



AIRCRAFT ACCIDENT REPORT

AIRPEACE/2018/12/14/F

Accident Investigation Bureau

**Final Report on the Serious Incident involving Boeing
737-300 aircraft belonging to Air Peace Limited with
nationality and registration marks 5N-BUO which
occurred at FL 310 enroute Enugu from Lagos
on 14th December, 2018**



This report is produced by the Accident Investigation Bureau, Nigeria (AIB-N), Nnamdi Azikiwe International Airport, Abuja.

The report is based on the investigation carried out by AIB-N, in accordance with the provisions of Annex 13 to the Convention on International Civil Aviation, Nigerian Civil Aviation Act 2006, and Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2019.

In accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of aircraft accident/serious incident investigations to apportion blame or liability.

Readers are advised that Accident Investigation Bureau, investigates for the sole purpose of enhancing aviation safety. Consequently, AIB-N reports are confined to matters of safety significance and should not be used for any other purpose.

Accident Investigation Bureau believes that safety information is of great value if it is passed on for the use of others. Hence, readers are encouraged to copy or reprint for further distribution, acknowledging the AIB-N as the source.

Safety Recommendations in this report are addressed to the Regulatory Authority of the State (NCAA). This authority ensures enforcement.

© Accident Investigation Bureau, Nigeria 2020.



TABLE OF CONTENTS

TABLE OF CONTENTS	ii
TABLE OF FIGURES	iv
GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT	v
SYNOPSIS	3
1.0 FACTUAL INFORMATION.....	6
1.1 History of the flight	6
1.2 Injuries to persons	8
1.3 Damage to aircraft	8
1.4 Other damage.....	8
1.5 Personnel information.....	8
1.5.1 Pilot.....	8
1.5.2 Co-pilot.....	9
1.5.3 Engineer	10
1.5.4 Purser.....	10
1.6 Aircraft information	11
1.6.1 General information.....	11
1.6.2 Powerplant.....	11
1.7 Meteorological information.....	13
1.8 Aids to Navigation	13
1.9 Communications.....	14
1.10 Aerodrome Information	14
1.11 Flight Recorders.....	14
1.12 Wreckage and impact information	17
1.13 Medical and pathological information.....	18

1.14	Fire	18
1.15	Survival aspects	19
1.16	Test and Research	19
1.17	Organizational and Management information	19
1.17.1	Air Peace Limited.....	19
1.18	Additional Information	26
1.18.1	A background to the history of flight.....	26
1.18.2	Engine bleed air distribution system	26
1.18.3	Pressurization system	29
1.18.4	Crew Resource Management.....	32
1.19	Useful or effective investigation techniques.....	33
2.0	ANALYSIS	34
2.1	General	34
2.2	The crew	34
2.3	Conduct of the flight.....	34
2.4	Crew Resource Management.....	36
3.0	CONCLUSION	37
3.1	Findings.....	37
3.2	Causal Factor	38
3.3	Contributory Factors.....	38
4.0	SAFETY RECOMMENDATIONS.....	39
4.1	Safety Recommendation 2020-013	39

TABLE OF FIGURES

Figure 1: FDR plot identifying the incident flight.....	15
Figure 2: FDR plot for the incident flight showing the cabin altitude warning	16
Figure 3: The left engine bleed switch on air-conditioning control panel with 'INOP' placard.....	17
Figure 4: The passenger oxygen switch in normal position and wire-locked during post occurrence inspection	18
Figure 5: Engine bleed air distribution system (Engine cross-section)	28
Figure 6: Engine bleed air distribution system	29
Figure 7: Pressurization panel	32

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AIB-N	Accident Investigation Bureau, Nigeria
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
C of A	Certificate of Airworthiness
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
DNEN	location indicator for Akanu Ibiam International Airport, Enugu
DNMM	Location indicator for Murtala Muhammed International Airport
FDR	Flight Data Recorder
FL	Flight Level
hPa	Hectopascal
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
kt	Knots
km	Kilometre
NCAA	Nigerian Civil Aviation Authority
Ops	Operations
PF	Pilot Flying

PM	Pilot Monitoring
QNH	Altimeter setting above mean sea level
RWY	Runway
SOP	Standard Operating Procedures
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
TEMP	Temperature
TOD	Top of Descent
UTC	Coordinated Universal Time
VIS	Visibility
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Radio Range
Wx	Weather

Aircraft accident report number:	AIRPEACE/2018/12/14/F
Registered owner and operator:	Air Peace Limited
Manufacturer:	Boeing Aircraft Company, USA
Year of manufacture:	1997
Aircraft type and model:	B737-36Q
Serial number:	28660
Nationality and registration marks:	5N-BUO
Location:	Akanu Ibiam International Airport, Enugu
Date and Time:	14 th December, 2018

*(All times in this report are local
time, equivalent to UTC+1 unless
otherwise stated)*

SYNOPSIS

Accident Investigation Bureau (AIB-N) became aware of the serious incident on the social media before being officially notified by the operator in the evening of 14th December, 2018. The aircraft was ferried from Enugu to Lagos and parked at GAT apron when investigators arrived.

On 14th December 2018, a Boeing 737-300 aircraft with Nationality and Registration Marks 5N-BUO operated APK7100 scheduled passenger flight from Murtala Muhammed International Airport (DNMM), Lagos to Akanu Ibiam International Airport (DNEN), Enugu. The service was initially scheduled to be operated using another Boeing 737-300 with nationality and registration marks 5N-BUK in the operator's fleet but was changed to 5N-BUO, due to technical reasons by the OCC of the company.

During Cockpit Crew Pre-Flight checks, it was noticed that No. 1 engine bleed air indication was reading 18psi, left bleed switched off placarded "INOP" (inoperative) and pressurization selector knob in "STBY" (standby). The engineer reset and reselected to "AUTO" and advised Crew to monitor during the flight.

