWR	KARACHI Tower	121.500 MHZ	H24	Emergency

Table 19 – ATS Communication Facilities JIAP, Karachi

1.9.3. Throughout the flight the total communication plan with pertinent events are mentioned below: -

Time Duration	**Frequency (Aerodrome Unit)**	**Event**
07:55:00 – 08:00:00	118.4 MHz (Lahore Ground Movement Control)	**Push back / start up – Taxi till holding point**
08:01:00 – 08:06:00	118.1 MHz (Lahore Tower Control)	**ATC clearance – Airborne**
08:06:00 – 08:08:00	121.3 MHz (Lahore Approach)	**After airborne – Changeover to Lahore Control**
08:08:00 – 08:24:00	127.5 MHz (Lahore Control)	**Remained with Lahore Control till MOLTA**
08:24:00 – 09:24:23	123.15 MHz (Karachi Control)	**From MOLTA – Changeover to Karachi Approach** • Aircraft initiated descent from FL340. • 09:23:30 - 09:24:23 Karachi Control gave 03 calls and asked through another aircraft in air (but there was no reply from PIA 8303).
09:24:36 - 09:40:18	125.5 MHz (Karachi Approach)	**Changeover from Karachi Control till Aircraft impact** • At 09:24:36, Karachi Approach called PIA 8303 on 125.5 MHz which was not replied. • Karachi Approach then gave three calls on Guard frequency. • Third call on Guard was responded by the flight crew, “Strength 2 sir confirm changeover to 126.5”. • Karachi Approach replied, “Contact 125.5”. Normal RT contact was established between aircraft and Karachi Approach thereafter.

Table 20 – Event Flight Total Communication Plan with Pertinent Events

1.9.4. Communication facilities at the departure, enroute and destination were fully functional during the event flight.

1.10. **Aerodrome Information**

1.10.1. PIA 8303 took off from AIIAP, Lahore and planned arrival Aerodrome was JIAP, Karachi.

1.10.2. The data of AIIAP, Lahore (Departure Aerodrome) as per AIP of Pakistan is appended below: -

AD 2 OPLA-8 AIP
23 APR 20 Pakistan

OPLA AD 2.12 RUNWAY PHYSICAL CHARACTERISTICS

Designations RWY NR	True bearing	Dimensions of RWY (M)	Strength (PCN) and surface of RWY and SWY	THR coordinates	THR elevation and highest elevation of TDZ of precision APP RWY	Slope of RWY/SWY
1	2	3	4	5	6	7
18L	180.00°	3360 x 46	85/R/B/X/U Concrete	313211.94N 0742417.44E	THR 216.90 M / 711.61 FT	0.050%
36R	360.00°	3360 x 46	85/R/B/X/U Concrete	313023.30N 0742415.49E	THR 215.10 M / 705.71 FT	0.050%
18R	180.00°	2743 x 46	69/F/C/Y/T	313202.10N 0742410.19E	THR 216.50 M / 710.30 FT	0.050%
36L	360.00°	2743 x 46	69/F/C/Y/T	313033.10N 0742408.60E	THR 214.80 M / 704.72 FT	0.050%

SWY dimension (M)	CWY dimension (M)	Strip dimension (M)	RESA dimension (M)	Arresting system	Obstacle Free Zone	Remarks
8	9	10	11	12	13	14
122	305-	3724 x 300	-	-	Available	-
122	305	3724 x 300		-		-
244	244-	3381 x 300	-	-	Available	-
274	274	3381 x 300	92 x 90	-		-

Remarks: Concrete platforms height 1 ft. 9 inches of Arresting Barrier (on Stop way) on both sides of extended centerline of runway 36R and 18L.

OPLA AD 2.13 DECLARED DISTANCES (M)

Designations RWY NR	TORA	ASDA	TODA	LDA	Remarks
1	2	3	4	5	6
18L	3360	3482	3665	3360	-
36R	3360	3482	3665	3360	-
18R	2743	2987	2987	2743	-
36L	2743	3017	3017	2743	-

Table 21 – R/W Physical Characteristics and Declared Distances AIIAP, Lahore

OPLA AD 2.14 APPROACH AND RUNWAY LIGHTS

Designations RWY NR	APCH LGT type LEN INTST	THR LGT colour WBAR	VASIS (MEH) PAPI	TDZM LGT LEN	RWY Centre line LGT Length, spacing, colour, INTST	RWY EDGE line LGT Length, spacing, colour, INTST	RWY End LGT colour WBAR	SWY LGT LEN (M) colour	Remarks
1	2	3	4	5	6	7	8	9	10
18L	SALS 420 M LIH	GREEN	PAPI BOTH/3°	-	3360 M 15 MWhite/ Red-	3360 M 60 M3360, 60M, Yellow (in last 600M) WHITE-	46M, 9MRED	122 M RED	Strobe Lights on both sides of RWY THR
36R	CAT III PALS 900 M LIH	46MGREEN	PAPI BOTH/3°	900 M-	3360 M 15 M White/Red-	3360 M 60 M3360, 60M, Yellow (in last 600M) WHITE-	46M, 6M, GREENRED	122 M RED	Standard Sequence Flashers in Approach & Strobe Lights on both sides of RWY THR
18R	SALS 420 M LIL	46MGREEN	PAPI /3°	-	-	2743 M 60 M2743, 60M, Yellow(in last 600M) WHITE LIL-	46M, 9MRED		Strobe Lights on both sides of RWY THR
36L	SALS Precision Approach CAT-I 420 M LIL	46MGREEN	PAPI /3°	-	-	2743 M 60 M2743, 60M, White, Yellow(in last 600M) WHITE LIL-	46M, 9MRED		Strobe Lights on both sides of RWY THR

Table 22 – Approach and R/W Lights AIIAP, Lahore

OPLA AD 2.15 OTHER LIGHTING, SECONDARY POWER SUPPLY

1. ABN/IBN location, characteristics and hours of operation	
2. LDI location and LGT **Anemometer location and LGT**	- LDI not available Anemometer in MET observatory located East of RWY-36R/18L and lighted.,
3. TWY edge and centre line lighting	TWY edge lights except TWY G & K Centre line: TWY centerline lights except TWY F, G, H, J, K, L & M
4. Secondary power supply / switch-over time	Secondary power supply to all AD facilities. Switch over time less than one minute and to ILS CAT III B less than one second.
5. Remarks	-

OPLA AD 2.16 HELICOPTER LANDING AREA: Nil

Table 23 – Other Lighting, Secondary Power Supply AIIAP, Lahore

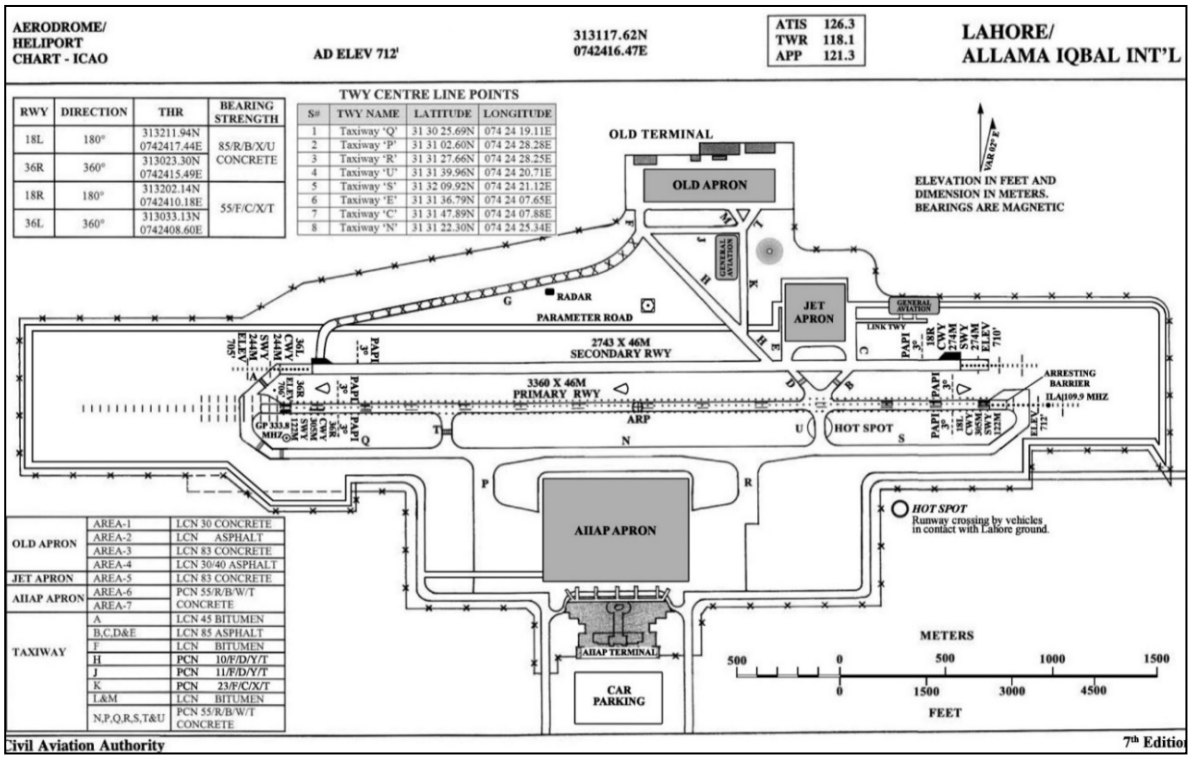
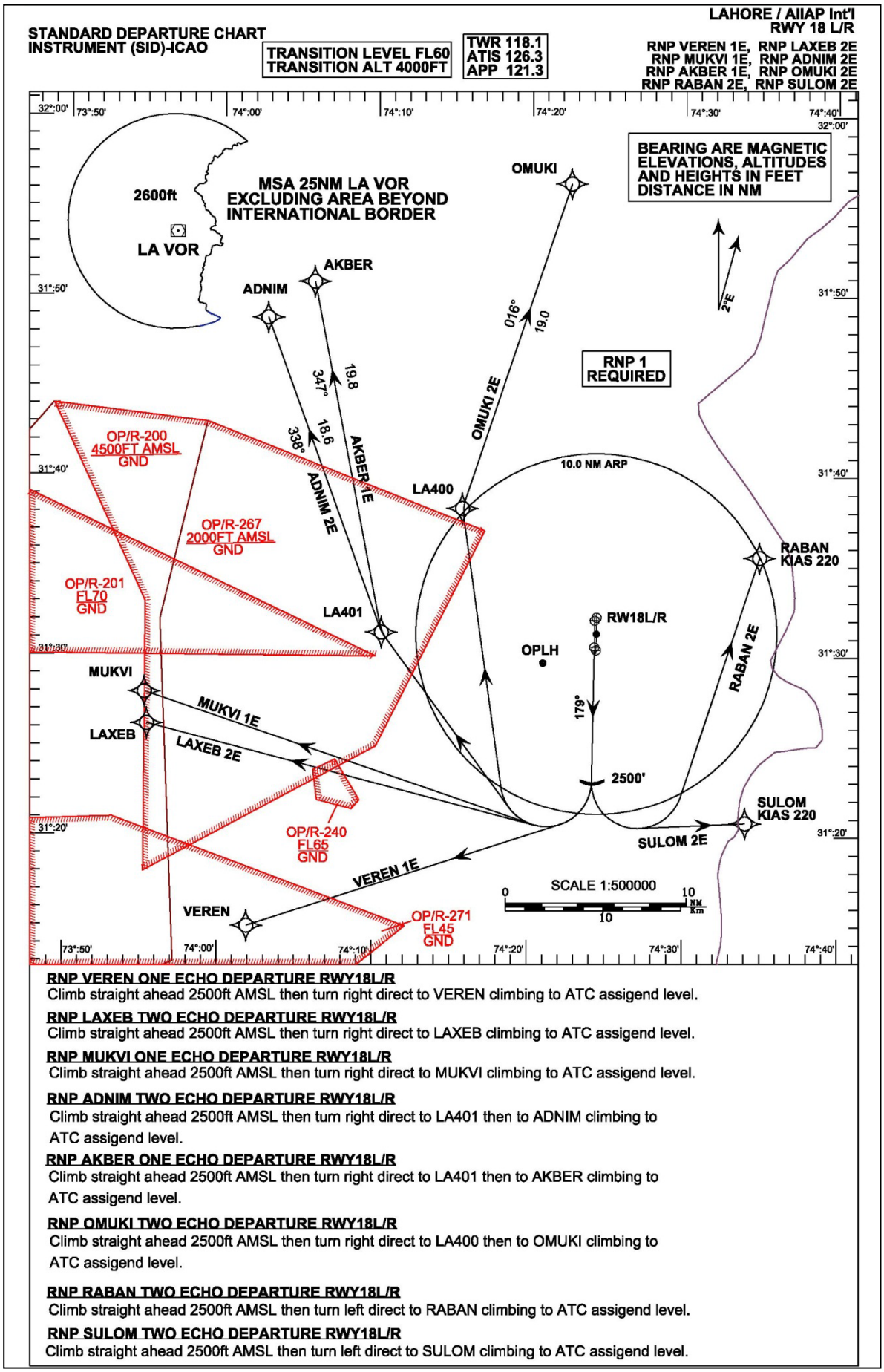


Figure 12 – Aerodrome / Helicopter Chart AIIAP, Lahore



RNP VEREN ONE ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to VEREN climbing to ATC assigend level.

RNP LAXEB TWO ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to LAXEB climbing to ATC assigend level.

RNP MUKVI ONE ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to MUKVI climbing to ATC assigend level.

RNP ADNIM TWO ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to LA401 then to ADNIM climbing to ATC assigend level.

RNP AKBER ONE ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to LA401 then to AKBER climbing to ATC assigend level.

RNP OMUKI TWO ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn right direct to LA400 then to OMUKI climbing to ATC assigend level.

RNP RABAN TWO ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn left direct to RABAN climbing to ATC assigend level.

RNP SULOM TWO ECHO DEPARTURE RWY18L/R
Climb straight ahead 2500ft AMSL then turn left direct to SULOM climbing to ATC assigend level.

Figure 13 – Standard Instrument Departure (SID) AIIAP, Lahore

1.10.3. The data of JIAP, Karachi (Arrival Aerodrome) as per AIP of Pakistan is appended below: -

OPKC AD 2.12 RUNWAY PHYSICAL CHARACTERISTICS

Designations RWY NR	True bearing	Dimensions of RWY (M)	Strength (PCN) and surface of RWY and SWY	THR coordinates	THR elevation and highest elevation of TDZ of precision APP RWY	Slope of RWY/SWY
1	2	3	4	5	6	7
07L	74.29°	3200 x 46	54/R/C/X/U Concrete ACFT upto A310 are permitted	245416.90N 0670851.02E	THR 23.50 M / 77.10 FT	0.200% UP
25R	254.29°	3200 x 46	54/R/C/X/U Concrete ACFT upto A310 are permitted	245444.69N 0671040.84E	THR 30.40 M / 99.74 FT	0.200% UP
07R	74.29°	3400 x 45	87/R/B/W/T Concrete SWY bitumen	245402.15N 0670833.56E	THR 21.62 M / 70.93 FT	0.168% UP
25L	254.29°	3400 x 45	87/R/B/W/T Concrete SWY bitumen	245431.79N 0671030.20E	THR 27.25 M / 89.40 FT	0.168% UP

SWY dimension (M)	CWY dimension (M)	Strip dimension (M)	RESA dimension (M)	Arresting system	Obstacle Free Zone	Remarks
8	9	10	11	12	13	14
305 x 46	914	3930 x 300	-	-	-	-
305 x 46	580	3930 x 300	-	-	-	-
305 x 45	870 x 150	4126 x 300	-180 x 120	-	-	-
301 x 45	483 x 150	4126 x 300	-150 x 150	-	-	-

OPKC AD 2.13 DECLARED DISTANCES (M)

Designations RWY NR	TORA	ASDA	TODA	LDA	Remarks
1	2	3	4	5	6
07L	3200	3505	4114	3200	-
25R	3200	3505	3780	3200	-
07R	3400	3705	4270	3400	-
25L	3400	3701	3883	3400	-

Table 24 – R/W Physical Characteristics and Declared Distances, JIAP, Karachi

OPKC AD 2.14 APPROACH AND RUNWAY LIGHTS

Designations RWY NR	APCH LGT type LEN INTST	THR LGT colour WBAR	VASIS (MEH) PAPI	TDZM LGT LEN	RWY Centre line LGT Length, spacing, colour, INTST	RWY EDGE line LGT Length, spacing, colour, INTST	RWY End LGT spacing colour WBAR	SWY LGT LEN (M) colour	Remarks
1	2	3	4	5	6	7	8	9	10
07L	SALS 420 M LIH	GREEN	PAPI LEFT/3°	-	-	3200 M 60 M	RED-		Strobe LGT
25R	PALS 900 M LIH	GREEN	PAPI LEFT/3°	-	-	WHITE LIH	RED-		-
07R	SALS 300 M LIH	GREEN	PAPI BOTH/ 2.91°	-	3400 M 30 M WHITE LIH-	3400 M 60 M WHITE LIH	RED-		-
25L	PALS 900 M LIH	GREEN	PAPI BOTH/ 2.98°	900 M	Last 900 M alternate white/red	- Last 600 M yellow	RED--		Flashers

Table 25 – Approach and R/W Lights, JIAP, Karachi

OPKC AD 2.15 OTHER LIGHTING, SECONDARY POWER SUPPLY	
1. ABN/IBN location, characteristics and hours of operation	-
2. LDI location and LGT **Anemometer location and LGT**	300 M S of ARP, lighted Anemometer: on Control Tower, lighted,
3. TWY edge and centre line lighting	Centre line: All TWY
4. Secondary power supply / switch-over time	Secondary power supply to all facilities at AD. Switch-over time: Less than 1 minute
5. Remarks	-

OPKC AD 2.16 HELICOPTER LANDING AREA: Nil

Table 26 – Other Lighting, Secondary Power Supply JIAP, Karachi

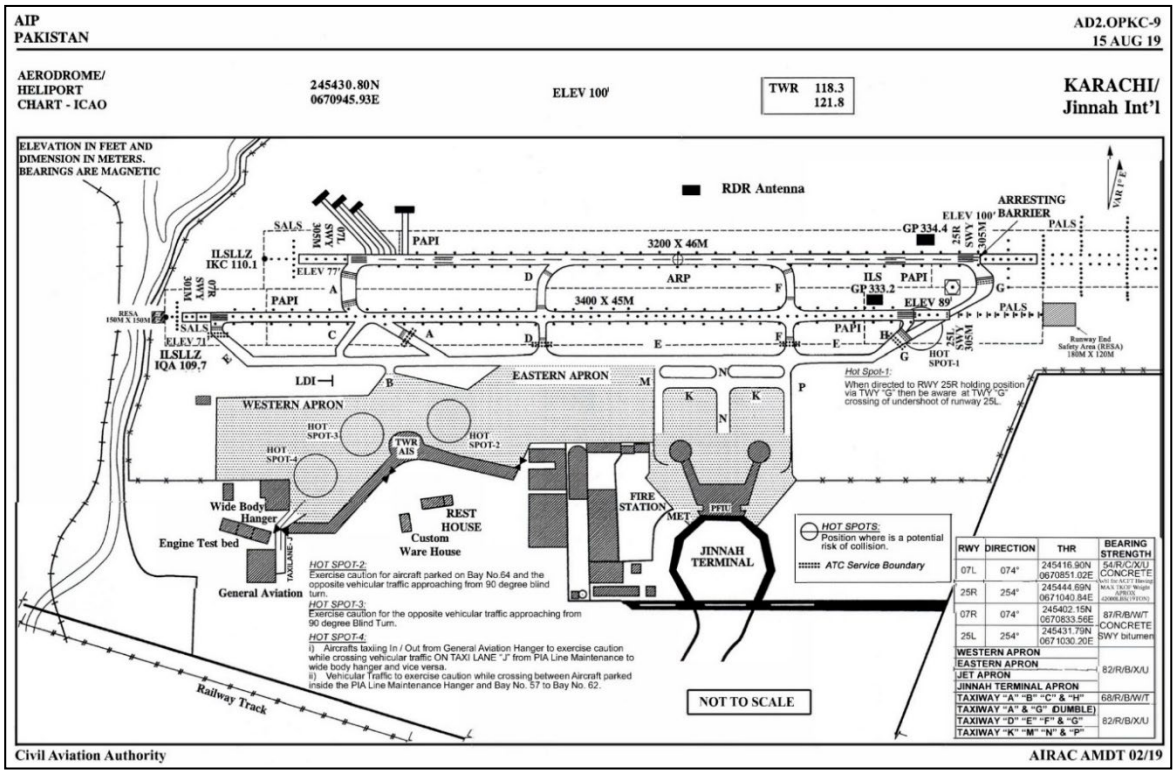


Figure 14 – Aerodrome / Helicopter Chart JIAP, Karachi

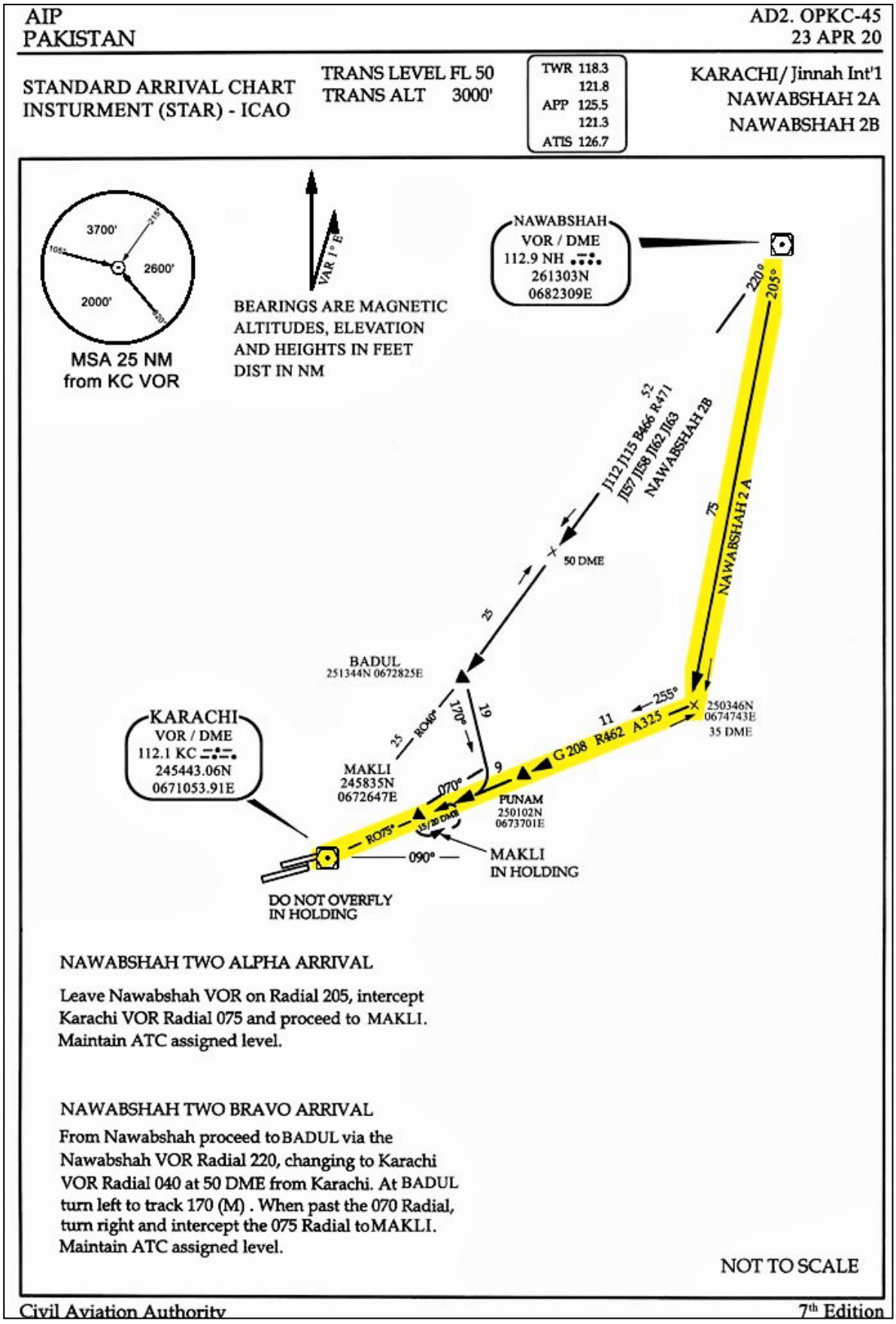


Figure 15 – STAR NAWABSHAH 2A

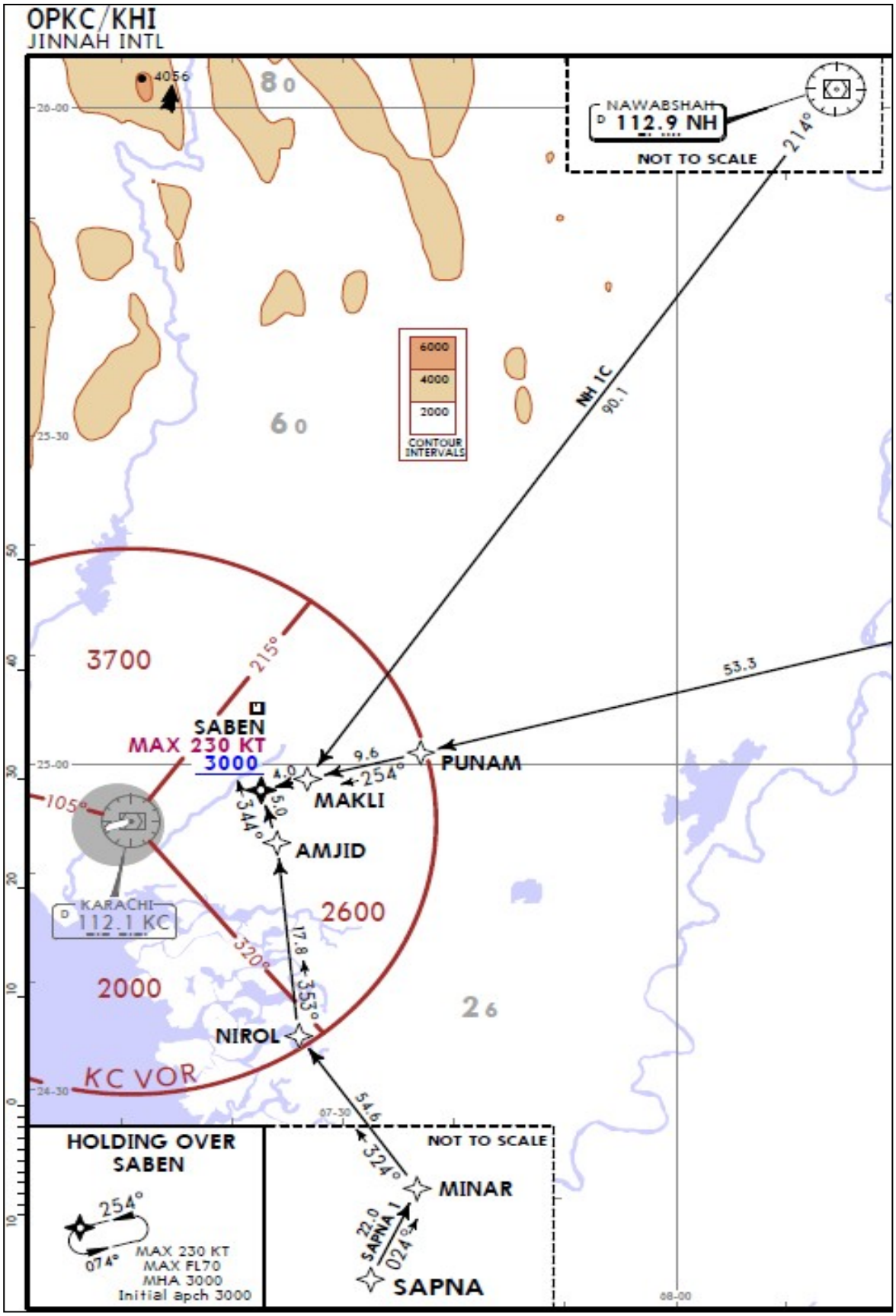


Figure 16 – STAR NAWABSHAH 1C

1.10.4. Aerodrome facilities at the departure and destination were fully functional during the event flight.

1.11. **Flight Recorders**

1.11.1. The aircraft was equipped with solid-state DFDR and solid-state CVR. DFDR and CVR were recovered from the accident site and taken to BEA, France by Investigator In-charge (IIC) from AAIB, Pakistan on 1st June, 2020. Despite having crash and heat effects, both recorders were successfully downloaded by BEA experts. DFDR stopped at 09:36:17, at this time aircraft reconfigured to Emergency Electrical Configuration (EEC) and DFDR was no more powered in this configuration. CVR faced a transient shutdown at 09:36:19 during reconfiguration phase of aircraft electrical system into EEC. CVR recovered after about 8 s at 09:36:27 due to RAT deployment and then remained available till end of flight at 09:40:18. Due to non-availability of DFDR recording after 09:36:17, both aircraft and Engine parameters were not available. However, availability of CVR helped in limited analysis of Engine parameters through spectral analysis. CVR and DFDR were synchronized and UTC time in DFDR was used as a standard reference throughout the investigation process. After the end of DFDR recording and non-availability of Frequency Shift Keying (FSK) signal, the CVR audio content was synchronized using common messages available both in ATC transcription and the remaining CVR recording[20]. Technical details of both recorders are as under: -

Recorder	Manufacturer	Part No.	Serial No.
DFDR	L3-Harris	2100-4043-02	000219808
CVR	Honeywell	980-6022-001	10189

Table 27 – DFDR and CVR Technical Information

Figure 17 – Digital Flight Data Recorder

Figure 18 – Cockpit Voice Recorder

1.12. **Wreckage and Impact Information**

1.12.1. The Trimmable Horizontal Stabilizer Actuator (THSA) position before impact was determined to be 2.8° nose up. According to Rudder Travel Limitation Unit (TLU), aircraft speed before impact was below 150 kts Indicated Air Speed (IAS). Layout of aircraft parts on the accident site is consistent with aircraft impacting buildings on both sides of the street indicating low speed slightly nose up impact. Search and Rescue (SAR) work started immediately by local populous and subsequently by rescue teams which may have resulted in slight movement / shifting of wreckage from last impact position, however, overall wreckage remained intact at accident site for analysis.

[20] BEA Contribution Report on Aircraft Systems dated 16th June, 2022, Pg – 7

Figure 19 – CCTV Footage before Impact

Figure 20 – CCTV Footage After Impact

1.12.2. **Accident Site Location –** The accident site was in a residential area North-East of JIAP, Karachi (24 54'42.07N 67 11'18.99E). The wreckage lies approximately 1,340 m from R/W 25L threshold on extended R/W centreline. Aircraft parts were spread out over 75 m in a single street.

Figure 21 – Aircraft Wreckage Distance from the R/W 25L Threshold

Figure 22 – Arial View of the Accident Site (Direction of Flight from Left to Right)

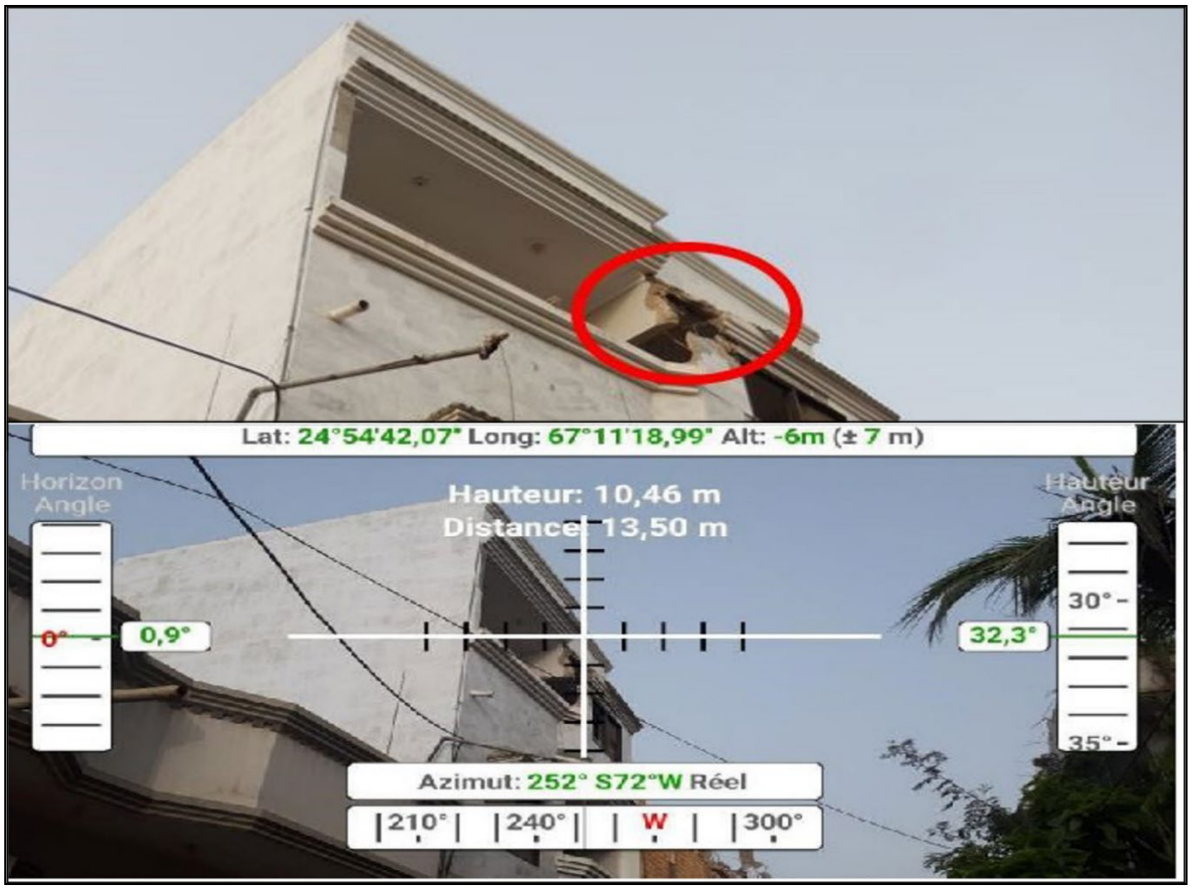


Figure 23 – Impact Point at Height 10.50 m and 46 m Distance from East End of Street

1.12.3. **Wreckage Survey**

1.12.3.1. **Aircraft Parts Identification**

(a) Most of aircraft parts were located on south side of the street. Parts were located on roofs of the buildings adjacent to the street and on the ground. The building heights are between 9 m and 11 m. Probably most of the parts have been moved during the Search and Rescue Operations. There was no clear picture available of Vertical Tail Plane (VTP) as it was probably extensively damaged during SAR phase. Pictures of the main aircraft parts identified at accident site are appended below: -

Figure 24 – Horizontal Tail Plane

Figure 25 – L/H Wing Top Skin with FLAP Fairing

Figure 26 – Horizontal Tail Plane L/H

Figure 27 – Elevator Servo-Control

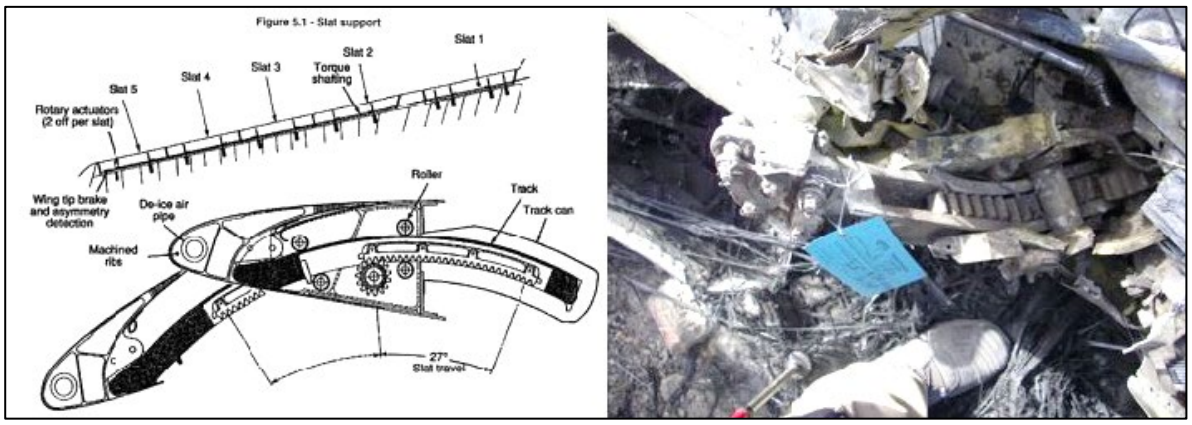


Figure 28 – L/H SLAT Track

Figure 29 – R/H Wing (Rib 15 to 24) Lower Surface Facing Up and FLAP Track 4 Visible

Figure 30 – L/H MLG with Missing Wheel and Tyres

Figure 31 – L/H MLG Tyre

Figure 32 – MLG Lower Leg, Wheels and Tyres

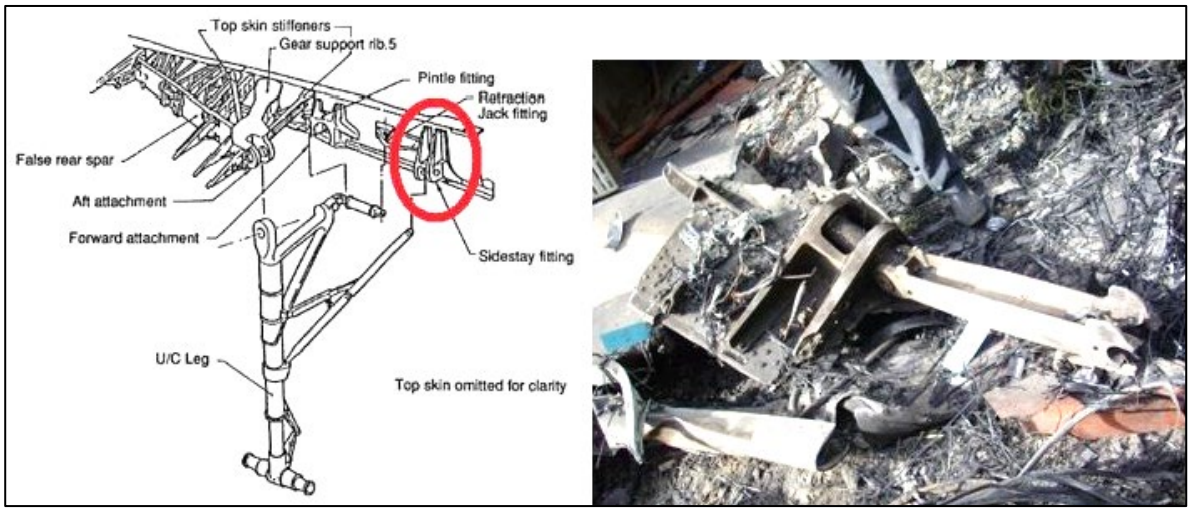


Figure 33 – MLG L/H Side Stay Fitting

Figure 34 – RAT Without Blades and Cone

Figure 35 – Left Wing at Rooftop

Figure 36 – Engine No. 1 with Pylon and Reverse Cowls

Figure 37 – Engine No. 2 with Pylon Attached

(b) All parts recovered from the accident site were brought to a reserved area at JIAP, Karachi and placed on the layout marked on the ground.

Figure 38 – Wreckage Layout at JIAP, Karachi

1.12.3.2. **Parts Recovered from R/W Surface**

(a) After R/W contact with Landing Gears retracted, four scratch marks were identified on R/W 25L (Refer section 1.16.17 – "Runway Inspection Report") and few aircraft parts were found on the R/W surface.

Figure 39 – Parts Found on the R/W

(b) **Identification of the Parts Found from R/W Surface**

(i) Figures of fan cowl and Thrust Reverser (TR) cowl latches installed at 6 O'clock of the nacelles are appended below: -

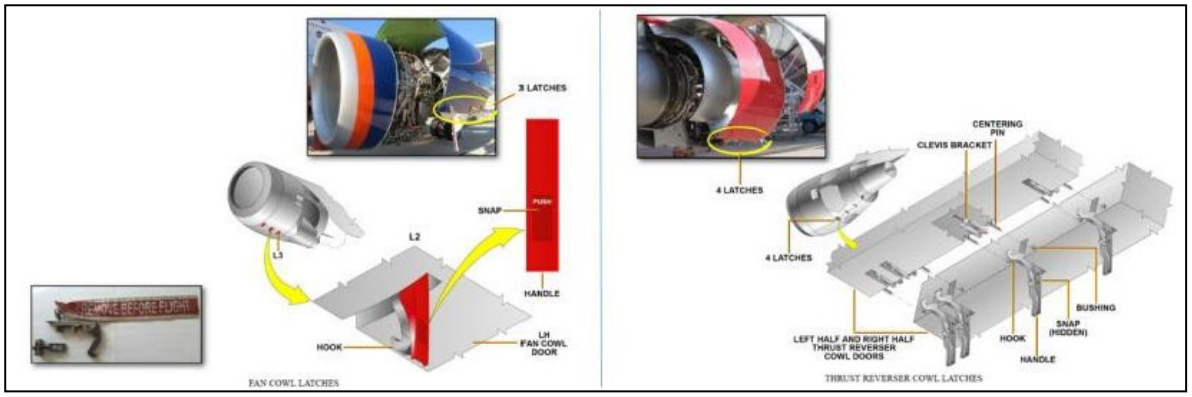


Figure 40 – Fan Cowl Latches and TR Cowl Latches

(ii) A TR latch box was found after the Taxiway A on the North ("right") side of R/W 25L, most likely coming from Engine No. 2. The box was damaged, and scratches were observed. A piece of the box was missing.