At 09:27 h 5N-BUO departed Murtala Muhammed International Airport, Lagos to Akanu Ibiam International Airport, Enugu. The Co-pilot was the Pilot Flying (PF) and the Pilot was the Pilot Monitoring (PM).

According to Flight crew witness statement "The take off and climb phases of flight was normal, during cruise at flight level 310 above mean sea level (amsl), at about 20 miles to Top of Descent (TOD), the First Officer noticed a "BLEED TRIP OFF LIGHT" on No 2 engine illuminated".

At 09:45 h APK7100 established two-way contact with Enugu ATC and gave estimates, ATC cleared AK7100 to Enugu FL310, no delay expected for ILS Approach RWY 26, QNH 1015 TEMPT 28°.

At 09:48 ATC Lagos cleared APK 7100 to descend to FL110.

At 09:54 APK7100 was in contact with Enugu and requested further descent.

At 10.01:46 Enugu ATC recleared APK7100 to FL065 and to report 25 miles.

At 10.08:40 APK7100 reported 25 miles and was cleared 3500 ft, QNH 1015 cleared ILS Approach RWY 26 report established and the crew acknowledged. According to crew statement Pilot took over controls of the aircraft and continued the flight.

At 10.21:53 APK7100 established on the ILS Approach, "we are doing a 180".

At 10.22:15 Enugu ATC called APK7100 "Going around, what is the reason for going around" and crew confirmed "Affirmative we were not established".

At 10.24:41 APK7100 reported "we are currently doing a 180, then coming back to shoot the ILS".

At 10.27:11 APK7100 reported "we are currently left base, left downwind RWY 26".

At 10.30:46 APK7100 reported "Established on the localizer. At 10.31:08 AKP7100 reported "Established on the Glide Slope RWY 26". ATC cleared APK7100 to land RWY 26 wind indicating 090/09 kts.

At 10.33:32 ATC reported APK7100 landed at 10:30 h and gave taxi instruction,

At 11.35:35 ATC called the crew to ask the nature of the problem and the crew responded "we had pressurization problem coming into Enugu, we are in contact with our Engineers, we are standing by a team of Engineers down to look at it".

All passenger disembarked normally.

Causal Factor

Non-adherence of the cockpit crew to the one air-conditioning pack inoperative dispatch limitations and requirements in accordance with the MEL (Minimum Equipment List).

Contributory Factors

1. Ineffective monitoring of the air conditioning and pressurization system.
2. Inadequate Crew Resource Management.

One Safety Recommendation was made.



1.0 FACTUAL INFORMATION

1.1 History of the flight

On 14th December 2018, a Boeing 737-300 aircraft with nationality and registration marks 5N-BUO operated APK7100 scheduled passenger flight from General Aviation Terminal (GAT), Murtala Muhammed International Airport (DNMM), Lagos to Akanu Ibiam International Airport (DNEN), Enugu. The service was initially scheduled to be operated using another Boeing 737-300 with nationality and registration marks 5N-BUK in the operator's fleet but was changed to 5N-BUO, due to technical reasons by the Operations Control Centre (OCC) of the company.

During cockpit crew pre-flight checks, it was noticed that the left bleed switch was in the OFF position and placarded "INOP" (inoperative) with pressurization mode selector knob in "STBY" (standby) position. The Pilot invited the engineer to the cockpit, who reset the system, selected pressurization mode to "AUTO" and advised crew to monitor during the flight. After engine start, No. 1 engine bleed air indication was 18 psi.

At 09:27 h, 5N-BUO departed Murtala Muhammed International Airport, Lagos (DNMM) to Akanu Ibiam International Airport, Enugu (DNEN). On-board were 138 persons inclusive of 7 crew and 8,100 kg of fuel. The Co-pilot was the Pilot Flying (PF) and the Pilot was the Pilot Monitoring (PM). The take off and climb phases of the flight were normal.

According to flight crew witness statement, the pressurization system was monitored until reaching cruising altitude of 31,000 ft above mean sea level, cabin altitude indication was normal for about thirteen minutes. However, at 20 nautical miles to Top of Descent (TOD), while the Co-pilot was briefing the Pilot for descent, right engine (No. 2) BLEED TRIP OFF light illuminated. The crew carried out the appropriate procedure in the QRH (quick reference handbook).

The crew also stated that some minutes after completion of the BLEED TRIP OFF checklist, the aircraft cabin altitude started climbing at a rate of 3,500 ft/m.

The crew requested for descent and were cleared to FL110 by Lagos ATC.

According to flight crew statement, during descent the cabin altitude warning horn sounded at about FL165 and they accomplished the rapid depressurization checklist as the cabin altitude remained uncontrollable. Hence the emergency descent checklist was accomplished but at about FL120, the passenger oxygen masks deployed automatically.

At 09:54 h, the crew were in contact with Enugu ATC and requested for further clearance and were cleared to FL065.

The first landing attempt on RWY26 was aborted as the aircraft was high during approach and was not on the localizer. The Pilot took control of the aircraft as PF and asked the Co-pilot (PM) to request an orbit clearance from ATC. The Pilot executed the orbit, approach and landing procedures were completed and the aircraft touched down at 11:30 h. Taxi instruction was given by ATC, the crew acknowledged and requested the services of medical personnel.

The aircraft was parked and the crew and passengers disembarked normally with no injuries. The incident occurred in daylight and Visual Metrological Conditions (VMC) prevailed.

The aircraft departed Enugu at 17:43 h and landed in Lagos at 18:34 h as a ferry flight maintaining FL100.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor	Nil	Nil	Nil
None	6	128	134
TOTAL	6	130	136

1.3 Damage to aircraft

The aircraft was not damaged.

1.4 Other damage

Nil.

1.5 Personnel information

1.5.1 Pilot

Nationality:	Nigerian
Age:	40 years
Licence type:	Airline Transport Pilot Licence (A)
Licence validity:	28th October, 2023
Aircraft ratings:	Boeing 737-200/500, Lear Jet 45, Dornier-328-30, Baron 58
Medical certificate validity:	8th January, 2019
Simulator validity:	27th April, 2019

Proficiency check:	27th April, 2019
Route/Line check:	1st December, 2017
Total flying time:	5,884:50 h
Total on type:	1640 h
Total on type (PIC):	1800 h
Last 90 days:	129:50 h
Last 28 days:	36:05 h
Last 24 hours:	0 h

1.5.2 Co-pilot

Nationality:	Nigerian
Age:	33 years
Licence type:	Commercial Pilot Licence (A)
Licence validity:	11th May, 2023
Aircraft ratings:	Boeing 737-300/500
Medical certificate validity:	1st October, 2019
Simulator validity:	5th April, 019
Proficiency check:	5th April, 2019
Route/Line check:	1st March, 2018
Total flying time:	922:25 h
Total on type:	922:25 h
Last 90 days:	194:05 h
Last 28 days:	62:30 h
Last 24 hours:	03:20 h

1.5.3 Engineer

Nationality:	Serbian
Age:	54 years
Licence type:	Cabin Crew Licence
Licence validity:	26th March, 2020
Ratings:	B737-300/400/500/600-900, A318/19/20/21
Medical validity:	3rd February, 2021

1.5.4 Purser

Nationality:	Nigerian
Age:	41 years
Licence type:	Cabin Crew Licence
Licence validity:	13th September, 2019
Ratings:	DHC-8Q400, A320-200, Boeing737-300/500, DASH-8, EMB170/190, EMB-135/145
Medical validity:	13th September, 2019

1.6 Aircraft information

1.6.1 General information

Manufacturer:	The Boeing Company, USA
Model:	Boeing 737-300
Serial number:	28660
Year of manufacture:	1997
Registered owner/operator:	Air Peace Limited
Nationality and registration marks:	5N-BUO
C of A validity:	10th December, 2019
Certificate of Insurance Validity	9th January 2019
Total Hours since New:	58,092.9 h
Total cycles since new:	36,669

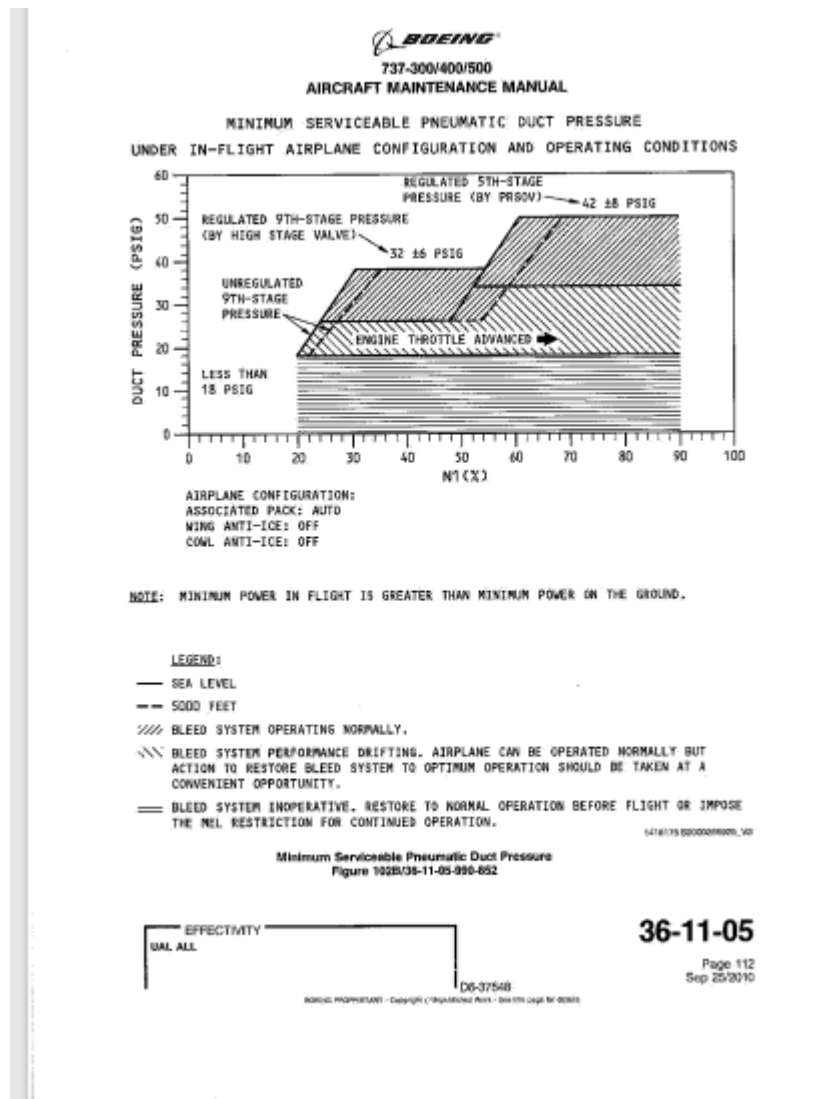
1.6.2 Powerplant

	Engine No. 1	Engine No. 2
Manufacturer	CFM International, USA	CFM International, USA
Engine Type	CFM 56-3C1	CFM 56-3C1
Year of Manufacture	1997	1997
Serial Number	857616	724992
Total time since new	47,015.43 h	52,831.08 h
Cycles	34,209	36,223

Engine No. 1 bleed switch on the air-conditioning panel was placarded 'INOP'. The left duct pressure was 18 psi and this was entered in the Deferred Defect Log book on 12th December, 2018 with a limit of 22nd December, 2018. Action on the low bleed on engine no. 1 was raised in accordance with MEL (36-05 CAT C).

On 12th December 2018, a defect was recorded in the tech log as follows: 'LARGE DIFFERENCE IN L & R DUCT, INDICATOR IN CLB & CRZ, L- 18 PSI, R-48 PSI'. The action taken was 'ADD 076 RAISED IAW MEL 36-05 CAT C'.