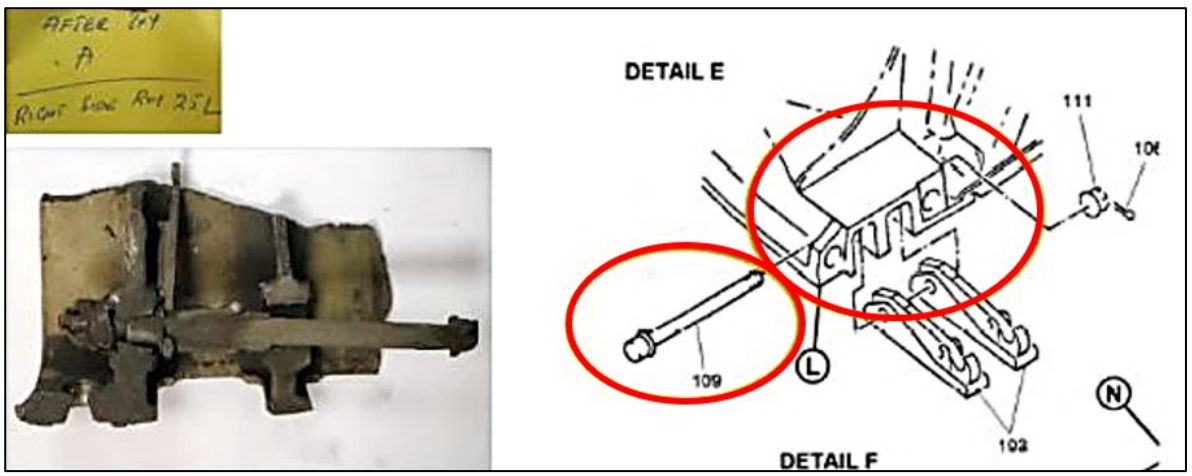


Figure 41 – TR Latch Box

(iii) Piece of seal and retainer of one fan cowl door was found as below: -

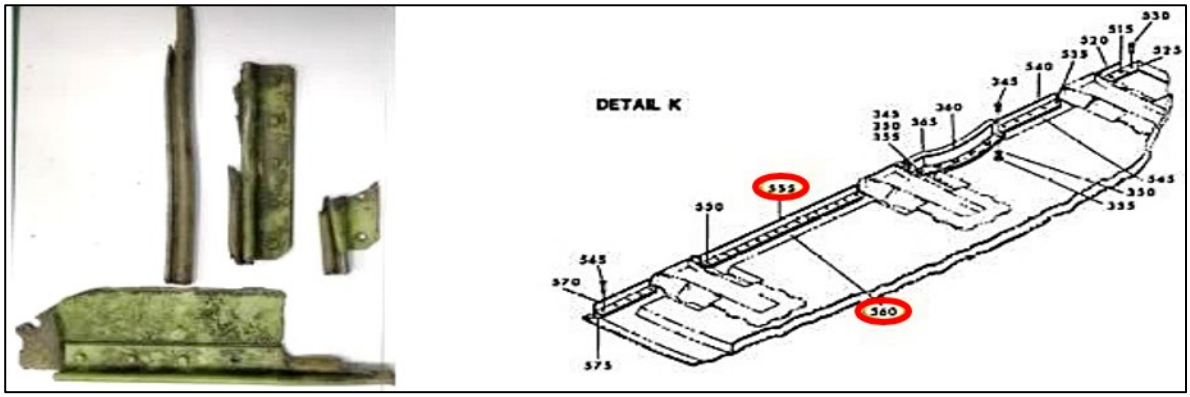


Figure 42 – Seal and Retainer of Fan Cowl Door

(iv) Several pieces of nacelle hooks were found. The smallest one was most likely one hook from the fan cowl latch. The two others were most likely from the TR cowl latches. All the nacelle parts are fitted at the lowest side of the nacelle at 6 O'clock position.

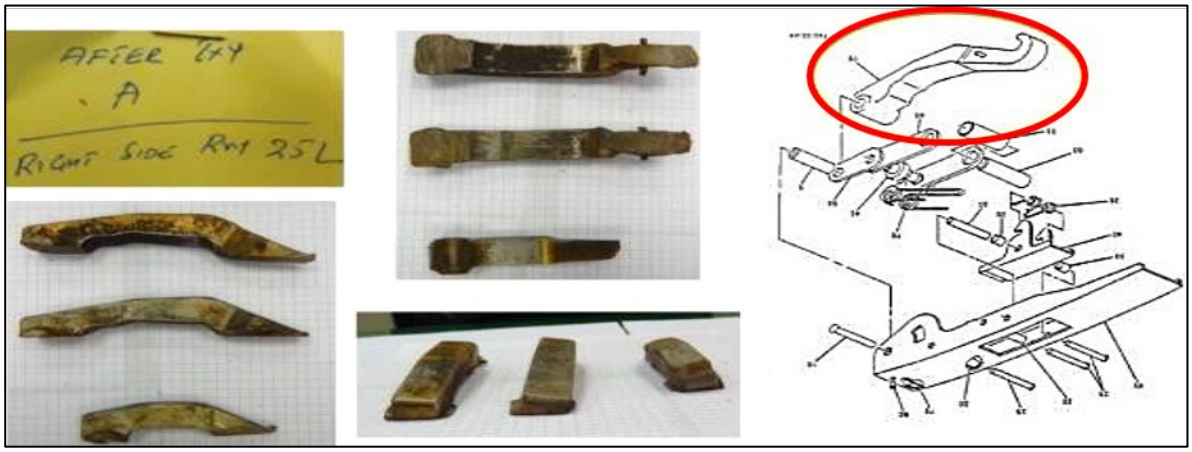


Figure 43 – 03 Hooks of Nacelle Latches

(v) Bracket Part Number (P/N) 338-046-101-0 located at 6 O'clock position on the Engine.

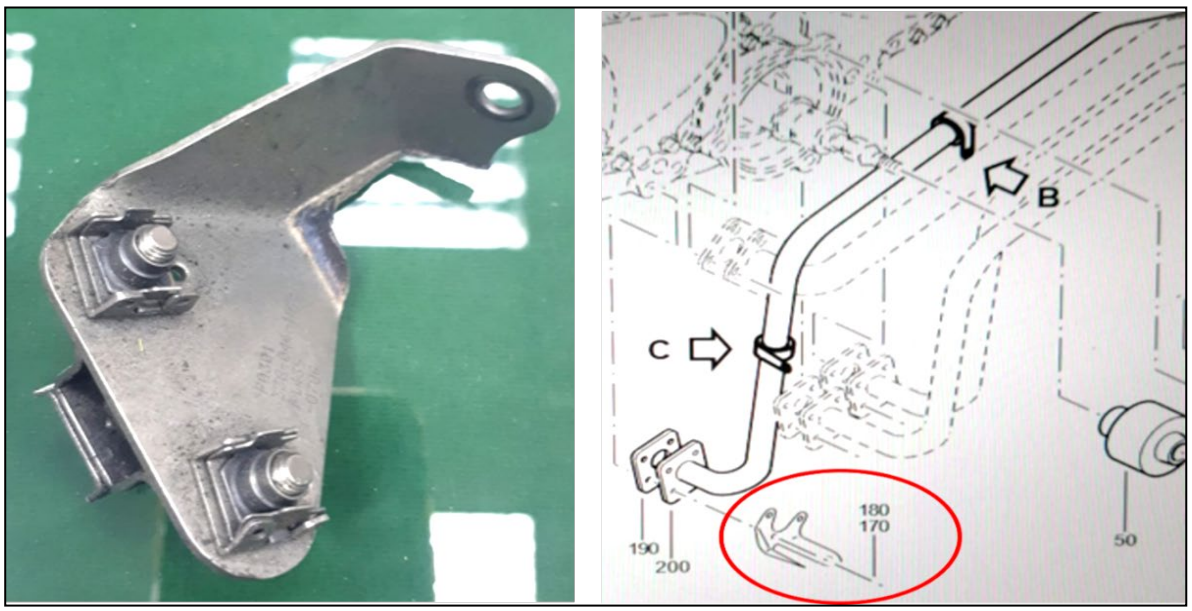


Figure 44 – Damaged Bracket Found on the R/W

(c) **Conclusion of Parts Recovered on the R/W –** Some parts recovered from the R/W 25L were identified as CFM56-5B Engine and Nacelle parts, consistent with the CCTV videos of airport showing lower part of Nacelle and Engine impacting R/W during the first landing attempt. Engine side (L/H or R/H) on the above parts was not identifiable.

1.12.4. Systems

1.12.4.1. Flight Controls

(a) **Trimmable Horizontal Stabilizer Actuator (THSA)**

(i) A Trimmable Horizontal Stabilizer (THS), hinged on rear part of the fuselage, ensures the pitch trim control. A THSA, with a fail-safe ball screw jack, drives the THS. The THSA P/N 47145-133, S/N 2357 was found complete and detached from the structure and horizontal stabilizer.

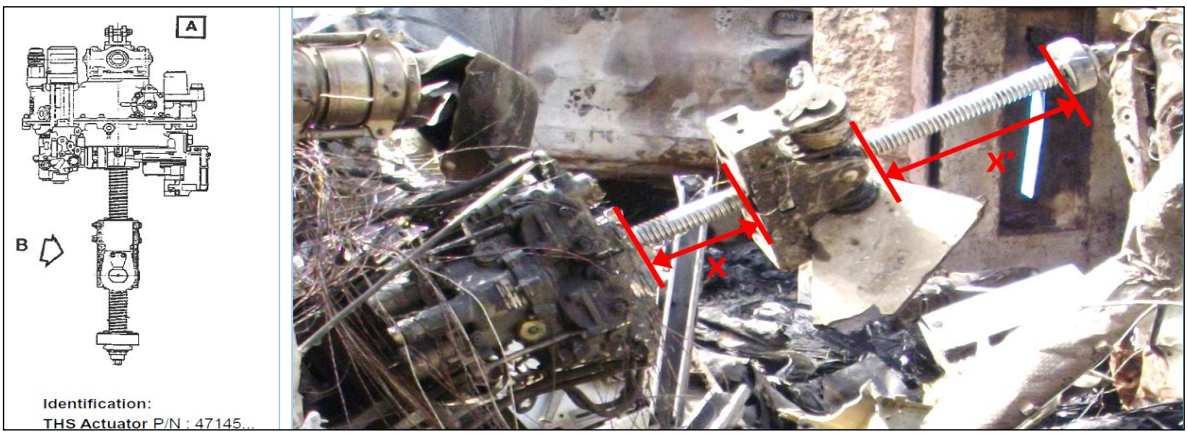


Figure 45 – THSA

(ii) On the THSA screw jack, dimension X between nut and gearbox was measured to be 21 cm and dimension X' between nut and lower claw stop was 32.5 cm, consistent with a 2.8° aircraft nose up THS position before impact.

(b) **Rudder Travel Limitation Unit (TLU)**

(i) Rudder Travel Limiting System limits the control inputs to servo controls to change rudder travel in relation to air speed. The system is made of a TLU which is under the control of the Flight Augmentation Computers (FACs). A simplified emergency control system (open loop) brings back automatically the stops to the "low-speed" position when two FACs are failed and SLATS are extended.

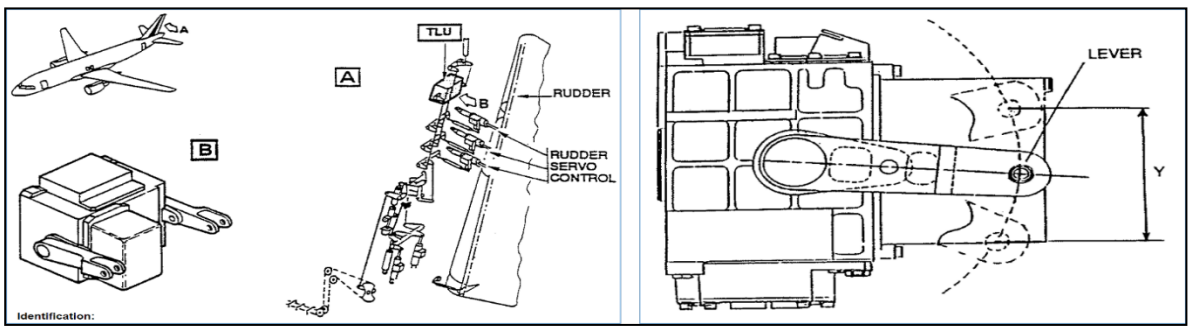


Figure 46 – Rudder TLU

(ii) Rudder TLU distance Y was measured to be 115 mm, corresponding to the maximum opening range of the rudder travel (+/-25°). This rudder travel limitation range is achieved when the aircraft speed is below 150 kts.

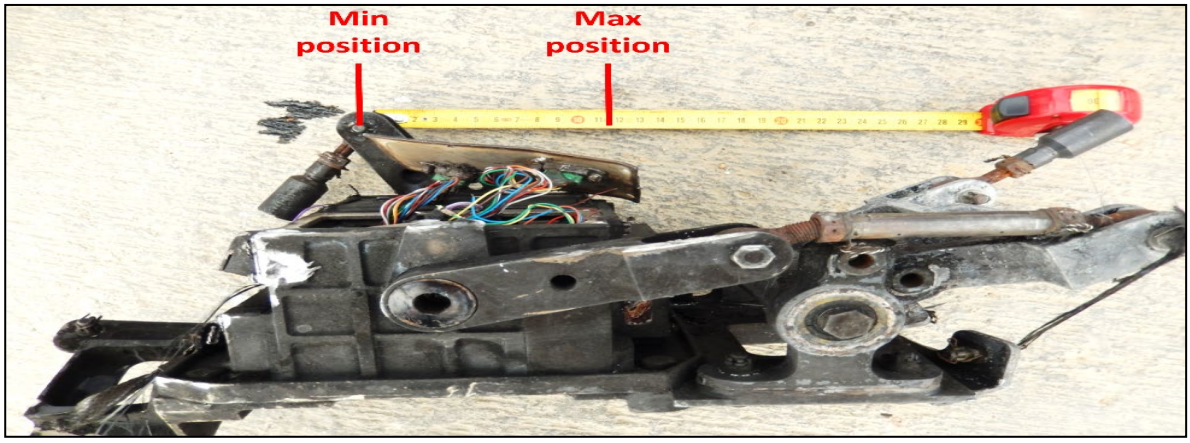


Figure 47 – Rudder TLU LEVER Position (Minimum and Maximum)

(c) **SLATS**

(i) The aircraft has 05 SLATS on the leading edge of each wing. Together with the FLAPS, SLATS are used to increase lift. The SLATS are installed on tracks which are attached to the leading edge of each wing.

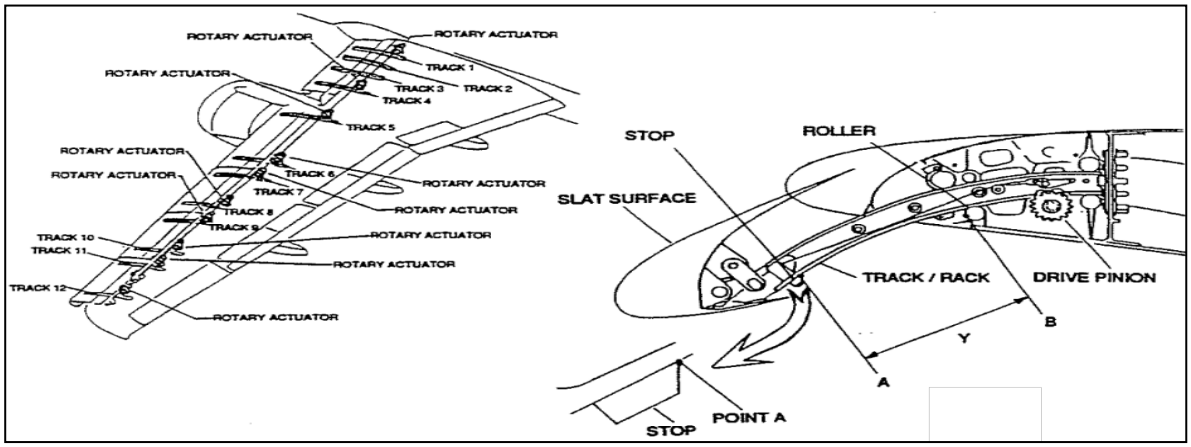


Figure 48 – SLATS Description

(ii) Several SLAT Tracks were identified on the L/H and R/H wings. For the SLAT tracks found in a condition that allowed reliable extension indication, the dimension Y measured between the roller and the mechanical stop was between 16 cm and 20 cm, consistent with the Position 1.

Figure 49 – SLAT Tracks in Position 1

(d) **FLAPS**

(i) The aircraft has 04 FLAPS (02 on each trailing edge of wing) and 10 SLATS (05 on each leading edge of wing) to increase lift during take off and landing. The FLAPS are connected to carriages (at Track 2, 3 and 4) and pendulum (Track 1), which move along the track beam assembly.

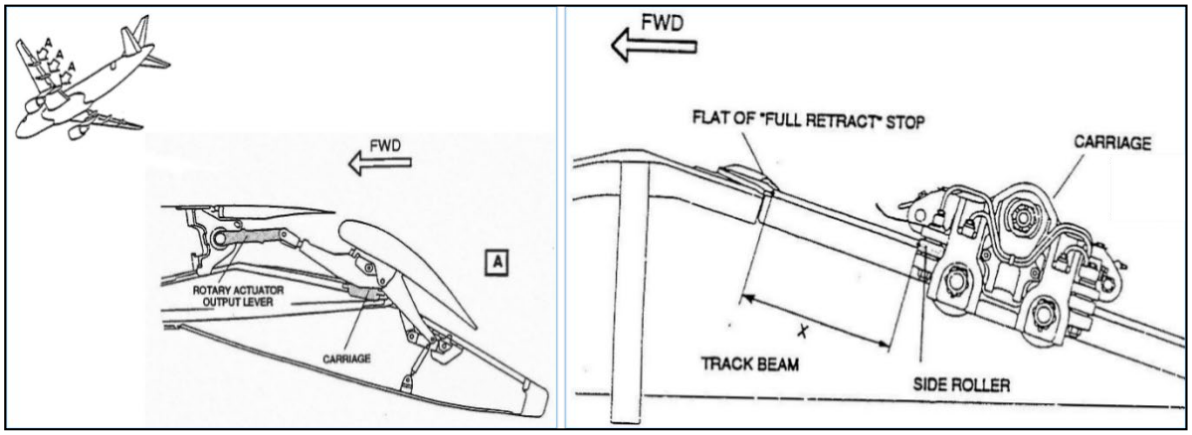


Figure 50 – FLAPS Description

(ii) A part of the L/H wing with FLAP Track 4 carriage was against its mechanical stop (X = 0 mm), consistent with a FLAP retracted position.

Figure 51 – L/H FLAP Track 4 Fully Retracted

(iii) FLAP Track 2 was severely damaged and Track 3 was not accessible and therefore measurement was not possible. However, the position of the actuator lever corresponded to a fully retracted position, corresponding to the position of the carriage against its stop.

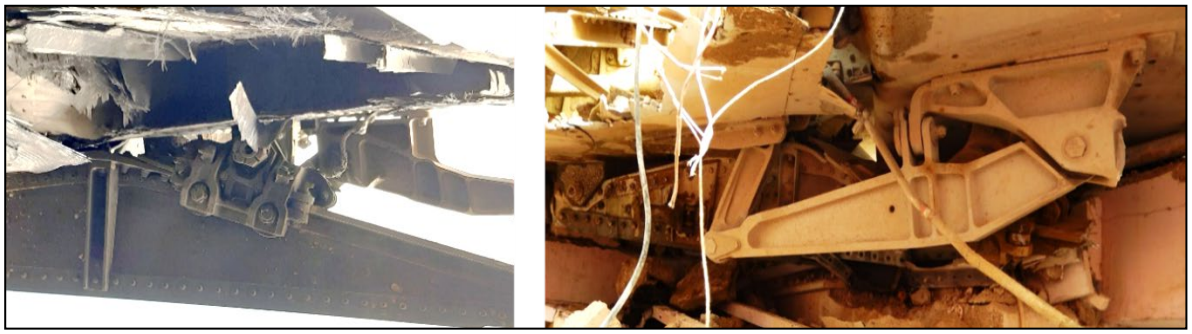


Figure 52 – L/H FLAP Track 2 and 3 Fully Retracted

1.12.4.2. **Landing Gears**

(a) **Landing Gears Control Lever –** The Landing Gears and Braking Mode Control Panel was found on the top of a building. The Landing Gears Control Lever was in DOWN position.

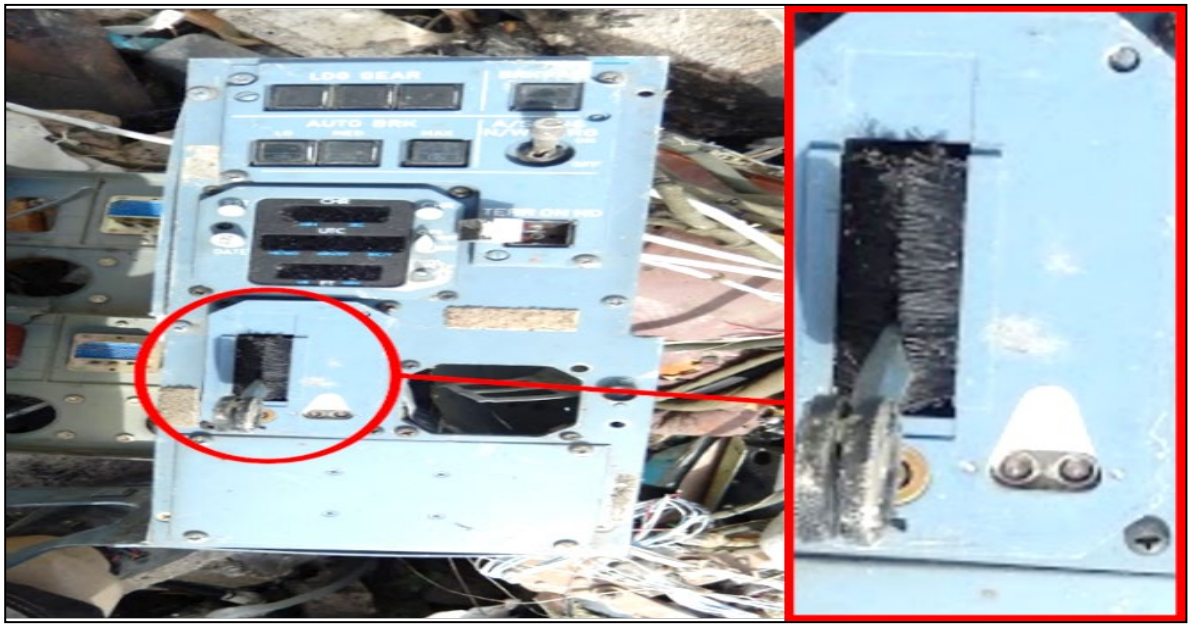


Figure 53 – Landing Gears Control Lever in Down Position

(b) **Main Landing Gears (MLG)**

(i) MLG has two leg assemblies. MLG legs, each with a twin-wheel assembly, are installed in wings. They retract inboard into bays within the fuselage. MLG supports aircraft on the ground and (through the shock absorbers in the legs) absorbs loads during landing, take off and taxiing. When an MLG is extended, a side-stay assembly prevents sideways movement of MLG and helps keep it extended.

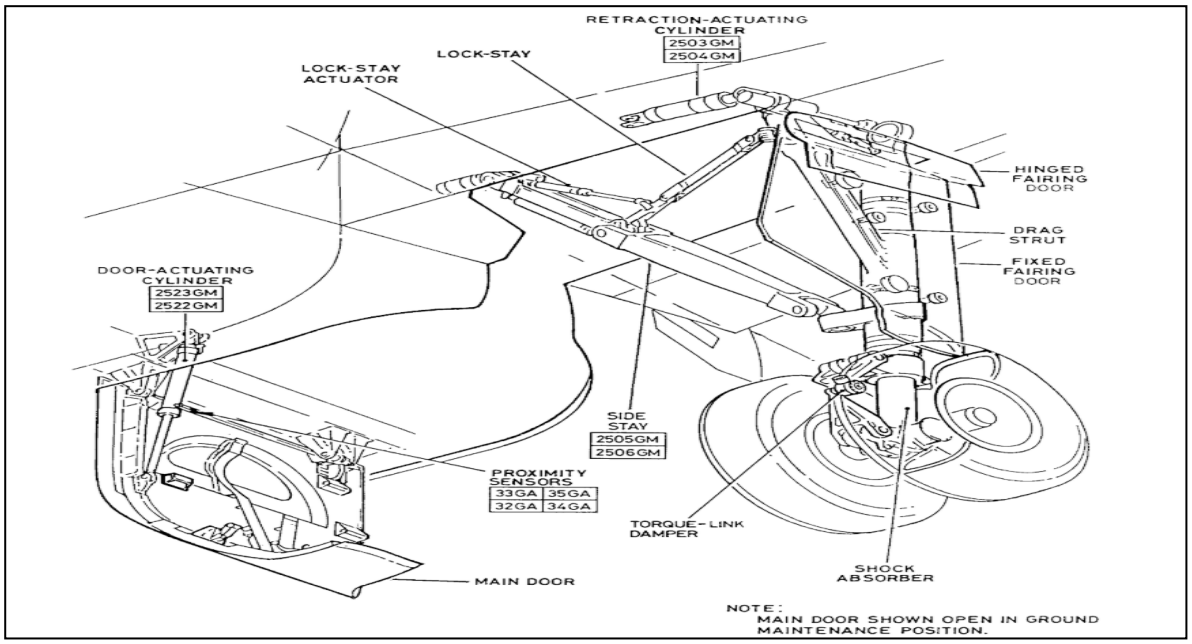


Figure 54 – MLG Description

(ii) L/H MLG was located at very beginning of accident site on the East side of the street. The retraction actuator was not attached to MLG and was found in a retracted position, corresponding to MLG in a DOWN position. The Uplock roller was in good condition.

Figure 55 – L/H MLG and Uplock Roller

(iii) R/H MLG retraction actuator was found in a retracted position, corresponding to MLG in a DOWN position. The Uplock roller was in good condition.

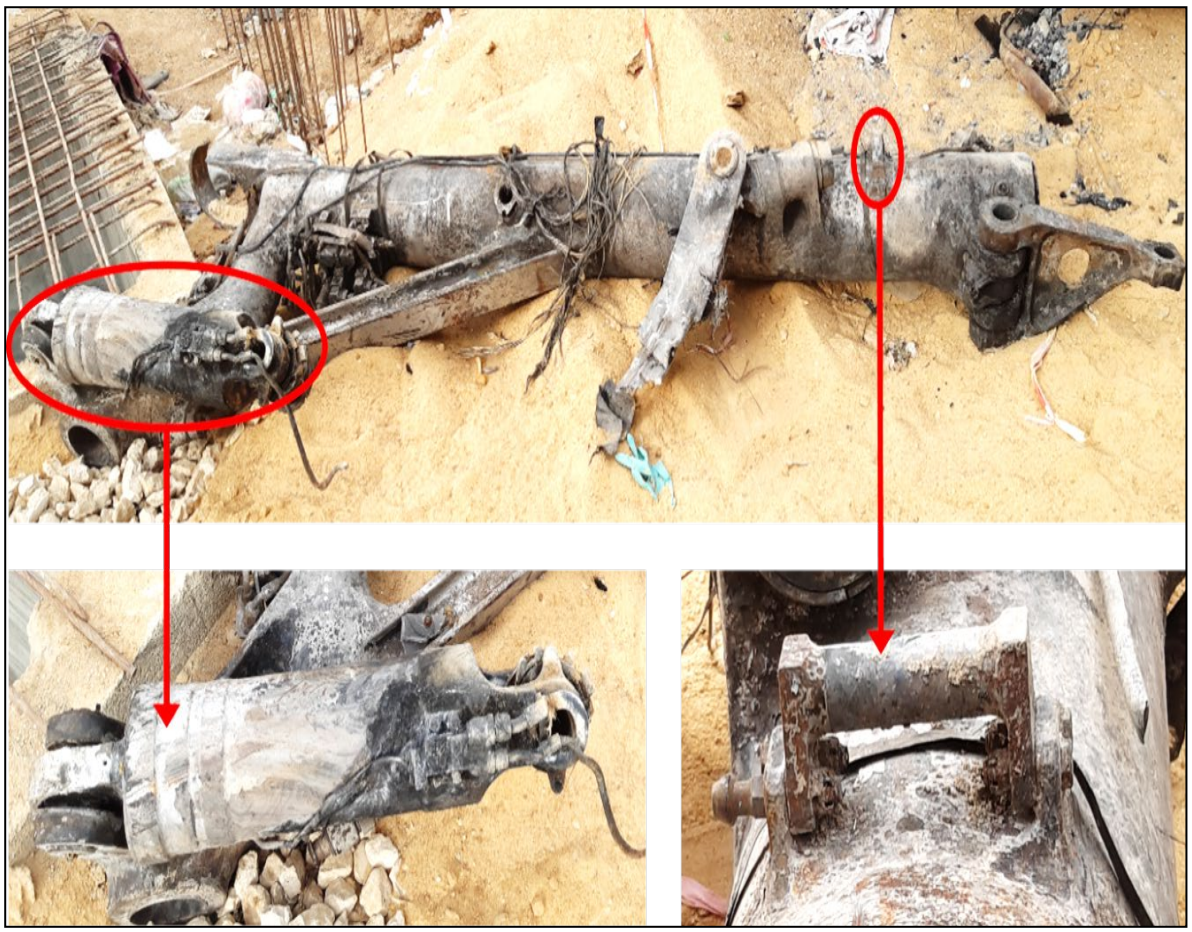


Figure 56 – R/H MLG with the Retraction Actuator and Uplock Roller

(c) **Nose Landing Gear (NLG)**

(i) NLG includes on oleo-pneumatic shock absorber and retracts forward into a bay in the fuselage. A two-piece drag strut assembly with a lock, locks the leg in the extended position.

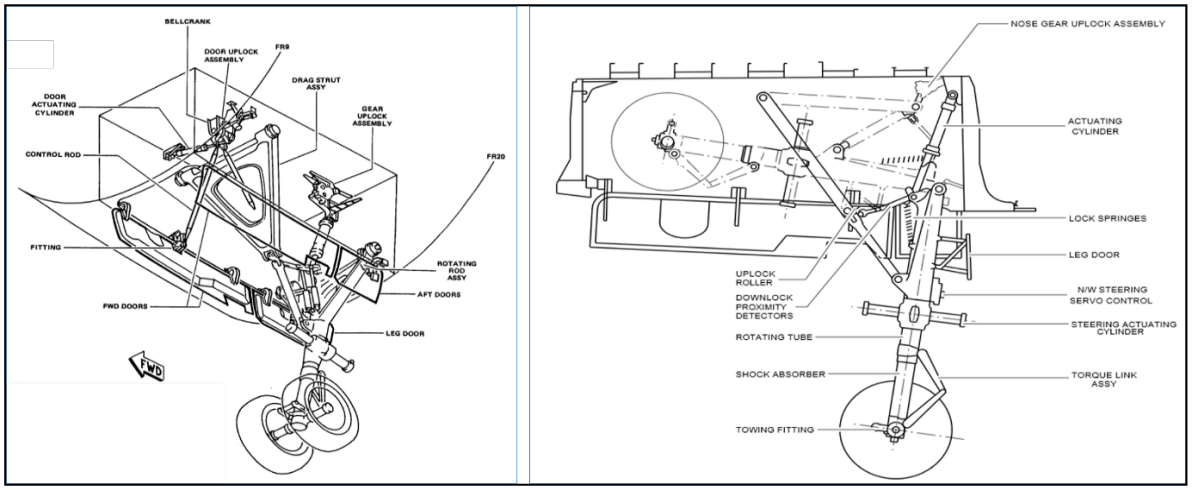


Figure 57 – NLG Description

(ii) The drag strut assembly of NLG was located on the top of a building. It was detached from NLG. The uplock roller was missing.

Figure 58 – NLG Drag Strut Assembly with Missing Uplock Roller

(iii) NLG uplock was found with its hook in open position. The rigging pin holes of the free fall input lever and of the uplock body were almost aligned. The alignment of the rigging pin holes corresponds to the normal position when the free fall lever is stowed.

Figure 59 – NLG Uplock with its Hook in Open Position and its Free-Fall Input Lever in Position “Not Used”

(iv) A vent valve (MLG or NLG) was found in the street. The P/N and S/N identification plate was lost during the impact. Vent valve is activated by the free-fall extension handle to release the remaining pressure of the Landing Gears hydraulic circuit. The rigging pin holes of the free fall input lever and of vent valve body were almost aligned. The alignment of the rigging pin holes corresponds to the normal position when the free fall lever is stowed.

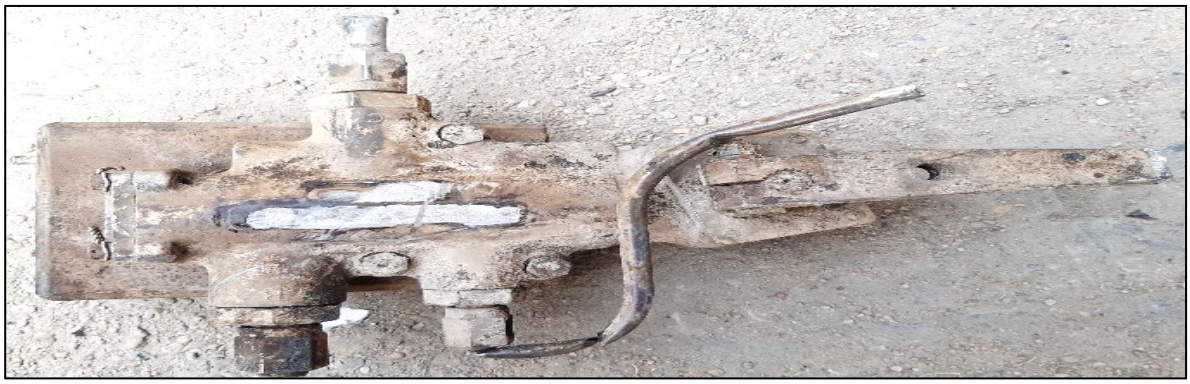


Figure 60 – MLG or NLG Vent Valve with the Free-Fall Input Lever in Position "Not Used"

1.12.4.3. **Braking –** On the Landing Gears and Braking Mode Control Panel, the Auto-Brake Medium (AUTO BRK - MED) switch was selected and the Anti-Skid (A/SKID) Nose Wheel Steering switch was ON.

Figure 61 – AUTO BRK MED Switch Selected and A/SKID-Nose Wheel Steering Switch ON

1.12.4.4. **Ram Air Turbine (RAT) –** Measurement of RAT cable was 95 mm. The RAT was found broken in two parts.

Figure 62 – RAT

1.12.4.5. **Powerplant**

(a) **Engine No. 1**

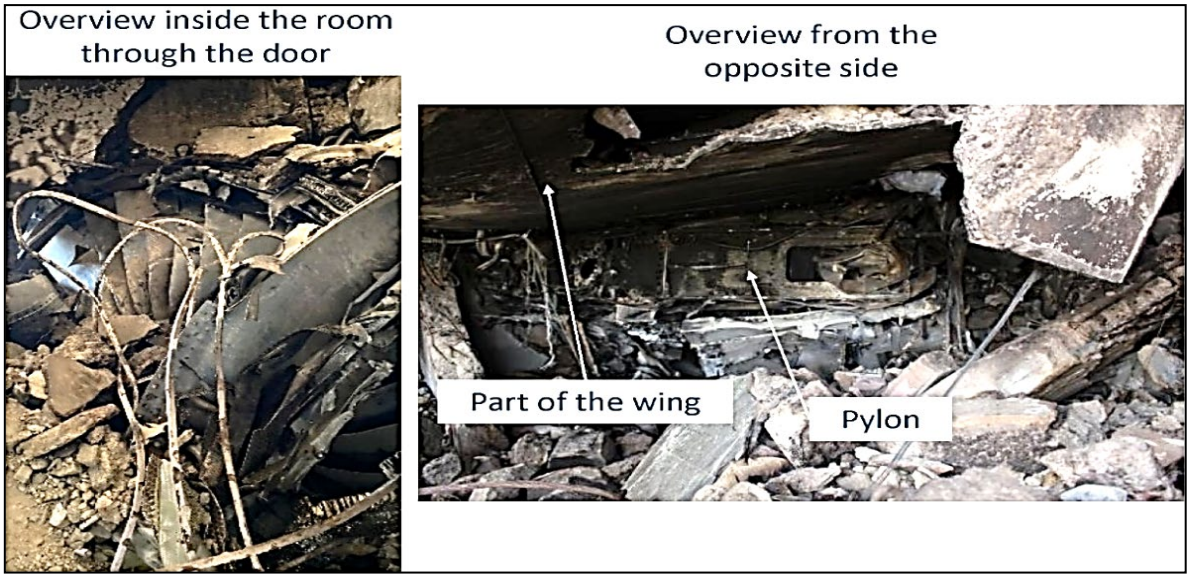


Figure 63 – Overview Through the Door (Left) and Opposite Side (Right)

Figure 64 – Fan Blades Damaged and Bent

(i) At the time of impact, the fan case was compressed disturbing the round geometry of the fan case and causing the fan blades to curl. Engine was running at a very low RPM.

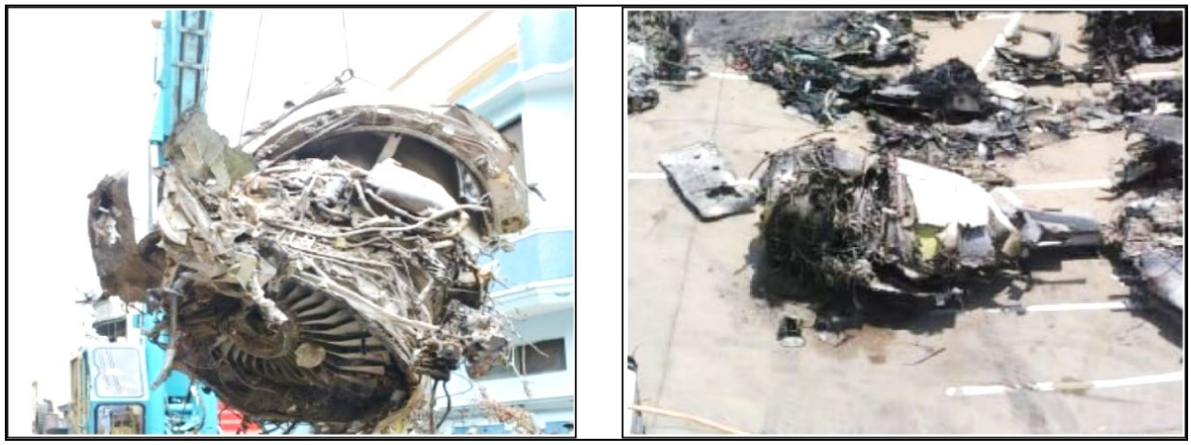


Figure 65 **–** Engine Lifted from Roof Top and Engine at Wreckage Storage Site

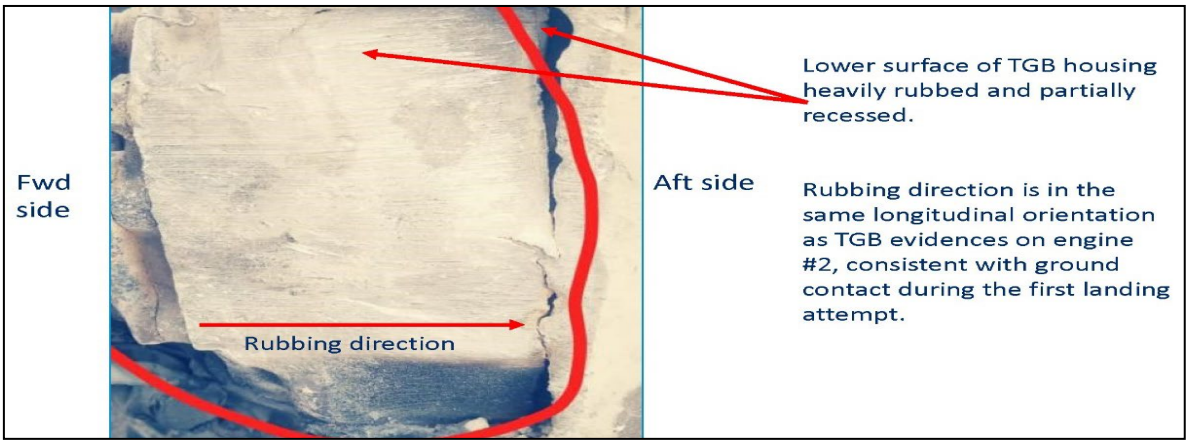


Figure 66 – TGB Housing Condition

Figure 67 – Heavy Rubbing on End Fitting Installed on Hose

(ii) Engine No. 1 showed evidence of external fire. Visible fan blades condition was consistent with the Engine No. 1 being at low rotational speed at the time of impact, most likely not producing any thrust.

(iii) 6 O'clock localization of Engine had heavy rubbings traces on different parts (TGB, end fitting of pipes, flexible hoses etc.). TGB damages with punctured wall allowed oil leakage. These rubbing marks / Oil leakages are consistent with Engine R/W contact during the first landing attempt.

(b) **Engine No. 2**

Figure 68 – ECU is Missing

Figure 69 – Front View of Fan Blades not bent. No indication of Soft Body (i.e. birds) Impact Damage

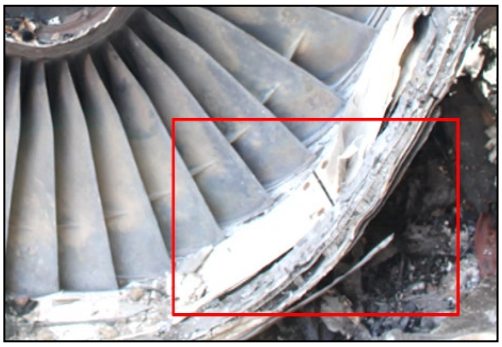


Figure 70 – Rubbing on Abradable Coating between 9 to 12 O'clock (AFT looking forward) assumed due to Displacement of the Engine during Rescue Operation

Figure 71 – Fan Blade's Fire Foam Agent Traces

Figure 72 – Few Tip Curls, No Bent Blades. Indication of No or Low Rotation during Crash

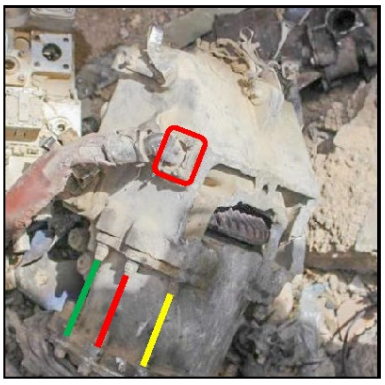


Figure 73 – Damaged TGB

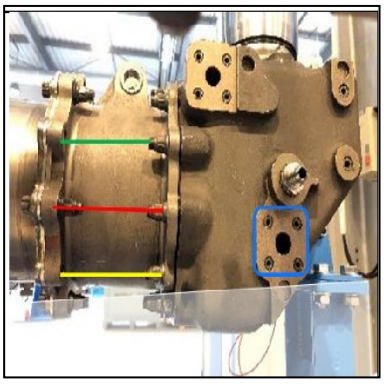


Figure 74 – Engine's TGB with Missing Part on New Engine (in Grey Shade)

Figure 75 – Engine's TGB and AGB with Missing Part on New Engine (in Grey Shade)

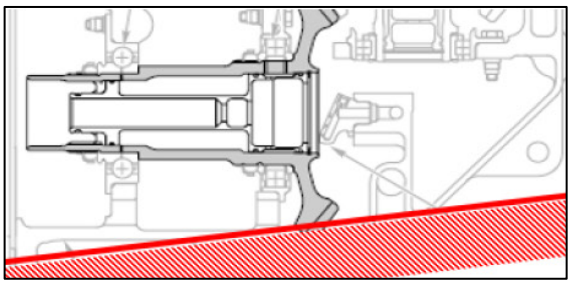


Figure 76 – TGB Conical Gear: Accident Case vs New

Figure 77 – TGB Conical Gear: Rubbing of the Outer End Gear Teeth: Cylindrical Shape

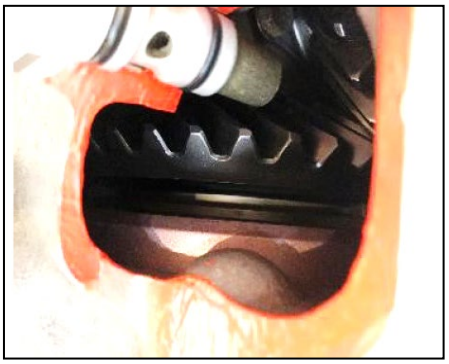


Figure 78 – TGB Conical Gear: Cut View

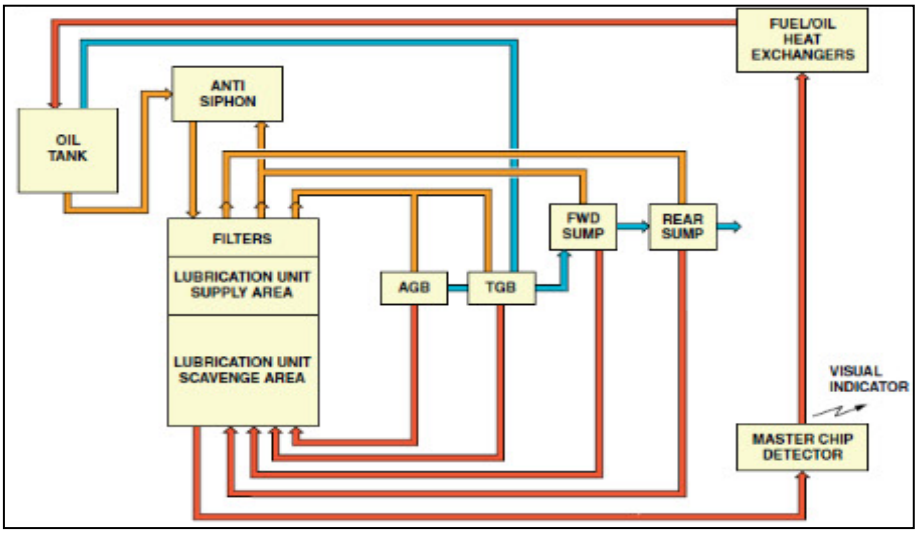


Figure 79 – Oil Distribution: Loss of Oil due to TGB (Possibly TGB and Pipes) Housing Hole

Figure 80 – Fuel Filter Cover with Missing Handle (Accident Case)

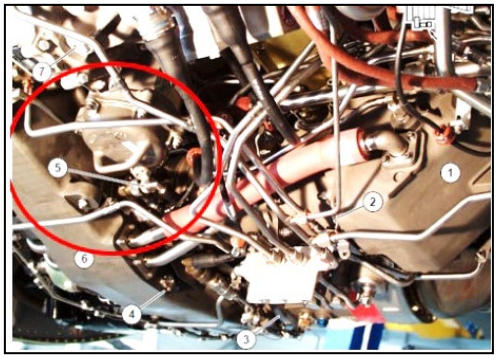


Figure 81 – Fuel Filter cover on a New Engine

Figure 82 – Fuel Filter Cover with Missing Handle
(Accident Case): Heavy Rubbing

(i) Engine No. 2 showed evidence of external fire. Fan blades were in good condition being consistent with the Engine No. 2 at low rotational speed and most likely not producing any thrust at the time of impact.

(ii) TGB located at the Engine lower part showed marks of friction with hard flat surface, material displacement and loss of material. Damages on TGB along with punctured wall allowed Oil leakage. It was consistent with the lower part of the Nacelle and Engine No. 2 impacting the R/W during the first landing attempt.

(c) **Drain Case Assembly –** These lines are provided on Engines to collect waste fluids and vapours that come from Engine systems and accessories and drain them overboard. The system consists of a Drain Collector Assembly, a Drain Module and a Drain Master. Drain Collector Assembly is installed exactly at 6 O'clock position on the Engine. One Drain Case Assembly found from the accident site and it the corresponding Engine could not be identified. Accident Drain Case Assembly was compared with undamaged Drain Case Assembly. It was found that it made ~ 20° roll rub angle when rubbing with the R/W during the first landing attempt.

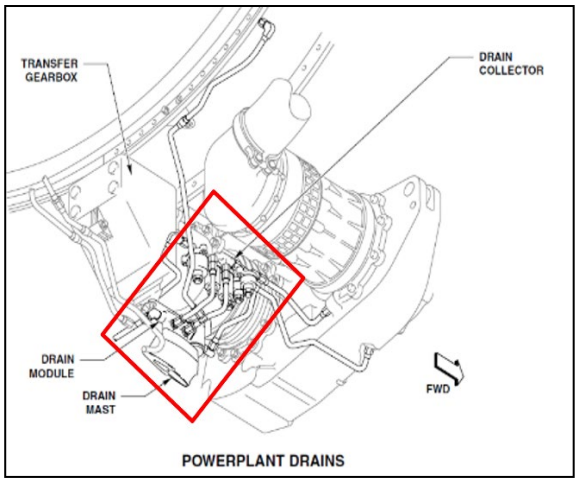


Figure 83 – Drain Collector Assembly

Figure 84 – Drain Collector Assembly
(Undamaged)

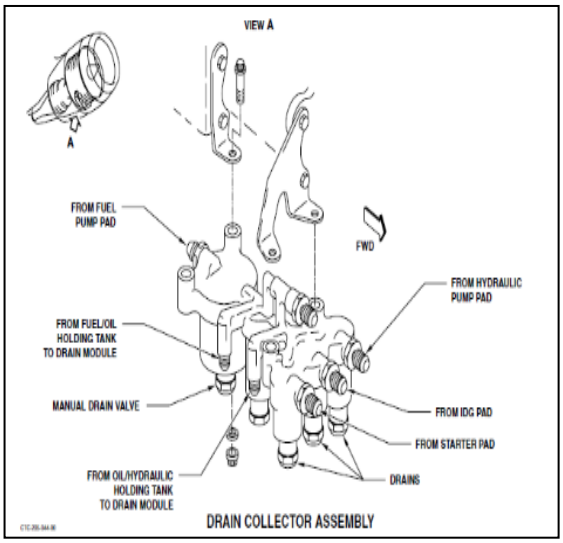


Figure 85 – Drain Collector Assembly Installed Exactly at 6 O'clock Position

Figure 86 – Drain Collector Assembly (Undamaged)

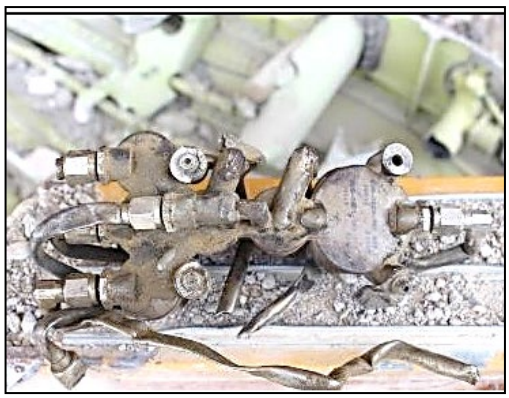


Figure 87 – Drain Collector Assembly (Accident Case)

Figure 88 – Drain Collector Assembly (Undamaged)

Figure 89 – Drain Collector Assembly (Accident Case)

Figure 90 – Drain Collector Assembly (Undamaged)

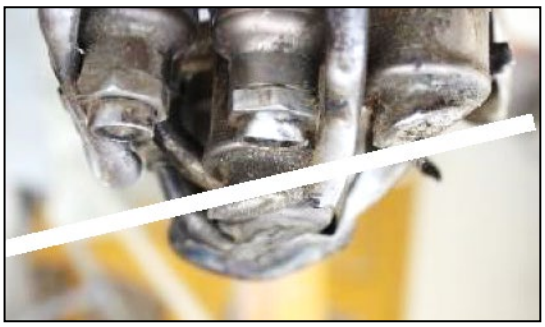


Figure 91 – Drain Collector Assembly Forward View (Accident Case)

Figure 92 – Drain Collector Assembly AFT View (Undamaged)

Figure 93 – Drain Collector Assembly Forward View (Undamaged)

Figure 94 – Drain Collector Assembly Forward View (Undamaged)

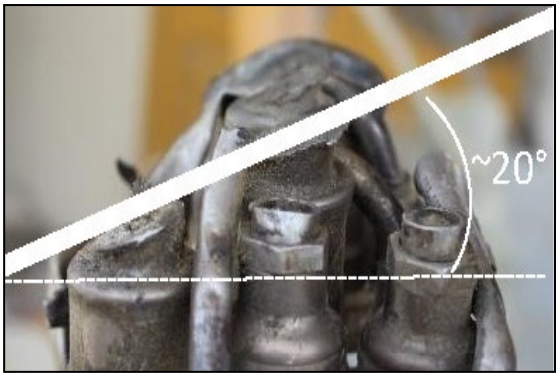


Figure 95 – Estimated Roll Rub Angle

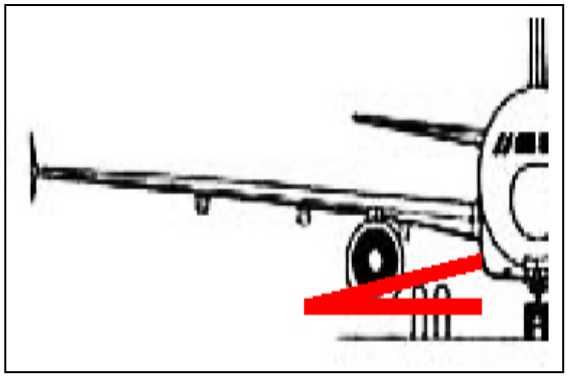


Figure 96 – Pictorial Representation of Impact Angle on Powerplant

(d) **Auxiliary Power Unit (APU) –** APU air intake flap actuator was not in the "retracted" position meaning that the APU flap door position was closed or only partially open. It was consistent with the fact that the APU was not supplying bleed air pressure and electrical power at the time of impact.

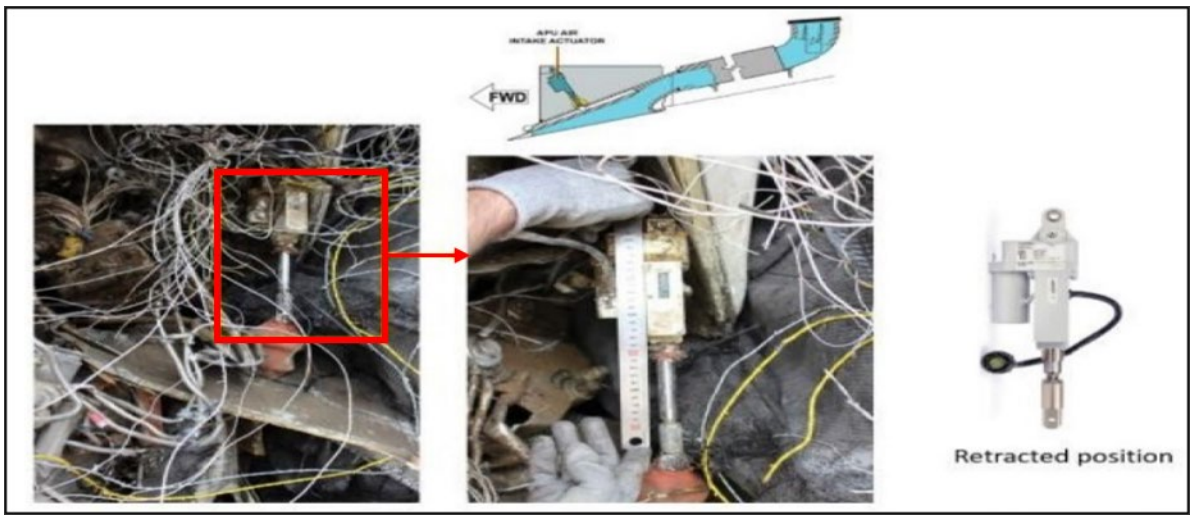


Figure 97 – APU Air Intake Flap Actuator Position vs New Actuator Position

1.13. **Medical and Pathological Information**

1.13.1 Both Captain and FO were fit to undertake the scheduled flight as per medical records.

1.13.2 Post-mortem of both the flight crew was performed by Jinnah Postgraduate Medical Centre (JPMC) Karachi. Forensic toxicology analysis report did not indicate influence of drugs, volatiles or intoxication of both flight crew.

1.13.3 CVR recording did not reveal medical anomaly or incapacitation of both flight crew till end of flight.

1.14. **Fire**

1.14.1. Aircraft made R/W contact on nacelles during first landing attempt. CCTV videos of airport indicate fire / sparks while nacelles were scrubbing the R/W surface (Refer section 1.1.7 – "Phase 4: From 1st Impact with R/W to Go-Around"). CCTV video of aircraft just before the impact did not indicate in-flight fire. DFDR / CVR readouts and Inspection of wreckage did not reveal any indication of in-flight fire.

1.14.2. Aircraft impact on ground resulted in on-ground fire. The fire engulfed the aircraft resulting in complete destruction of aircraft (Refer section 1.12 – "Wreckage and Impact Information").

1.14.3. PCAA Rescue and Fire Fighting Services (RFFS) duty team observed fire / sparks at R/W during first landing attempt of PIA 8303. PCAA fire station rang crash bell and RFFS fire vehicles rushed to the taxiways immediately. Meanwhile, aircraft made a touch and go. Full scale emergency was declared at the airport by ATC. A huge cloud of dark dense smoke was observed outside the fencing area at Model Colony undershoot R/W 25L due to aircraft accident. PCAA RFFS fire vehicles and ambulances reached at accident site within 10 minutes. After reaching accident site fire vehicles started fire-fighting operation and applied extinguishing media (foam and water). Fire vehicles of PCAA, Local City Government, Pakistan Navy and Pakistan Army participated in the fire-fighting operation. Ambulances of PCAA, Pakistan Army, Local City Government, NGO's and Medical vehicles of different Hospitals participated. A total of 26,000 litres of water and 250 litres of extinguishing agent [Aqueous Film Forming Foam (AFFF)] was utilized during this operation[21].

1.15. **Survival Aspects**

1.15.1. Rescue Coordination Centre (RCC), Karachi was activated after 10 min (minutes) of accident. Contacts were established with local Hospitals, Police, Military and local NGOs regarding the accident and most of the agencies had already deployed their resources[22]. PIA also established an Emergency Cell at JIAP, Karachi.

1.15.2. Search and Rescue Operations were undertaken by local administration and was supported by populous of surrounding area. All persons on board were fatally injured because of impact / ground fire, except 02 passengers.

[21] PCAA RFFS Accident Report dated 2nd June, 2020
[22] PCAA RCC Accident Report dated 28th May, 2020

1.15.3. Emergency Locator Transmitter (ELT) signal was not received after the accident. ELT could not be recovered from the wreckage and most likely it was destroyed during impact / fire.

1.16. Test and Research

1.16.1. During the course of investigation, there were numerous discussion and collaboration sessions between various participants including both online and in person sessions to establish the root cause. Additionally, various simulations were carried out to reconstruct the event flight, understanding the flight crew behaviour and establishing the available flight crew options in final stages of the flight. As an outcome of analysis, tests and research, numerous presentations / reports were generated from time to time by the member state ACCREPs and their Technical Advisors by putting in immense efforts and man-hours with the sole aim to establish root cause and avoid recurrence. A tabulated summary of all the major reports / presentations produced are mentioned below. Important findings / conclusion of all these have been incorporated in relevant portions of this investigation report.

S/N	Report Title	Date Received	Received From
1.	**Executive Brief**	May, 2020	PIA
	Rationale: Aircraft Basic Data, Technical and Maintenance Data, Defect Status, Engines and APU Data		
2.	**R/W Inspection Report JIAP, Karachi**	May, 2020	PCAA
	Rationale: R/W Inspection after the accident and parts collected		
3.	**On Site Observations Wrap Up**	May, 2020	Airbus, France
	Rationale: Wreckage and structure recommendations to quarantine parts with regards to aircraft (if recovered) for further investigation		
4.	**On Site Investigation Report**	May, 2020	CFM, France
	Rationale: Overview of Engines and its parts on accident site and quarantine of Engine parts		
5.	**AP-BLD Recordings**	May, 2020	BEA, France
	Rationale: Attainment of Data containing sources i.e. Recorders, Computers, Airport CCTV, Other CCTV and Flightradar24 (website)		
6.	**Contribution Report**	May, 2020	BEA, France
	Rationale: Accident site and wreckage survey, DFDR and CVR readouts, ATC data CCTV videos and Flightradar24 (website) data analysis		
7.	**Visual Transcription – CCTV videos**	May, 2020	BEA, France
	Rationale: Transcript of the elements that were observed and calculated from the work on the CCTV videos		
8.	**Preliminary Sound and Warnings Chronology (Ver. 1.0.4)**	June, 2020	BEA, France
	Rationale: Transcript of the elements which were understood from the work on the CVR recording		
9.	**Preliminary Sound and Warnings Chronology (Ver. 1.2.0)**	June, 2020	BEA, France
	Rationale: Transcript of the elements which were understood from the work on the CVR recording		

10.	**Answers to AAIB Pakistan and BEA France Questions**	June, 2020	Airbus, France
	Rationale: Airbus answers to the questions raised by the AAIB and BEA		
11.	**Engine No. 1 Condition Report**	August, 2020	PIA
	Rationale: Report on analysis of Engine position and damages		
12.	**Preliminary Investigation Report**	June, 2020	AAIB, Pakistan
	Rationale: Initial report by AAIB, Pakistan on the accident		
13.	**Technical Document**	November, 2020	BEA, France
	Rationale: CVR and DFDR Data Analysis		
14.	**Operational Performance Analysis**	November, 2020	Airbus, France
	Rationale: Identification of hazards during operation		
15.	**Airbus Report**	May, 2021	Airbus, France
	Rationale: Analysis by Airbus on Event Flight		
16.	**Contribution Report on Aircraft Systems**	June, 2021	BEA, France
	Rationale: Analysis on history of flight and aircraft systems		
17.	**Airbus answers to AAIB Pakistan questions**	February, 2022	Airbus, France
	Rationale: Provision of additional information based on queries raised on Technical Reports submitted by BEA, France		
18.	**Airbus answers to Questions raised during AP-BLD concluding meeting at Toulouse**	April, 2022	Airbus, France
	Rationale: Provision of additional information based on queries raised during the meeting at Toulouse, France		
19.	**Contribution Report (Version 2)**	June, 2022	BEA, France
	Rationale A second version after incorporating changes to the earlier Contribution Report based on discussions during the concluding meeting		

Table 28 – Major Reports and Presentations

1.16.2. **Flight Controls**

1.16.2.1. Seven flight control computers process pilot and AP inputs according to normal, alternate, or direct flight control laws in various Flight MODES. The computers include 2 Elevator Aileron Computers (ELACs) for normal Elevator and Stabilizer control and Aileron control, 3 Spoilers Elevator Computers (SECs) for Spoilers control and standby Elevator and Stabilizer control, and 2 Flight Augmentation Computers (FACs) for Electrical Rudder control.

1.16.2.2. With change in system status, or under different emergency situations, the Flight Control Laws may change from direct to alternate or direct law for Pitch, Roll, and Yaw. Each Law has its corresponding level of protection which ranges from normal, to reduced, to even no protection where the movement of corresponding control surface deflection becomes a direct relation to the Pilot input. Complete details are available in FCOM section DSC-27-10 and DSC-27-20. Only the relevant section related to EEC is discussed.

1.16.2.3. **Flight Control Laws in Emergency Electrical Configuration (EEC) –** In EEC, the Flight Control Laws reconfigure from Normal Law to: -

(a) Alternate Law in Pitch, with reduced protections.

(b) Direct Law in Roll.

(c) Mechanical or Alternate Law in Yaw (depends on FAC-1 state).

1.16.2.4. **Flare MODE[23] –** In Normal Law, when the aircraft passes 50 ft RA, the THS is frozen and the normal Flight MODE changes to Flare MODE as the aircraft descents to land. Flare MODE is essentially a direct stick-to-elevator relationship (with some damping provided by the load factor and the pitch rate feedbacks). The system memorizes the aircraft's attitude at 50 ft, and it becomes the initial reference for pitch attitude control. As the aircraft descents through 30 ft, the system begins to reduce the pitch attitude to -2° over a period of 8 s. Consequently, to flare the aircraft, a gentle nose up action by the pilot is required.

1.16.2.5. **Ground MODE[24] –** Ground MODE is a direct relationship between sidestick deflection and elevator deflection, without Auto Trim. It automatically sets the THS at 0° (inside the green band). A setting that pilot enters manually to adjust for Centre of Gravity (CG) has priority for take off. When aircraft reaches 75 kts during take off roll, the system reduces the maximum up elevator deflection from 30° to 20°. After touchdown, aircraft smoothly transitions from In-Flight MODE to Ground MODE.

1.16.2.6. **Alternate Law in Pitch with Reduced Protections**

(a) In flight, the Alternate Law Pitch MODE follows a load-factor Demand Law similar to the Normal Law Pitch MODE, but it has less built-in protection. The ground Alternate Law is identical to the Ground MODE of the Normal Law (it becomes active on the ground 5 s after touchdown). When passing in Alternate Law (ALTN LAW), a message FLT CTL ALTN LAW is shown on the ECAM. Even if the protections are reduced, audio Stall Warnings (Crickets and “STALL” synthetic voice message) still activate at an appropriate margin from the Stall condition under the Alternate Law. The Stall Warning Speed (Vsw) is still shown on the PFD.

(b) In Pitch, Alternate Law Flight MODE changes to Flare MODE when pilot selects Landing Gears DOWN. The Flare MODE in Pitch Alternate Law is also a direct stick-to-elevator relationship. Under Alternate Law the Ground MODE becomes active on the ground 5 s after touchdown. It is identical to Ground MODE of the Normal Law.

1.16.2.7. **Direct Roll Law –** The Direct Roll Law is a direct stick-to-surface-position relationship. System gains are set automatically to correspond to SLATS / FLAPS configuration. With aircraft in the clean configuration, the maximum roll rate is about 30° / s. With SLATS extended, it is about 25° / s. To limit roll rate, the Direct Roll Law uses only Ailerons and Spoilers No. 4 and 5. If Spoiler No. 4 has failed, Spoiler No. 3 replaces it. If the Ailerons have failed, all roll Spoilers become active.

[23] Airbus FCOM, Flare MODE, Pg – 1643
[24] Airbus FCOM, Ground MODE, Pg – 1641

1.16.2.8. **Mechanical or Alternate Yaw Law –** When emergency electrical generation is supplied from batteries, the yaw mechanical control is active and pilot controls yaw with the rudder pedals. The yaw damping and turn coordination functions are lost. When emergency electrical generation is supplied by RAT, the Alternate Yaw Law is active and only the yaw damping function is available, with damper authority limited to ±5° of rudder deflection.

1.16.3. Flight Control Unit (FCU)

1.16.3.1. FCU located on the glareshield, is the short-term interface between flight crew and Flight Management Guidance Computer (FMGC). It is used to select any flight parameters or modify those selected in the MCDU. APs and A/THR functions may be engaged or disengaged. Different Guidance MODES can be selected to change various targets [Speed (SPD), Heading (HDG), Track (TRK), Altitude (ALT), Flight Path Angle (FPA) and Vertical Speed (V/S)]. FCU has three control panels; One for the Automatic Flight Controls and two for the Electronic Flight Instrument System (EFIS). FCU has two channels, each of which can independently command the central control panel. If one channel fails, the other channel can control all the functions.

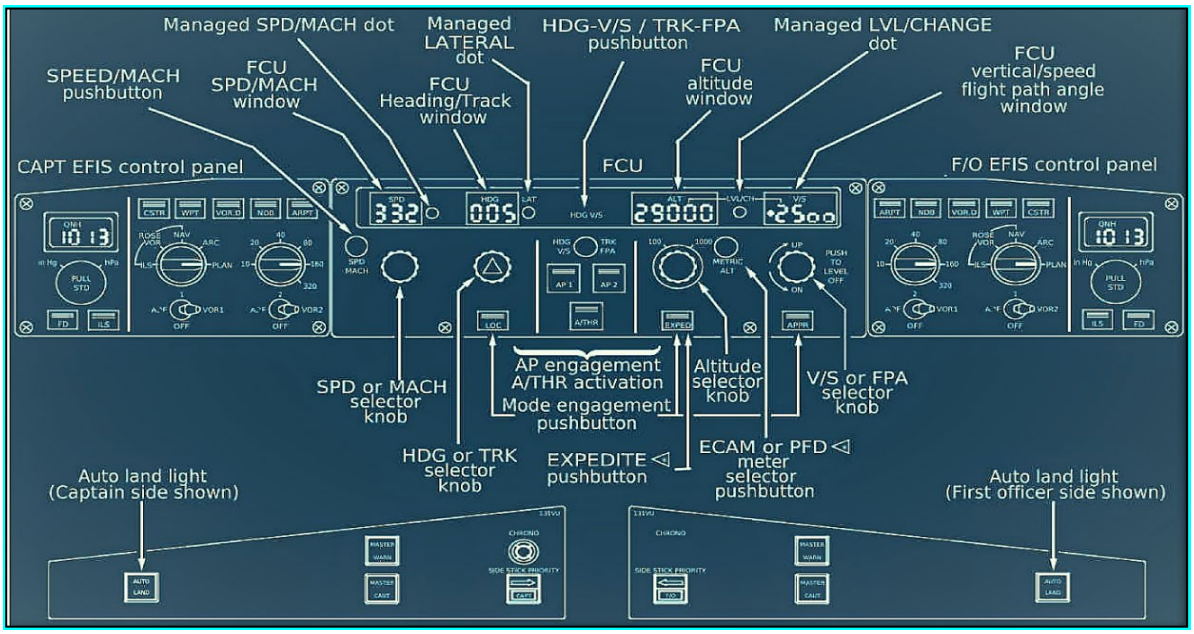


Figure 98 – Pictorial Illustration of FCU

1.16.3.2. The FCU has four knobs which are SPD-MACH, HDG-TRK, ALT, and V/S-FPA. The knobs can be rotated, pushed in, and pulled out.

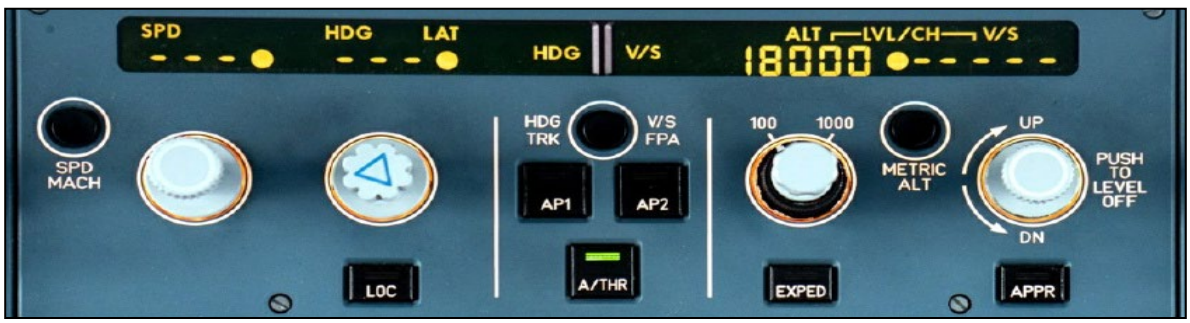


Figure 99 – FCU Automatic Flight Controls Panel

1.16.3.3. The flight crew can use two types of guidance to control the aircraft in auto flight. One type is managed by the Flight Management Guidance System (FMGS). The other uses target quantities which are manually entered by the flight crew.

1.16.3.4. **Managed Guidance**

(a) When the aircraft uses target quantities from the FMGS (managed guidance), the FCU windows display dashes and the white dots next to those windows light up. In order to arm or engage managed guidance for a given MODE, the flight crew pushes in the associated knob. If, for example, they push in the HDG knob, they engage or arms the NAV MODE.

(b) In managed guidance (Lateral, Vertical Guidance or Managed Speed), the corresponding window is dashed. Turning a knob without pulling it displays a value that is the sum of the current target and the turn action value. The display remains for 45 s on the HDG/TRK and V/S windows and 10 s on the SPD / MACH window before the dashes reappear. This rule does not apply to the ALT knob / window.

1.16.3.5. **Selected Guidance –** When the aircraft uses target quantities, entered by the flight crew, the windows display the selected numbers and the white dots do not light up. The altitude window always displays an altitude selected by the flight crew (never dashes). In order to engage a selected Guidance MODE, the flight crew turns the knob to set the desired value, and then pulls the knob out to engage the MODE with a target value equal to the selected value.

1.16.3.6. **Descent (DES) MODE[25]**

(a) The DES MODE is a managed MODE. It guides the aircraft along the descent path computed by the FMGS. The flight path is computed backwards from the deceleration point up to the top of descent point, considering all constraints of the flight plan. The deceleration point is computed so that Final Approach Speed (VAPP) is reached at 1,000 ft above touchdown (at beginning of the final descent path).

(b) DES MODE can be engaged during cruise to descent to a lower flight level, as long as a vertical flight plan is valid and NAV or LOC/LOC* MODE is engaged. DES MODE engages as soon as the flight crew selects a lower altitude, and pushes the FCU ALT knob. The selected altitude has to be lower than the present altitude. The aircraft will follow the computed descent path to the selected altitude. When the FCU selected altitude is reached, the aircraft levels off (ALT MODE is then engaged). The crew has to set another lower clearance to re-engage DES MODE. If constraints exist between present altitude and target altitude, they are automatically met.

(c) The aircraft flies the descent path computed by the FMGS towards the FCU selected altitude with a managed speed. If the flight crew reverts to selected speed (by pulling out the SPEED / MACH FCU knob), the DES MODE stays engaged so the aircraft continues to follow the computed descent path, this time with the selected speed. If the FCU SPEED / MACH knob is pushed, DES MODE will follow the managed speed.

[25] Airbus FCOM section DSC-22-30-70, Pg – 1257 & BEA Contribution Report on Aircraft Systems dated 17th June, 2022, Pg – 27

(d) During the descent in DES MODE, if the aircraft is at or above the profile, it descents at IDLE Thrust, and the speed will increase towards the upper limit of the acceptable speed range. If necessary, a message on the PFD "MORE DRAG" is displayed for the flight crew to use Speed Brakes.

(e) If the aircraft is below the profile, it descents at a constant V/S at the target speed in order to converge to the descent path. Then, aircraft descents at IDLE Thrust to follow the profile.

(f) If the aircraft cannot fly the profile at IDLE Thrust, AP / FD controls the vertical path and A/THR controls the speed.

(g) An intercept point (↘↝) is present on the ND. It indicates the position where the system predicts that the aircraft will intercept the descent profile.

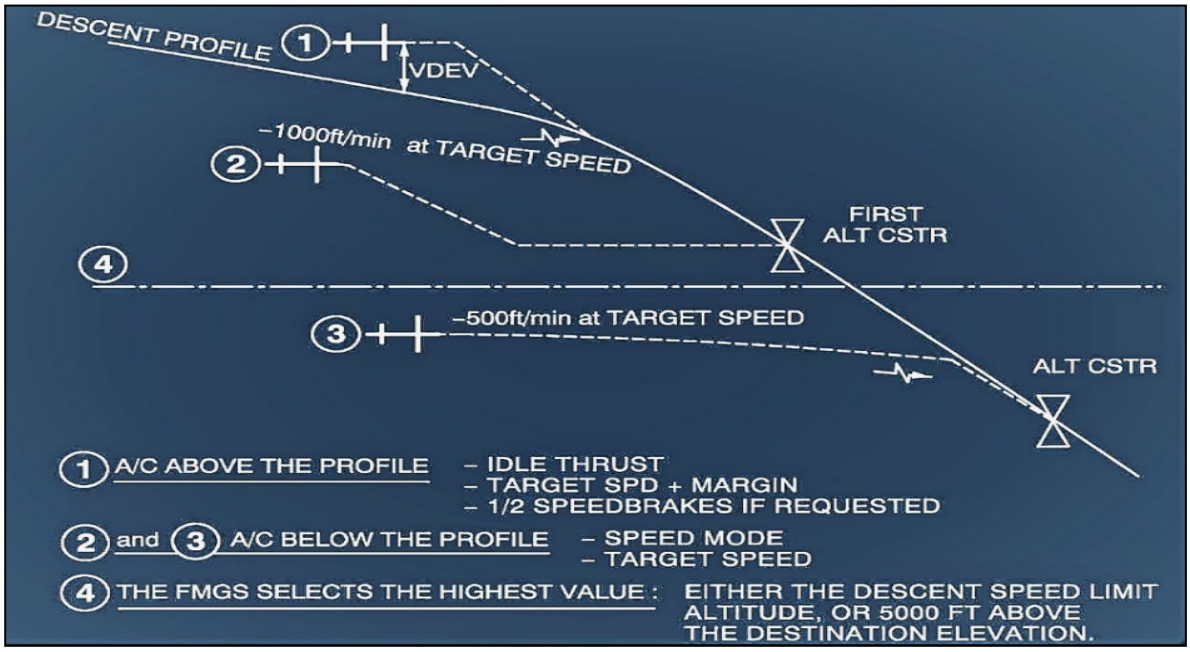


Figure 100 – Auto-Pilot / Flight Director Vertical MODES – Descent MODE[26]

1.16.3.7. **Open Descent (OPEN DES) MODE –** The OPEN DES MODE is a selected MODE. It maintains SPD / MACH (selected or managed) with the AP / FD Pitch MODE while A/THR (if active) maintains IDLE thrust. It is not to be used for final Approach. To engage the OPEN DES MODE, the aircraft has to be in flight for more than 5 s, Land MODE must not be engaged, and FCU selected altitude shall be lower than the present altitude. Once the above-mentioned conditions are met, pulling out the ALT knob on FCU engages the OPEN DES MODE.

1.16.4. Flight Mode Annunciator (FMA)

1.16.4.1. FMA is provided in the cockpit just above the PFDs in the same screen. The FMA shows the status of the A/THR, AP/FD Vertical and Lateral MODES, Approach capabilities and AP/FD-A/THR engagement status. A white box is displayed for 10 s around each new annunciation. The white box display time may be increased to 15 s in some MODE reversion cases associated with an Aural triple click.

[26] Airbus FCOM, Aircraft Above the Descent Profile, Pg – 1274

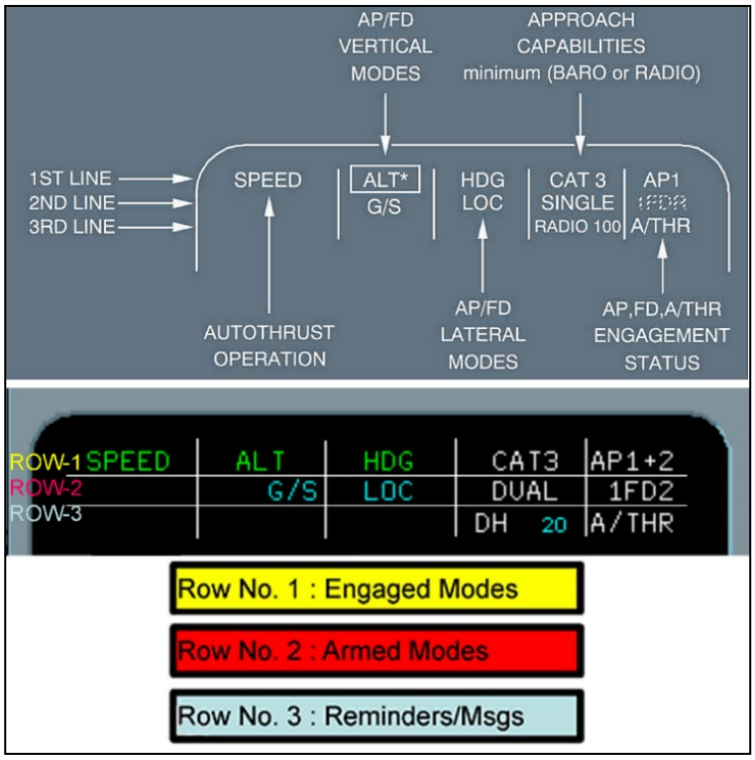


Figure 101 – Visual Description of FMA[27]

1.16.4.2. In the three left most columns, the first line shows the engaged MODES in green. The second line shows armed MODES in blue or magenta. Magenta indicates that MODES are armed or engaged because of a constraint. The third line displays special messages. The messages related to flight controls are having first priority and those related to FMGS have second priority. In fourth column from left, Approach capabilities are displayed in white, and Decision Height (DH) or Minimum Descent Altitude (MDA) / Minimum Descent Height (MDH) are displayed in blue. The fifth column displays engagement status of AP, FD, and A/THR in white. It displays a box around FD for 10 s in case of automatic FMGC switching and displays A/THR in blue when A/THR is armed but not active.

1.16.4.3. **Procedure for Glide Slope (G/S) Interception from Above –** The following procedure should only be applied when established on the localizer[28].

In order to get the best rate of descent when cleared by ATC and below the limiting speeds, the flight crew should lower the landing gear and select flaps as required (at least CONF 2 should be selected to ensure that the aircraft speed will not increase).

- **If above the glideslope:**
  APPR mode ..... ARM / CHECK ARMED
  FCU ALTITUDE..... SET ABOVE A/C ALTITUDE
  V/S MODE..... SELECT
  - *Select V/S 1 500 ft/min initially. V/S in excess of 2 000 ft/min will result in the speed increasing towards VFE.*
  - *When reaching VFE, the AP maintains VFE and reduces the V/S without MODE REVERSION.*

Figure 102 – G/S Interception from Above

[27] Airbus FCOM, Flight Mode Annunciator (FMA), Pg – 1361
[28] Airbus FCOM, Glide Interception from Above, Pg – 3854

1.16.5. **Aircraft Warning System and Warning Chronology**

1.16.5.1. The aircraft is equipped with two identical FWCs which generate Alert Messages, Memos, Aural Alerts, and Synthetic Voice Messages. For this purpose, they acquire data directly from aircraft sensors, or systems, to generate Red Warnings, and through the System Data Acquisition Concentrators (SDACs) to generate Amber Cautions. The Alert messages generated by the FWCs are displayed on ECAM displays and are also accompanied by Aural Alerts and voice messages. The communication loudspeakers announce Aural Alerts and voice messages even when they are turned OFF. The ECAM has two display units. One for the Engine / Warning Display (E/WD), and the other one for the System / Status Display (SD).

1.16.5.2. There are three priority levels for Warnings and Cautions observed by FWC. According to those priority levels, a level 3 Warning has priority over a level 2 Caution which has priority over a level 1 Caution. Warning and Caution classification of ECAM Failure MODES are as following: -

	Level	Signification	Aural	Visual
Failure MODE	Level 3	Red Warning: - The configuration, or failure requires immediate action	CRC or specific sound or synthetic voice	MASTER WARN light Red flashing or specific Red light Warning message (Red) on E/WD Automatic call of the relevant system page on the SD
	Level 2	Amber Caution: - The flight crew should be aware of the configuration or failure, but does not need to take any immediate action. However, time and situation permitting, these Cautions should be considered without delay to prevent any further degradation of the affected system	Single Chime	MASTER CAUT light Amber steady Caution message (Amber) on E/WD Automatic call of the relevant system page on the SD
	Level 1	Amber Caution: - Requires crew monitoring	None	Caution message (Amber) on E/WD generally without procedure.

Table 29 – Warning / Caution Classification

1.16.5.3. In case more than one Warning or Alert is active, then there are priorities defined within Warnings and Alerts which may vary according to the FWC standard installed in the aircraft. The event aircraft was fitted with the FWC of standard F9D. In this standard, the “OVERSPEED” Warning has a higher priority than the AUTO FLT AP OFF Red Warning, therefore if both Alerts are present at the same time, the Aural Warning generated will be the CRC (associated with the “OVERSPEED” Warning), and not the Cavalry Charge (associated with the AP disconnection).

1.16.5.4. The FWCs also drive the attention-getters. Each pilot has a set of these on the panel under the glareshield on either side of FCU. They include a Master Warning Light, that flashes “MASTER WARN” in Red for level 3 Warnings accompanied by an Aural Warning (CRC, specific sounds or synthetic voice), and a Master Caution Light, that illuminates “MASTER CAUT” in Amber, for level 2 Cautions accompanied by a Single Chime.

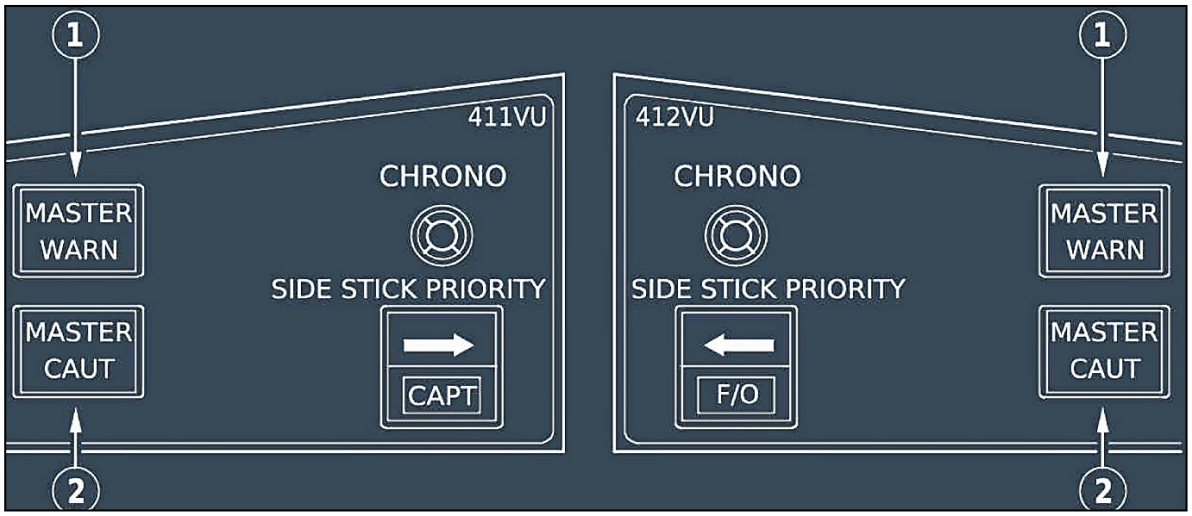


Figure 103 – FCU Attention Getters[29]

1.16.5.5. The audio Alerts can be cancelled by the flight crew using two manners. The first and standard manner [as described in the Flight Crew Techniques Manual (FCTM) section "Handling of ECAM"] is by pressing “MASTER WARN” PB (located either side of FCU). This action will cancel all the audio Alerts except “OVERSPEED” and “L/G GEAR NOT DOWN” Warnings. The second manner (non standard one) is by “EMER CANC” PB located on ECAM Control Panel; as mentioned in the FCOM section Aircraft Systems / Indicating / Recording Systems / ECAM Controls / ECAM Control Panel, this PB should only be used to suppress spurious Master Cautions, and not genuine Master Warnings[30].