Engine no. 2 with serial number 724992 was installed on the 11th of December 2018. The aircraft was operated from 12th to 14th of December, the day of the incident. On the 13th of December 2018, the RIGHT SIDE bleed trip OFF LIGHT illuminated during descent. QRH procedure was followed and flight continued to destination (Lagos).



Extract from Aircraft Maintenance Manual (AMM) for Boeing 737-300/400/500.

1.7 Meteorological information

The following records WX information at Port Harcourt Airport on the day:

Time: 0900 UTC

Wind:	Calm
VIS:	6 km
WX:	Nil
Cloud:	NSC
Temp/Dew point:	28°C/19°C
QNH:	1015 hPa

Time: 1000 UTC

Wind:	Calm
VIS:	6 km
WX:	Nil
Cloud:	NSC
Temp/Dew point:	31°/15°C
QNH:	1015 hPa

1.8 Aids to navigation

Status of the navigational aids at Enugu Airport on the day of the occurrence is as follows:

'EN' VOR/DME -'S'-

'EN' ILS/DME -'S'-

1.9 Communications

There was effective communication between the aircraft and the ATC throughout the duration of the flight.

1.10 Aerodrome information

Akanu Ibiam International Airport (DNEN) has Aerodrome Reference Point N 062824.7379⁰, E 0073332.1556⁰ and an elevation of 157 m (513.83 ft) above mean sea level (AMSL). The aerodrome has a runway orientation of 08/26. The length and width of the runway are 3,000 m/ 40 m respectively, with an asphalt/concrete surface

1.11 Flight recorders

The aircraft is fitted with Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR). The recorders, whose particulars are given below were retrieved and taken to the Bureau's Flight Safety Laboratory in Abuja for download and analysis.

	Cockpit Voice Recorder	Flight Data Recorder
Manufacturer	Honeywell International, USA	Honeywell International, USA
Model	SSCVR	SSFDR
Part Number	980-6022-001	980-4700-042
Serial Number	CVR120-05860	SSFDR-08740

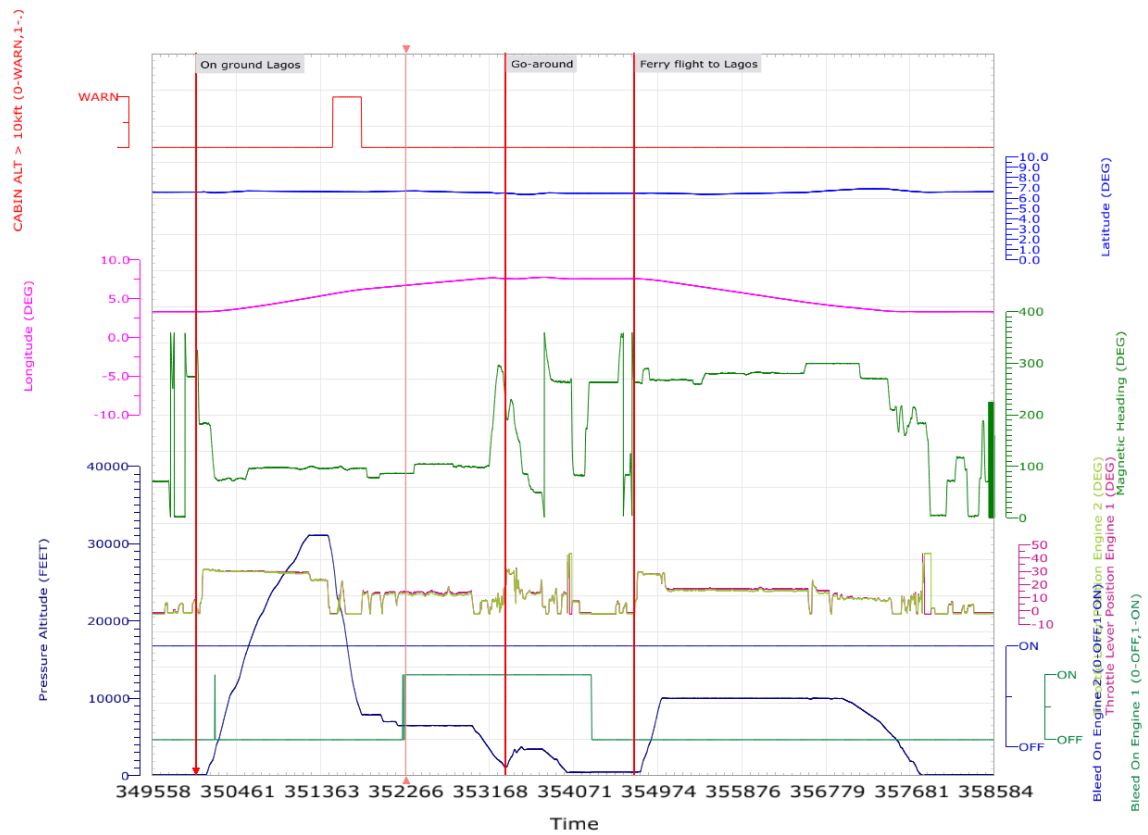


Figure 1: FDR plot identifying the incident flight.