Figure 104 – ECAM Control Panel[31]

1.16.5.6. The “EMER CANC” PB affects both Warnings and Cautions. If pressed in case of Warnings it cancels (stops) an Aural Warning for as long as the failure condition continues, extinguishes the Master Warnings lights, but it does not affect the ECAM message display. If pressed in case of Cautions, it cancels any present Caution (single chime, “MASTER CAUT” lights, ECAM message) for the rest of the flight.

[29] Airbus FCOM, Attention Getters, Pg – 1895
[30] Airbus FCOM, ECAM Control Panel, Pg – 1892
[31] Airbus FCOM, ECAM Control Panel, Pg – 1890

1.16.6. **Overspeed Limits and Triggering Conditions –** Overspeed condition in various aircraft configurations is indicated with flashing Red "MASTER WARN" Warning light accompanied with CRC Aural Alert. The speed limits and associated triggering conditions are as following: -

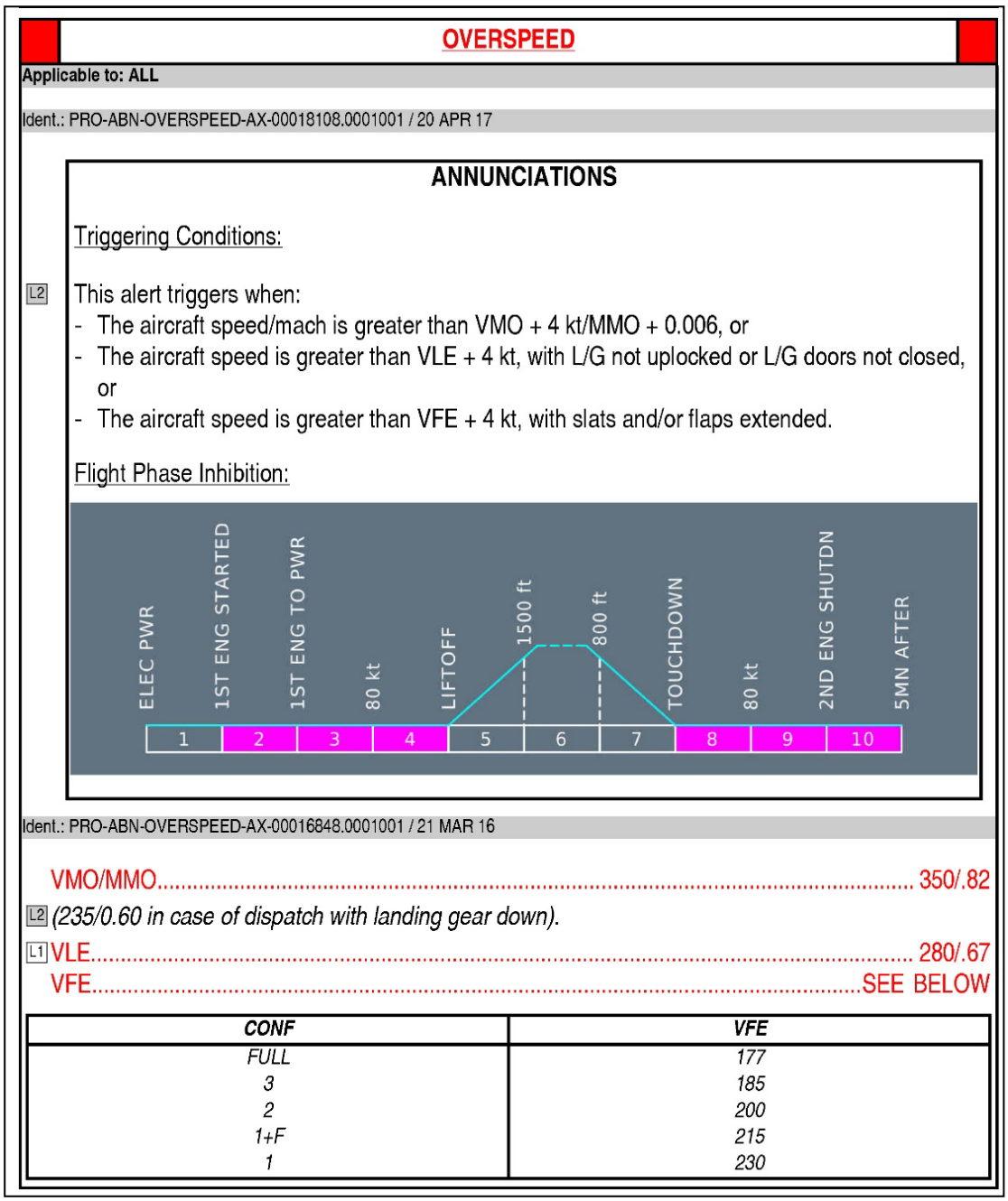


Figure 105 – Overspeed Limits and Triggering Conditions

1.16.7. **Landing Gears Not Down Alert Triggering Conditions –** Landing Gears Not Down Alert is indicated by flashing MASTER WARN red light accompanied by CRC Aural Alert and an ECAM message. In addition, a Red Arrow on the instrument panel besides Landing Gears Lever also comes ON. The triggering conditions for this Alert are as following: -

L/G GEAR NOT DOWN

Applicable to: ALL

Ident.: PRO-ABN-LG-AA-00017859.0001001 / 21 MAR 16

ANNUNCIATIONS

Triggering Conditions:

L2 This alert triggers when:

1. L/G is not downlocked and radio height is lower than 750 ft and both engines N1 lower than 75% (or if engine shutdown N1 of remaining engine lower than 97%) or
2. L/G is not downlocked and radio height is lower than 750 ft and both engines are not at T.O power and flaps at 1, 2, 3 or FULL or
3. L/G is not downlocked and flaps at 3 or FULL and both radio altimeters are failed.

Note: *In the cases 2 and 3 above, the aural warning can only be cancelled by the emergency cancel pushbutton.*

Flight Phase Inhibition:

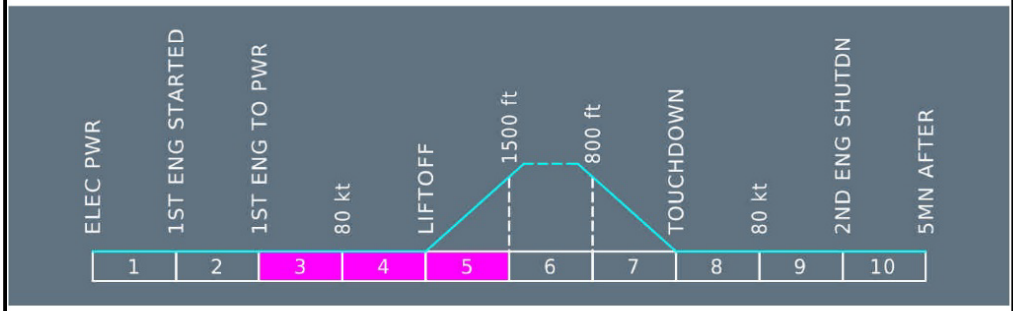


Figure 106 – "L/G GEAR NOT DOWN" Triggering Conditions

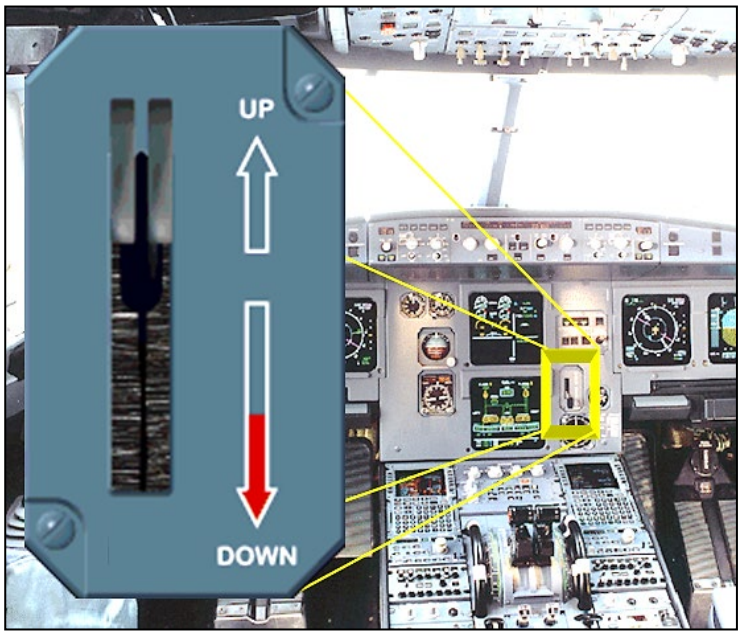
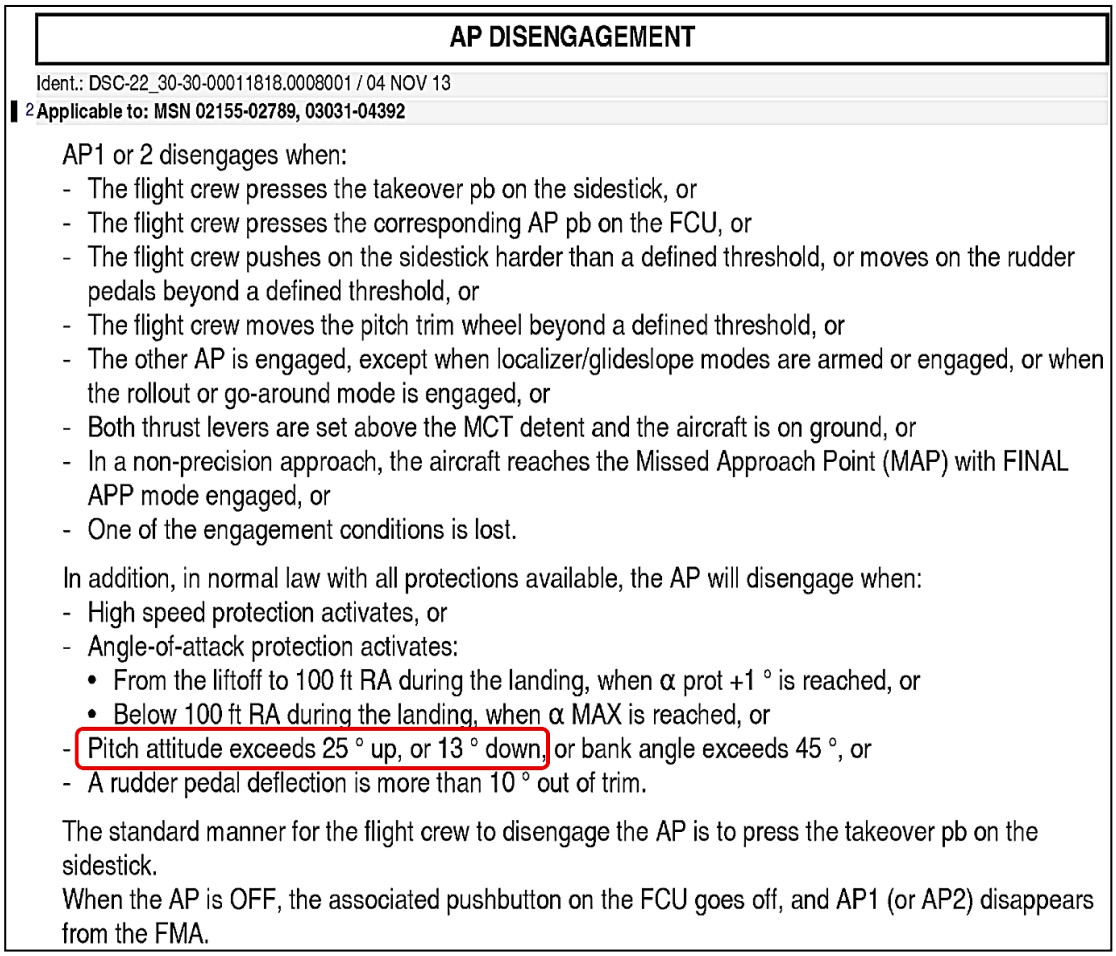


Figure 107 – Landing Gears Lever and Red Arrow

1.16.8. **AP Disengagement Conditions –** AP disengagement conditions are mentioned in following table. Pitch attitude exceeding 13° down is one of the conditions for disengagement of AP.



AP DISENGAGEMENT

Ident.: DSC-22_30-30-00011818.0008001 / 04 NOV 13

[2] **Applicable to: MSN 02155-02789, 03031-04392**

AP1 or 2 disengages when:
- The flight crew presses the takeover pb on the sidestick, or
- The flight crew presses the corresponding AP pb on the FCU, or
- The flight crew pushes on the sidestick harder than a defined threshold, or moves on the rudder pedals beyond a defined threshold, or
- The flight crew moves the pitch trim wheel beyond a defined threshold, or
- The other AP is engaged, except when localizer/glideslope modes are armed or engaged, or when the rollout or go-around mode is engaged, or
- Both thrust levers are set above the MCT detent and the aircraft is on ground, or
- In a non-precision approach, the aircraft reaches the Missed Approach Point (MAP) with FINAL APP mode engaged, or
- One of the engagement conditions is lost.

In addition, in normal law with all protections available, the AP will disengage when:
- High speed protection activates, or
- Angle-of-attack protection activates:
  - From the liftoff to 100 ft RA during the landing, when α prot +1 ° is reached, or
  - Below 100 ft RA during the landing, when α MAX is reached, or
- Pitch attitude exceeds 25 ° up, or 13 ° down, or bank angle exceeds 45 °, or
- A rudder pedal deflection is more than 10 ° out of trim.

The standard manner for the flight crew to disengage the AP is to press the takeover pb on the sidestick.
When the AP is OFF, the associated pushbutton on the FCU goes off, and AP1 (or AP2) disappears from the FMA.

Figure 108 – Auto-Pilot Disengagement Conditions[32]

1.16.9. Ground Proximity Warning System (GPWS)

1.16.9.1. The purpose of the GPWS is to warn the flight crew of potentially hazardous situations, such as a collision with terrain. It detects terrain collision threats and triggers applicable Aural and Visual indications. The GPWS includes five basic MODES which are active up to radio height of 2,500 ft. The MODES are as follows: -

(a) Excessive Rate of Descent (MODE-1)

(b) Excessive Terrain Closure Rate (MODE-2)

(c) Altitude Loss after Take off or Go-Around (MODE-3)

(d) Terrain clearance not sufficient, if not in Landing Configuration (MODE-4). MODE-4 has three sub-MODES (MODE-4A, 4B, and 4C)

(e) Excessive Descent below the G/S (MODE-5)

1.16.9.2. In the event flight GPWS MODE-1, and MODE-4 were activated during the Approach phase with associated Aural and Visual Warnings. Both MODES are therefore further elaborated: -

(a) **MODE-1 –** GPWS Basic MODE-1 “Excessive Rate of Descent” triggers Aural and Visual Alerts for excessive Rates of Descent, based on the radio height, and Rate of Descent of the aircraft. The GPWS MODE-1 is active for all phases of flight. The activation envelope of MODE-1 is appended below: -

[32] Airbus FCOM, AP Disengagement, Pg – 1223

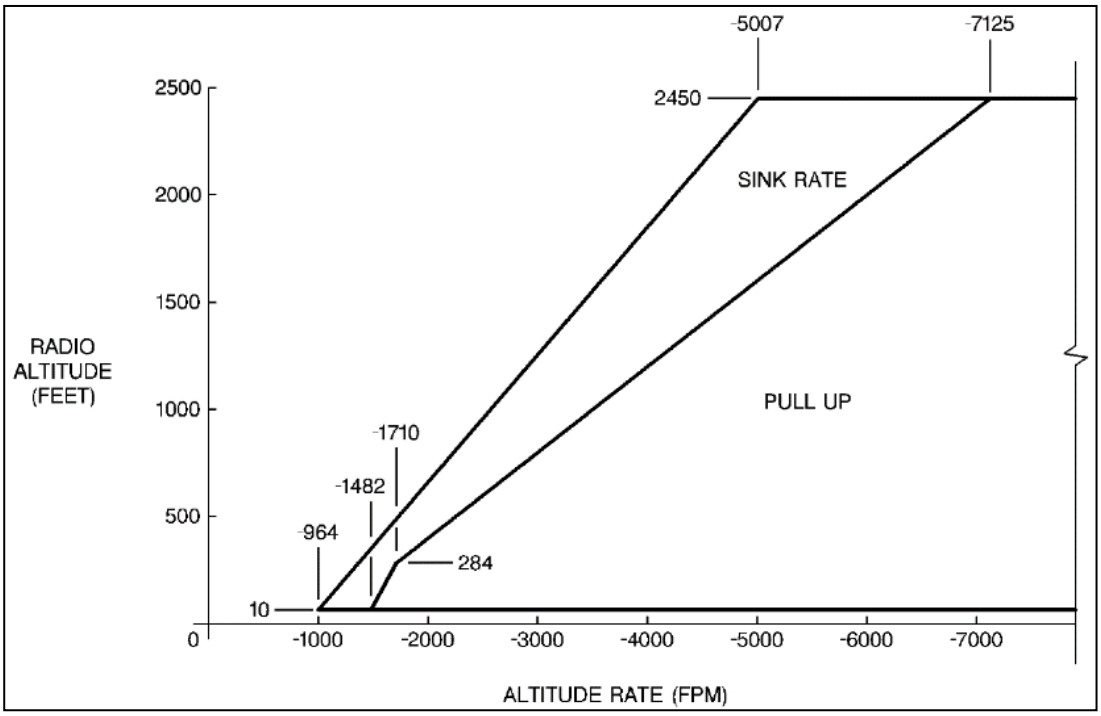


Figure 109 **–** GPWS Basic MODE-1 envelope[33]

(b) **MODE-4 –** GPWS Basic MODE-4 "Unsafe Terrain Clearance When Not in Landing Configuration" has two types of Alerts active during Cruise and Approach, MODE-4A and MODE-4B, which trigger Aural and Visual Alerts when terrain clearance is not sufficient based on the phase of flight, aircraft speed, and the Landing Gears and FLAPS configuration. MODE-4C is active during Take off and triggers Aural and Visual Alerts based on the minimum terrain clearance and the radio height of the aircraft. MODE-4A was more specific to event flight and triggers when FLAPS are DOWN and Gears are UP during the Approach phase. Following figure provides the GPWS MODE-4A envelope, which corresponds to the Landing Gears UP situation: -

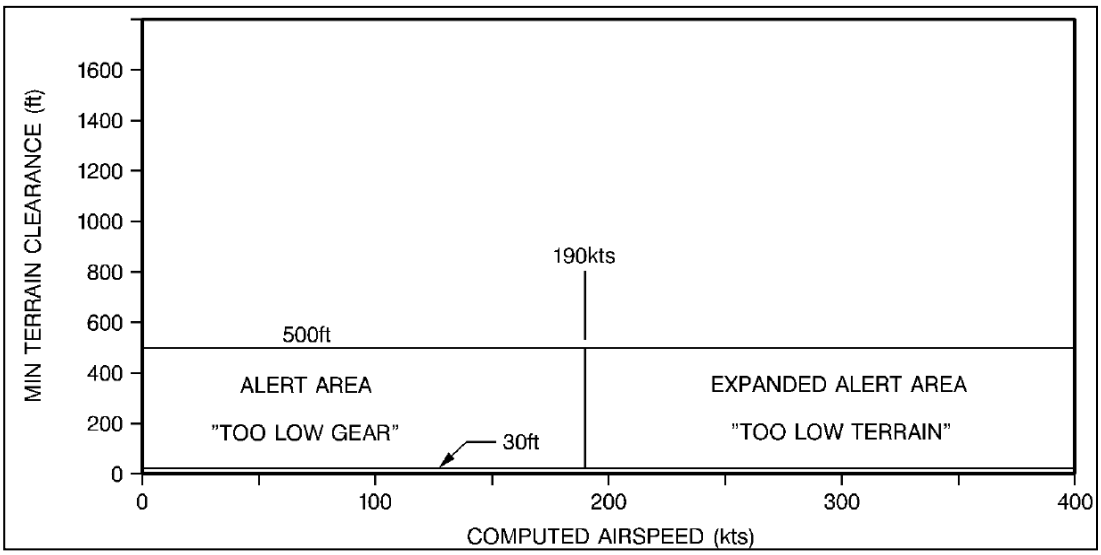


Figure 110 **–** GPWS Basic MODE-4A Envelope[34]

[33] Airbus Report dated 31 May, 2021, Pg – 45
[34] Airbus Report dated 31 May, 2021, Pg – 46

1.16.9.3. **GPWS Alerts During the Event**[35]

(a) The GPWS uses internally processed parameters to compute Alerts such as the Rate of Descent and terrain closure rate. From the DFDR data, a Rate of Descent was recomputed to provide a rough order of magnitude of the consistency of triggering of the Alerts recorded in the CVR. In the DFDR fitted on the event aircraft, the Boolean GPWS15 is associated with the activation of the GPWS Alerts. This Boolean is recorded at 1 Point Per Second (PPS).

(i) When GPWS15=1, there is no GPWS Alert.

(ii) When GPWS15=0, a GPWS Alert is triggered. This can be either an Amber Caution or a Red Warning.

(b) 3 sequences of GPWS Alerts triggering were recorded during the event.

(c) **Sequence No. 1** – Starting at 09:32:52 (for 4 s), during this first sequence, the CVR transcript indicates that: -

(i) “SINK RATE” Amber Caution was triggered at 09:32:53.

(ii) First “PULL UP” Red Warning was triggered at 09:32:54.

(iii) Second “PULL UP” Red Warning was triggered at 09:32:56.

(iv) During this time period, the aircraft was below 2,450 ft RA, which is the upper limit of the GPWS Alerts. In addition, the computed Rate of Descent (altitude rate, V/S) was between 6,000 and 7,600 ft/min.

(v) The activation envelope of the GPWS Basic MODE-1 “Excessive Rate of Descent” is provided in the figure below. As described in the FCOM section DSC-34-SURV (Aircraft Systems / ATA 34-SURV Surveillance / 34-SURV-40-20 GPWS Basic MODES), the GPWS MODE-1 triggers Aural and Visual Alerts about excessive Rate of Descent, based on the radio height, and the Rate of Descent of the aircraft. The GPWS MODE-1 is active for all phases of the flight.

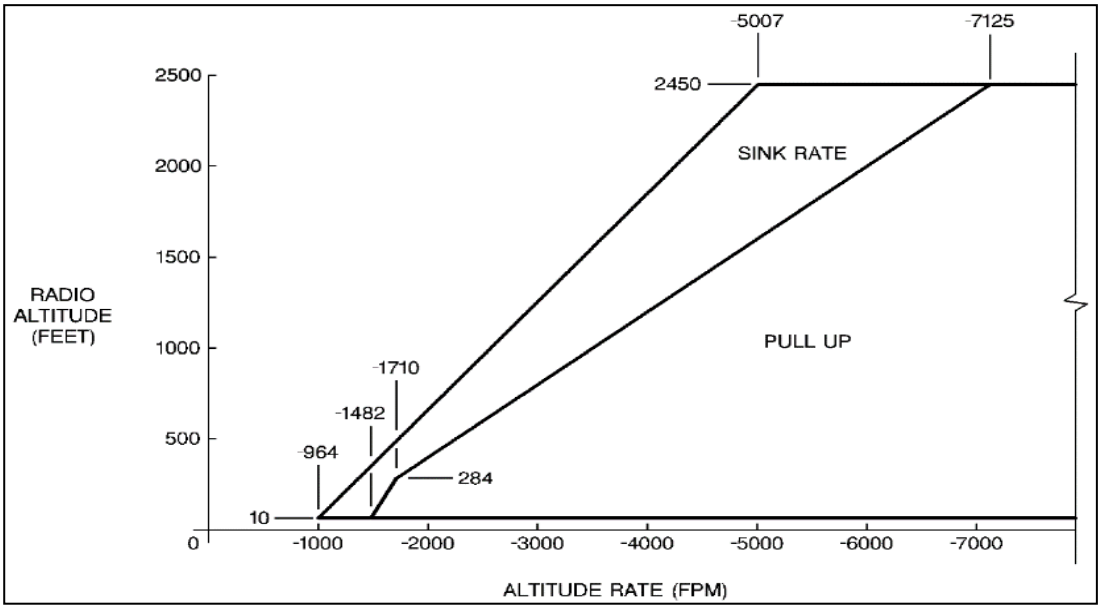


Figure 111 – GPWS Basic MODE-1 Envelope

[35] Airbus Report dated 31st May, 2021, Pg – 45

(vi) The aircraft parameters (RA and V/S) during the first sequence of GPWS Alerts were consistent with the recorded triggering of the GPWS Basic MODE-1 “SINK RATE” Caution and “PULL UP” Alerts.

(d) **Sequence No. 2** – Starting at 09:33:55 (for 20 s, with RA below 500 ft), during this second sequence, the CVR transcript indicates that: -

(i) Two (2) “TOO LOW TERRAIN” Amber Cautions were triggered (09:33:55 then 09:33:56).

(ii) “PULL UP” Red Warning was triggered at 09:33:58.

(iii) Three (3) “TOO LOW TERRAIN” Amber Cautions were triggered (09:33:59, 09:34:01 and 09:34:04).

(iv) SINK RATE Amber Caution was triggered at 09:34:06.

(v) “PULL UP” Red Warning was triggered at 09:34:06.

(vi) Five (5) “TOO LOW TERRAIN” Amber Cautions were triggered (09:34:08, 09:34:10, 09:34:12, 09:34:14 and 09:34:16).

(vii) During this time period, the aircraft was between 450 ft and 30 ft RA, and the computed V/S was between -600 and -2,000 ft/min. In addition, the Landing Gears was retracted and aircraft CAS was between 205 kts and 220 kts.

(viii) The activation envelope of the GPWS Basic MODE-4 “Unsafe Terrain Clearance When Not in Landing Configuration” is provided below. As described in the FCOM section DSC-34-SURV, there are two types of GPWS MODE-4 Alerts active during Cruise and Approach, MODE-4A and MODE-4B, which trigger Aural and Visual Alerts when terrain clearance is not sufficient based on the phase of flight, aircraft speed and Landing Gears / FLAPS configuration.

(ix) The figure below provides the GPWS MODE-4A envelope, which corresponds to the Landing Gears UP situation: -

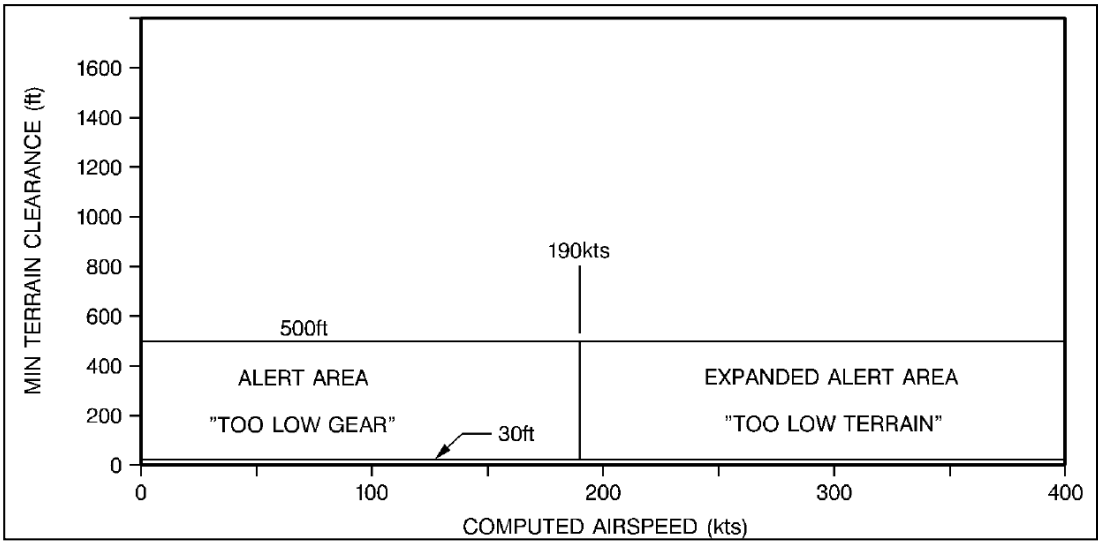


Figure 112 – GPWS Basic MODE-4A Envelope

(x) The aircraft parameters (RA, V/S, Landing Gears UP and CAS>190 kts) during the second sequence of GPWS Alerts were consistent with the recorded triggering of the GPWS Basic MODE-1 Alerts (“SINK RATE” Caution and “PULL UP” Warnings) and Basic MODE-4A Alerts (“TOO LOW TERRAIN” Cautions).

(e) **Sequence No. 3** – Starting at 09:34:53 (for 20 s), during this third sequence, the CVR indicates that the "TOO LOW GEAR" Amber Caution was triggered at 09:34:55. During this time period, the aircraft was between 70 ft and 500 ft RA (climbing away after R/W contact) and the aircraft CAS was between 168 kts and 187 kts. The Landing Gears was selected DOWN transiently for 1 sample then UP again at 9:34:57, and was therefore UP at the time of the "TOO LOW GEAR" Caution triggering. The aircraft parameters (RA, Landing Gears UP and CAS<190 kts) during the third sequence of GPWS Alerts were consistent with the recorded triggering of the GPWS Basic MODE-4A "TOO LOW GEAR" Caution.

(f) GPWS Warning procedure is provided in the FCOM section Procedures / Abnormal and Emergency Procedures / SURV / [MEM] GPWS Warnings.

PAKISTAN International Airlines
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A318/A319/A320/A321
FLIGHT CREW OPERATING MANUAL

PROCEDURES
ABNORMAL AND EMERGENCY PROCEDURES
SURV

[MEM] EGPWS WARNINGS

Ident.: PRO-ABN-SURV-00016878.0019001 / 04 DEC 18
Applicable to: MSN 02155-02789, 03031-03097

- **"PULL UP" - "TERRAIN AHEAD PULL UP" - "OBSTACLE AHEAD PULL UP"**

Simultaneously:

AP	OFF
PITCH	PULL UP

L2 Pull to full backstick and maintain in that position.

L1

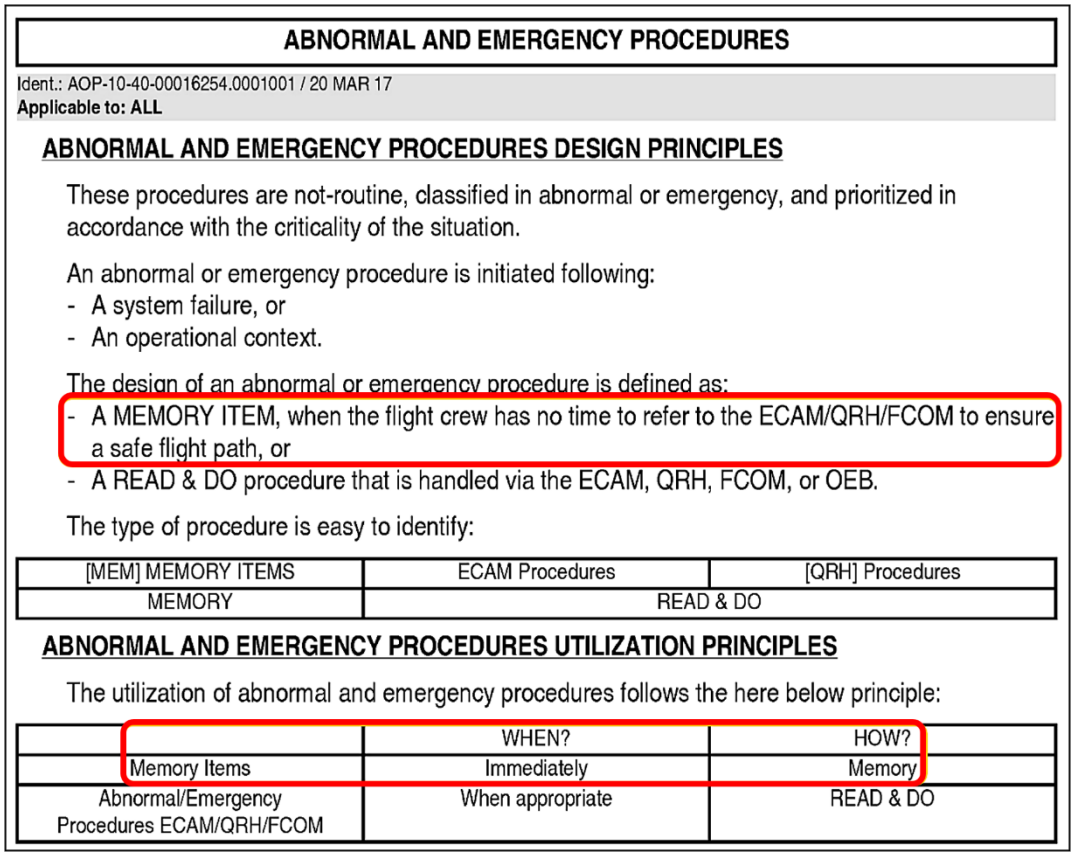
THRUST LEVERS	TOGA
SPEED BRAKES lever	CHECK RETRACTED
BANK	WINGS LEVEL or ADJUST

L2 Aircraft obtain the best climb performance when the wings are as level as possible. The flight crew can adjust bank while climbing, provided that turning is the safest action.

L1 DO NOT CHANGE CONFIGURATION (SLATS/FLAPS, GEAR) UNTIL CLEAR OF OBSTACLE.

Figure 113 – GPWS Warnings

(g) As indicated by the MEM prefix, this procedure is a Memory (MEM) Item. As explained in the FCTM (see extract below), such procedure shall be applied immediately and by memory, as the flight crew has no time to refer to the ECAM / QRH / FCOM to ensure a safe flight path: -



ABNORMAL AND EMERGENCY PROCEDURES

Ident.: AOP-10-40-00016254.0001001 / 20 MAR 17
Applicable to: ALL

ABNORMAL AND EMERGENCY PROCEDURES DESIGN PRINCIPLES

These procedures are not-routine, classified in abnormal or emergency, and prioritized in accordance with the criticality of the situation.

An abnormal or emergency procedure is initiated following:
- A system failure, or
- An operational context.

The design of an abnormal or emergency procedure is defined as:
- A MEMORY ITEM, when the flight crew has no time to refer to the ECAM/QRH/FCOM to ensure a safe flight path, or
- A READ & DO procedure that is handled via the ECAM, QRH, FCOM, or OEB.

The type of procedure is easy to identify:

[MEM] MEMORY ITEMS	ECAM Procedures	[QRH] Procedures
MEMORY	READ & DO	

ABNORMAL AND EMERGENCY PROCEDURES UTILIZATION PRINCIPLES

The utilization of abnormal and emergency procedures follows the here below principle:

	WHEN?	HOW?
Memory Items	Immediately	Memory
Abnormal/Emergency Procedures ECAM/QRH/FCOM	When appropriate	READ & DO

Figure 114 – Abnormal and Emergency Procedures

1.16.10. Landing Gears Not Down Alerts Available to Flight Crew

1.16.10.1. In case flight crew forgets to put Landing Gears DOWN during Approach, he will have two types of Aural and Visual Alerts available in the cockpit which are generated independently by FWC and GPWS.

1.16.10.2. FWC will generate CRC Aural Alert, with MASTER WARN Red light flashing, accompanied with an ECAM message and illumination of Red Arrow besides Landing Gears Lever. The GPWS will generate “TOO LOW GEARS” synthetic Aural Alert accompanied with illumination of Amber GPWS Caution light on instrument panel, below 500 ft RA height and speed less than 190 kts. Both Alerts are generated independently, and if present simultaneously, the audio Alerts will superimpose.

1.16.11. Medical Requirements: Mental Health for Flight Crew

1.16.11.1. ICAO Medical Requirements about Mental Health for Flight Crew Licensing

(a) As per ICAO Doc 8984, piloting an aircraft requires utilization of a complex set of physical and cognitive skills. Interference with any aspect of these skills and their coordination may have serious personal and public safety consequences. The assessment of mental fitness shall therefore be made with due regard to privileges of license and ratings applied for or held, and to the conditions in which the applicants will have to carry out their duties. The period of validity of Medical Assessment (between 06 months and 05 years) must also be taken into consideration[36].

[36] ICAO Doc 8984 (Manual of Civil Aviation Medicine) section 9.1.1, Pg – 285

(b) As per ICAO Annex-1 (section 6.1), flight crew medical assessment has been divided into three categories (Class - I, II, and III) according to the type of license being applied. An applicant for a Medical Assessment (issued in accordance with the terms of Annex-1, section 1.2.4.1) shall undergo a medical examination based on the following requirements: -

(i) Physical and Mental.

(ii) Visual and Colour Perception.

(iii) Hearing.

(c) ICAO Annex-1 requirement on mental fitness (section 6.3.2.2), applicable to all categories of licenses and ratings, are as follows: -

(i) The applicant shall have no established medical history or clinical diagnosis of: -

- An organic mental disorder.
- A mental or behavioural disorder due to use of psychoactive substances; this includes dependence syndrome induced by alcohol or other psychoactive substances.
- Schizophrenia or a schizotypal or delusional disorder.
- A mood (affective) disorder.
- A neurotic, stress-related or somatoform disorder.
- A behavioural syndrome associated with physiological disturbances or physical factors.
- A disorder of adult personality or behaviour, particularly if manifested by repeated overt acts.
- Mental retardation.
- A disorder of psychological development.
- A behavioural or emotional disorder, with onset in childhood or adolescence.
- A mental disorder not otherwise specified; such as might render the applicant unable to safely exercise the privileges of the license applied for or held.

(d) Psychological testing of flight crew members is rarely of value as a screening tool. Personality tests alone have not been proven reliable tools to predict mental disorders or to assess with any degree of certainty an applicant's suitability for an aviation career. In general, ability to pass the pilot ground school course is proof of adequate intelligence. Personality inventory testing may be of value in the hands of a psychiatric consultant when used as an adjunct to a psychiatric evaluation. Specific testing may be conducted for research and / or treatment purposes[37].

[37] ICAO Doc 8984 (Manual of Civil Aviation Medicine) section 9.3.1, Pg – 287

(e) It is further mentioned in ICAO Doc 8984, "the Standards and Recommended Practices (SARPs) of Annex-1, Chapter 6, while not sufficiently detailed to cover all individual conditions, require specific levels of mental fitness. Many decisions relating to individual cases will be left to the discretion of the medical examiner or will have to be decided by the medical assessor of the Licensing Authority"[38].

(f) As per ICAO SARPs, validity of Class-I medical assessment for CPL, and ATPL is 12 months. The period of validity of a Medical Assessment may be reduced when clinically indicated. Moreover, when holders of ATPLs - Aeroplane, Helicopter and Powered-Lift, and CPLs - Aeroplane, Airship, Helicopter and Powered-Lift, who are engaged in single-crew Commercial Air Transport Operations carrying passengers, have passed their 40th birthday, the period of validity shall be reduced to 06 months[39]. The level of medical fitness to be met for the renewal of a Medical Assessment shall be the same as that for the initial assessment except where otherwise specifically stated[40].

1.16.11.2. **Flight Crew Medical Assessment Process in PCAA**

(a) PCAA has established Civil Aviation Medical Board (CAMB) at various locations for medical examinations of flight crew for initial issue of particular class of license and subsequent renewals. The CAMB shall comprise an Aviation Medical Examiner (AMEX), Ear Nose and Throat (ENT) Specialist, Eye Specialist and Co-opted Cardiologist where ever necessary. Also, on the basis of work load requirements, AMEXs are designated at each location to conduct medical examinations of fitness of applicants for licenses or ratings for which medical requirements are prescribed. For all the initial issue of flight crew licenses requiring Class-I Medical Assessment, the medical examinations are carried out by one of the CAMBs. The license holder then has to go to either of the CAMB every 02 years for medical assessment. In between, the single renewal of the Class-I medical assessment is done by approved AMEX. The frequency of renewal for Class-I is once a year below the age of 40 years and once every 06 months after the age of 40 years. Initial issue / renewal of other than Class-I is done by designated AMEX. The criteria for initial issue and renewal of medical assessment are same till otherwise specifically stated. The requirements of mental fitness for all types of medical assessment[41] are same as per ICAO standard defined in Annex-1.

(b) Prior to year 2015, the flight crew were examined as per the defined criteria by CAMBs and AMEXs which also included the mental health; and further consultation from the concerned specialist was done only where required. While the practice of carrying out Psychiatric Evaluation for flight crew induction was adopted by PIA as a proactive measure, detailed Psychiatric Evaluation was not a requirement for issuance of flight crew license by the PCAA. However, in year 2015, during the Board Meeting of PCAA, a decision was taken to make Psychiatric Evaluation mandatory for issuance of license to flight crew and Air Traffic Controllers.

[38] ICAO Doc 8984 (Manual of Civil Aviation Medicine) section 9.1.2, Pg – 285
[39] ICAO Annex-1 section 1.2.5.2.2, Pg – 33
[40] ICAO Annex-1 section 6.1.4, Pg – 116
[41] PCAA ANO-001-XXAM-2.0 dated 13th December, 2010, section D4.9.4, Pg – 22

(c) Since 2015, Psychiatric Evaluation and Electroencephalogram (EEG) have been made a compulsory requirement of medical assessment for initial issues of license for flight crew and Air Traffic Controllers. Subsequent psychiatric oversight is maintained by AMEX during renewals and medical board. In addition, the license holder is required to submit a certificate during renewal of medical assessment to declare any illness or disability (if any) during the period between two assessments.

(d) The Psychiatric Evaluation is carried out at three locations, Karachi, Lahore, and Islamabad by PCAA designated Institutes / Clinics. The criteria given by PCAA for psychometry are elaborate and sufficiently cover related aspects.

1.16.11.3. **Flight Crew Psychiatric Evaluation in PIA –** PIA had a policy of compulsory Psychiatric Evaluation for flight crew at the time of induction of the Captain of accident flight (although not an ICAO standard). The candidate considered 'UNFIT' by the Psychiatrist of PIA was referred to Pakistan Air Force (PAF) Aero Medical Institute (AMI) for second opinion. If the candidate declared 'UNFIT' by the AMI, he was not considered for induction. However, in case the candidate declared 'FIT' by Psychiatrist at AMI, he was further referred to a third Psychiatrist. Candidate getting 'FIT' remarks from two Psychiatrist is cleared for induction.

1.16.11.4. **ICAO Standard on use of Psychoactive Substances –** As per ICAO Annex-1, holders of licenses shall not exercise the privileges of their licenses and related ratings while under the influence of any psychoactive substances which might render them unable to safely and properly exercise these privileges[42].

1.16.11.5. **PCAA Policy on use of Psychoactive Substances[43] –** As per PCAA regulations, no person acting as crew member, Air Traffic Controller, and operational personnel shall have taken or used psychoactive substances while exercising the privileges of his / her license / rating / permits. Pre-Flight Medical Check is compulsory for all crew members of the flight operating in Pakistan. For the purpose, it is mandated for all Operators to maintain at least two serviceable breath analysers. Prior to every flight, breath analyser test shall be conducted and all crew members shall sign undertaking in pre-flight examination document that they are not under influence of any psychoactive substances. Designated officers of PCAA are authorized to conduct breath analyser check, or blood and urine tests for screening of psychoactive substances for any of crew members' pre, during or post flight in Pakistan.

1.16.12. Flying while Fasting

1.16.12.1. PCAA Regulations on Flight Crew Fasting

(a) CARs 1994, Rule 41(3) states, "The holder of a medical assessment issued under this Part shall not exercise the privileges of his license if he is aware that his capacity to efficiently perform his duties is likely to be impaired by a decrease in his medical fitness, or by a period of Fasting".

[42] ICAO Annex-1, section 1.2.7.1, Pg – 34
[43] PCAA ANO-002-XXAM-1.0 dated 23rd November, 2015 section D2 to D5, Pg – 04

(b) Air Navigation Order (ANO) of PCAA Aero Medical "Flight Crew Medical Requirements" (ANO-001-XXAM-2.0) section D2.1.8.1 states, "If the holder of a license is aware, or has reasonable grounds to believe that, his physical, aural or visual condition has deteriorated in any manner, even if only temporarily, as the result of a common minor ailment or by a period of Fasting so that it may be below the standard of medical fitness required for the grant of such a license, he shall not act in any capacity for which he is so licensed until he is satisfied that his condition has improved / recovered to meet the required standards as laid-down in this ANO". After the accident, this ANO was revised on 2nd February, 2021 as ANO-001-XXAM-3.0. However, section D2.1.8.1 related to flight crew Fasting remained unchanged.

(c) Prior to accident, ANO-012-FSXX-5.0 of PCAA Flight Standards Directorate (FSD) "Flight Time, Flight Duty Period, Duty Period & Rest Periods for Fatigue Management – Flight and Cabin Crew" did not specify anything related to flying while Fasting. After the accident, this ANO was revised on 1st December, 2020 as ANO-012-FSXX-6.0 and included "Flying while Fasting" at para D11.2. It states, "In compliance of CARs 1994 Rule 41(3) no crew member shall exercise the privileges of his / her license as a crew member while Fasting".

1.16.12.2. **PIA Safety Alerts on Flight Crew Flying while Fasting –** PIA regularly issued internal Safety Alerts on flying while fasting in line with PCAA regulations. Post-accident Safety Alerts on same subject were also explicit in line with PCAA regulations[44].

1.16.12.3. **PCAA Regulations on Flight Crew Nutrition**

(a) ANO of PCAA FSD "Contents of Operations Manual" (ANO-003-FSXX-5.0) provides guidance for Operators to prepare an Operations Manual in line with SARPs in ICAO Annex-6 Operation of Aircraft (Parts I and III) and CARs 1994 Rule 191 and 192. Under CARs 1994 Rule 191, an Operator (of commercial Operations) must create and provide an Operations Manual for use by, and guidance of the Operations personnel of the Operator. The Operations Manual must contain all necessary information, procedures and instructions to ensure the safe conduct of aircraft Operations.

(b) The ANO specifies inclusion of relevant regulations and guidance to crew members concerning health including meal precautions prior to and during flight[45].

1.16.12.4. **European Aviation Safety Agency (EASA) Regulations on Flight Crew Nutrition**[46]

(a) EASA Regulations on ensuring flight crew nutrition are more specific and elaborate. The concerned regulation is elaborated in ORO.FLT.240 Nutrition as following: -

(i) During the Flight Duty Period (FDP) there shall be the opportunity for a meal and drink in order to avoid any detriment to a crew member's performance, especially when the FDP exceeds 6 hours.

[44] PIA Safety Alert 2021, 2022
[45] PCAA ANO-003-FSXX-5.0 dated 26th February, 2015, section D5.1.7, Pg – 13-14
[46] https://www.easa.europa.eu/document-library/easy-access-rules/online-publications/easy-access-rules-air-operations?page=33

(ii) An Operator shall specify in its Operations Manual how the crew member's nutrition during FDP is ensured.

(b) Meal Opportunity is further elaborated in AMC1 ORO.FLT.240 Nutrition as following: -

(i) The Operations Manual should specify the minimum duration of the meal opportunity, when a meal opportunity is provided, in particular when the FDP encompasses the regular meal windows (e.g., if the FDP starts at 1100 hours and ends at 2200 hours meal opportunities for two meals should be given).

(ii) It should define the time frames in which a regular meal should be consumed in order not to alter the human needs for nutrition without affecting the crew member's body rhythms.

1.16.12.5. **PIA Regulations on Crew Nutrition**[47]

(a) PIA Operations Manual include the aspect of Nutrition and Health. The policy on crew meals as mentioned in Operations Manual is as following: -

(i) Preferably, crew meals should be taken on the ground. In flight, the crew meals shall normally be taken at the respective working stations.

(ii) Both flight and cabin crew shall have regular meals while on duty. It is recommended that light refreshments be taken between meals.

(iii) No two members of the same flight crew are permitted to eat the same type of food when operating a flight. Every reasonable precaution should be taken to avoid eating same food during meals taken within 12 hours of commencement of duty.

1.16.12.6. **Study on Effects of Hydration on Flight Crew**[48]

(a) A study was carried out to examine the effect of fluid intake and possible dehydration on cognitive[49] flight performance of pilots. A repeated-measures, counterbalanced, mixed study design was used to examine differences in working memory, spatial orientation, and cognitive flight performance of randomly selected healthy pilots.

(b) Flight performance was measured using a General Aviation Trainer (GAT) - II full-motion flight simulator. Each participant operated the simulator with simulated flight conditions being standardized for all participants. Air speed control, heading control, and altitude control were the performance tasks evaluated. These flight tasks are considered basic flight procedures by the Federal Aviation Administration (FAA) in the practical test standards for all FAA flight-testing for Private, Commercial, and Airline Transport Pilot Certification. Deviations from the assigned heading, air speed, and altitude in IMC (the entire flight was flown in the clouds) were recorded.

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[47] PIA Operations Manual Part-A (General), section 14.4 Nutrition and Health, Pg – 387-390
[48] Effects of Hydration on Cognitive Function of Pilots 1st July, 2013
[49] **Cognitive** are brain-based skills needed in acquisition of knowledge, manipulation of information and reasoning. The American Psychological Association defines cognitive ability as "the skills involved in performing the tasks associated with perception, learning, memory, understanding, awareness reasoning, judgment, intuition, and language. [*Source: https://www.skybrary.aero/articles/cognitive-capabilities-and-limitations]*

(c) Results showed flight performance and spatial cognition[50] test scores were significantly poor for pilots who had low fluid intakes and experienced dehydration in comparison to the hydrated pilots.

1.16.12.7. **The Impact of Somatic Stressors[51] on Flight Crew[52]**

(a) The study was to analyse the impact of noise, hypoglycemia and increased blood alcohol on piloting accuracy during the ILS Precision Approach procedure, since landing is the phase of flight with the highest accident rate and the pilot is subjected to the greatest mental stress. For the sake of safety, tests were conducted on pilots in a flight simulator.

(b) While short-term activation of stress response is essential for the organism to cope with stressful situations, excessive and repeated activation of stress response has an adverse effect on the body's activity. At present, stressors affect individuals relatively often, with long-term and excessive stressors having a proven adverse effect on the human body's activity. Thus, stress, as an inseparable part of human life is on the one hand an essential factor of life, on the other hand if it is excessive it can be a damaging factor leading to adverse reactions.

Kind of average deviation	Procedure Phase	Value [%]			
		Reference	Noise	Hypoglycemia	Alcohol
Vertical deviation from the descent axis	1. FAF (Final Approach Fix) - OM (Outer Marker)	6.23	15.95	26.31	18.65
	2. OM-MAPt (Missed Approach Point)	17.01	33.84	41.31	40.08
	Overall	17.01	33.84	41.31	40.08
Horizontal deviation from the descent axis	1. FAF-OM	6.61	7.16	8.6	4.7
	2. OM-MAPt	12.67	13.3	11.88	12.18
	Overall	9.83	10.4	10.38	8.78
Deviation from specified speed	1. FAF-OM	0.15	4.32	11.01	7.35
	2. OM-MAPt	24.91	23.89	29.37	27.37
	Overall	13.21	14.58	21.11	18.13

Table 30 – Average Deviation Values

(c) Based on a comprehensive evaluation of the results of the measurements, it was found that the hypoglycemia of the pilots tested had the greatest influence on the accuracy of the pilots, followed by increased blood alcohol levels and the least impact on the noise load.

Type of Measurement	The Greatness of the Total Average Deviation
Hypoglycemia	24.28 %
Alcohol	22.33 %
Noise	19.61 %
Reference measurement	13.35 %

Table 31 – Type of Measurement and Average Deviation

[50] **Spatial Cognition** is a branch of cognitive psychology that studies how people acquire and use knowledge about their environment to determine where they are, how to obtain resources, and how to find their way home. [*Source: https://www.apa.org/pubs/books/4318108]*

[51] **Somatic Stressors** is defined as relating to the body, especially as distinct from the mind.

[52] The Impact of Somatic Stressors on Pilot', 8th International Conference on Air Transport – INAIR 2019, University of Zilina, Zilina, Slovakia

(d) The results of research pointed to the risk of somatic stressors, mostly the effect of hypoglycemia. It is a stressor that is caused by a decrease in blood glucose. Hypoglycemia can be improved / maintained with proper diet.

1.16.13. **Sterile Flight Deck Procedure**

1.16.13.1. **ICAO Sterile Flight Deck Procedure**

(a) ICAO Doc 9870 defines Sterile Flight Deck as "Any period of time when the flight crew should not be disturbed, except for matters critical to the safe operation of the aircraft". Disturbances may include, but not be limited to, calls received from non-operational areas (e.g., company), entry onto the flight deck by cabin crew, and extraneous conversations not related to the current phase of flight[53].

(b) It is accepted that the need for a sterile cockpit commences as follows[54]: -

(i) Departure: when the aircraft Engine(s) are started and ceases when the aircraft reaches 10,000 ft elevation above the departure Aerodrome;

(ii) Arrival: when the aircraft reaches 10,000 ft elevation above the arrival Aerodrome until the Engine(s) are shut down after landing; and

(iii) At any other time determined and announced by the flight crew (e.g., in-flight emergency, security alert).

1.16.13.2. **Federal Aviation Administration (FAA) Regulation on Sterile Flight Deck**

(a) FAA Regulation on Sterile Flight Deck is covered in FAR 121.542 (Sterile Cockpit Rule) and reads as following[55]: -

(i) No certificate holder shall require, nor any flight crew member perform, any duties during a critical phase of flight except those duties required for the safe operation of the aircraft. Duties such as company required calls made for such non-safety related purposes as ordering galley supplies and confirming passenger connections, announcements made to passengers promoting the air carrier or pointing out sights of interest, and filling out company payroll and related records are not required for the safe operation of the aircraft.

(ii) No flight crew member may engage in, nor any pilot in command permit, any activity during a critical phase of flight which could distract any flight crew member from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in non-essential conversations within the cockpit and non-essential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft.

(iii) For the purposes of this section, critical phases of flight include all ground operations involving taxi, take off and landing, and all other flight operations conducted below 10,000 ft, except cruise flight.

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[53] ICAO Doc 9870 section 6.3.8, Taxi best practices, Pg – 46
[54] ICAO Doc 9870 section 6.3.9, Taxi best practices, Pg – 46
[55] Electronic Code of Federal Regulations (e-CFR) 121.542 - Flight Crew Member Duties para (c) [*Source: https://www.law.cornell.edu/cfr/text/14/121.542*]

1.16.13.3. **Sterile Flight Deck Concept by EASA[56]**

(a) As per the EASA website, the term 'Sterile Flight Deck' is used to describe any period of time when the flight crew shall not be disturbed e.g., by cabin crew, except for matters critical to the safe operation of the aircraft and / or the safety of the occupants. In addition, during these periods of time the flight crew members should focus on their essential operational activities without being disturbed by non-flight related matters, i.e. flight crew members should avoid non-essential conversations, should not make non-safety related announcements towards the passengers etc.

(b) Sterile flight deck procedures are meant to increase the flight crew members' attention to their essential operational activities when their focused alert is needed, i.e. during critical phases of flight (take off, landing etc.), during taxiing and below 10,000 ft (except for cruise flight).

1.16.13.4. **Sterile Cockpit Rule by Airbus –** Airbus FCTM includes Sterile Cockpit Rule[57] which states, "when the aircraft is below 10,000 ft, any conversation that is not essential should be avoided; this includes conversations that take place in the cockpit, or between the flight crew and cabin crew. It is important to adhere to this policy, in order to facilitate communication between both flight crew, and to ensure the effective communication of emergency or safety-related information, between flight and cabin crew members".

1.16.13.5. **Sterile Flight Deck PCAA**

(a) Air Safety Circular (ASC) of PCAA FSD "Guidance for Air Operators on Avoiding Unstabilized Approaches" (ASC-022-FSXX-1.0) includes a typical Approach divided in stages with key events and includes sterile cockpit at around 10,000 ft[58].

(b) Moreover, in ASC of PCAA FSD "Standard Operating Procedures" (ASC-010-FSXX-2.0) Sterile Cockpit Procedure is included under the heading of Flight Deck Discipline in Standard Operating Procedure (SOP) Template[59].

1.16.13.6. **Sterile Flight Deck Rule in PIA**

(a) PIA Operations Manual Part-A (General) includes a comprehensive Sterile Cockpit Rule[60]. The flight deck shall be considered sterile during all flight operations at or below 10,000 ft Above Ground Level (AGL) including ground operations of the aeroplane, and during all other critical phases of flight as declared by Pilot In-Command (PIC). Following protocols shall be followed during the sterile phase: -

(i) Cockpit crew shall not leave their seats below 10,000 AGL.

(ii) All communication and activities on the flight deck should be limited to those essential to the safe operation of the flight.

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[56] EASA FAQs (n.19134) Sterile Flight Deck Procedures *[Source: http://data.europa.eu/eli/reg/2015/140/oj]*
[57] Airbus FCTM, Sterile Cockpit Rule, Pg – 157,158
[58] PCAA Air Safety Circular ASC-022-FSXX-1.0 (Guidance for Air Operators on Avoiding Unstabilized Approaches), Figure Typical Approach Stages, Pg – 3
[59] PCAA Air Safety Circular ASC-010-FSXX-2.0 (Standard Operating Procedures), Standard Operating Procedures Template (Appendix-A), Pg – 8 & 9
[60] PIA Operations Manual, Part-A (General), Sterile Cockpit Rule, section 8.1.8, Pg – 239

(iii) Interphone shall be used for all communication between cockpit and cabin crew. Headset and boom mikes shall be used for all communication with ATC.

(iv) Remember, below 10,000 ft if it's not directly related to flight safety, it's in violation with the sterile cockpit rule.

(b) Sterile Cockpit Procedure for cabin crew is explained in Safety Equipment and Procedure (SEP) Manual.

1.16.14. **Flight Data Analysis (FDA) / Flight Data Monitoring (FDM)**

1.16.14.1. FDA is a process of analysing recorded flight data in order to improve the safety of flight operations[61]. In some documents it is referred as FDM and also as Flight Operational Quality Assurance (FOQA). As per ICAO standard, the Operator of an aeroplane of a maximum certificated take off mass in excess of 27,000 kg shall establish and maintain an FDA programme as part of its Safety Management System (SMS)[62].

1.16.14.2. With the availability of efficient onboard recorders, and ease of downloading data, the implementation of FDM has become more efficient and easier. The programme's true benefit can be accrued by effectively dovetailing it with the SMS. For the analysis of retrieved / downloaded data various software solutions are available in the market which analyse the data for various pre-selected exceedance datum. Effective FDM application increases effectiveness of SMS and can help identify the potential operational hazards in a proactive manner, and identify the training needs of the flight crew. An Operator can also outsource the FDA / FDM programme to another party while maintaining the overall responsibility for the maintenance and implementation of such programme.

1.16.14.3. FDM is based on non-punitive approach and data is de-identified for analysis. The identified data is only available to a very selective group, and it is recommended to have robust procedures in place to ensure the confidentiality. However, there are exceptions in case of continuous safety concerns, and gross violation etc. The detailed guidelines for developing an FDA / FDM programme are given in ICAO Doc 10000 (FDA Programmes Manual).

1.16.14.4. **PCAA Regulation for FDA**

(a) ANO of PCAA FSD "Flight Data Analysis Programme and Flight Data Monitoring" (ANO-028-FSXX-3.0) requires the Operators of the aircraft with maximum certified take off mass in excess of 27,000 kg to establish and maintain FDA Programme, combining it with SMS. It also gives guidance on maintaining confidentiality of flight crew while elaborating exceptions where this protection may become invalid.

(b) An exception to the de-identification of FDM data should be made when there is an incident that is subjected to a Mandatory Occurrence Report (MOR). In this case the identified data must be retained for any subsequent safety investigation. A safety rather than disciplinary approach should be taken in these cases[63].

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[61] ICAO Annex-6 (Part-I) – Aeroplanes – Chapter-1, Definitions, Pg – 45
[62] ICAO Annex-6 (Part-I) – Aeroplanes – section 3.3.2, Safety Management, Pg – 57
[63] PCAA ANO-028-FSXX-3.0, FDA Programme and FDM, D-17.5, Crew Identification in Mandatory Occurrences, Pg – 21

1.16.14.5. **FDA Procedure of PIA –** PIA has developed FDA procedure (SP-01 Rev. 06, 3rd September, 2020) in line with PCAA ANO-028-FSXX-3.0. PIA is using AirFASE as its FDA software solution. AirFASE is provided by Airbus containing Airbus Flight Data Analysis Event List (AFDAEL) which is referencing all existing FDA events (triggers).

1.16.15. Stabilized Approach Criteria

1.16.15.1. The Operations Manual shall contain Stabilized Approach Procedure in list of items of Operations Manual as per ICAO Annex-6[64].

1.16.15.2. Stabilized Approach Criteria recommended by the Flight Safety Foundation (FSF) Approach and Landing Accident Reduction (ALAR) Task Force is as follows[65]: -

(a) All flights must be stabilized by 1,000 ft above airport elevation in IMC and by 500 ft above airport elevation in VMC.

(b) An Approach is stabilized when all of the following criteria are met: -

(i) The aircraft is on the correct flight path.

(ii) Only small changes in heading / pitch are required to maintain the correct flight path.

(iii) The aircraft speed is not more than VREF +20 kts IAS and not less than VREF.

(iv) The aircraft is in the correct landing configuration.

(v) Sink Rate is no greater than 1,000 ft/min; if an Approach requires a Sink Rate greater than 1,000 ft/min, a special briefing should be conducted.

(vi) Power setting is appropriate for the aircraft configuration and is not below minimum power for Approach as defined by the aircraft Operating Manual.

(vii) All briefings and checklists have been conducted.

(viii) Specific types of Approaches are stabilized if they also fulfil the following: -

- ILS Approaches must be flown within one dot of the G/S and Localizer.
- Category II or Category III ILS Approach must be flown within the expanded Localizer band.
- During a circling Approach, wings should be level on final when the aircraft reaches 300 ft above airport elevation.

(ix) Unique Approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized Approach require a special briefing.

(c) An Approach that becomes unstabilized below 1,000 ft above airport elevation in IMC or below 500 ft above airport elevation in VMC requires an immediate Go-Around.

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[64] ICAO Annex-6 (Part-I) – Aeroplanes – 2.1.25, General, Pg-154

[65] FSF ALAR *[Source: https://flightsafety.org/wp-content/uploads/2016/09/alar_bn7-1stablizedappr.pdf]*

1.16.15.3. **Stabilized Approach Criteria recommended by Airbus –** Stabilization Criteria recommended by Airbus in FCOM of A320 aircraft is as following: -

(a) The stabilization height is defined as one of the following: -

(i) 1,000 ft Above Aerodrome Level (AAL) in IMC, or

(ii) 500 ft AAL in VMC, or

(iii) Any other height defined in Operator policies or Regulations.

(b) In order for the Approach to be stabilized, all of the following conditions must be satisfied before, or at the stabilization height: -

(i) The aircraft is on the correct lateral and vertical flight path.

(ii) The aircraft is in the desired landing configuration.

(iii) The thrust is stabilized, usually above IDLE, and the aircraft is at target speed for Approach.

(iv) The flight crew does not detect any excessive flight parameter deviation.

Note: In IMC, a later speed and thrust stabilization can be acceptable provided that: -

- It is in accordance with Operator policies and Regulations.
- The aircraft is in deceleration toward the target Approach speed.
- The flight crew stabilizes speed and thrust as soon as possible and not later than 500 ft AAL.

(c) If one of the above-mentioned conditions is not satisfied, flight crew must initiate a Go-Around, unless they estimate that only small corrections are required to recover stabilized Approach conditions.

1.16.15.4. **Stabilized Approach Criteria by PCAA**

(a) PCAA has issued ASC on "Guidance for Air Operators on Avoiding Unstabilized Approaches". Recommended altitude datum to achieve Approach stabilization is 1,000 ft AAL in both IMC and VMC. However, in IMC, only if ATC procedures require higher speeds and is allowed in Operations Manual, stabilization criteria of 1,000 ft may not be met, stabilization of speed and thrust must be achieved as soon as possible but not later than 500 ft AAL. In case the Approach stabilization criteria are not met by these altitudes, pilots must initiate a Go-Around[66].

(b) The circular mentions that regulatory bodies do not mandate criteria for a stable Approach. But the criteria are instead established by each airline to suit their operations and then included in the airline's Operations Manual. Therefore, the criteria for continuing an Approach tends to vary. The criteria recommended by FSF has been reproduced in the circular as a rough reference for illustration purposes with a mention that criteria used by most airlines tend to be reasonably close to those criteria[67].

[66] ASC-022-FSXX-1.0, Guidance for Air Operators on Avoiding Unstable Approaches, section C4, Typical Stages Criteria for Stabilized Approach, Pg – 4

[67] ASC-022-FSXX-1.0, Guidance for Air Operators on Avoiding Unstable Approaches, section C5, Pg – 4

(c) The circular specifies that the stabilization criteria on Approach is judged to be stable varies with the airline SOPs, and can be 1,000 ft or more AAL in IMC as well as in VMC. Should the aircraft not meet these criteria, it is considered to be unstable, and a pilot must execute a Go-Around[68].

1.16.15.5. **Stabilized Approach Criteria by PIA**

(a) Approach Stabilization Criteria and other relevant aspects are given in PIA Operations Manual (Part-A). The Approach is stabilized when all of the following conditions are met: -

(i) The aeroplane is on the correct flight path.

(ii) Only small changes in heading / pitch are required to maintain the correct flight path.

(iii) The aeroplane speed is not more than VREF+20 kts IAS and not less than VREF; or as adjusted by minimum GS techniques.

(iv) The aeroplane is in the correct landing configuration.

(v) Rate of Descent is no greater than 1,000 ft/min below 2,000 ft AGL. If an Approach requires a Rate of Descent greater than 1,000 ft/min, a special briefing should be conducted.

(vi) Power setting is appropriate for the aeroplane configuration and is not below the minimum power for Approach as defined by aeroplane Operating Manual.

(vii) All briefings and checklists have been completed.

(b) Unique Approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized Approach require a special briefing.

(c) PIA has a no-fault Go-Around policy when crew decides to execute a Go-Around after having committed to land at any airfield due to factors deemed against safety of flight. However, for feedback and data compilation purposes only, Captain shall annotate any Go-Around or diversion in debriefing.

(d) A Go-Around is mandatory if the aeroplane is not stabilized on Approach by 1,000 ft AGL, irrespective of VMC or IMC.

(e) Where certain type of Approaches (e.g., low visibility, circling, non-precision) necessitate turns for alignments purpose below 500 ft, it is essential that special attention be given to bank angle.

(f) The Operations Manual also mentions that both pilots shall monitor the Approach, and PM shall make the appropriate callouts as per FCOM / SOP.

[68] ASC-022-FSXX-1.0, Guidance for Air Operators on Avoiding Unstable Approaches, section C7, Pg – 5

1.16.15.6. **Standard Callouts during Approach**[69]

(a) The FCOM of Airbus for A320 aircraft mentions standard callouts to be announced by PM during Approach as following: -

(i) "SPEED" if the speed decreases below the speed target -5 kts or increases above the speed target +10 kts.

(ii) "SINK RATE" when the Descent Rate exceeds 1,000 ft/min.

(iii) "BANK" when bank angle becomes greater than 7°.

(iv) "PITCH" when pitch attitude becomes lower than -2.5° or higher than +10°.

(v) "LOC" or "GLIDE" when either Localizer or Glide Slope deviation is: -

- ½ dot LOC.
- ½ dot G/S.

(vi) "CROSS TRACK" when the XTK is greater than 0.1 NM.

(vii) "V/DEV" when the vertical deviation is greater than ½ dot.

(viii) "COURSE" when greater than ½ dot or 2.5° (VOR) or 5° (ADF).

(ix) "__ FT HIGH (LOW)" at altitude checks points.

Note: The PM announces the attitude deviations until landing.

1.16.16. **Crew Resource Management (CRM)**

1.16.16.1. **CRM Training Requirement by PCAA**

(a) Crew Resource Management (CRM) Training is a worldwide accepted tool to create awareness about human performance and its limitations, and various concepts and techniques to harness the human error. Efficient utilization of CRM training can help in effective utilization of all human and material resources, hardware, and information towards safe operation of flight.

(b) Detailed guidelines for an effective CRM programme are mentioned in ANO of PCAA FSD “Crew Resource Management Training” (ANO-014-FSXX-2.0). PCAA has included CRM in the list of mandatory ground courses required by a pilot to exercise privileges of license. Each crew member is required to undergo a CRM refresher every 24 months after the initial course, and no waiver is admissible in this regard[70]. The Operators are responsible for flight crew initial and refresher CRM training and record keeping.

1.16.16.2. **CRM Training of Flight Crew by PIA –** PIA Operations Manual (Part-A) pertains to Crew Resource Management Training[71]. PIA has trained CRM Facilitators for conduct of CRM training of flight crew.

[69] Airbus FCOM, SOP Callouts, Pg – 3904
[70] PCAA FSD letter No. HQCAA/1076/019/FSAC/4443 dated 11th April, 2022, Page – 2 (m)
[71] PIA Operations Manual, Part-A (General) section 3.8, Crew Resource Management Training, Pg – 147-165

1.16.17. **Runway Inspection Report**[72]

1.16.17.1. Post-accident inspection of R/W 25L at JIAP, Karachi indicated both Engines touched on R/W at four different locations leaving scratch marks of varying length and width. The Engines dragging occurred almost symmetrical about R/W centre line. R/W surface being concrete pavement remained intact; however, the surface got severely abraded due to scrubbing of both Engines at high speed.

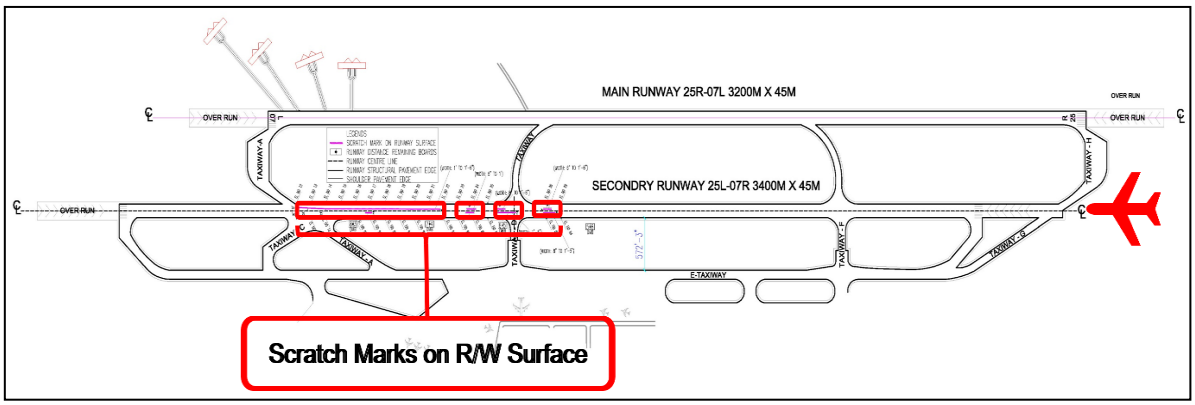


Figure 115 – Scratch Marks on R/W Surface

1.16.17.2. **First Touchdown –** Aircraft touched down almost 4,500 ft from threshold R/W 25L. Initially left Engine touched on the R/W followed by the right Engine. The total dragging distance of left Engine was 155 ft (with scratch marks width varying from 8 inches to 17 inches). Whereas, the total dragging distance of right Engine was 105 ft (with scratch marks width varying from 6 inches to 18 inches).

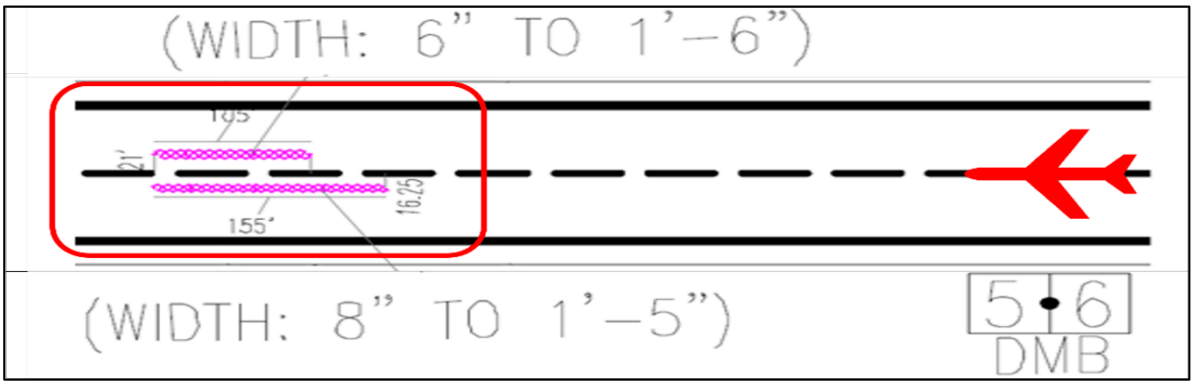


Figure 116 – First Touchdown Scratch Marks on R/W Surface

1.16.17.3. **Second Touchdown –** Aircraft second touchdown was almost 6,000 ft from threshold R/W 25L. Initially left Engine touched on the R/W followed by the right Engine. The total dragging distance of left Engine was 235 ft (with scratch marks width of 18 inches). Whereas, the total dragging distance of right Engine was 110 ft (with scratch marks width from 8 inches to 18 inches).

[72] PCAA Runway Inspection Report - JIAP/1396-1/5/4/KCAS dated 29th May, 2020

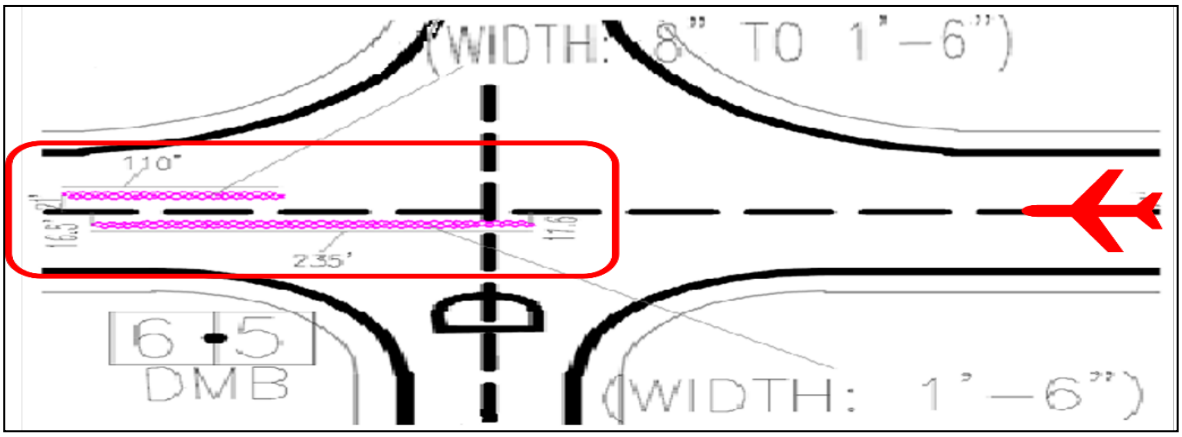


Figure 117 – Second Touchdown Scratch Marks on R/W Surface

1.16.17.4. **Third Touchdown –** Aircraft third touchdown was almost 6,330 ft from threshold R/W 25L. Initially right Engine touched on the R/W followed by the left Engine. Lengths of left Engine and right Engine scratch marks were 112 ft and 124 ft respectively and widths varying from 6 inches to 12 inches).

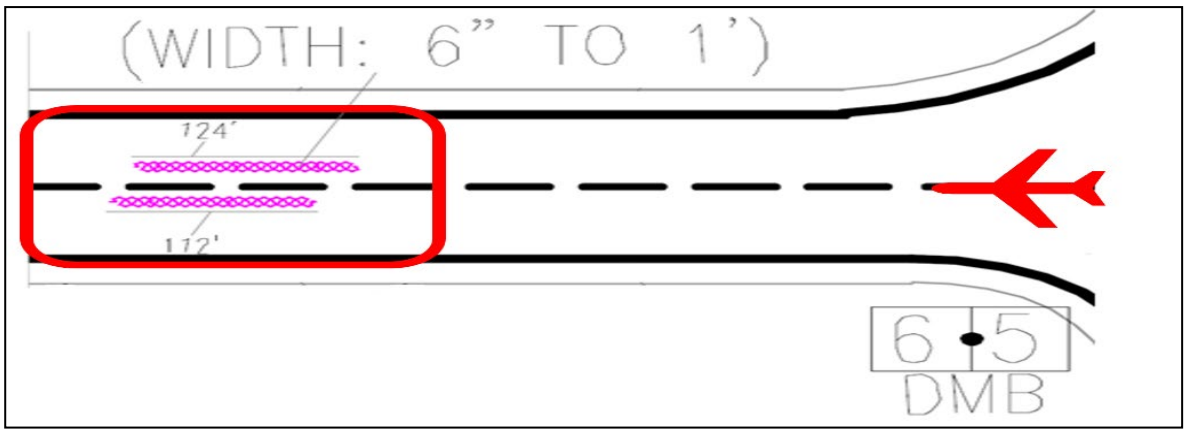


Figure 118 – Third Touchdown Scratch Marks on R/W Surface

1.16.17.5. **Fourth Touchdown –** Aircraft fourth touchdown was almost 6,810 ft from threshold R/W 25L. Initially right Engine touched on the R/W followed by the left Engine. The total dragging distance of right Engine was 1,855 ft (with scratch marks width varying 12 to 18 inches). Whereas, the total dragging distance of left Engine was 81 ft. It appears that right Engine dragged for a quite long time as compared to left Engine. Additionally, the right Engine marks were deviating from the centre line after the last ¾ portion of total dragging distance in fourth touchdown.

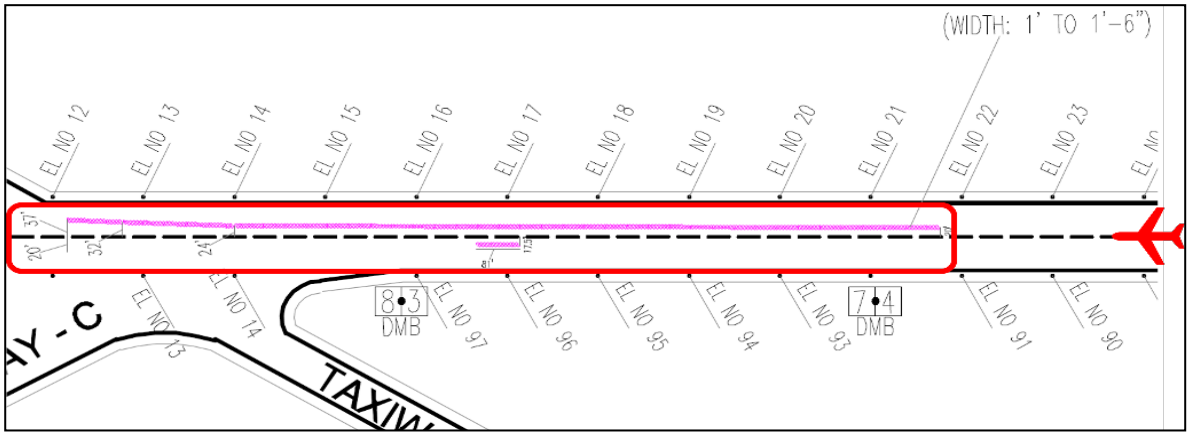


Figure 119 – Fourth Touchdown Scratch Marks on R/W Surface

1.17. **Organizational and Management Information**

1.17.1 **Pakistan International Airlines (PIA)[73]**

1.17.1.1 PIA is the national flag carrier of Pakistan. It has a well-established organizational structure, and held valid state issued Air Operator Certificate (AOC) at the time of accident. PIA main base is at Karachi, with additional bases located at Lahore and Islamabad. PIA aims to be safe, efficient, reliable, profitable and is performing the corporate functions of Air Transport Service of following types: -

(a) Regular Public Transport (RPT).

(b) Charter.

(c) Aerial Work.

1.17.1.2 PIA has a Management system for the Flight Operations intended to ensure supervision and control of Flight Operations, Management of Safety and Security functions and other associated activities in accordance with standards set forth by PIA itself and requirements of the state (AOC). Flight Operations Department is aimed to achieve these objectives by efficiently managing the personnel, equipment and facilities that have been provided to it. Flights are to be conducted in accordance with the PIA operating policy as follows: -

(a) Safety is always the first priority.

(b) Depending on the actual situation and with due regard to possible consequences, economy, schedule and passenger comfort is weighed carefully.

1.17.1.3 The key position holders of the Flight Operations Department are made responsible for the outcome of safety, quality audits, implementation of accident / incident investigation report's recommendations etc in their respective areas of responsibilities.

1.17.1.4 Director Flight Operations has been made accountable to senior Management for ensuring the day-to-day Security, Safety and Supervision of Flight Operations and its activities in accordance with conditions and restriction as per AOC and in compliance with all applicable regulations and standards which are outlined in PIA's Operations Manual.

1.17.1.5 PIA Training Centre Karachi conducts various courses for both flight crew and cabin crew including initial as well as recurrent trainings. In addition, Flight Simulator Complex, a part of PIA Training Centre is established at Karachi. At the time of the accident, it had Boeing 777 flight simulator functional, simulator training requirements of A320 and ATR were fulfilled at simulator facilities abroad. However, in April, 2022, PIA started the induction process for flight simulator of A320 at its Flight Simulator Complex to ease out its training challenges. The facility is operational now.

1.17.1.6 The management and control of Flight Operations documentation and / or data used in the conduct or support of operations is being maintained through Centralized Documentation System (CDS) on PIA's website. The CDS provides all information pertaining to the control management of documents. These documents include: -

[73] PIA Operations Manual – Part-A (General) section 1.1.1, Conduct of Flight Operations, Pg – 33

(a) Operations Manual Part-A, Operational Manual Part-D

(b) FCTM / SOP (All Aircrafts)

(c) On-Board Technical Library

(d) Other relevant documents for the flight crew

1.17.1.7 A detailed overview of PIA as an organization and its management of operations is provided in PIA's Operations Manual Part-A (General). This publication comprises of all non-type related policies, instructions and procedures needed for safe operations.

1.17.1.8 **Flight Crew Training Policy at PIA –** PIA has a Training Policy that provides basic principles for governing the entire domain of training of flight crew, and of oversight and supervision of all flight training activities. This policy is directed towards achieving high standards during operations. This training policy and related functional matters are provided in the PIA Operations Manual Part-D (Training)[74], Salient aspects of the Training Policy are as follows: -

(a) It is based on the requirements of the PCAA as promulgated in the CARs 1994 and ANOs. Additionally, it also encompasses PIA's own requirements, which relate to simulator and aircraft endorsements, recurrent cyclic training, technical courses, examinations and evaluations, etc.

(b) Chief Pilot Crew Training has been made over all responsible. He ensures that all Training Division personnel are qualified for their respective duties and are familiar and current with layout and contents of Operations Manual Part-D. These personnel shall include training schedulers, crew licensing and administrative support personnel.

(c) The documents and material authorized and / or published by PIA shall be used by the flight crew, and by the training and check flight crew for all operating, training and evaluation activities.

1.17.1.9 **Safety Programme Management of PIA**

(a) PIA has a Safety Programme Management System supported by adequate resources, a safety policy, relevant management tools, and systems to conduct analysis of related aspects. A SMS Manual[75] has been updated from time to time and encompasses various aspects important for safety management.

(b) PIA also has an elaborate Corporate Safety and Quality Assurance Department. General Manager (GM) Safety / Head of Safety reports directly to the Chief Executive Officer (CEO). Quality Assurance responsibilities are delegated to Deputy General Manager Corporate Quality Assurance (DGM CQA) who functionally reports to GM Safety / Head of Safety. PIA organizational chart, is depicted in SMS Manual. The Manual also elaborates Safety Management as the primary function of the department with numerous related sub-functions. The sub-functions (not limited to only these) are as following: -

[74] PIA Operations Manual Part-D (Training), section 1.1.1, General Training Policy, Pg – 27
[75] PIA Safety Management System Manual dated 23rd January, 2019

(i) Safety Assurance of Airline Operation
(ii) Safety Performance Monitoring
(iii) Hazard Assessment and Risk Management
(iv) Spot Checks and Safety Inspections
(v) Investigations of Accidents / Incidents
(vi) Health Safety Environment (HSE), Food and Water Hygiene Programmes
(vii) Safety Promotion
(viii) Ramp Inspection
(ix) Fire Protection Services
(x) Liaison with Internal and External Regulatory and Safety Bodies
(xi) Flight Data Monitoring and Analysis
(xii) Crew Resource Management Training
(xiii) Safety Information Dissemination
(xiv) Safety Auditing of the Organization
(xv) Emergency Response Planning
(xvi) Safety Training of Cockpit and Cabin Crew
(xvii) Establishing MOR System
(xviii) Establishing and Maintaining a Confidential Reporting System
(xix) Creation of Emergency Equipment Location Charts
(xx) Safety Training of Ground Personnel

1.17.2 **Pakistan Civil Aviation Authority (PCAA) as an Oversight Organization**

1.17.2.1 PCAA is a public sector autonomous body working under the Federal Government of Pakistan through Ministry of Aviation. PCAA was established in 1982 through PCAA Ordinance 1982. PCAA provides regulations for Civil Aviation activities for safe and efficient operations for the Civil Air Transport Service in Pakistan, in accordance with International SARPs. PCAA in addition to the regulatory function also performs the service provider functions of Air Navigation Services (ANS) and Airport Services (APS). The Headquarters of PCAA (HQCAA) is located at Karachi.