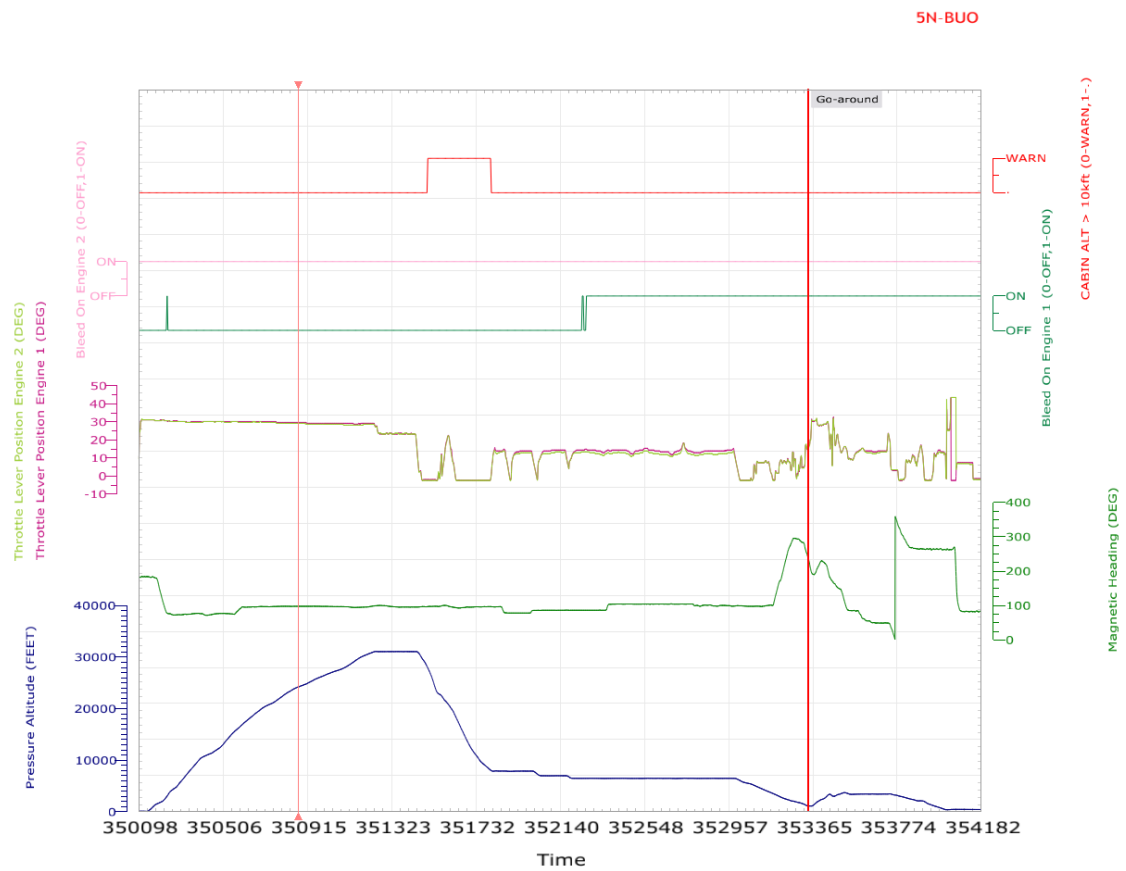


Figure 2: FDR plot for the incident flight showing the cabin altitude warning

1.12 Wreckage and impact information

The aircraft experienced loss of pressurisation at FL310 and the cabin altitude warning horn sounded while descending through FL165. At FL120, the crew and passengers oxygen mask automatically deployed.



Figure 3: The left engine bleed switch on air-conditioning control panel with 'INOP' placard



Figure 4: The passenger oxygen switch in normal position and wire-locked during post occurrence inspection

1.13 Medical and pathological information

No medical or pathological tests were carried out on the flight crew.

1.14 Fire

There was no pre or post occurrence fire.



1.15 Survival aspects

The occurrence was survivable in that the crew and passenger's oxygen masks automatically dropped and were donned by the occupants as required, which enabled them to breathe normally until they got to a safe altitude.

The cabin crew also briefed the passengers properly before departure and at the onset of the emergency.

1.16 Test and Research

Not Applicable.

1.17 Organizational and Management information

1.17.1 Air Peace Limited

Air Peace is a private Nigeria airline founded in 2013 with Head Office in Lagos State, Nigeria. Her operating Base is Murtala Muhammed International Airport, Lagos. Air Peace provides commercial, charter flights, and serves the major cities of Nigeria. She also flies to 20 International destinations, including Countries West Africa and the Middle East.

Air Peace Hopper, is a subsidiary of Air Peace Limited and was established in 2018. Air Peace Limited holds an approved AOC, Number APL/AOC/09-14/01, valid from 8th September 2018 to 7th September 2020.

There are a total of 25 aircraft in her fleet, including 13 B737, 3 B777, 1 Dornier Do-328JET, and 8 EMB ERJ-145.

Air Peace has the following Designations: P4 (IATA), APK (ICAO) and PEACE BIRD (Call sign).

1.17.1.1 Extracts from Operations Manual Part B OPS/Standard Operating Procedures SOP

This manual also known as Standard Operating Procedure Manual (SOP) is prepared as a guide for all Air Peace crew for safe operations of our Boeing 737-500 aircraft. Majority of its contents especially those relating to certification limitations are propriety in nature and have therefore been copied as is from the Airplane Flight Manual (AFM).

Team work is the key concept to an understanding of the SOP. As a pilot, you are an integral part of a coordinated operation. The SOP explains not only your duties but also the duties of other crew members. Knowing what to expect from the other pilots aids in standardization and is an important factor in cockpit resource management. This knowledge enables the crew member to detect and correct errors or omissions.

The Pilot has the authority to deviate from the SOP, but only when unusual circumstances require him to do so in the interest of safety.

Issue: 01 Revision: 00 Date: May, 2013	MINIMUM EQUIPMENT LIST (B737)	
	SPECIAL PROCEDURES	

SPECIAL PROCEDURE 21-1

NOTE: For an inoperative air conditioning pack, the associated pack airflow shutoff valve may be deactivated closed per MEL Item 21-2 Maintenance Procedure.

PLACARD

Affected pack switch(es) - INOP

MAINTENANCE (M)

TWO PACKS INOP (Unpressurized)

1. Manually position outflow valve full open.
2. Advise dispatch for unpressurized flight. Maximum altitude for flight planning will be affected.

OPERATIONS (O)

A. ONE PACK INOP (Pressurized)

When dispatching with the operating pack supplied by engine bleed air for takeoff, VMCG should be determined based on AC packs OFF (not applicable to -100/-200 since VMCG is not dependent on pack status). Takeoff performance should be determined based on AC packs AUTO.