1.17.2.2 The administration of PCAA is vested with PCAA Board which exercises all powers, and performs all functions that are required by the PCAA. Chairman PCAA Board is the Secretary, Ministry of Aviation. Additionally, PCAA has an Executive Committee, which is the highest decision-making body of the Organization. It exercises powers as delegated to it by the Authority. Director General (DG) PCAA is the Chairman of PCAA Executive Committee.

1.17.2.3 PCAA has well established setup to oversee all the Operators (as per the guidelines provided in relevant SARPs and ICAO publications) for safe and efficient management of Flight Operations, Maintenance Management, Training, Licensing, and various aspects of Quality Management and Proactive Safety Programs.

1.17.2.4 While each directorate / office holder is responsible for various regulatory functions, PCAA FSD is most relevant considering its oversight functions and the circumstances unfolded during the investigation of PIA 8303. Therefore, functions and organization of FSD were analysed in detail.

1.17.2.5 FSD performs the task of maintaining regular surveillance of the operational aspects of all Air Transport Operators in order to ensure safe and efficient Flight Operations. In order to accomplish these tasks, qualified Flight Operations Inspectors are appointed to conduct Surveillance / Inspection / Checks etc to ensure that the proficiency of the flight crew is in accordance with the ICAO SARPs. The directorate also conducts annual Audits of the Operators at the time of renewal of AOC. AOC Audit reports of PIA for the years 2016 to 2019 were examined during the course of this investigation.

1.17.2.6 State Safety Programme (SSP) of Pakistan aims to establish an overarching surveillance over various regulatory and safety functions of the state. Being a recent initiative, this setup is based on the provisions contained in ICAO Annex-19 and the procedures established in ICAO Doc 9859. Safety oversight policy states that under SSP, PCAA is responsible for oversighting certificate holders / service providers operating in an SMS environment. During May, 2020, the programme was not fully matured and the responsibility of surveillance of the operational aspects of Air Transport Operators was vested with the PCAA FSD.

1.17.2.7 ICAO conducted Universal Safety Oversight Audit Program (USOAP) Continuous Monitoring Approach (CMA) activity for Pakistan from 29th November to 10th December, 2021. Final report of the USOAP CMA Audit published in April, 2022, indicates 72.31% overall Effective Implementation for the 08 Critical Elements (CEs) of the State's safety oversight system.

1.18. Additional Information

1.18.1. Karachi Area Control Centre (ACC) and Tower

1.18.1.1. As per Station Air Traffic Instructions (SATI) JIAP, Karachi[76], Air Traffic Control at Karachi is divided into following units: -

(a) Aerodrome Control

(b) Approach Control

(c) Area Control

(d) Ground Operation Control

(e) Pre-Flight Information Unit

1.18.1.2. Karachi Aerodrome Control Service is responsible for the provision of ATS in the vicinity and on the manoeuvring / movement area of Aerodrome at JIAP, Karachi. Karachi Aerodrome Control Service is provided by an Aerodrome Controller, Ground Movement Controller and Ground Operation Controller.

1.18.1.3. Karachi Approach Control Services are being provided by an Approach Controller (Radar / Procedure).

[76] PCAA Station Air Traffic Instructions (SATI) JIAP, Karachi

1.18.1.4. Area Control JIAP, Karachi is responsible for the provision of Air Traffic Services (ATS) in Karachi Flight Information Region (FIR). Karachi FIR has been divided into four Sectors i.e. Sector East, Sector West, Sector North and Sector South. Each Sector has an Area Radar Controller and Area Procedure Controller.

1.18.1.5. **Manning of Karachi ACC and Tower**

(a) In the month of March, 2020, lockdown was imposed in Pakistan due to COVID-19 Pandemic. Due to the lockdown, air traffic density was considerably reduced. Comparison of average daily traffic before and during lockdown period is as follows: -

Average Daily Traffic Density Before COVID-19 Pandemic Lockdown			
Month	**Arrivals**	**Departures**	**Transits**
1st January, 2020 – 31st January, 2020	77	77	663
1st February, 2020 – 29th February, 2020	77	77	656
1st March, 2020 – 23rd March, 2020	69	69	508
Average Daily Traffic Density During COVID-19 Pandemic Lockdown			
Month	**Arrivals**	**Departures**	**Transits**
24th March, 2020 – 31st March, 2020	03	03	120
1st April, 2020 – 30th April, 2020	05	05	105
1st May, 2020 – 31st May, 2020	08	08	136

Table 32 – Average Daily Traffic Density Before and During COVID-19 Pandemic Lockdown

(b) Considering decreased traffic density and guideline issued by PCAA Operations Directorate[77], contingency duty roaster was prepared by merging different ATC positions. Same duty roster was followed on the day of accident. The available record indicate that all the controlling positions were manned as per duty roster. Manning of Karachi ACC and Tower before and during COVID-19 Pandemic is as follows: -

Manning of Karachi ACC and Tower		
Manpower Detail	**Before COVID-19 Pandemic Lockdown**	**During COVID-19 Pandemic Lockdown**
Team Leader	01	-
Approach Controller	01	01 (Team Leader)
Area Radar Controller	04	03
Area Non-Radar Controller	04	01
Aerodrome Controller	01	01 (Aerodrome and Ground Movement Controller combined)
Ground Movement Controller	01	-
Ground Operation Controller	01	01
Pre Flight-Information Officer	01	01
Total	**14**	**08**

Table 33 – Manning of ACC and Tower Before and During COVID-19 Pandemic Lockdown

[77] PCAA Operations Directorate Telex No. HQCAA/1221/047/OPAT dated 24th March, 2020

1.19. **Useful or Effective Investigation Techniques**

1.19.1. Standard investigation techniques and engineering simulations were used during the course of this investigation.

SECTION 2 - ANALYSIS

2.1 General

2.1.1 Aircraft touched the R/W surface with Landing Gears in retracted position, it sustained damages which affected its subsequent flight performance and caused loss of both Engines during Go-Around. The analysis is therefore conducted with an aim to find out reasons leading to the accident.

2.1.2 It was neither possible to predict or simulate the thrust available after damage to the Engines during R/W contact nor the aircraft is designed or certified for such flight conditions. Original Equipment Manufacturer (OEM) publication contains comprehensive procedures, warnings, and alerts to keep the flight crew aware, and avoid such situations.

2.2 Flight Operations

2.2.1 **Flight Crew Qualifications –** The flight crew were certified and qualified in accordance with applicable Rules of PCAA[78]. Both pilots fulfilled desired qualification and fitness criteria for flight crew and were scheduled to operate the event flight in the respective assigned roles.

2.2.1.1 Captain

(a) Captain started his career in PIA on 3rd March, 1996. During his career he flew as FO on Fokker F-27, Boeing 737, Airbus 310, and Boeing 777 aircrafts. He was promoted as Captain on ATR aircraft in March, 2013 and subsequently on A320 in May, 2015. At the age of 58 years, he had accumulated 4783:46 hrs on A320 aircraft as a Captain and a total of 17252:27 hrs of flying experience. His career progression remained smooth without any significant observation. In year 2019, he was appointed as Standards Inspector on A320 aircraft.

(b) He was issued show cause notice by PCAA for violating flight duty time limit and for exceeding stipulated limits of flying hours within 30 / 365 days. In the year 2014, he was considered for supervisory assignment on ATR aircraft but was not recommended during evaluation due to lacking in technical knowledge and general awareness. Analysis of his flying hours from 2017 to 2019 indicates that he was a keen flyer. During a period of 3 years (2017-2019) his yearly flying hours were almost 33% more than the yearly average of all A320 Captains of PIA during the same time period.

(c) His training record did not reveal any significant observation. He has been fulfilling the requirements stipulated by PCAA in terms of training and proficiency. At the time of accident, he had valid ATPL, Medical Certificate, Instrument rating, Type Rating on A320 and CRM Currency.

(d) He was married and led a normal family life. There were no social / psychological issues reported / documented by PIA / PCAA in their respective records.

[78] Records regarding flight crew licensing / medical fitness and training.

(e) He was of bossy nature, firm, dominant and overbearing. He had below average intelligence. He tends to have little regard for the authority. He had low mechanical comprehension with low comprehension of space relations. His level of stress tolerance was also quite inadequate[79].

2.2.1.2 **First Officer**

(a) First Officer started his career in PIA on 9th August, 2010. During his career he flew as FO on ATR and Airbus 320 aircraft. At age of 33 years, he had accumulated 1504:58 hrs on A320 aircraft and a total of 2291:15 hrs of flying experience. He had few observations on his flying performance during his initial checks on ATR aircraft as FO. He was endorsed with 03 SBs (Satisfactory with Briefing) entries {Engine Failure after V1 (M), Abnormal and Emergency Procedures, Pilot Assessment [Procedural Execution and Adherence (M)]} during his initial Simulator Check on ATR aircraft conducted in July, 2014 for which he was advised by PIA Chief Pilot Crew Training. He was again endorsed with 05 SBs (Knowledge and Procedures) in his initial line check during December, 2014 for which he was again advised by PIA Chief Pilot Crew Training. Moreover, he was put under observation by PCAA Inspector during 2015. Based on these observations, his promotion as FO on A320 aircraft was initially withheld during promotion board conducted in February, 2016.

(b) He was subsequently cleared for promotion and completed his training successfully on A320 aircraft and was cleared to fly as FO. He has been fulfilling all the requirements stipulated by PCAA in terms of training and proficiency. At the time of accident, he had valid CPL, Medical Certificate, Instrument Rating, and CRM Currency.

(c) FO was unmarried, lived with his parents and led a normal life. There were no social / psychological issues reported / documented by PIA / PCAA in their respective records.

2.2.2 **Operational Procedures**

2.2.2.1 **Cockpit Environment of PIA 8303 –** CVR analysis revealed that the cockpit environment was conducive and cordial. Throughout the flight, flight crew continued discussion on various topics. The discussion also included the topic of COVID-19 Pandemic, however, there was no indication of any fear or compulsion to fly during the COVID-19 Pandemic.

2.2.2.2 **Sterile Cockpit Rule –** Flight deck shall be considered sterile during all flight operations at or below 10,000 ft AGL including ground operations of the aircraft, and during all other critical phases of flight as declared by PIC. Communication and activities on the flight deck should be limited to those essential to the safe operation of the flight. Flight crew did not follow the Sterile Cockpit Rule during the event flight and were discussing various topics not related to aircraft operations.

[79] Aviation Psychologist Analysis dated 29th June, 2022

2.2.2.3 **Approach Briefing Prior to Descent –** Prior to descent, flight crew were required to conduct Approach briefing. However, they were discussing various topics not relevant to this phase of flight. Approach briefing was not conducted which includes briefing of arrival trajectory, missed Approach strategy and accordingly cross checking of FMS preparation (Descent Preparation by flight crew FCOM / PRO / NOR / SOP / 16 & FCTM / PR / NP / SOP / 160).

2.2.2.4 **Beginning of Descent, FL340 / >100 NM**

(a) Prior to descent, FO was found to be Pilot Flying (PF), whereas Captain was found Pilot Monitoring (PM). Aircraft was in cruise at FL340, CAS 268 kts and Mach 0.77. Thrust Levers were in Climb Notch, SLATS were retracted (CONF0). The display of selected altitude on FCU was set to FL150. AP-2 and both FDs (FD-1 and FD-2) were engaged, and A/THR was active.

(b) At 09:15:00, FO requested ATC for descent. At 09:15:07, ATC called “Pakistan 8303 Descent FL100, Pilot discretion proceed direct MAKLI”. The MAKLI waypoint is located 4 NM before SABEN and 15.3 NM from R/W 25L threshold.

(c) At 09:15:38, flight crew initiated descent from FL340, the selected altitude on FCU was changed to FL100 and DES MODE was engaged (flight crew pushed the ALT knob on the FCU). The CAS was 268 kts (managed target speed). V/S was constant, around 1,000 ft/min, which indicated that aircraft was below the FMS descent profile.

(d) After clearance of PIA 8303 to descent FL100 direct to MAKLI, there was neither FMA callout nor cross check of FMS setting by flight crew (“DIR TO MAKLI” and “DES Green – FL100 – Check”). As per the Airbus Golden Rules for pilots provided in the FCTM, understanding / monitoring the FMA is required at all time and it also includes cross-checking of all FMA changes. Indicative of lack of application of procedures / adherence to SOP by flight crew (Golden Rules for Pilot FCTM / AOP / 40).

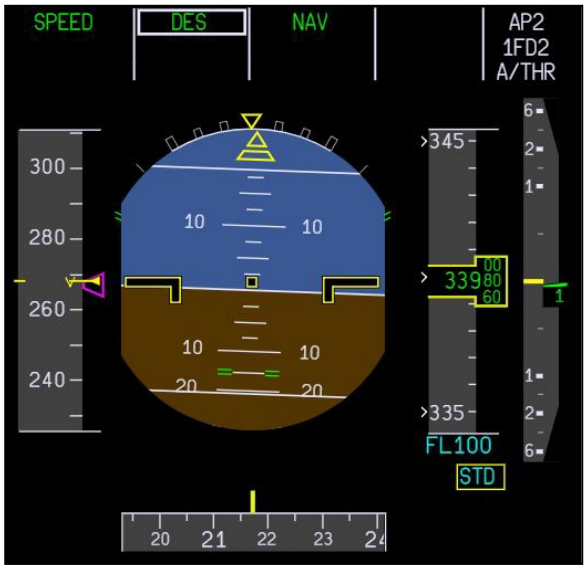


Figure 120 – Primary Flight Display
(“DES Green - FL100 – check”)

2.2.2.5 **During Descent, FL315 / 88 NM –** After clearance from Karachi Approach at 09:18:13 for 5,000 ft, at 09:18:36, aircraft was passing through FL310 with A/THR Thrust MODE engaged (N1 reduced to IDLE on both Engines), which indicated that the aircraft was starting to capture the FMS descent profile. V/S increased to 2,400 ft/min. CAS increased to a maximum of 284 kts before reducing towards the managed target air speed of 269 kts. A/THR MODE changed to IDLE MODE to adjust the thrust while AP followed descent profile. The selected altitude became 5,000 ft. It was observed that no FMA callout or check (FL50 - check) were performed by either of flight crew, they were discussing various topics not relevant to this phase of flight. Indicative of lack of application of procedures / adherence to SOP (Golden Rules for Pilot FCTM / AOP / 40).

Figure 121 – Primary Flight Display
("FL50 – check")

2.2.2.6 **Mistuning of Radio Frequency –** Till 09:18:16, PIA 8303 was in contact with Area Control Karachi. At 09:19:30, a sound similar to Audio Control Panel (ACP) VHF PB was heard in CVR recording. From 09:23:16 to 09:24:36, seven (07) calls were given to PIA 8303 by Area Control Karachi, Approach Control Karachi and PIA 8368 (another aircraft in air). PIA 8303 did not respond to any call during this time and these calls were also not recorded in CVR. After analysing CVR and ATC transcripts, it appeared that probably flight crew mistuned the radio frequency (126.5 MHz instead of 125.5 MHz). PIA 8303 did not communicate radio frequency change to any of the ATC unit. It was observed that (during this time) both flight crew were busy in discussion not relevant to this phase of flight. At 09:25:37, PIA 8303 responded to Approach Control Karachi on Guard Frequency after receiving two calls on the Guard Frequency, thereafter, two-way communication was established between PIA 8303 and Approach Control Karachi.

UTC	PIA 8303	PIA 8368 (Another A/C in Air)	ACC Karachi (123.15 MHz)	Approach Control		Remarks
				125.5 MHz	121.5 MHz*	
09:18:13			Pakistan 8303 descent FL 50			Recorded in CVR and ATC transcript
09:18:16	FL50 Pakistan 8303					Recorded in CVR and ATC transcript
09:19:30						Sound similar to ACP VHF PB recorded in CVR
09:23:16			Pakistan 8303 contact APP 125.5			• Not recorded in CVR • Recorded in ATC transcript
09:23:30			Pakistan 8303 Karachi			• Not recorded in CVR • Recorded in ATC transcript
09:23:42			Pakistan 8303 Karachi			• Not recorded in CVR • Recorded in ATC transcript
09:23:55			Pakistan 8368 Karachi			• Not recorded in CVR • Recorded in ATC transcript
09:23:56		Go ahead				• Not recorded in CVR • Recorded in ATC transcript
09:23:57			Pakistan 8368 give a call to company PIA 8303 advise him to contact Approach 125.5			• Not recorded in CVR • Recorded in ATC transcript
09:24:08		Roger *break break* Pakistan 8303 this is Pakistan 8368 how do you read?				• Not recorded in CVR • Recorded in ATC transcript
09:24:23		Hello Pakistan 8368 I think switched over to the APP frequency long time back				• Not recorded in CVR • Recorded in ATC transcript
09:24:36				Pakistan 8303 APP		• Not recorded in CVR • Recorded in ATC transcript
09:25:03					Pakistan 8303 this is Karachi calling on Guard	Recorded in CVR and ATC transcript
09:25:21					Pakistan 8303 Karachi calling on Guard	Recorded in CVR and ATC transcript
09:25:25	Read you strength 3 strength 2 confirm 126.5					• Recorded in CVR • Not recorded in ATC Transcript • Probably not Tx on guard frequency or 125.5 MHz
09:25:32					Pakistan 8303 Karachi calling on guard frequency how do you read	Recorded in CVR and ATC transcript
09:25:37	Strength 2 sir confirm change over to 126.5					Recorded in CVR and ATC transcript
09:25:41					Contact 125.5	Recorded in CVR and ATC transcript
09:25:43	125.5 Pakistan 8303					Recorded in CVR and ATC transcript
09:25:48	Karachi APP Pakistan 8303 AOA descending out of FL162 for FL050					Recorded in CVR and ATC transcript

Table 34 – Communication after Mistuning of Radio Frequency

2.2.2.7 **Descent to 3,000 ft –** At 09:25:54, Karachi Approach called PIA 8303 to descent 3,000 ft baro altitude 1004 hPa and cleared for ILS R/W 25L. At 09:26:00, the selected altitude became 3,000 ft. However, Captain and FO altimeter were set at baro altitude 1004 hPa 15 s later. The aircraft was descending through 15,369 ft baro altitude. No FMA callout or check (FL30 - check) were performed by either of flight crew (Golden Rules for Pilot FCTM / AOP / 40).

2.2.2.8 **Final Approach, LOC Captured 9,640 ft / 16 NM**

(a) At 09:29:53, APPR guidance MODES were armed (G/S and LOC blue on FMA). AP-1 was engaged in addition to AP-2. At 09:30:22, at 16 NM from R/W 25L, LOC* (Localizer Capture) MODE was engaged.

(b) Between 09:29:53 and 09:30:39 CAS remained around 250 kts and A/THR MODE switched between SPEED and IDLE MODE.

(c) During this time, there was no FMA cross check and verbal confirmation, related to “AP-1+2, A/THR SPEED 250 kts, G/S LOC blue” and “THR IDLE, LOC*” by flight crew, indicative of lack of airmanship and adherence to SOP (Golden Rules for Pilot FCTM / AOP / 40 & Glide Slope Interception from above FCTM / PR / NP / SOP / 190 / GUI).

AP-1+2, A/THR SPEED 250 kts, G/S LOC blue and THR IDLE, LOC*

Figure 122 – Primary Flight Display

2.2.2.9 **Holding Pattern in FMS Flight Plan**

(a) As managed DES MODE was active, the selection of 3,000 ft on FCU did not lead to any change in FMS flight plan. NAV MODE was still engaged, therefore descent profile was still computed by FMS to reach SABEN at FL089 / 230 kts (as per the flight plan entered into FMS).

(b) With this selection the aircraft still considered Holding Pattern at SABEN in its Lateral Profile, thus causing distance to the R/W threshold to increase by 23 NM (from 15 NM to 38 NM).

(c) Two main cockpit cues were available to the flight crew to indicate the presence of the Holding Pattern at the SABEN waypoint. On the ND, before reaching MAKLI, the Holding Pattern was indicated via a white curved arrow (left photo). After passing MAKLI (i.e. MAKLI had been sequenced), SABEN became the "TO" waypoint and, the full Holding Pattern was depicted (right figure): -

Figure 123 – Cockpit Cues available to flight Crew on ND

(d) On the Flight Plan displayed on the MCDU, the Holding Pattern was marked by a white "HOLD L", as appended below: -

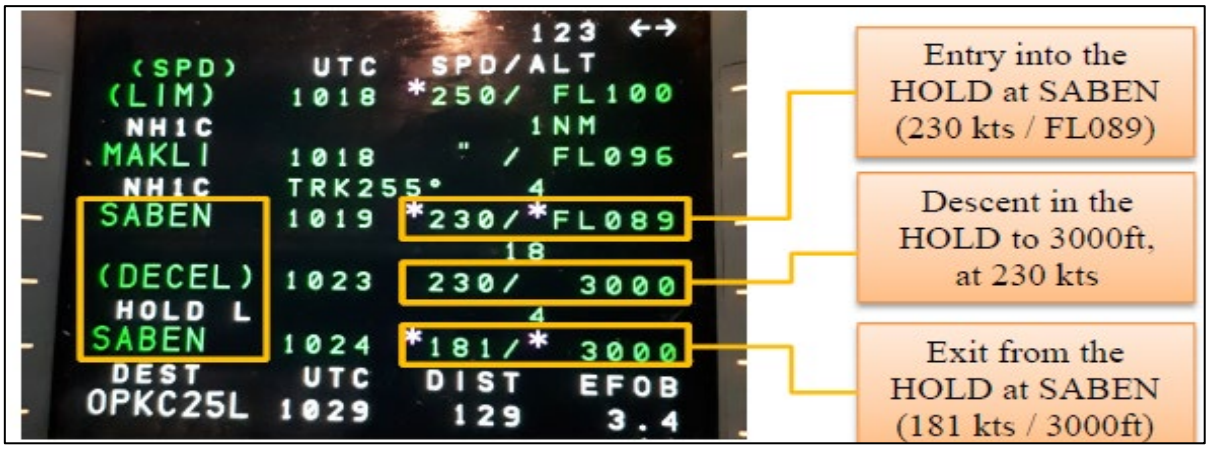


Figure 124 – Cues Available to Flight Crew on MCDU

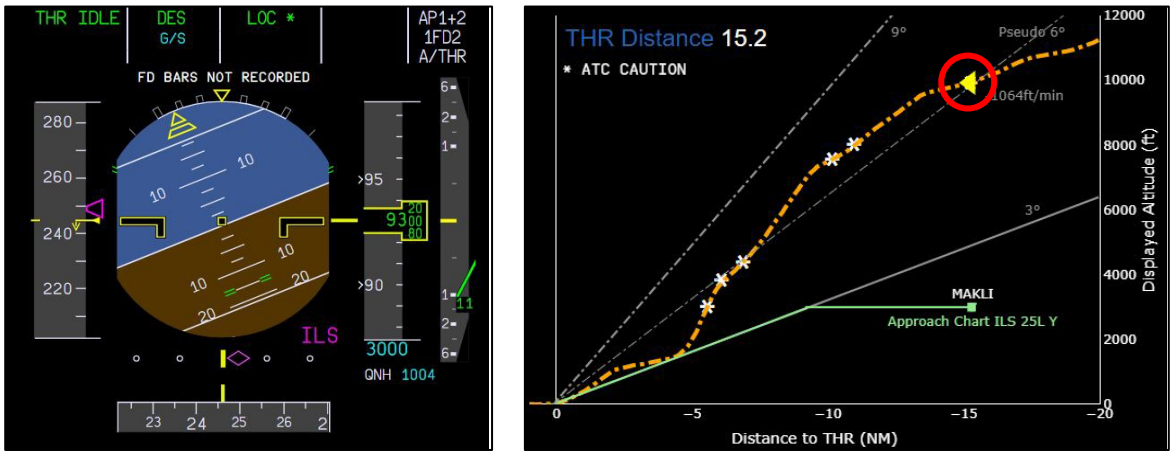
(e) As the DES MODE was still engaged, on the vertical axis, aircraft continued to follow the descent profile computed by the FMS in order to reach 1,000 ft AGL at VAPP on Karachi ILS R/W 25L-Z trajectory. As flight crew had not cleared FMS flight path, Holding Pattern distance of 23 NM was still considered in distance computation (increasing the track mile). The FMS did not compute descent path assuming 15 NM (i.e. radial distance between MAKLI and R/W 25L), but assuming 38 NM (with additional descent in a left-hand pattern). Thus, the vertical profile was still managed by FMS including Holding Pattern at SABEN in descent computations. Without this Holding Pattern, the simulator tests have shown that FMS would have computed a managed vertical profile leading to MAKLI at 3,000 ft, while the lateral guidance would have followed the Localizer Signal for R/W 25L (when captured).

(f) In CVR recording, there was a discussion between Flight crew of "*Take out the HOLD"* which also confirms the presence of HOLD at SABEN in FMS Flight Plan.

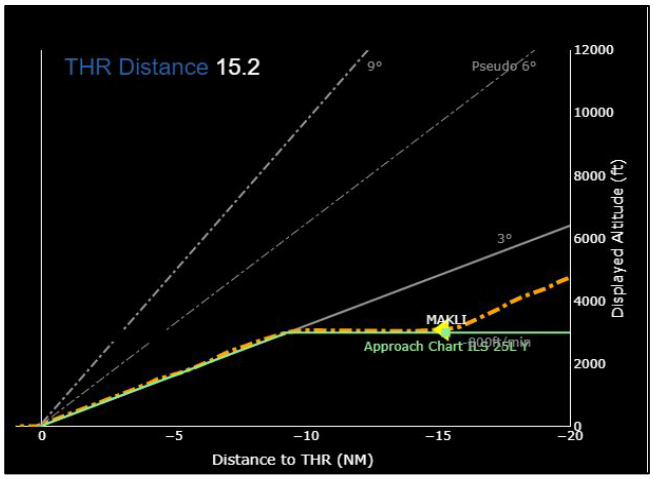
2.2.2.10 **ATC 1st Call (Track Mile Comfortable for Descent at 15 NM)**

(a) At 09:30:35, aircraft passed MAKLI with 9,363 ft baro altitude, 245 kts CAS, and FLAPS at 0°. 1 s later, Karachi Approach asked, "Pakistan 8303 confirm track mile comfortable for descent?" to which PIA 8303 replied, "Affirm". Aircraft was still around 9,000 ft baro altitude at approximately 15 NM from R/W 25L threshold. In CVR recording, Captain exclaimed, *"What has happened?, Stop, Stop Oh No! Take out the HOLD, take out the HOLD, take out the HOLD, take out the HOLD*" (in Urdu). FO responded, "*HOLD taken out, should we report this issue?*" (in Urdu). Captain replied, "*No, this could be due to HOLD*", tell Karachi Approach *"Established on Localizer"* (Both in Urdu).

(b) There was no verbal re-calculation, no crosscheck between flight crew of the vertical flight path of aircraft [Situation Awareness, Flight Path Monitoring (FPM): Detection of Deviations vs Normal Flight Path and Profile Computation (FCTM / PR / NP / SOP / 170) and Human Factor Attitude: Overconfidence & Complacence].



PIA 8303 Approach: ALT 9,300 ft / Distance 15.2 NM ~ FPA 6.1°



Standard Approach: ALT 3,000 ft / Distance 15.2 NM ~ FPA 2.4°

Figure 125 – PIA 8303 Approach vs Standard Approach at 15.2 NM

2.2.2.11 **Open Descent (OPEN DES) MODE on Final Approach**

(a) At 09:30:44, OPEN DES MODE was engaged with a target at 3,000 ft by pulling the ALT Knob on FCU. Aircraft was at 9,210 ft baro altitude, 245 kts CAS, Rate of Descent had reduced to 660 ft/min and distance from R/W 25L threshold was approximately 14.8 NM. Speed Brakes were extended at this time.

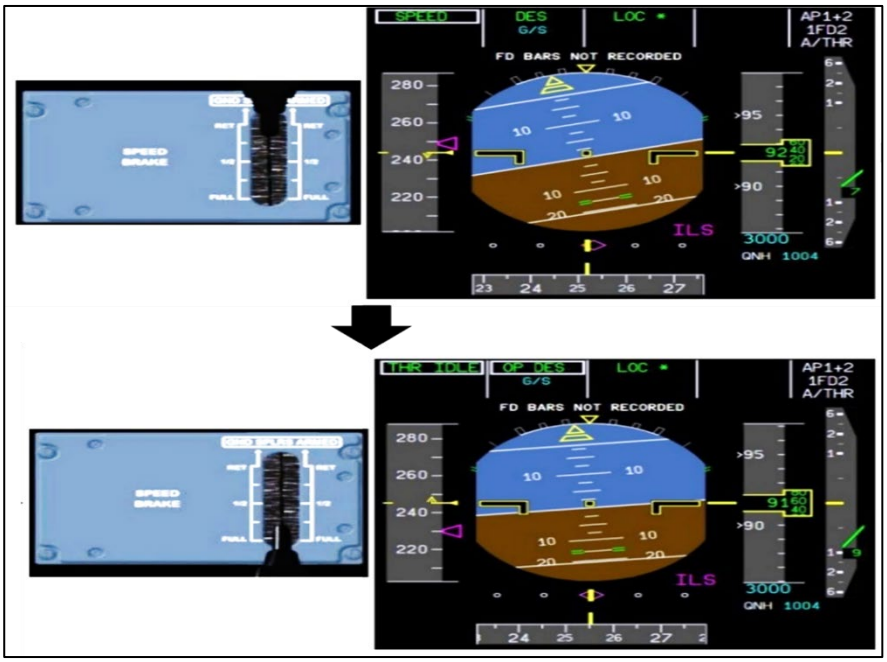


Figure 126 – PFD and FMA Display

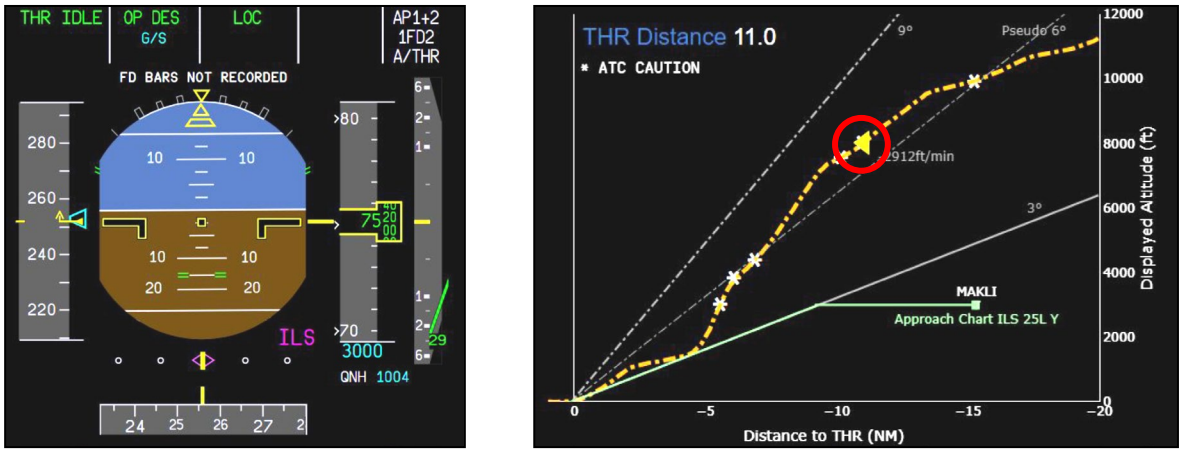
(b) For a 3° G/S at 14.8 NM from R/W 25L threshold, aircraft was required to be at 4,700 ft baro altitude. Aircraft was significantly above the published vertical Approach path and was actually at flight path angle of almost 6°. This was a scenario of Glide Slope Interception from above (FCOM / PRO / NOR / SOP / 18 Initial Approach / Flight path monitoring interception glide from above). V/S MODE should be used with an initial target at 1,500 ft/min. However, OPEN DES MODE was used which is not recommended on final Approach. This was the lack of airmanship due to non-adherence to SOP for G/S capturing from above. There were no FMA call out (THR IDLE, OP DES, G/S) and information sharing on descent strategy (FCOM / PRO / NOR / SOP / 18 / Approach using LOC G/S guidance and lack of situation awareness regarding vertical profile).

2.2.2.12 **ATC 2nd Call (Level Passing at 10 NM)**

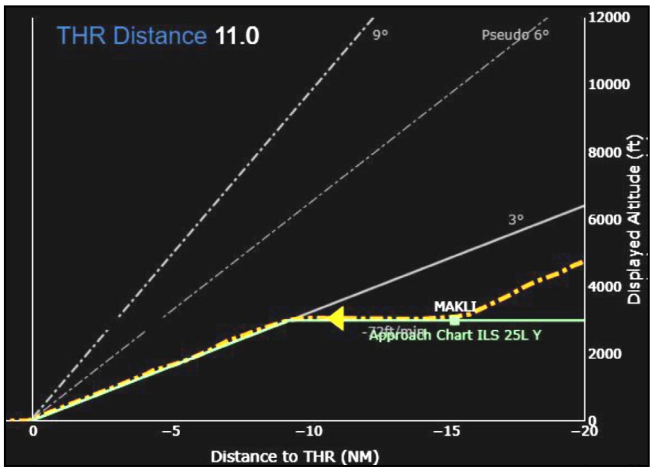
(a) At 09:31:13, Karachi Tower contacted Karachi Approach on hotline and shared its observation about incoming PIA 8303, "*Sir, it's too high*" (in Urdu). Karachi Approach responded, "*Yes, it is too high and I am observing it and will give orbit*" (in Urdu). This indicates awareness of ATC that aircraft was high on Approach.

(b) At 09:31:24, Karachi Approach called, "Pakistan 8303 report level passing". Flight crew replied, "Out of 75 for 3,000". Flight crew verbalized "75" (7,500 ft) to ATC while still at 7,700 ft, rounding down the actual altitude.

(c) At 09:31:26, 11.4 NM from R/W 25L threshold, 250 kts CAS, SABEN waypoint was overflown at 7,830 ft baro altitude. As per the ILS-Z R/W 25L Approach Chart, target altitude for set course from SABEN is 3,000 ft. Therefore, aircraft was excessively high (4,830 ft in excess) above the desired G/S.



PIA 8303 Approach: ALT 7,500 ft / Distance 11 NM ~ FPA 6.8°



Standard Approach: ALT 3,000 ft / Distance 11 NM ~ FPA 2.7°

Figure 127 – PIA 8303 Approach vs Standard Approach at 11 NM

(d) When aircraft was at 11 NM from R/W 25L threshold, it was still excessively high (4,500 ft), At 09:31:31, Karachi Approach prompted, “75 for 3,000, the present position is 10 miles from touchdown”. ATC reminded aircraft position versus flight level and suggested aircraft was too high with regard to the distance remaining to the R/W. However, Karachi Approach suggestion was not taken into account by the flight crew and at 09:31:37, PIA 8303 replied “No problem, Sir”.

2.2.2.13 **Management of Flight Path**

(a) The factors that led aircraft to pass SABEN at 7,800 ft and continue descent straight towards R/W 25L were: -

(i) Flight crew not clearing flight path in FMS, which led FMS to compute vertical profile including Holding Pattern distance in the track mile.

(ii) Non-selection by flight crew of OPEN DES MODE after ATC clearance at beginning of descent. Even if flight crew did not clear the flight plan, use of OPEN DES MODE would have allowed a direct vertical profile to 3,000 ft and ILS-Z R/W 25L G/S.

(iii) Activation of Approach MODE (APPR PB pressed) before SABEN waypoint, with FMS flight plan still including the holding pattern (NAV / DES engaged and LOC* / GS* armed). This led to engagement of LOC MODE and FMS to follow R/W 25L localizer while the altitude was significantly above the G/S. As flight crew had already activated Approach MODE, it would have been necessary to activate NAV MODE at SABEN to ensure that FMS follows Holding Pattern instead of continuing ILS LOC.

(iv) Continuation of descent after SABEN without realizing holding pattern, even though aircraft was at 7,800 ft baro altitude, still being significantly above the G/S and despite of ATC calls.

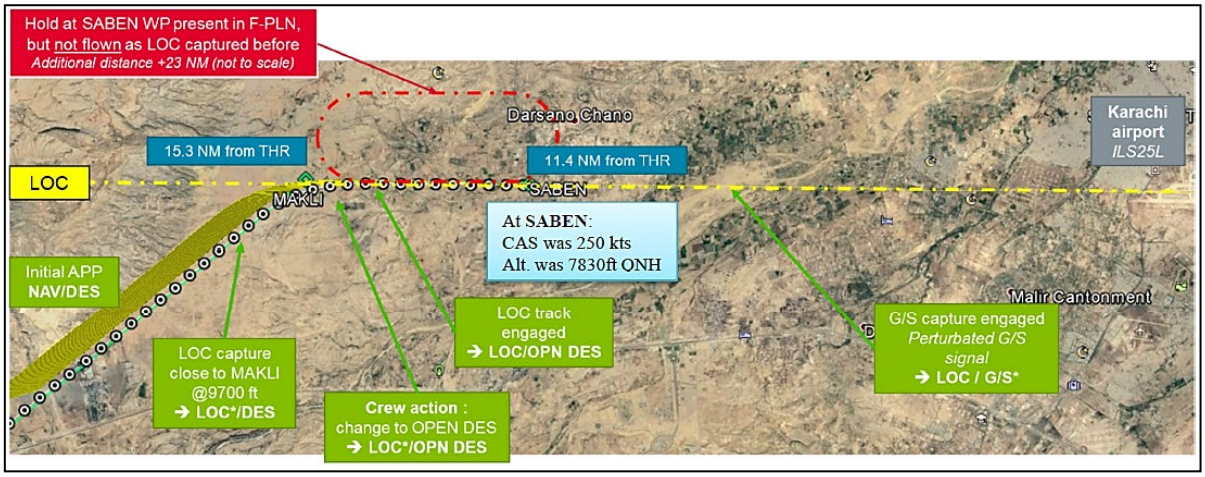


Figure 128 **–** Final Approach to JIAP, Karachi (Landing Direction Left to Right)

(b) Aircraft trajectory was not challenged by flight crew and there was no mental picture of the flight path even after being prompted by ATC (lack of situation awareness). Rather flight crew verbalized that situation was under control (Human performance: Overconfidence and Complacency).

2.2.2.14 **Landing Gears Down –** At 09:31:34, 7,440 ft baro altitude, 10.8 NM from R/W 25L threshold, Rate of Descent 2,900 ft/min, target speed was changed to 248 kts. At 09:31:39, Landing Gears selector was set to DOWN position. Landing Gears were DOWN and Locked 13 s later at 7,239 ft baro altitude. Neither PF nor PM verbalized the selection of the Landing Gears Lever to DOWN position and there was no cross check (lack of adherence to SOP, FCOM / PRO / NOR / SOP / 90 / Gear Callouts). At the time of extension of Landing Gears, the Rate of Descent was around 2,350 ft/min, which increased up to 7,500 ft/min probably due to increase in drag along with Speed Brakes extended and FLAPS1 selected.

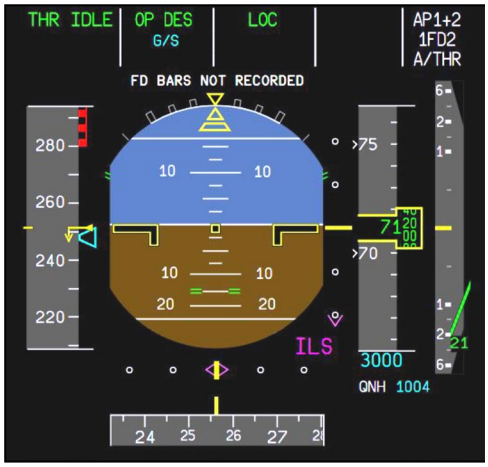
	CALLOUT	REMARKS
PF	"GEAR UP (DOWN)"	
PM	"GEAR UP (DOWN)"	The PM selectes the L/G lever position and replies after checking the red lights on the LDG GEAR indicator to confirm gear operation.

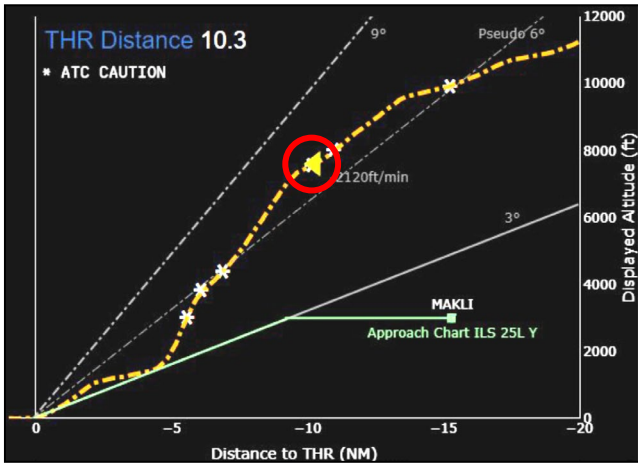
Table 35 – FCOM Standard Gear Callouts[80]

[80] Airbus FCOM, SOP Gear Callouts, Pg – 3904

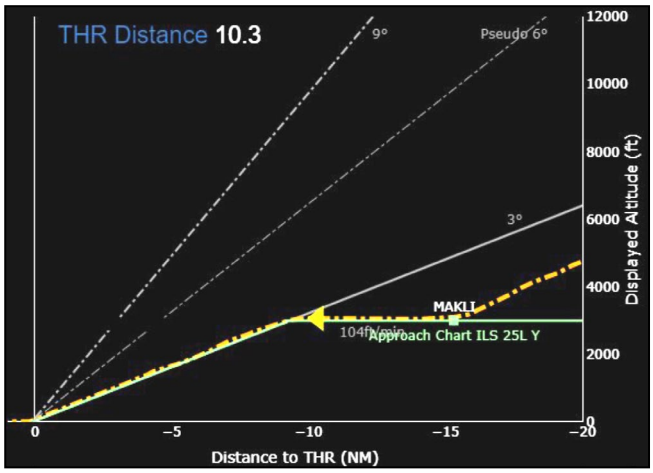
2.2.2.15 **ATC 3rd Call (Orbit Proposal)**

(a) At 09:31:41, Karachi Approach asked PIA 8303, “Sir orbit is available if you want”. Captain verbalized, “Say it’s OK”. After 6 s, FO replied to ATC, “Negative Sir we are comfortable, we can make it, Insha-Allah”.





PIA 8303 Approach: ALT 7,100 ft / Distance 10.3 NM ~ FPA 6.9°



Standard Approach: ALT 3,000 ft / Distance 10.3 NM ~ FPA 2.9°

Figure 129 – PIA 8303 Approach vs Standard Approach at 10.3 NM

(b) At this time, aircraft trajectory was still excessively high (4,100 ft). ATC proposal for use of orbit pattern was aimed at losing altitude. However, flight crew did not consider this option, instead continued excessively high on Approach (lack of situation awareness).