1. Limit altitude to FL 250.
 2. Only one galley 4B food cart chiller (if installed) may be used inflight.
 3. ER operations are not allowed.
 4. Position the associated pack switch to OFF (except -900). To maintain isolated bleed sources, position the isolation valve switch to CLOSE.
 5. If desired, increased air flow can be obtained when flaps are extended (takeoff and landing) if the APU is used instead of engine bleed to supply bleed air to the operating pack. The following procedure can be used to accomplish this.
- A. Right Pack Inoperative: Use the Flight Crew Operations Manual Supplementary Procedure, "No Engine Bleed Takeoff and Landing Procedure". Per Step 4, the right pack switch is to remain OFF (except -900) and the isolation valve switch CLOSED.
- B. Left Pack Inoperative:
- 1) Prior to takeoff or landing, position engine no. 1 bleed air switch to OFF, right pack switch to AUTO (left pack should be OFF, except for -900), isolation valve switch to OPEN, engine no. 2 bleed air switch to OFF and APU bleed air switch to ON.
 - 2) After takeoff or landing, position the APU bleed air switch to OFF, engine no. 2 bleed air switch to ON, isolation valve switch to CLOSE and engine no. 1 bleed air switch to ON.

Extracts from Boeing 737 Airplane Flight Manual

BOEING 737-500

AIRPLANE FLIGHT MANUAL

EMERGENCY
PROCEDURES

C A B I N A L T I T U D E W A R N I N G O R R A P I D D E P R E S S U R I Z A T I O N (Required by AD 2011-03-14)

Condition: The CABIN ALTITUDE warning light illuminates or the intermittent warning horn sounds in flight above 10,000 ft MSL.

RECALL

Oxygen Masks and Regulators ON, 100%
Crew Communications ESTABLISH

REFERENCE

Pressurization Mode Selector. MANUAL
Outflow VALVE Switch. CLOSE

If Cabin Altitude is uncontrollable:

Emergency Descent (If Required) INITIATE
Passenger Oxygen Switch ON
Thrust Levers CLOSE
Speed Brakes FLIGHT DETENT
Target Speed VMO/MMO

D I T C H I N G

Select the GEAR INHIBIT and TERR INHIBIT switches (if installed) to INHIBIT, turn OFF engine air bleeds and APU, and manually close the cabin outflow valve.

Seat passengers with life vests on and seat belts fastened.

For ditching approach, gear is up with landing flaps and speed VREF with rate of descent approximately 200 to 300 feet per minute.

Do not open aft entry or service doors as they may be partially submerged.

To ensure no cabin differential pressure, open cockpit windows immediately after ditching.

P A S S E N G E R E V A C U A T I O N

In the event passengers must be rapidly evacuated from the airplane, reduction of personal injury and damage may be enhanced by early notification of the evacuation. Set parking brake, select Flaps 40, speedbrake lever down, shut down engines, discharge engine and APU fire bottles (as required) prior to leaving the airplane.



BOEING 737-500

AIRPLANE FLIGHT MANUAL

**EMERGENCY
PROCEDURES**

WARNING HORN OR WARNING LIGHT - CABIN
ALTITUDE OR TAKEOFF CONFIGURATION

With the CABIN ALTITUDE and TAKEOFF CONFIG lights not installed, or installed but not activated:

RECALL

Condition: An intermittent warning horn sounds, or a CABIN ALTITUDE or TAKEOFF CONFIG warning light (if installed) illuminates:

In flight, at an airplane flight altitude above 10,000 feet MSL, an intermittent horn or a CABIN ALTITUDE warning light (if installed) indicates the cabin altitude is at or above 10,000 feet.

On the ground an intermittent horn or a TAKEOFF CONFIG warning light (if installed) indicates an improper takeoff configuration when advancing thrust levers to takeoff thrust.

If an intermittent horn sounds or a CABIN ALTITUDE warning light illuminates in flight at an airplane flight altitude above 10,000 feet MSL:

OXYGEN MASKS AND REGULATORS. ON, 100%
CREW COMMUNICATIONS. ESTABLISH
Do the CABIN ALTITUDE WARNING OR RAPID DEPRESSURIZATION checklist.

If an intermittent horn sounds or a TAKEOFF CONFIG warning light illuminates on the ground:

Assure proper airplane takeoff configuration.

LANDING CONFIGURATION

Condition: A steady warning horn sounds in flight.

Assure proper airplane landing configuration.



BOEING 737-500

AIRPLANE FLIGHT MANUAL

NORMAL
PROCEDURES

A U X I L I A R Y P O W E R U N I T

APU in-flight starts have been successfully demonstrated to 35,000 feet pressure altitude for APU Model GTCP85-129C/E/F/G/H/J/K and to 30,000 feet pressure altitude for other model GTCP-85-129 APU's. APU in-flight starts may be attempted at any altitude.

APU in-flight starts have been successfully demonstrated to 35,000 feet pressure altitude for APU Models APS-2000 and GTCP 36-280 (B). APU in-flight starts may be attempted at any altitude.

Except for engine start do not open APU bleed air valve when LH engine bleed air valve is open, or when isolation and RH engine bleed air valves are open.

With ground air supply connected and isolation valve open do not open APU bleed air valve.

C A B I N A L T I T U D E W A R N I N G T A K E O F F
B R I E F I N G (required by AD 2008-23-07)

With the CABIN ALTITUDE and TAKEOFF CONFIG lights not installed, or installed but not activated:

The following briefing is important to further reduce the risk of flight crew incapacitation due to hypoxia. Because of the dual purpose of the intermittent cabin altitude/takeoff configuration warning horn, this briefing serves to remind flight crews that the sounding of the cabin altitude warning horn in flight requires immediate action, beginning with the immediate donning of oxygen masks. Upon completion of the applicable WARNING HORN OR WARNING LIGHT - CABIN ALTITUDE OR TAKEOFF CONFIGURATION non-normal checklist memory items, other alerts and indications on the flight deck (e.g., air/ground sensing system failures, equipment cooling OFF, etc.) may then be addressed. Memory item cabin altitude warning indications and procedures must be briefed on airplanes in which the CABIN ALTITUDE and TAKEOFF CONFIG lights are not installed, or are installed but not activated. This will be included as an additional item on the Takeoff briefing before engine start for the first flight of the day, or following any change of either flight crew member.