2.2.2.16 **Altitude Capture –** At 09:32:18, 4,817 ft baro altitude, 7.7 NM from R/W 25L threshold, AP Vertical MODE changed to ALT*, Rate of Descent was 4,115 ft/min. 2 s later, selected Speed target was reduced from 248 kts to 230 kts. Flight crew didn’t call FMA check, no call out of “SPEED”, “ALT*” (Non adherence to SOP, Golden Rules for Pilot FCTM / AOP / 40).

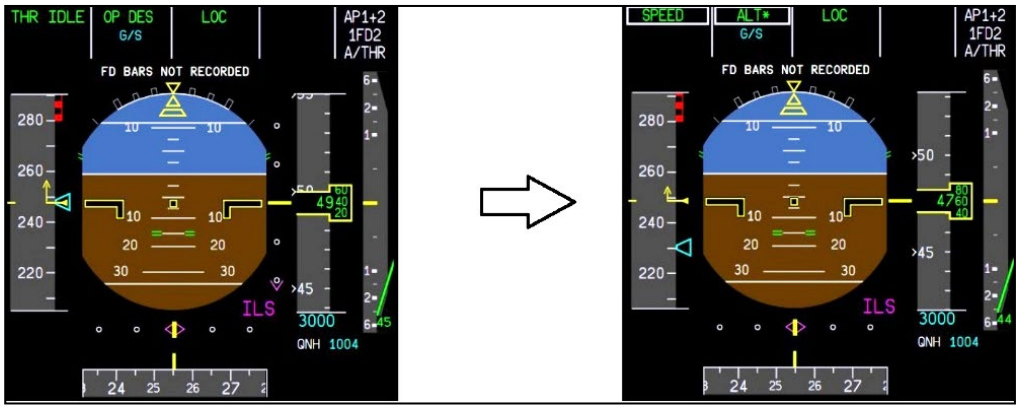
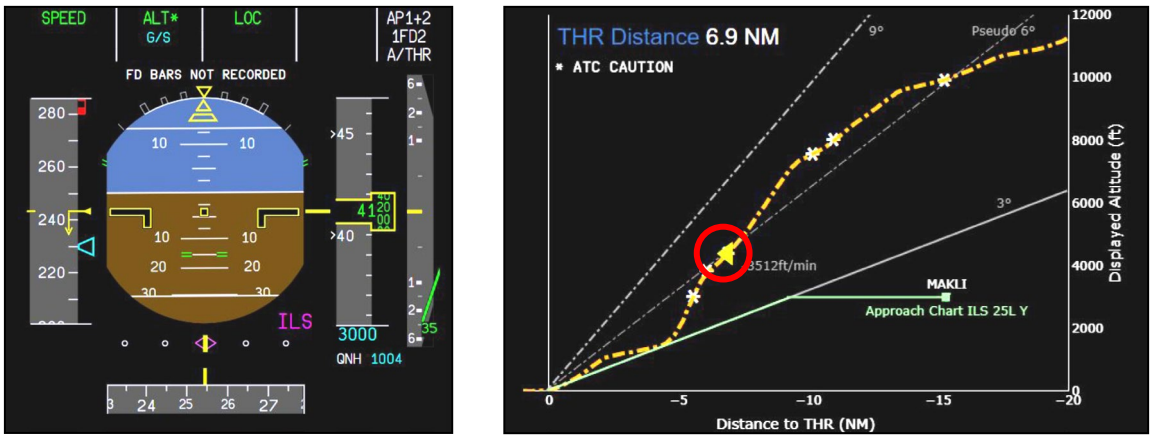


Figure 130 – PFD: Altitude Capture

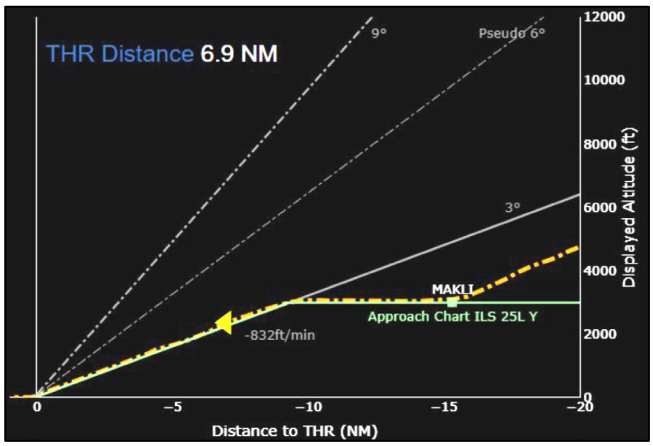
2.2.2.17 **ATC 4th Call (Turn Left Heading 180°)**

(a) At 09:32:24, Captain said to FO, *"He will be surprised what we have done"* (in Urdu); probably Captain was referring to ATC Controller during his discussion with FO, indicating overconfidence and complacence.

(b) At 09:32:25, Karachi Approach gave call, "Pakistan 8303 disregard turn left heading 180". Aircraft parameters at this time were as follows: -



PIA 8303 Approach: ALT 4,100 ft / Distance 6.9 NM ~ FPA 5.9°



Standard Approach: ALT 2,300 ft / Distance 6.9 NM ~ FPA 2.9°

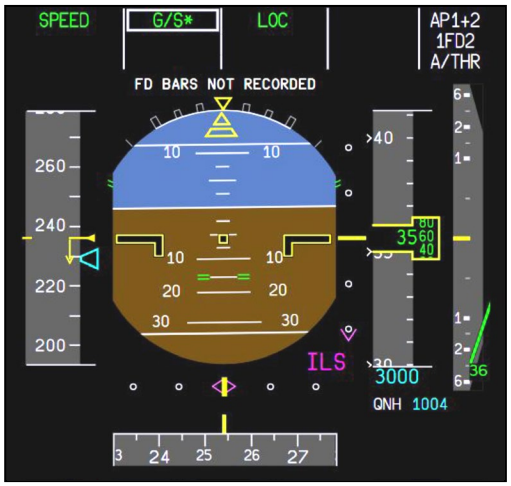
Figure 131 – PIA 8303 Approach vs Standard Approach at 6.9 NM

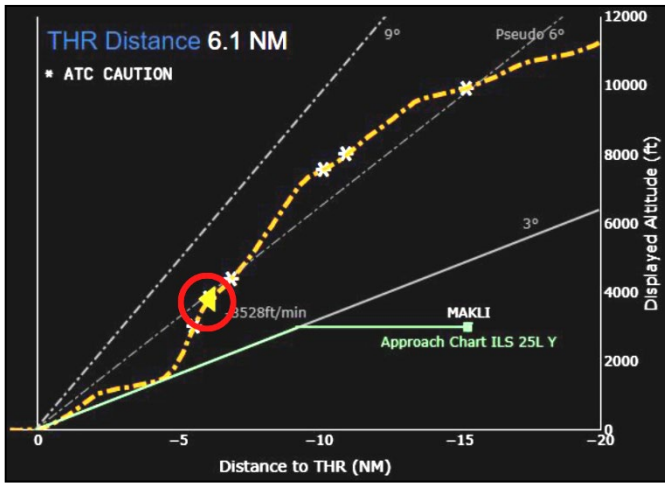
(c) 8 s later, aircraft was descending through 3,900 ft baro altitude. PIA 8303 replied, "Sir, we are comfortable now and we are out of 3,500 for 3,000 established ILS 25L". ATC instructions were disregarded by flight crew verbalizing 3,500 ft to ATC while still at 3,900 ft and once again rounding down the actual altitude.

2.2.2.18 **G/S* MODE Engagement due to Perturbations –** At 09:32:34, AP Vertical MODE changed to Glide Slope Capture (G/S*). Aircraft was passing through 3,830 ft baro altitude and 6.5 NM from R/W 25L threshold. Despite being significantly above desired G/S, the G/S* MODE was engaged due to perturbations caused by the proximity of 3° G/S lobe top and 9° G/S lobe bottom. The criteria for G/S* MODE was met while aircraft being close to 6° G/S. Flight crew were unable to challenge the flight path.

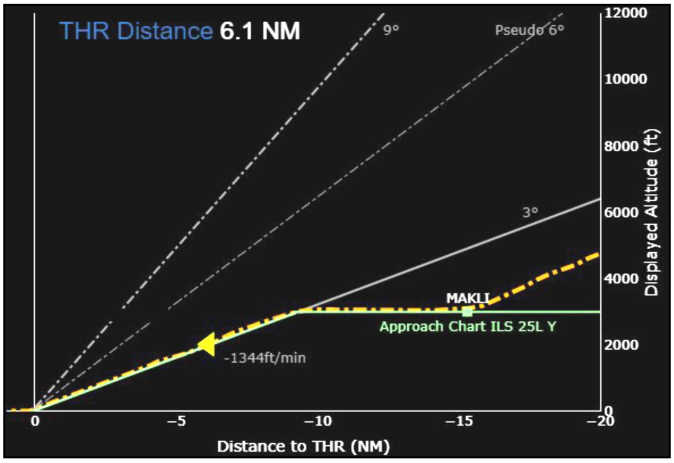
Figure 132 – FMA Display G/S MODE Engagement

2.2.2.19 **ATC 5th Call (Turn Left Heading 180°) –** At 09:32:38, Karachi Approach again called PIA 8303, “Negative turn left heading 180”. PIA 8303 responded, “Sir, we are established on ILS 25L”. Once again ATC instructions were disregarded by flight crew despite being significantly above the standard flight path.





PIA 8303 Approach: ALT 3,560 ft / Distance 6.1 NM ~ FPA 5.8°



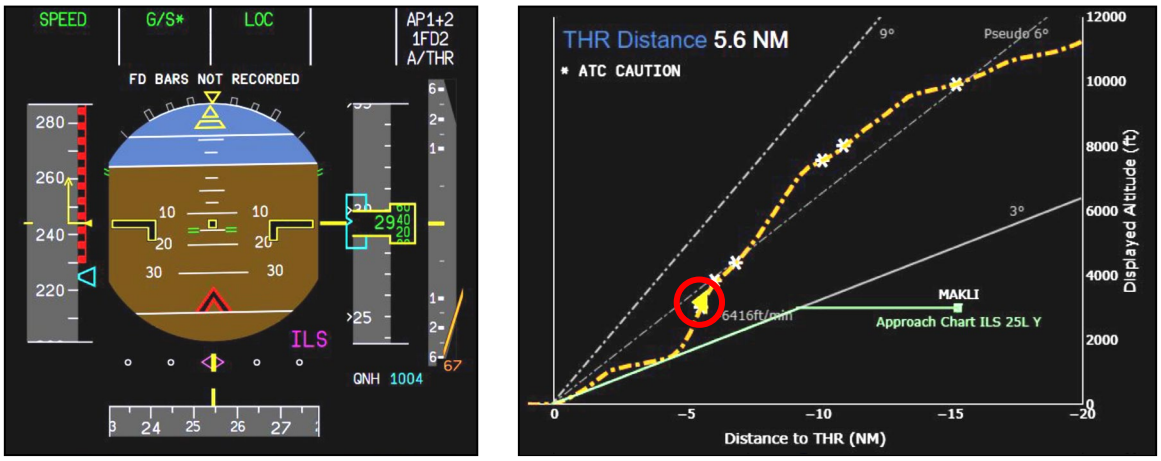
Standard Approach: ALT 2,100 / Distance 6.1 NM ~ FPA 3.0°

Figure 133 – PIA 8303 Approach vs Standard Approach at 6.1 NM

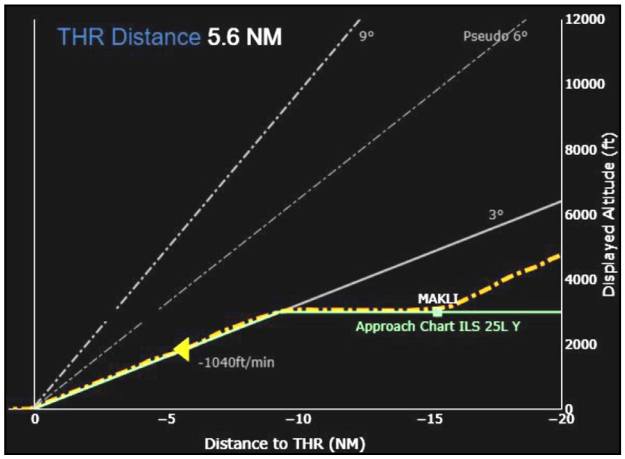
2.2.2.20 **ATC 6th Call (Caution)**

(a) At 09:32:46, 3,090 ft baro altitude, 5.7 NM from R/W 25L threshold, CAS 242 kts, selected target speed CAS 225 kts and SLATS / FLAPS CONF1 was selected (VFE CONF1=230 kts). Pitch angle was -12.6° and still decreasing.

(b) At 09:32:46, Karachi Approach called, “Sir, you are five Miles from touchdown still passing 3,500”. At 09:32:51, PIA 8303 responded, “Roger”. Karachi Approach again cautioned that aircraft was still too high on the Approach path, however flight crew continued to press on high Approach.



PIA 8303 Approach: ALT 2,900 ft / Distance 5.6 NM ~ FPA 5.2°



Standard Approach: ALT 1,900 / Distance 5.6 NM ~ FPA 3.0°

Figure 134 – PIA 8303 Approach vs Standard Approach at 5.6 NM

2.2.2.21 **Auto-Pilots (APs) Disengagement**

(a) At 09:32:47, 2,730 ft baro altitude, 5.5 NM from R/W 25L threshold, pitch attitude reached -13.7°. This led to both APs disengagement due to excessive pitch down, as it exceeded 13° nose down. Rate of Descent reached 6,800 ft/min. FDs and A/THR remained engaged. Auto-Pilot OFF Warning triggered accordingly.

Figure 135 – FMA Display after AP Disengagement

(b) Flight crew did not verbalize acknowledgement of the Master Warning. Flight crew did not monitor FMA, did not call out of AP disconnection and even no call out for manual takeover of the aircraft (Non-adherence to SOP, Golden Rules for Pilot FCTM / AOP / 40).

2.2.2.22 **OVERSPEED Warning FLAPS1 Extended (VFE)**

(a) 4 s later, almost simultaneous with the AP disconnection, "OVERSPEED" [Maximum speed with FLAPS Extended (VFE)] Warning triggered Master Warning along with CRC Aural Alert. The triggering condition for VFE Warning is VFE +4 kts with SLATS and / or FLAPS extended.

(b) Flight crew did not verbalize acknowledgement of the Master Warnings. They selected FLAPS beyond the VFE speed (Lack of application of procedures: Intermediate and final approach FCOM / PRO / NOR / SOP / 180).

2.2.2.23 **First Sequence of GPWS Alerts –** After 09:32:52, GPWS Alerts (GPWS MODE-1) triggered for 4 s. When "SINK RATE" Caution was triggered, flight crew did not call out GPWS Caution (airmanship and situational awareness FCOM / PRO / ABN / SURV / MEM / EGPWS Caution / Sink Rate). Just after GPWS Caution, there were 02 GPWS Warning of "PULL UP" that required an immediate Terrain Avoidance / Escape Manoeuvre. The procedure is a MEM item which is applied immediately by Memory to ensure a safe flight path as the flight crew has no time to refer to the ECAM / QRH / FCOM. However, flight crew did not perform this manoeuvre (Lack of situational awareness and application of abnormal procedures FCOM / PRO / ABN / SURV / MEM / EGPWS Warnings / PULL UP).

UTC	GPWS Alerts	Comments
09:32:51	-	• Pitch attitude -13.7° • ROD 6,800 ft/min • AP Disconnected exceeding 13° pitch attitude
09:32:52	-	• ROD 7,400 ft/min • Nose-up inputs were globally applied on FO (PF) sidestick up to 2/3 full back stick for 10 s
09:32:53	**SINK RATE**	• No call out of GPWS Caution
09:32:54	**PULL UP**	• No Go-Around triggered at "PULL UP" activation
09:32:56	**PULL UP**	• No Go-Around triggered at "PULL UP" activation • ROD 5,300 ft/min
09:32:57	-	Landing Gears were selected UP
09:32:58	-	Karachi Approach: Pakistan 8303 clear land 25L
09:32:59	-	Speed Brakes were retracted
09:33:02	-	• Pitch attitude 0° • ROD 2,000 ft/min • PIA8303: Roger Pakistan 8303

Table 36 – GPWS Alerts and Significant Events

2.2.2.24 **Landing Gears and Speed Brakes Retracted –** At 09:32:57, Landing Gears were selected UP, and 2 s later Speed Brakes were retracted. 14 s later, Landing Gears were recorded Uplocked which is consistent with a nominal retraction sequence. Retraction of Landing Gears and Speed Brakes were not verbalized by either of the flight crew.

2.2.2.25 **OVERSPEED Warning FLAPS2 / 3 Extended (VFE) –** At 09:33:25, 1,180 ft baro altitude, 2.9 NM from R/W 25L threshold, CONF2 was selected at CAS 232 kts and 2 s later CONF3 was selected. FLAPS selection without speed check triggered a Master Warning and Red Alert on the ECAM. Indicating lack of application of procedures, intermediate and final Approach FCOM / PRO / NOR / SOP / 180. Flight crew did not verbalize acknowledgement of the Master Warning.

2.2.2.26 **FO Suggested for an Orbit –** At 09:33:33, 1,100 ft baro altitude and CAS 227 kts, FO was heard saying *"Should we do the Orbit?"* (in Urdu) to which Captain replied *"No-No"*, followed by *"Leave it"* (both in Urdu). This communication indicates FO has intention for an Orbit. Most probably Landing Gears and Speed Brakes were retracted by FO at 09:32:57.

2.2.2.27 **Captain Took Over Controls –** At 09:33:37, Captain took over controls by pressing sidestick PB along with pitch down inputs and small dual inputs were recorded during 4 s. The change of controls was not verbalized by either of the flight crew.

2.2.2.28 **1,000 ft Stabilization Gate**

(a) At 09:33:42, 1.9 NM from R/W 25L threshold, aircraft crossed 1,000 ft RA. This is the Stabilization Gate for IMC as per stabilization criteria provided in Airbus FCOM. The comparison of actual aircraft parameters at 1,000 ft RA with standard parameters, callout limit and delta with callout limit is mentioned below: -

Flight Parameter	PIA 8303	Standard	Callout Limit	Delta
IAS (kts)	220	135	VAPP+10 / -5 kts	+75 kts
V/S ft/min	-1,800	-700	-1,000 ft/min	-800 ft/min
Pitch (°)	-5	2	< -2.5° or > +10°	-2.5°
Roll (°)	0	0	> 7°	0
G/S (dot)	>2	0	> ½ dot	> 1.5 dot
LOC (dot)	0.2	0	> ½ dot	0

Table 37 – Comparison of Flight Parameters at 1,000 ft Gate

(b) The aircraft parameters deviation was more than the call out threshold. However, there was no "Un-Stabilized" call out by either of the flight crew, flight parameters exceedance was not monitored and no Go-Around was initiated. It indicated lack of procedure implementation in the domain of FCOM / PRO / NOR / SOP / 18 Intermediate and Final Approach, FCTM / PR / NP / SOP / 190 Trajectory Stabilization and FCTM / PR / NP / SOP / 260 Considerations about Go-Around.

Standard Approach at 1,000 ft AGL

PIA 8303 Approach at 1,000 ft AGL

Figure 136 – Cockpit View at 1,000 ft AGL

2.2.2.29 **"L/G GEAR NOT DOWN" Warning –** At 09:33:48, aircraft was passing below 750 ft RA, 1.5 NM from R/W 25L threshold, CAS 217 kts (VFE CONF3 + 32 kts), Rate of Descent 2,100 ft/min, and Pitch attitude -5º. ECAM Red Warning "L/G GEAR NOT DOWN" and illumination of Red Arrow beside the Landing Gears Lever were triggered. The CRC and Master Warning Red light flashing were already active due to continued triggering of "OVERSPEED" VFE Alert. Flight crew did not monitor ECAM Warning and there was no call out of "L/G GEAR NOT DOWN" Warning (Lack of situation awareness and application of procedures).

2.2.2.30 **500 ft Stabilization Gate**

(a) 500 ft RA is Stabilization Gate for VMC as per stabilization criteria provided in Airbus FCOM. The comparison of actual aircraft parameters at 500 ft RA with standard parameters, callout limit and delta with callout limit is mentioned below: -

Flight Parameter	PIA 8303	Standard	Callout Limit	Delta
IAS (kts)	220	135	VAPP+10 / -5 kts	+75 kts
V/S ft/min	-2000	-700	-1,000 ft/min	-1,000 ft/min
Pitch (°)	-5.6	2	< -2.5° or > +10°	-3.1°
Roll (°)	0	0	> 7°	0
G/S (dot)	-2	0	> ½ dot	> 1.5 dot
LOC (dot)	0.2	0	> ½ dot	0

Table 38 – Comparison of Flight Parameters of Event Flight at 500 ft Gate

(b) The aircraft parameters deviation was more than the call out threshold. However, there was no "Un-Stabilized" call out by either of the flight crew, flight parameters exceedance was not monitored and no Go-Around was initiated. It indicated lack of procedure implementation in the domain of FCOM / PRO / NOR / SOP / 18 Intermediate and Final Approach, FCTM / PR / NP / SOP / 190 Trajectory Stabilization and FCTM / PR / NP / SOP / 260 Considerations about Go-Around.

Standard Approach at 500 ft AGL

PIA 8303 Approach at 500 ft AGL

Figure 137 – Cockpit View at 500 ft AGL

2.2.2.31 **Second Sequence of GPWS Alerts –** At 09:33:55 (440 ft RA), second sequence of GPWS Alerts triggered continuously until 09:34:16 (24 ft RA). CVR recording indicates that during this sequence a total of 13 Alerts were triggered: 10 "TOO LOW TERRAIN" Amber Cautions, 01 "SINK RATE" Amber Caution, and 02 "PULL UP" Red Warnings. On "SINK RATE" and "TOO LOW TERRAIN" (Amber Cautions), flight crew did not call out GPWS Caution (airmanship and situational awareness FCOM / PRO / ABN / SURV / MEM / EGPWS Caution / Sink Rate). On GPWS Warnings of "PULL UP", that required an immediate Terrain Avoidance / Escape manoeuvre, flight crew did not perform any such manoeuvre (Lack of situational awareness and application of abnormal procedures FCOM / PRO / ABN / SURV / MEM / EGPWS Warnings / PULL UP).

2.2.2.32 **Full Reverse Thrust Selected on Both Engines –** At 09:34:23, crossing 7 ft RA, 200 kts CAS, full Reverse Thrust was selected on both Engines. Thrust remained at IDLE, but Thrust Reversers remained locked and did not deploy as aircraft was still airborne. ENG REV SET ECAM Alert associated with selection of Reverse Thrust in air was triggered along with a Single Chime Aural Alert and Master Caution Amber light. Flight crew selected Reverse Thrust in air instead of after MLG touchdown (Lack of Application of procedures FCTM / PR / NP / SOP / 250 / Reverse Thrust Efficiency).

2.2.2.33 **R/W Contact and Go-Around**

(a) At 09:34:28, aircraft both Engine nacelles made first contact with R/W. Maximum brake pedal inputs and opposite sidestick inputs were recorded from both flight crew (Captain: full nose down input, FO: 2/3 of full back input). At 09:34:36, Engine No. 2 Fire Alert triggered for 10 s along with associated Master Warning. At 09:34:42, FO said, "*Take-off Sir, Take-off*" (in Urdu), and 2 s later at 160 kts CAS, both TLA were advanced to TOGA for Go-Around. Aircraft got airborne at 09:34:45.

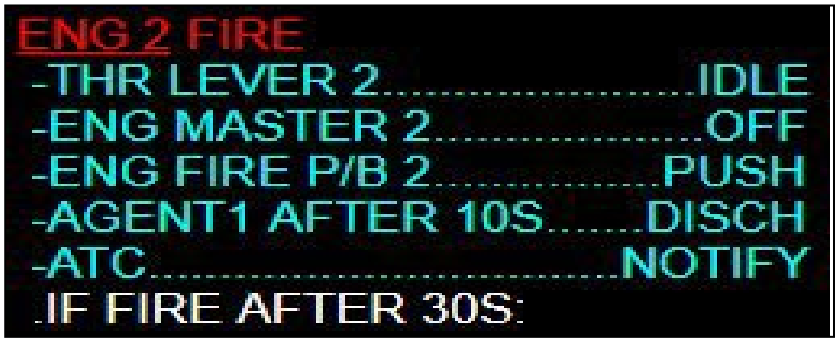


Figure 138 – ECAM Engine 2 Fire Warning

(b) The analysis of actions of both flight crew during R/W contact phase indicated an intention to Go-Around by the FO and intention to land out of same Approach by the Captain.

(c) Flight crew must not initiate a Go-Around after the selection of the Thrust Reversers. Regarding the Engine Fire Warning, the good airmanship should lead the flight crew to decide to stay on ground and stop the aircraft. (Lack of airmanship, situation awareness and application of procedures FCTM / PR / NP / SOP / 260 / Go-Around Near the Ground).

2.2.2.34 **Flight Crew Actions after Go-Around**

(a) At 09:34:52, 59 ft RA, CONF2 was selected, and third sequence of GPWS Alert initiated in which one "TOO LOW GEAR" Amber Caution was triggered. 5 s later, the flight crew instantly selected the Landing Gears Lever DOWN and UP. The duration was too short and there was no change in physical status of Landing Gears (UP and Locked). After getting airborne, the flight crew did not discuss about Gears Up landing and intended to fly ILS Approach for R/W 25L (lack of airmanship and situational awareness).

(b) At 09:36:12, 3,100 ft RA, Engine No. 2 Thrust Lever was reduced to IDLE, whereas Engine No. 1 Thrust Lever was kept at MCL. At 09:36:15, 3,000 ft RA, Engine No. 1 went to un-commanded IFSD and Engine No. 2 was at IDLE. Engine No. 2 (the only running Engine) remained at IDLE for about 1 min, until flight crew eventually realized it and Thrust Lever was re-advanced (lack of airmanship and situational awareness). After 1 min and 18 s (at 09:38:46), Engine No. 2 was operating at 65% nominal speed, multiple Stall Warnings were triggered and thereafter, aircraft altitude was continuously dropping. Aircraft Landing Gears were selected DOWN at 09:39:39 while descending below 800 ft. Aircraft altitude was continuously dropping and a sound similar to impact was heard in CVR at 09:40:18. Aircraft crashed 1,340 m short of R/W 25L threshold.

2.2.2.35 **Possibility of Stopping the Aircraft on R/W (If Landing Gears were DOWN)[81] –** Airbus Engineering simulation considered the event flight touchdown parameters (189 kts GS, 4,500 ft down the R/W 25L threshold) and assumed Landing Gears were extended. The computed Operational Landing Distance (OLD) indicate the possibility of stopping the aircraft on R/W 25L using maximum reverse and maximum manual braking. There could have been a risk of tyre burst due to touchdown speed just below maximum tyre speed (195 kts GS).

2.2.2.36 **Possibility of Safe Landing After Go-Around –** It is not possible to predict or simulate the thrust available after damage to Engines during R/W contact. It is also not possible to estimate the additional power available if Engine No. 2 was not retarded to IDLE for about 1 min. Therefore, it could not be ascertained if safe landing options were available after Go-Around.

2.2.2.37 **Flight Data Monitoring**

(a) **FDA Implementation by PIA**

(i) FDA records indicated that Captain flew 289 flights in last 12 months prior to accident, out of which only 06 flights were analysed. Overall FDA rate for PIA was less than 5% and dedicated Flight Data Analyst was not available in PIA Safety Department till event flight. Since July, 2020, almost all flights are being analysed by a dedicated Flight Data Analyst[82].

[81] Airbus answers to AAIB Pakistan questions February, 2022, Pg – 9
[82] PIA letter CS/INV-13(20)/2020/503 dated 22nd December, 2020

(ii) After the accident, flights of Captain for last 12 months were analysed which indicated, numerous triggers during Approach related to High Speed, Path High, High Rate of Descent, Long Flare Distance and GPWS Warnings[83]. There was no Go-Around initiated and several Unstabilized Approaches were continued.

(b) **FDA Oversight by PCAA**

(i) AOC Renewal Audit Inspections of PIA conducted by PCAA FSD indicated observations related to data gathering and FDA, which were open at the time of accident[84].

(ii) After the accident, on 30th June, 2020, PCAA FSD arranged a seminar on FDM for all Air Operators of Pakistan to emphasize its meaningful use.

2.2.2.38 **Crew Resource Management (CRM)**

(a) **CRM Analysis of Event Flight –** PIA has trained CRM Facilitators for conduct of CRM training. Both flight crew had valid CRM Rating at the time of accident. Analysis of flight crew actions, aircraft trajectory, and CVR recording highlighted inadequate level of CRM application by both flight crew. There were numerous deviations from SOPs, required briefings were not conducted and several Alerts and Warnings were either ignored, not verbalized, or cancelled.

(b) **CRM Oversight by PCAA –** CRM qualification / assessment markers are assessed by the examiner prior to and during Simulator / Flight Check as per PCAA Personnel Licensing (PEL) assessment forms[85] at CAAF-028-RGLC (Section 9) and CAAF-O29-RGLC (Section 15). On 23rd June, 2020, PCAA FSD disseminated a comprehensive letter[86] to Operators highlighting issues related to CRM effectiveness in the cockpit, and made several suggestions to the Operators to enhance CRM effectiveness, develop assertiveness in FOs (PMs), and utilization of FDM programme to gauge the effectiveness of CRM programme.

2.2.2.39 **SMS Implementation**

(a) **Decision of EASA**

(i) PIA was issued with the Third Country Operator (TCO) Authorization on 17th May, 2015. As part of the continuous monitoring, EASA carried out an assessment of the PIA Operations under the TCO Authorization in order to assess continued compliance of PIA with the applicable requirements of Annex-1 (Part-TCO).

(ii) In the course of assessment (June-September, 2019), EASA raised one Finding (Level-1) related to SMS which stated “PIA could not demonstrate having effectively implemented all elements of a SMS as required by Annex-6 Part-1 and Annex-19 to the Chicago Convention”. Corrective Action Plans (CAPs) to address Level-1 Finding (proposed by PIA) was evaluated by EASA and was found insufficient due to following: -

[83] PIA Flight Data Analysis of Captain of last one year (Excel Sheet “Summary”)
[84] PIA AOC Renewal 2019 Audit Report and reply received from PIA
[85] PCAA PEL CAAF-028-RGLC-1.3 & CAAF-029-RGLC-1.0 Simulator & Route Check Report
[86] PCAA FSD letter HQCAA/1076/198/FSAC/6657 dated 23rd June, 2020

- The software application, for Safety Data Management, Risk Assessment and Analysis including the Statistical Analysis and the ability to identify repeated or similar hazards / occurrences was still under development.

- Insufficient evidence was provided confirming the complete implementation of agreed CAPs related to functional reporting of Safety Action Groups (SAGs) to the Corporate Safety Department as it did not contain revised policy and related procedures.

- On 23rd October, 2019, PIA issued a policy to timely address the safety reports. However, the submitted evidence revealed that since December, 2019 none of these reports were processed as for instance the respective root causes were still not identified.

- PIA proposed to develop extended guidance to facilitate the understanding and the application of the management of change and to issue a Bulletin endorsed by the accountable executive along with guidance material. Additionally, training was planned for the involved staff. However, PIA could not provide suitable evidence of complete implementation of this action.

- Submitted documents related to the measurement of Safety Performance Indicators (SPIs) revealed that some of the SPIs were controlled by different departments with different target settings. Furthermore, the submitted corporate SPIs did not contain all indicators measured by the departments themselves.

(iii) EASA showed concern that the SMS was not achieving its primary objective. PIA was unable to address CAPs within the agreed time period and TCO authorization of PIA was suspended on 1st July, 2020.

(b) **PIA Progress on Corrective Action Plans (CAPs) for SMS**

(i) On 16th November, 2020, PIA provided EASA with a comprehensive set of documents as evidence to support the implementation of the agreed CAPs for SMS. EASA has reviewed the submitted material and found it satisfactory and sufficient as a first important step towards the closure of Findings[87]. PIA physical Audit by EASA is awaited.

2.2.3 **Weather –** Meteorological conditions on departure Aerodrome, enroute and destination Aerodrome, did not contribute to the accident.

2.2.4 **Air Traffic Control (ATC)**

2.2.4.1 **ATS Shift Management –** Average daily air traffic density during COVID-19 Pandemic Lockdown at JIAP, Karachi was significantly reduced and the shift manning was adjusted accordingly. At the time of the accident, ATC shift was present on duty as per roaster and was adequate to handle Flight Operations and Emergency Services at JIAP, Karachi.

[87] EASA letter No. JMAR/JRAS/FS.2.3 dated 2nd December, 2020

2.2.4.2 **Role of Air Traffic Controllers**

(a) The record showed that Karachi Approach and Karachi Aerodrome were manned by qualified and experienced Air Traffic Controllers with valid ATC Ratings.

(b) After changeover from Karachi Area Control, PIA 8303 remained under Karachi Approach Control till crash including Gears Up R/W contact. Karachi Approach Control obtained the landing clearance from Aerodrome Controller and cleared PIA 8303 for first Approach [in accordance with PCAA "Manual of Air Traffic Services" (MNL-001-OPAT-4.0)][88].

(c) Karachi Approach cautioned PIA 8303 thrice about High on Approach. Subsequently, Karachi Approach asked PIA 8303 twice to turn left heading 180 to adjust the altitude but flight crew continued the Approach saying that they were comfortable. At 05 miles from threshold R/W 25L Karachi Approach once again Cautioned PIA 8303 about excessively High on Approach. Flight crew acknowledged the Caution but continued with the same Approach.

(d) **Actions by Air Traffic Controller in case of Abnormal Aircraft Configuration and Condition –** Whenever an abnormal configuration or condition of an aircraft, including conditions such as Landing Gears not extended or only partially extended, or unusual smoke emissions from any part of the aircraft, is observed by or reported to the Aerodrome Controller, the aircraft concerned shall be advised without any delay by the Air Traffic Controller [in accordance with PCAA "Manual of Air Traffic Services" (MNL-001-OPAT-4.0)][89].

(e) While PIA 8303 was on Approach, Aerodrome Controller could not ascertain whether aircraft Landing Gears were DOWN or not probably because of aircraft pitch down attitude (CAS 204 kts – 189 kts). It was also observed through CCTV that prior to touchdown aircraft attitude seems to be slightly nose down and then getting parallel to the R/W.

(f) When PIA 8303 made Gears Up contact with the R/W (almost 4,500 ft from R/W 25L threshold), sparks were observed by Aerodrome Controller. As a good airmanship, Aerodrome Controller could have immediately communicated to the aircraft about the anomaly. PIA 8303 remained on the R/W approximately for 14 s before initiating a Go-Around. Instead, Aerodrome Controller communicated on landline to Approach Controller that aircraft's Landing Gears were not DOWN during R/W contact and told him to inquire from the aircraft whether Landing Gears were DOWN or not? However, Approach Controller did not inform (or question) PIA 8303 about Gears Up landing.

(g) The extracts of the communication between Approach Controller and Aerodrome Controller on landline is appended below: -

[88] PCAA MNL-001-OPAT-4.0, Manual of Air Traffic Service, 5.3.2.1.1, Pg – 45
[89] PCAA MNL-001-OPAT-4.0, Manual of Air Traffic Service, 8.4.1.7.1, Pg – 142

Time (UTC)	From	To	Communication	PIA 8303
09:34:45	APP	TWR	Hello…	RA (2 ft) height started to increase. Aircraft airborne.
09:34:49	TWR	APP	*He did not put Gears DOWN. Going up after touching* (in Urdu)	
09:34:53	APP	TWR	*Where is he now?* (in Urdu)	
09:34:54	TWR	APP	*Now over at Threshold, Stop way* (in Urdu)	
09:34:58	PIA 8303	APP		Pakistan 8303 Going Around
09:35:01	APP	TWR	*What do you mean going Up?* (in Urdu)	
09:35:05	APP	PIA 8303	Pakistan 8303 say again	
09:35:08	PIA 8303	APP		Going Around sir
09:35:10	APP	PIA 8303	Roger	
09:35:45	TWR	APP	*Yes* (in Urdu)	
09:35:46	APP	TWR	*What happened?* (in Urdu)	Request heading for Pakistan 8303 we would like to come again for ILS 25L (PIA 8303 – APP)
09:35:47	TWR	APP	*He had not put the Landing Gears DOWN* (in Urdu)	
09:35:53	APP	PIA 8303	Roger, turn Left heading 110, climb 3,000	
09:35:57	PIA 8303	APP		Left heading confirm?
09:36:00	APP	PIA 8303	Affirm left heading 110 climb 3,000	
09:36:03	PIA 8303	APP		110 climb, 3,000 Pakistan 8303
09:36:06	APP	TWR	*What happened?* (in Urdu)	
09:36:07	TWR	APP	*He had not put the Landing Gears DOWN. I have declared Full-Scale (Emergency)* (in Urdu)	
09:36:10	APP	TWR	*For the time being*…(in Urdu)	
09:36:12	TWR	APP	*He touched and there was fire, belly landing type, then went Up* (in Urdu)	
09:36:21	APP	TWR	*OK* (in Urdu)	
09:36:23	APP	TWR	*I was telling him to discontinue* (in Urdu)	
09:36:26	TWR	APP	*Ask him whether Gears were DOWN or not? I saw those were not DOWN* (in Urdu)	
09:36:32	APP	TWR	*OK* (in Urdu)	

Table 39 – Conversation between Approach Controller and Aerodrome Controller

(h) Approach and Aerodrome Controllers did not inform PIA 8303 about abnormal conditions of the Gears Up landing. Aerodrome Controller declared Full Scale Emergency and deployed PCAA RFFS vehicles along the R/W.

2.3 Aircraft

2.3.1 Electrical System

2.3.1.1 Mono-Generator Configuration after R/W Contact

(a) Two Integrated Drive Generators (IDGs) named GEN 1 and GEN 2, driven by respective Engine through an integrated drive, supply electrical power to the aircraft. Each generator can supply up to 90 Kilovolt-Ampere (KVA) of three phase 115 / 200 Volt (V) 400 Hertz (Hz) constant Frequency AC power. In case of Engine failure, the generator will disconnect from its Engine if N2 drops below 56.3% (for 500 ms). One generator is sufficient to provide AC power to all electrical bus bars of aircraft, as shown below where GEN 2 is inoperative.

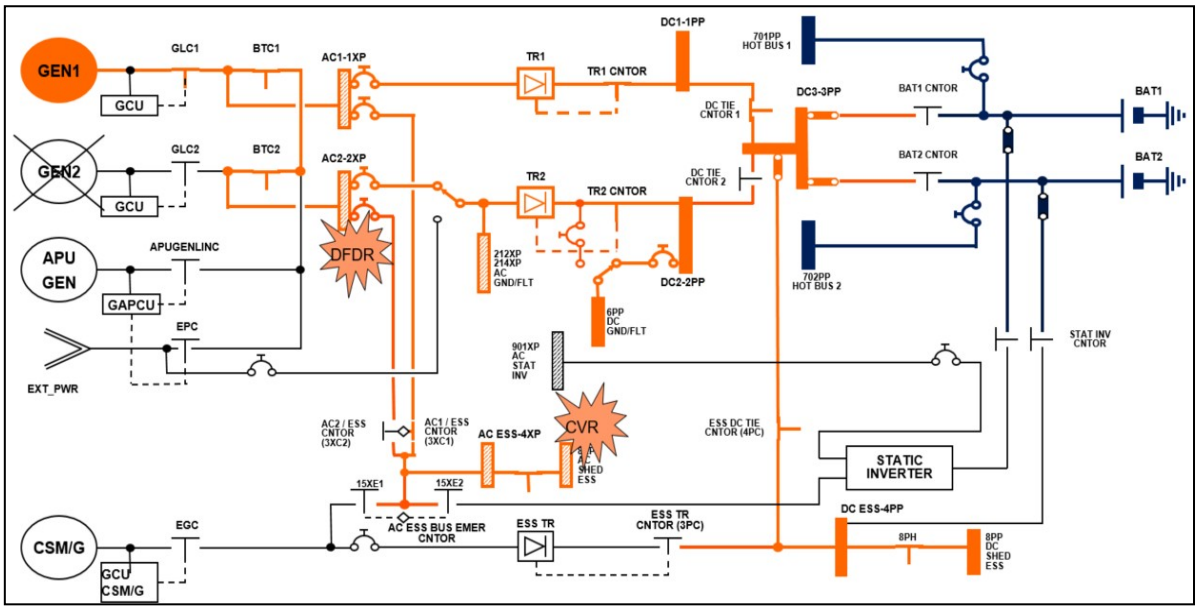


Figure 139 – GEN 2 Inoperative

(b) At the time of the stop of the DFDR recording, the Engine No. 1 was spooling down; the last recorded values were N1=16% and N2=55%. This value of N2 is consistent with the GEN 1 disconnection threshold. Engine No. 2 was still running and delivering thrust, as the N1 actual was 56%, following the N1 command, and the N2 actual was high.

(c) The DFDR is not powered in Emergency Electrical Configuration "EMER ELEC", i.e. electrical system is being powered by the RAT. DFDR stopped recording at the time of the failure of Engine No. 1 (and its electrical generation) is consistent with an EEC starting at that point. This means that the GEN 2 was already not available, otherwise it would have taken over the electrical network on Engine No. 1 failure.

(d) **GEN 2 -** Each IDG is connected to its respective Engine's AGB which is connected to the TGB. The lower part of the TGB (recovered from the accident site) showed marks of friction with a hard flat surface, material displacement and large loss of material. Rubbing was found on the TGB horizontal shaft gear. Both the AGB and the TGB are located at the lower part of the fan case (6 O'clock) as appended below: -

Figure 140 – TGB Missing Part

(e) Based on the analysis of missing parts (due to rubbing on the R/W), it is most probable that the AGB of the Engine No. 2 experienced damage similar to TGB during the event. As GEN 2 is connected with the AGB, it is most likely that it was damaged during R/W contact and became inoperative. The electrical system then reconfigured on the remaining generator (GEN 1), until the spool down and failure of the Engine No. 1.