The briefing must include the following items:

Whenever the intermittent warning horn sounds in flight at an airplane flight altitude above 10,000 feet MSL:

1. Immediately, don oxygen masks and set regulators to 100%
2. Establish crew communications.
3. Do the CABIN ALTITUDE WARNING OR RAPID DEPRESSURIZATION checklist

Both pilots must verify on the overhead Cabin Altitude Panel that the Cabin Altitude is stabilized at or below 10,000 feet before removing oxygen masks.

FAA APPROVED **08-23-11**

D6-8735

Code 4000

Section 3.1 Page 7



BOEING 737-500

AIRPLANE FLIGHT MANUAL

NORMAL
PROCEDURES

C A B I N P R E S S U R I Z A T I O N

Operate no more than one air-conditioning pack from one engine.

For normal operations, the pressurization mode selector should be in AUTO prior to takeoff. (Required by AD 2011-03-14)

Normal Automatic Operating Differential Pressure

Below 28,000 feet pressure altitude 7.45 $\pm$ 0.1 psi

Above 28,000 feet pressure altitude 7.80 $\pm$ 0.1 psi



1.18 Additional Information

1.18.1 A background to the history of flight

At 07:15 h passengers boarding was completed on 5N-BUK, the crew noticed discrepancy in the number of passengers on board (134 persons) and the figure in the manifest was (123 persons), Pilot ordered passengers head count and the discrepancy was resolved.

At 08:15 h aircraft entry door was closed, engines started and before taxing, the crew noticed No2 engine "COWL VALVE OPEN" light illuminated, (The "COWL VALVE OPEN" light remained bright blue, indicating a disagreement between switch and valve position. Engine No2 Anti-ice valve failed OPEN with switch in OFF position)

Engines were shut down and the engineer was invited to check and was rectified.

Crew started engines and ready for taxi and observed the flap indicator showing "Asymmetry flap position" hence, engines were shut down and Pilot instructed flight purser to open aircraft door for passengers to disembark and be conveyed to the terminal building as the aircraft is unserviceable. The Pilot called operation control centre (OCC) on company radio frequency and requested for another aircraft.

At 09:15 h, the Pilot noticed the passengers being directed from 5N-BUK to 5N-BUO without prior notification to the operating crew hence, the Pilot and his crew transferred to 5N-BUO.

1.18.2 Engine bleed air distribution system (Boeing 737 AMM)

The engine bleed air distribution system is a manifold of ducts and valves which carries hot compressed air from the engine compressor to the air conditioning packs and to the air-dependent units and subsystems in other systems. Air source, pressure and temperature controlling components are part of the system. Ducts

from the engines pass through control components and join the respective left or right wing manifolds.

A crossover duct forward and below the center wing section front spar joins the left and right wing manifold sections to form the complete cross-ship pneumatic manifold. The air control components connecting the pneumatic manifold to related systems are covered as part of the systems they serve.

The primary supply of bleed air from the mid (5th) compressor stage of each engine through a check valve. When 5th stage bleed air pressure is not high enough, high (9th) stage bleed air is used. Switching from mid to high stage bleed on each engine is controlled automatically by the high stage valve and regulator. The pressure regulating and shutoff valve (PRSOV) controls the pressure of air supplied to the precooler to within the range between 34 and 50 psig.

The high stage air is controlled to within the range between 25 and 35 psig by the high stage regulator. Air from either stage is routed through a precooler on each engine before entering the pneumatic manifold. The precooler control valve, controlled by a downstream temperature sensor regulates manifold air temperature by controlling the amount of fan air flow through the precooler.

Two pressure transmitter are provided for pressure indication of the bleed air. One transmitter is used for each engine. Both pressure transmitter are connected to dual pressure indicator on the overhead panel. The engine bleed air overtemperature indication consists of overtemperature switches with ducting system, which are connected to the overhead panel trip lights. The temperature switches illuminate the trip lights and the corresponding engine PRSOV closes when the bleed air temperature exceeds approximately 490° F. Also, the bleed trip light will illuminate if there is excessive pressure at the bleed valve inlet.