2.3.1.2 Emergency Electrical (EMER ELEC) Configuration During Go-Around

(a) The aircraft reconfigured into the EMER ELEC configuration, following the failure of Engine No. 1 during Go-Around. RAT extension can be seen in following picture taken during the event after Go-Around: -

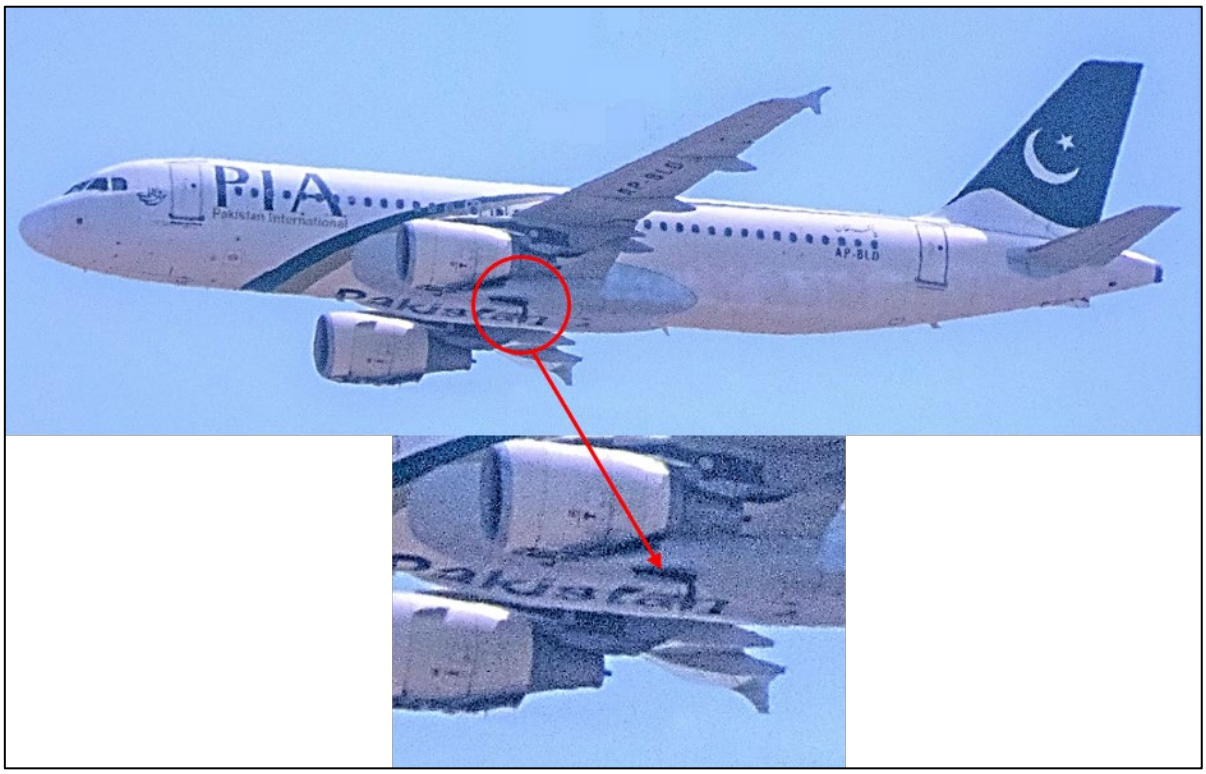


Figure 141 – RAT Extended After Go-Around[90]

[90] *[Source: Plane Spotters Pakistan]*

(b) There are two phases during the reconfiguration into the EMER ELEC Configuration: -

(i) **First Phase –** During this phase, RAT is in the process of deployment and only batteries are available. The batteries supply HOT BUS 1+2, Direct Current (DC) ESS Busbar and AC ESS Busbar through static inverter. The AC SHED ESS and DC SHED ESS are not powered to save electrical power. As the CVR is supplied by AC SHED ESS Busbar therefore it is transiently unpowered.

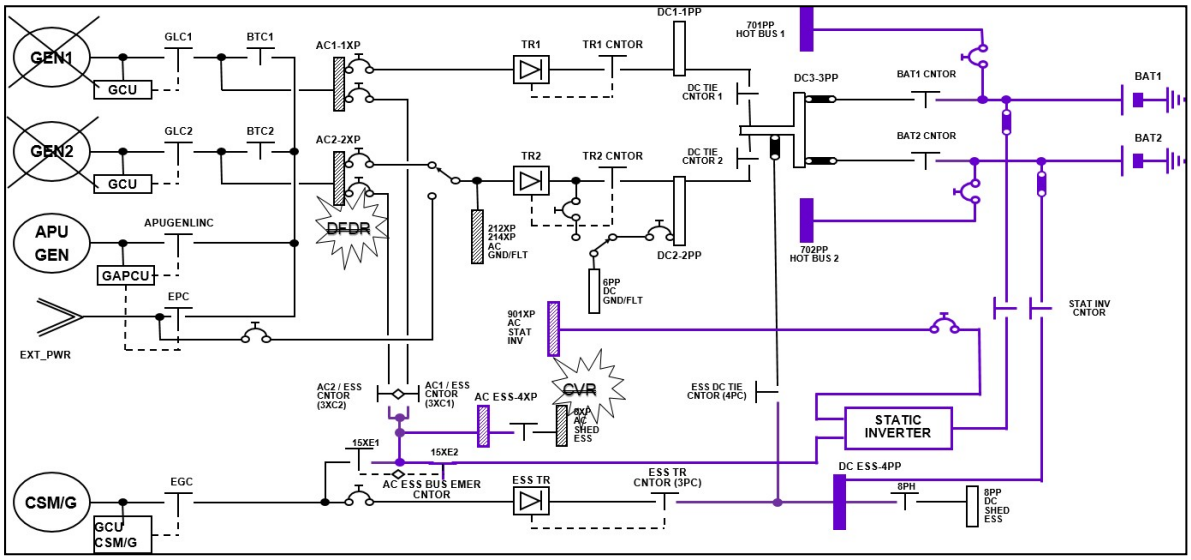


Figure 142 – First Phase of EMER ELEC Configuration

(ii) **Second Phase –** During this phase, RAT is fully extended and the Constant Speed Motor / Generator (CSM/G) is started. It supplies the complete AC ESS and DC ESS network; AC SHED ESS and DC SHED ESS Busbars are then supplied and therefore the CVR is recovered.

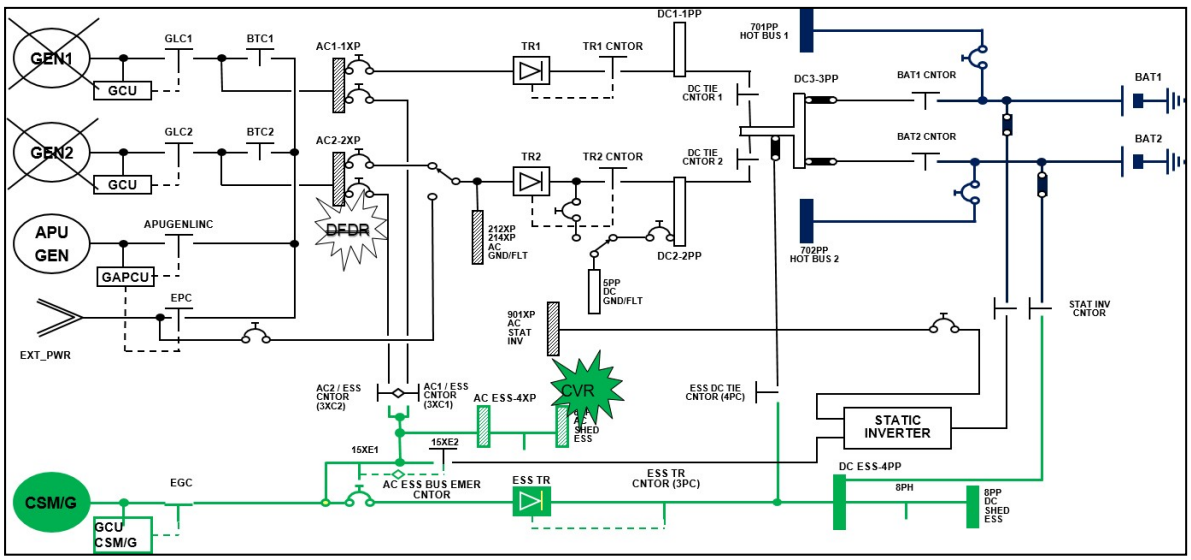


Figure 143 – Second Phase of EMER ELEC Configuration

(iii) As per the CVR recording, there was a transient CVR shutdown at 09:36:19. The CVR was then recovered (after 8 s) at 09:36:27 and remained powered until the ground impact. This is consistent with a nominal reconfiguration of the electrical system in EEC.

2.3.1.3 **Electrical System Synthesis –** Following table provides the synthesis of the electrical system during the event flight: -

Description	Flight Phase		
	Before R/W contact	**After R/W contact (Before Go-Around)**	**During Go-Around (Until DFDR stopped)**
Engine No. 1	Available	Available	Failed
Engine No. 2	Available	Available	Available
GEN 1	Available	Available	Lost (disconnected)
GEN 2	Available	Failed	Failed
Electrical System	Normal situation, each electrical side supplied by respective GEN	Mono-generator situation (reconfiguration) AC power to all electrical bus bars by GEN 1	EMER ELEC configuration

Table 40 – Synthesis of the Electrical System of Event Flight

2.3.2 **Flight Warning System (FWS)**

2.3.2.1 The FWS manages the priorities between the different Alerts. There are three Priority Levels for Warnings and Cautions; a Level 3 Warning has priority over a Level 2 Caution, which has priority over a Level 1 Caution. Priorities are also set between Alerts of the same Level.

2.3.2.2 The FWC fitted in this aircraft was of standard F9D. Following priorities exist between the 03 Red Warnings (Level 3) generated during the event flight (from the highest to the lowest): -

(a) "OVERSPEED" Red Warning.

(b) "L/G GEAR NOT DOWN" Red Warning.

(c) "AUTO FLT AP OFF" Red Warning.

2.3.2.3 ECAM E/WD Red Warning sequence during the event flight until R/W contact were as below: -

(a) From 09:32:46 to 09:32:48: "OVERSPEED" VFE Warning (CONF1) was active.

Figure 144 – "OVERSPEED" (CONF1) Warning

(b) From 09:32:48 to 09:33:24: "OVERSPEED" VFE Warning (CONF1) and "AUTO FLT AP OFF" Warning were active.

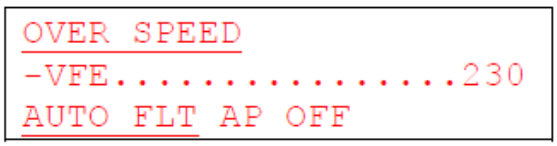


Figure 145 – "OVERSPEED" (CONF1) and "AUTO FLT AP OFF" Warning

(c) From 09:33:25 to 09:33:27: "OVERSPEED" VFE Warning (CONF2) and "AUTO FLT AP OFF" Warning were active.

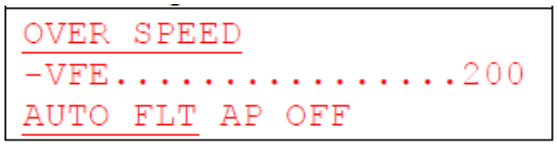


Figure 146 – "OVERSPEED" (CONF2) and "AUTO FLT AP OFF" Warning

(d) From 09:33:27 to 09:33:48: "OVERSPEED" VFE Warning (CONF3) and "AUTO FLT AP OFF" Warning were active.

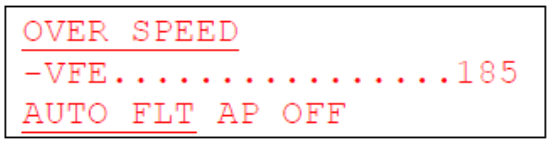


Figure 147 – "OVERSPEED" (CONF3) and "AUTO FLT AP OFF" Warning

(e) From 09:33:27 to R/W contact (09:34:28): "OVERSPEED" VFE Warning (CONF3), "L/G GEAR NOT DOWN" Warning and "AUTO FLT AP OFF" Warning were active.

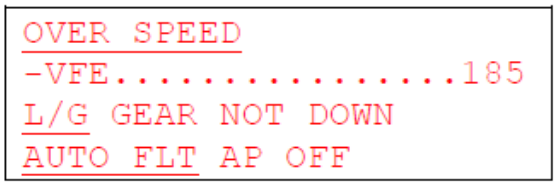


Figure 148 – "OVERSPEED" (CONF3), "L/G GEAR NOT DOWN" and "AUTO FLT AP OFF" Warning

2.3.2.4 Triggering of above Red Warnings sequence was as per FWS priority rules.

2.3.3 **Landing Gears**

2.3.3.1 During Approach, there was an extension of Landing Gears at 09:31:39, 7,440 ft baro altitude, 10.8 NM from R/W threshold (confirmed Downlocked 13 s later).

2.3.3.2 Before the R/W contact at 09:32:57, 1,700 ft baro altitude, 4.9 NM from R/W threshold Landing Gears were retracted (confirmed Uplocked 13 s later).

2.3.3.3 During the last part of event flight, at 09:39:39, sound similar to Landing Gears extension was heard in CVR recording.

2.3.3.4 The analysis of available evidence highlights that during the event, the Landing Gears system behaved nominally and as commanded during the Approach and Landing. The durations of the Landing Gears extension and retraction sequences for first extension and retraction were nominal (13 s). Duration of final extension sequence could not be verified due to end of DFDR recording by that time. However, on site analysis and CCTV footage corresponds that Landing Gears were DOWN at the time of accident.

2.3.4 **Powerplant**

2.3.4.1 Both Engines were damaged during the contact with the R/W, particularly AGBs and TGBs. Both TGBs had a punctured wall (hole in the casing) allowing Oil leakage. This resulted in the total loss of Engine Oil on both Engines, and the triggering of the OIL LOW PRESSURE Red Warnings. Subsequent to the loss of lubrication, both Engines failed in sequence (Engine No. 1 followed by Engine No. 2). On-site observations on the fan blades were consistent with both Engines being at low rotational speed at the time of the impact, most likely not producing any thrust.

2.3.4.2 **Engine No. 2 Stalled during R/W Touchdown**

(a) At 09:34:37, Engine No. 2 was commanded at IDLE (Both TLA were physically at MAX REV) and several Engine No. 2 parameters showed invalid variations for 4 s. Engine No. 2 Fire Warning triggered for 7 s. There were N1 vibration on Engine No. 2 above 5 CU. At 09:34:41, both TLA were pushed to TOGA, the Engine No. 1 N1 command increased to 94% and the Engine No. 2 N1 command decreased to 16%. As the Engine No. 2 N2 was below 47%, the Engine status changed to “START” and it waited for N2 to increase above 53.9% for further increase of N1. This is coherent with the DFDR parameters showing the Engine No. 2 N1 command at IDLE.

(b) Most probably there was a transient loss of ECU 2 power supply, due to the failure of the PMA following AGB contact with the R/W. The failure of PMA resulted in loss of electric power supply to ECU. Backup power and ECU initialization takes approximately 4 s after which normal Engine behaviour is restored. This is also consistent with loss of ECU parameters for around 4 s in DFDR data. Engine manufacturer simulations showed that the Engine No. 2 most probably stalled at 09:34:41. The aircraft got airborne at 09:34:45 with only Engine No. 1 operative.

2.3.5 **Flight Controls**[91]

2.3.5.1 Aircraft stayed controlled in Normal Law for the complete duration of the DFDR recording. There was no ELAC nor SEC fault recorded in the DFDR for the event flight. No sidestick fault and no elevator faults were recorded in the DFDR. In the CVR, which remained available till the end of flight (except 8 s of RAT deployment) there was no discussion from the flight crew with relation to the flight controls, even after the EEC (Refer section – 1.16.2.3 “Flight Control Laws in Emergency Electrical Configuration”).

2.3.5.2 During Approach below 50 ft RA, Flare MODE was engaged but it never changed to Ground MODE during R/W contact phase as the Landing Gears were not DOWN. After getting airborne it changed to Normal Flight MODE.

2.3.5.3 When DFDR stopped recording, EEC was activated, supplied by the batteries. The aircraft was in Alternate Law in pitch (with reduced protections), Direct Roll Law and Mechanical Yaw Control. When the RAT became online, FAC 1 was powered again and Alternate Yaw Law was activated.

[91] BEA Contribution Report on Aircraft Systems dated 16th June, 2022

2.3.5.4 When flight crew selected the Landing Gears DOWN, which was heard in CVR recording at 09:39:39, the Pitch Control Law changed to Direct Law (Flare MODE activated from the Landing Gears extension) as described in FCOM Section DSC-27-20-20.

2.3.5.5 The analysis of the recorded data showed that the flight controls worked as expected during the event flight. Flight crew had adequate control of the aircraft in Pitch, Roll, and Yaw as per applicable Flight Control Laws. The flight controls did not become a limiting factor in flight crew emergency handling throughout the event flight.

2.3.6 **Emergency Locator Transmitter (ELT) Non-Activation –** ELT (P/N. S1819502-02, S/N J015-0186) was fitted on this aircraft. ELT was not registered with Pakistan Space and Upper Atmosphere Research Commission (SUPARCO). ELT Signal was not received at SUPARCO after the accident. ELT could not be recovered from the accident site and most likely it was destroyed during impact / fire as it is not crash survivable.

2.3.7 **Aircraft Quarantine due to COVID-19 Pandemic Restrictions –** The aircraft remained on ground for 46 days (from 22nd March, 2020 to 6th May, 2020) during COVID-19 Pandemic due to restrictions on flying operations. Maintenance records indicate compliance of all applicable inspections by the Operator before the release of the aircraft for normal flying (post quarantine).

2.4 Human Factors

2.4.1 Physiological and Psychological Factors

2.4.1.1 **Probability of Flight Crew under influence of Psychoactive Substances –** Breath analyser check for the flight crew was not carried out prior to the event flight, and the undertaking certificates for psychoactive substances were also not rendered which is not in line with regulations in vogue[92] (Refer section 1.16.11.5 – "PCAA Policy on use of Psychoactive Substances"). Post-accident, forensic toxicology analysis reports of both flight crew did not show any drugs / volatiles / intoxication[93].

2.4.1.2 **Pre-existing Medical Conditions –** There was no evidence to indicate that the flight crew performance might have been adversely affected by pre-existing medical conditions, medication, other drugs, or alcohol, etc during the event flight.

2.4.1.3 Psychiatric Evaluation of Captain

(a) Crew induction record, including Psychiatric Evaluation was not available with PIA[94] prior to year 2002. With the help of PCAA Legal Branch, AAIB Pakistan retrieved Captain's Psychiatric Evaluation case details from the court records. Captain, underwent Psychiatric Evaluation for Cadet Pilot as per PIA induction criteria (Refer section 1.16.11.3 – "Flight Crew Psychiatric Evaluation in PIA").

[92] PIA I/C ACMC Email dated 25th June, 2020
[93] Govt. of Sindh (Laboratory) Chemical Analysis and Toxicology Report of Flight Crew
[94] PIA I/C ACMC Email dated 4th June, 2020

(b) Captain was not recommended by PIA panel of Psychiatrist[95]. Subsequently, he got opinion from five other psychiatrists (three from United Kingdom and two from Pakistan), who declared him fit for Cadet Pilot[96].

(c) Psychiatric Evaluation other than the approved panel of specialists was not accepted by PIA due to change in policy. Captain filed a petition in Wafaqi Mohtasib (Federal Ombudsman*)* with the plea that change of policy occurred after his application and was not applicable on his induction. The Federal Ombudsman gave verdict in his favour. PIA went for appeal against Federal Ombudsman decision but case was discharged in Captain's favour[97].

(d) During service in PIA, Captain underwent regular medical check-up and was never identified with any abnormality or disorder related to mental health requirements as per ICAO Annex-1.

2.4.1.4 **Psychiatric Evaluation of First Officer –** FO underwent psychiatric evaluation at AMI, PAF in July, 2009. He was found free from any psychiatric illness, with normal EEG, and his screening for drugs was also negative[98]. FO satisfied mental health requirements given in ICAO Annex-1.

2.4.1.5 **Effects of Hydration and Somatic Stressors on Flight Crew**

(a) Tests results of study for effects of hydration on flight crew flight performance and spatial cognition were significantly poor for pilots who had low fluid intakes and experienced dehydration in comparison to the hydrated pilots (Refer section – 1.16.12.6 "Study on Effects of Hydration on Flight Crew"). Similarly result of research for hypoglycemia (decrease in blood glucose) pointed to the risk of increased somatic stressors because of hypoglycemia (Refer section – 1.16.12.7 "The Impact of Somatic Stressors on Flight Crew")

(b) Muslims abstain from food or drink each day from sunrise until sunset during the Holy Month of Ramadan. Islamic Fasting as a time restricting eating habit may invert the normal human day-night routine, sleep patterns (circadian rhythms) and general health (reduction in day time hydration, blood glucose, etc). Flying with Fasting may affect flight performance of a flight crew in terms of reduction of spatial cognition and increases the risk of somatic stressors (hypoglycemia).

(c) Accident took place during the Holy Month of Ramadan (Month of Fasting for Muslims). Both the flight crew were having regular Sehri (morning meal eaten by Muslims before the sun has come up during Ramadan) and Iftar (Evening meal eaten by Muslims after the sun has gone down during Ramadan). On the day of accident, both the flight crew had Sehri prior to the event flight. Moreover, in the initial part of flight, the flight crew were offered snacks by the cabin crew which was politely refused by them. Both flight crew were probably Fasting at the time of undertaking event flight and they continued with their Fast during the flight.

[95] PIA and PAF Psychiatrists' unfitness reports of Captain
[96] UK and Pakistan psychiatrists' fitness reports of Captain
[97] Federal Ombudsman Decision of Captain
[98] PAF Psychiatrists Evaluation of FO

(d) Flying with Fasting may affect flight performance of a flight crew in terms of reduction of spatial cognition and increases the risk of somatic stressors (hypoglycemia). The judgement of both flight crew was probably impaired due to effects of fasting while flying. However, its consequence on flight performance of the flight crew could not be determined.

2.4.1.6 **PCAA Regulations on Flight Crew Fasting**

(a) At the time of accident, PCAA's regulations [CARs 1994, Rule 41(3) and ANO of PCAA Aero Medical, "Flight Crew Medical Requirements" (ANO-001-XXAM-2.0)] on flying while fasting left it to flight crew to decide about flying based upon his / her judgement on medical fitness effected by a period of Fasting (Refer section 1.16.12.1 "PCAA Regulations on Flight Crew Fasting"). Clear and precise regulations were not available to restrict flying while Fasting at the time of accident.

(b) After the accident, flying while Fasting was prohibited in revised ANO of PCAA FSD "Flight Time, Flight Duty Period, Duty Period & Rest Periods for Fatigue Management – Flight and Cabin Crew" (ANO-012-FSXX-6.0). Whereas, ANO of PCAA Aero Medical, "Flight Crew Medical Requirements" (ANO-001-XXAM-3.0) section D2.1.8.1 related to flight crew Fasting remained unchanged after the revision in year 2021[99]. Feedback mechanism on compliance is also not clear between Regulator and Operators.

(c) Presently CARs 1994, Rule 41(3), ANO of PCAA Aero Medical, "Flight Crew Medical Requirements" (ANO-001-XXAM-3.0) and ANO of PCAA FSD "Flight Time, Flight Duty Period, Duty Period & Rest Periods for Fatigue Management – Flight and Cabin Crew" (ANO-012-FSXX-6.0) pertaining to flight crew flying while Fasting contains different instructions, which may create ambiguity for Operators. Ambiguous and indirect directives have a room for misinterpretation.

(d) After the accident, Directives / Alerts have been issued by PCAA on commencement of Ramadan specifically forbidding flight crew from flying while Fasting. PCAA FSD has also advised those flight crew willing to Fast during Month of Ramadan to apply for leave and has instructed all Operators to facilitate such flight crew[100]. PCAA Aero Medical issued "Safety Measures" during the Month of Ramadan 2021 and advised all Operators for strict compliance that flight and cabin crew to consume at least a glass of water, juice or soft drink prior to operating flights. This action is to be done while signing undertaking for psychoactive substances and breath analyser tests for alcohol before the flight during the Month of Ramadan[101].

2.4.1.7 **Regulations on Flight Crew Nutrition**

(a) PCAA regulations require Operators to include relevant regulations and guidance to flight crew members concerning health including meal precautions prior to and during flight in the Operations Manual.

[99] PCAA FSD letter No. HQCAA/1076/019/FSAC/5629 dated 3rd August, 2022
[100] PCAA FSD letter No. HQCAA/1076/198/FSAC/4493 dated 13th April, 2022
[101] PCAA Aero Medical Email dated 12th April, 2021

(b) PIA Operations Manual does include detailed guidelines on health and nutrition of flight crew including policy on crew meals, as well as procedure for taking meals and fluids on flight deck. However, minimum duration of the meal opportunity and the time frames in which a regular meal should be consumed is not specified in the Operations Manual.

2.5 Survivability

2.5.1 Rescue Fire Fighting Service Response

2.5.1.1 PCAA RFFS vehicles and ambulances reached at accident site within 10 min and started fire-fighting operation. Military, Local Government and NGOs also participated in Search and Rescue Operation. Difficulty was faced in Search and Rescue Operation due to narrow streets, parked vehicles and huge public gathering around the accident site.

2.5.1.2 The persons involved in Search and Rescue Operations were inadequately aware / geared up for hazards at aircraft accident site.

2.5.1.3 Evidence preservation during Search and Rescue Operation was inadequate before the arrival of AAIB Investigation Team.

2.5.2 **Analysis of Injuries and Fatalities –** PCAA Medical team consisting of Medical Inspection Room (M.I. Room) JIAP, Karachi and Aero Medical Centre reached at the accident site to provide medical assistance to the victims. The dead bodies and injured persons were shifted to JPMC, Civil Hospital and Dar-ul-Sehat Hospital Karachi**.** Few dead bodies were identified through facial, belongings and dentures. Deoxyribonucleic Acid (DNA) Tests were carried-out by the Forensic Lab of Karachi University and Punjab Forensic Science Agency (PFSA) Lahore to identify the remaining dead bodies. Later, dead bodies were handed over to the families of the victims by the Operator.

S/N	Hospital	Dead Bodies	Injured Personnel
1	Civil Hospital	31	1
2	JPMC	66	-
3	Dar-ul-Sehat Hospital	-	1
Total		**97**	**2**

Table 41 – Details of Dead Bodies and Injured Shifted to the Hospital

SECTION 3 - CONCLUSIONS

3.1 Findings

3.1.1 Aircraft

3.1.1.1 The aircraft preservation procedure adopted during COVID-19 Pandemic (22nd March to 6th May, 2020) and at the time of reinduction for flying was in accordance with applicable maintenance procedures.

3.1.1.2 The aircraft was serviceable and flight worthy at the day of accident. There was no Minimum Equipment List (MEL) or other system related entry at the time of departure which could have contributed to the accident.

3.1.1.3 There was no evidence of terrorist activity, sabotage, in-flight fire, in-flight breakup, loss of control, bird hit, etc) causing the accident.

3.1.1.4 Flight controls worked as expected during the event flight and did not become a limiting factor in flight crew emergency handling throughout the event flight.

3.1.1.5 The Landing Gears system behaved nominally and as commanded during the Approach and Landing.

3.1.1.6 GPWS synthetic Aural Alert “TOO LOW GEARS” was not generated because speed remained above the triggering threshold (190 kts below 500 ft AGL) throughout the Approach.

3.1.1.7 Both Engines were damaged during contact with the R/W, particularly AGBs and TGBs. The resultant loss of Engine Oil and subsequent lack of lubrication resulted in failure of both Engines in sequence (Engine No. 1, followed by Engine No. 2).

3.1.1.8 ELT was not registered with SUPARCO by the Operator.

3.1.1.9 The sampled fuel from the refuelling source was of proper grade, quality and contained no contamination.

3.1.1.10 The aircraft was destroyed by impact forces and post impact fire.

3.1.2 Flight Crew / Pilots

3.1.2.1 Captain

(a) Captain was licensed, qualified and medically fit for the event flight in accordance with existing regulations.

(b) Captain was issued show cause notice by PCAA for violating flight duty time limit, and exceeding stipulated limits of flying hours within 30 / 365 days.

(c) Captain training record did not reveal any significant observation.

(d) There were no social / psychological issues reported / documented by PIA / PCAA in his record.

(e) Psychologist evaluation at the time of induction in PIA indicated that Captain was of a bossy nature, firm, dominant and overbearing. He had a tendency to have little regard for the authority, low mechanical / space relation comprehension and inadequate level of stress tolerance.

3.1.2.2 **First Officer**

(a) First Officer was licensed, qualified and medically fit for the event flight in accordance with existing regulations.

(b) There were no social / psychological issues reported / documented by PIA / PCAA in his records.

3.1.3 **Flight Operations**

3.1.3.1 Cockpit environment was conducive with no indication of fear or compulsion to fly during the COVID-19 Pandemic.

3.1.3.2 Flight crew did not follow the Sterile Cockpit Rule during departure.

3.1.3.3 Approach briefing was not conducted prior to descent.

3.1.3.4 Prior to descent FO was found to be PF, whereas Captain was PM.

3.1.3.5 There was neither FMA callout nor cross check of FMS setting starting from beginning of descent, by flight crew indicative of lack of application of procedures / adherence to SOP.

3.1.3.6 Flight crew did not clear flight path in FMS, which led FMS to compute vertical profile including holding pattern distance in the track mile.

3.1.3.7 Flight crew probably mistuned Approach Control Karachi radio frequency and several calls from ATC were not responded.

3.1.3.8 Karachi Approach asked, “Pakistan 8303 confirm track mile comfortable for descent?” to which PIA 8303 replied, “Affirm”. At that time aircraft was around 9,000 ft baro altitude (against 3,000 ft) at approximately 15 NM from R/W 25L threshold. Aircraft was significantly above the published vertical Approach path (almost 6°).

3.1.3.9 Flight crew were unable to follow SOP for “Glide Slope (G/S) Interception from Above”. There was no verbal re-calculation, no crosscheck between flight crew on vertical flight path of the aircraft.

3.1.3.10 SABEN waypoint was overflown at 7,830 ft baro altitude. Aircraft was excessively high (4,830 ft in excess) above the desired G/S.

3.1.3.11 Once aircraft was at 11 NM from R/W 25L threshold, it was still excessively high (4,500 ft). ATC reminded aircraft position versus flight level to which PIA 8303 replied that no problem.

3.1.3.12 Aircraft trajectory was not challenged by flight crew and there was no mental picture of the flight path even after being prompted by the ATC.

3.1.3.13 Activation of Approach MODE before SABEN waypoint, with FMS flight plan still including the Holding Pattern led to engagement of LOC MODE. It was necessary to activate NAV MODE at SABEN to ensure that FMS follows Holding Pattern instead of continuing ILS LOC.

3.1.3.14 After commencing descent, flight crew could not manage flight profile through appropriate MODE selections to intercept a stabilized Approach path.

3.1.3.15 Landing Gears were selected DOWN and locked at 7,239 ft baro altitude. Neither PF nor PM verbalized the selection of the Landing Gears lever to DOWN position and there was no cross check.

3.1.3.16 At 10 NM from R/W 25L, aircraft was still excessively high. ATC proposed an orbit to lose altitude. However, flight crew continued excessively high on Approach.

3.1.3.17 At 7.7 NM from R/W 25L threshold, AP Vertical MODE changed to ALT*, Rate of Descent was 4,115 ft/min. Flight crew didn't call FMA check, no call out of "Speed" and "ALT*".

3.1.3.18 At 4,100 ft baro altitude and 6.9 NM from R/W 25L threshold, Karachi Approach instructed PIA 8303 to turn left heading 180°, to which PIA 8303 reported that they are comfortable and established on ILS 25L. ATC instructions were disregarded twice by the flight crew.

3.1.3.19 At 3,000 ft baro altitude, Karachi Approach reminded again that aircraft was still too high on the Approach path, however flight crew continued to press high on Approach.

3.1.3.20 At 2,730 ft baro altitude, 5.5 NM from R/W 25L threshold, AP disengaged due to excessive pitch down (13°) and "Auto-Pilot OFF" Warning was triggered.

3.1.3.21 Flight crew did not verbalize acknowledgement of the Master Warning, monitor FMA, call out for AP disconnection and no call out for manual takeover.

3.1.3.22 After AP disconnection, "OVERSPEED" VFE triggered Master Warning along with CRC Aural Alert. Flight crew selected FLAPS without monitoring speed and did not verbalize acknowledgement of the Master Warning.

3.1.3.23 Two Sequence of GPWS Alerts were triggered before the R/W contact. During 04 GPWS Warnings of "PULL UP", flight crew did not perform an immediate Terrain Avoidance / Escape Manoeuvre. On 02 "SINK RATE" and 10 "TOO LOW TERRAIN" Amber Cautions, flight crew did not call out GPWS Caution.

3.1.3.24 At 1,600 ft baro altitude, 5 NM from R/W 25L, Landing Gears were selected UP, and Speed Brakes were retracted. Retraction of Landing Gears and Speed Brakes were not verbalized.

3.1.3.25 At 1,100 ft baro altitude and CAS 227 kts, FO was heard saying *"Should we do the Orbit?"* (in Urdu) to which Captain replied *"No-No"*, followed by *"Leave it"* (both in Urdu). This communication indicates FO has intention for an Orbit. Most probably Landing Gear and Speed Brakes were retracted by FO.

3.1.3.26 Captain took over controls and change of controls was not verbalized by either of the flight crew.

3.1.3.27 At 1.9 NM from R/W 25L threshold, aircraft crossed 1,000 ft RA. The aircraft parameters deviation was more than the call out threshold. However, there was no "un-stabilized" call out by either of the flight crew, flight parameters exceedance was not monitored and no Go-Around was initiated until the Gears Up touchdown / contact with the R/W.

3.1.3.28 At 750 ft RA, 1.5 NM from R/W 25L threshold, ECAM Red Warning "L/G GEAR NOT DOWN" and illumination of Red Arrow beside the Landing Gears Lever were triggered. Flight crew did not monitor ECAM Warning and there was no call out of "L/G GEAR NOT DOWN" Warning.

3.1.3.29 At 500 ft RA Stabilization Gate, aircraft parameters deviation was more than the call out threshold. However, there was no "un-stabilized" call out by either of the flight crew, flight parameters exceedance was not monitored and no Go-Around was initiated until the Gears Up touchdown / contact with the R/W.

3.1.3.30 Flight crew selected Reverse Thrust before MLG touchdown. "ENG REV SET" ECAM Alert associated with selection of Reverse Thrust in air was triggered along with a single chime Aural Alert and Master Caution Amber light.

3.1.3.31 Aircraft both Engine nacelles made contact with R/W. Engine No. 2 Fire Alert triggered with associated Master Warning. After R/W contact aircraft again got airborne.

3.1.3.32 During R/W contact phase, FO (most probably) had intentions to get airborne at the earliest, whereas the Captain showed the intentions to remain on the R/W and complete the landing. FO prompted Captain to Go-Around after which (most probably) Captain advanced both Thrust levers to TOGA.

3.1.3.33 Flight crew decision to initiate a Go-Around after the selection of the Thrust Reversers and Engine Fire Warning was contrary to the procedures and good airmanship.

3.1.3.34 After getting airborne, flight crew did not discuss about Gears Up landing and intended to fly ILS Approach for R/W 25L.

3.1.3.35 Engine No. 2 Thrust Lever was reduced to IDLE, whereas Engine No. 1 Thrust Lever was kept to MCL. Engine No. 1 went to un-commanded IFSD and for about 1 min Engine No. 2, the only running Engine, was at IDLE.

3.1.3.36 It was not possible to predict or simulate the thrust available after damage to the Engines during R/W contact. It was also not possible to estimate the additional power available if Engine No. 2 was not retarded to IDLE for about 1 min. Therefore, it could not be ascertained if safe landing options were available after Go-Around.

3.1.3.37 Flight history of Captain for last 12 months had numerous triggers during approach related to High Speed, Path High, High Rate of Descent, Long Flare Distance and GPWS Warnings. There was no Go-Around initiated and several Unstabilized Approaches were continued.

3.1.3.38 Analysis of flight crew actions, aircraft trajectory, and CVR highlighted inadequate level of CRM application by both flight crew.

3.1.3.39 The judgement of both flight crew was probably impaired due to effects of fasting while flying. However, its consequence on flight performance of the flight crew could not be determined

3.1.4 **Operator**

3.1.4.1 PIA could not demonstrate having effectively implemented all elements of SMS as required by ICAO Annex-6 Part-1 and ICAO Annex-19 (EASA Audit Finding June – September, 2019).

3.1.4.2 PIA was unable to address CAPs within the agreed time period and TCO authorization of PIA was suspended on 1st July, 2020 by EASA.

3.1.4.3 On 16th November, 2020, PIA provided EASA with a comprehensive set of documents as evidence to support the implementation of the agreed CAPs for SMS. EASA has reviewed the submitted material and found it satisfactory and sufficient as a first important step towards the closure of the above-mentioned finding. PIA physical audit by EASA is awaited.

3.1.4.4 Flight Data Analysis rate for PIA at the time of accident was less than 5% of the total flights. Dedicated Flight Data Analyst was not available in PIA Safety Department till event flight.

3.1.4.5 Since, July, 2020, almost all the flights are being analysed by a dedicated Flight Data Analyst.

3.1.4.6 Flight history of Captain for last 12 months had several Unstabilized Approaches which were continued. Operator could not ensure oversight due to ineffective SMS and deficiencies in implementation of FDA programme.

3.1.4.7 The CRM training arranged by Operator was not effective to promote good flight deck communication during the event flight.

3.1.4.8 PIA Operations Manual contains detailed guidelines on health and nutrition of flight crew. However, minimum duration of the meal opportunity and the time frames in which a regular meal should be consumed is not specified in the manual.

3.1.4.9 Crew induction record, including psychiatric evaluation was not available with PIA prior to year 2002.

3.1.4.10 Breath analyser check for the flight crew was not carried out and the undertaking certificates for psychoactive substances prior to the flight were not rendered.

3.1.5 **Air Traffic Control**

3.1.5.1 The duty Air Traffic Controllers were qualified, rated, medically fit and had valid licenses.

3.1.5.2 The number of Air Traffic Controllers on duty was adequate and in accordance with the contingency roster enforced due to COVID-19 Pandemic.

3.1.5.3 After changeover from Karachi Area Control, aircraft remained under Karachi Approach Control till aircraft crash including Gears UP R/W contact.

3.1.5.4 Karachi Approach Control obtained the landing clearance from Aerodrome Controller and cleared PIA 8303 for the first Approach.

3.1.5.5 While the aircraft was on Approach, the Aerodrome Controller could not ascertain whether aircraft Landing Gears were DOWN or not probably because of aircraft pitch down attitude.

3.1.5.6 Aerodrome Controller observed sparks when aircraft made Gears Up contact with the R/W, but did not communicate same to the aircraft.

3.1.5.7 Aerodrome Controller communicated to Approach Controller that aircraft made Gears Up contact with the R/W and asked him to inquire from aircraft whether Gears were DOWN or not?

3.1.5.8 Approach Controller did not inform (or question) aircraft about Gears Up landing.

3.1.6 Flight Recorders

3.1.6.1 The DFDR and CVR stopped recording 04 min prior to end of flight due to failure of both Engine generators.

3.1.6.2 CVR restarted 8 s later once electrical system was in Emergency Electrical Configuration.

3.1.6.3 Lack of FDR and CVR recording during above period did not limit investigation of the event flight.

3.1.7 Medical

3.1.7.1 Based on autopsy, toxicology and medical reports there was no evidence to indicate that the flight crew performance was degraded by physiological factors or incapacitation.

3.1.7.2 The death of both the flight crew occurred due to burnt trauma / multiple injuries and cardiopulmonary arrest.

3.1.7.3 Flight crew satisfied mental health requirements given in ICAO Annex-1.

3.1.8 Survivability

3.1.8.1 All occupants, except 02 passengers, succumbed due to the magnitude of the deceleration forces and the severity of the post impact fire.

3.1.8.2 The persons involved in Search and Rescue Operation were inadequately aware / geared up for hazards at aircraft accident site.

3.1.8.3 Evidence preservation during Search and Rescue Operations was inadequate before arrival of AAIB Investigation Team.

3.1.9 **Safety Oversight**

3.1.9.1 AOC Renewal Audit Inspections conducted by PCAA on Operator had identified deficiencies in implementation of FDA programme. However, the oversight programme was ineffective in producing sufficient and timely improvement.

3.1.9.2 PCAA monitoring system had been ineffective in identifying CRM deficiencies.

3.1.9.3 Clear and precise regulations were not available to restrict flying while fasting at the time of accident.

3.1.9.4 After the accident, flying while fasting was prohibited by a revision in ANO of PCAA FSD. Whereas, CARs 1994 and ANO of PCAA Aero Medical, not restricting flying while Fasting remain unchanged. Dichotomy exist on available regulations pertaining to flight crew flying while Fasting.

3.1.9.5 PCAA issued “Safety Measures” during 2021 for all Operators to ensure that flight and cabin crew drink at least a glass of water, juice or soft drink prior to operating flights during the month of Ramadan.

3.1 **Causes / Contributing Factors**

3.1.1 **Primary Causes**

3.1.1.1 Aircraft made Gears Up landing where both Engines’ nacelle made contact with R/W. Both Engines were damaged causing loss of Engine Oil and lubrication which resulted in failure of both Engines during Go-Around.

3.1.1.2 Non-adherence to SOPs and disregard of ATC instructions during the event flight.

3.1.1.3 Lack of communication between the ATC and the flight crew regarding Gears Up landing particularly once aircraft was on the R/W.

3.1.2 **Contributing Causes**

3.1.2.1 Ineffective implementation of FDA programme.

3.1.2.2 FDA regulatory oversight programme was ineffective in producing sufficient and timely improvement.

3.1.2.3 Lack of clear and precise regulations to restrict flying while fasting.

3.1.2.4 Inadequate level of CRM application during the event flight.

SECTION 4 – SAFETY RECOMMENDATIONS

4.1 **PIA**

4.1.1 PIA may take necessary measures for compliance of Standard Operating Procedures by flight crew, effective implementation of Flight Data Analysis Programme and its integration into Safety Management System.

4.1.2 PIA may review its Crew Resource Management programme to promote effective Flight Deck Communication.

4.1.3 PIA may take necessary measures for compliance of Regulations regarding Pre-Flight Medical Check and flying while Fasting.

4.1.4 Emergency Locator Transmitters (ELTs) may be registered with SUPARCO.

4.1.5 Minimum duration of the meal opportunity and the time frames in which a regular meal should be consumed by flight crew during flight may be specified in the Operations Manual.

4.2 **PCAA**

4.2.1 PCAA may take necessary measures for compliance of Standard Operating Procedures by Air Traffic Controllers and flight crew.

4.2.2 PCAA may develop an effective Flight Data Analysis and Crew Resource Management regulatory oversight programme.

4.2.3 PCAA may review its existing regulations pertaining to flight crew flying while fasting for uniform instructions in ANOs and CARs 1994 etc.

4.2.4 PCAA may ensure effective regulatory oversight for Pre-Flight Medical Checks including flying while Fasting.

4.2.5 PCAA may require Operators to include minimum duration of the meal opportunity and the time frames in which a regular meal should be consumed by flight crew during flight may be specified in the Operations Manual.

4.2.6 PCAA may devise a mechanism to educate and equip response personnel involved in Search and Rescue Operation for hazards at aircraft accident sites as per ICAO Circular 315. PCAA may also take appropriate measures for awareness on this aspect of other agencies responsible for Search and Rescue Operation.

4.2.7 PCAA may devise a mechanism to educate response personnel involved in Search and Rescue Operation for evidence preservation.