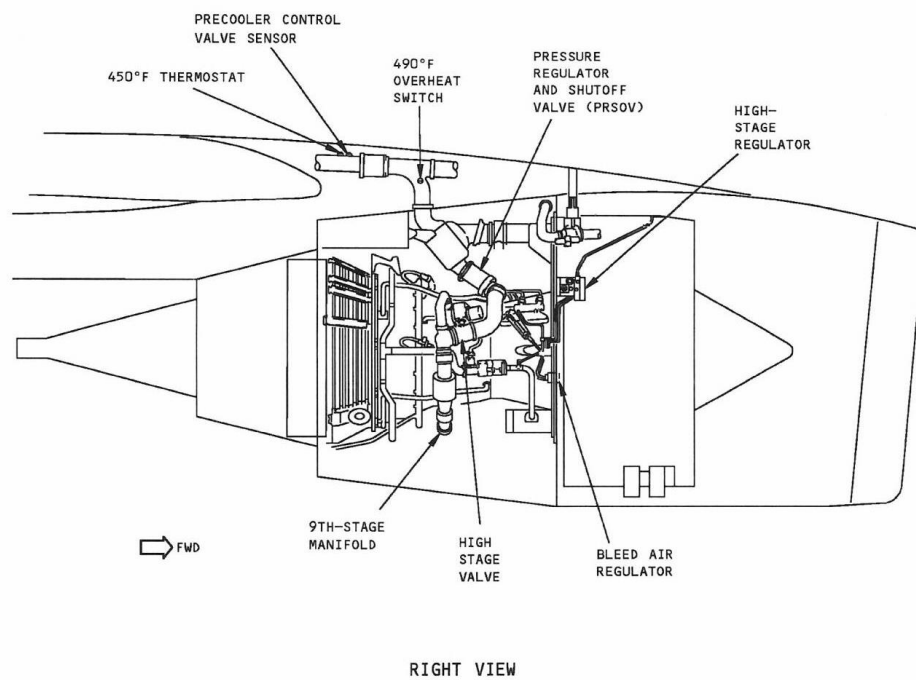
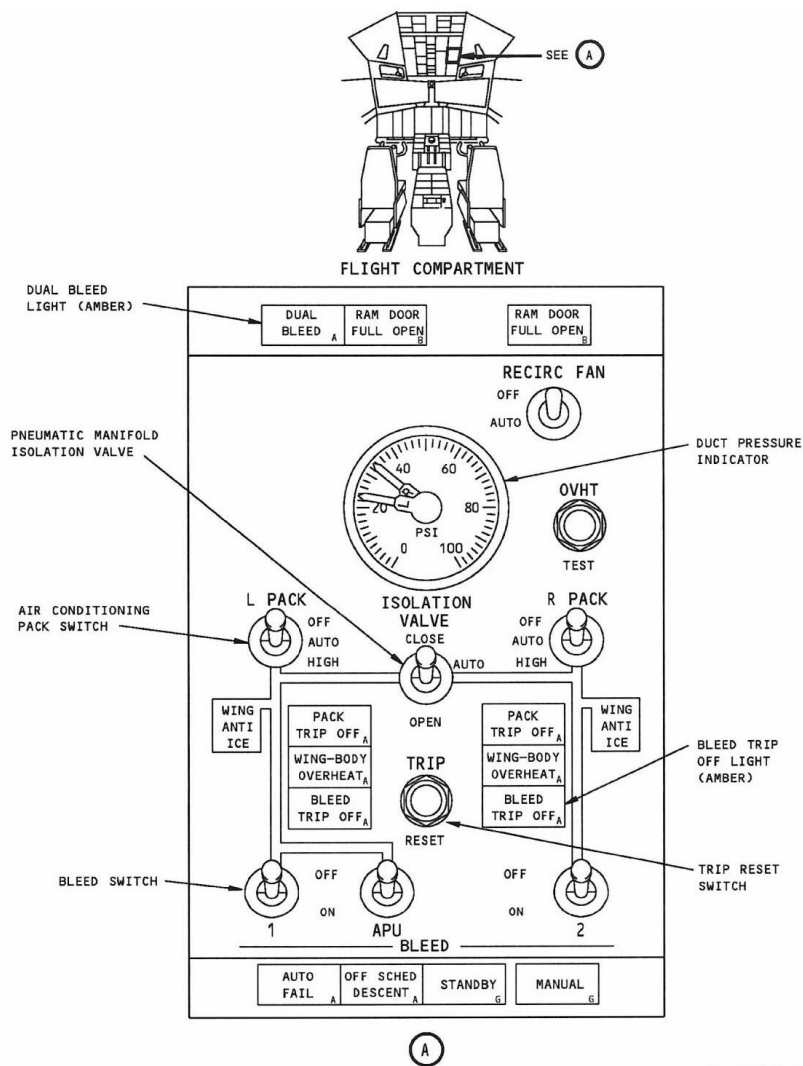


Figure 5: Engine bleed air distribution system (Engine cross-section)



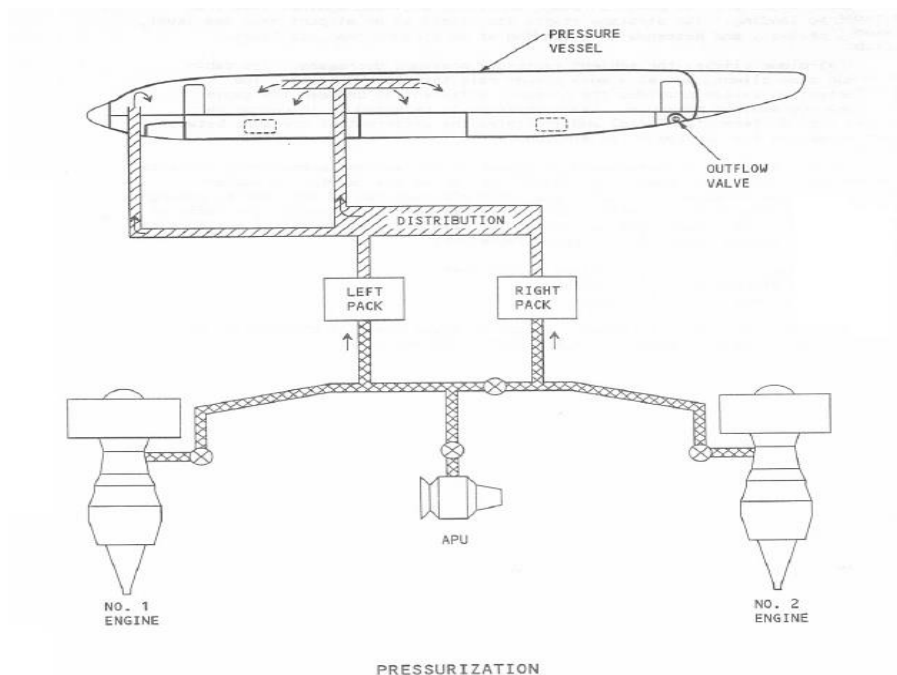
103875 S00041240405_V1

Figure 6: Engine bleed air distribution system

1.18.3 Pressurization system (Boeing 737 AMM)

Pressurization system the purpose of the pressurization is to provide a safe comfortable cabin altitude at all airplane altitudes by ensuring the air-conditioning packs supply conditioned air into the system, the pressurization system controls cabin altitude by regulating air flow from the fuselage through the outflow valve.

The pressurization system maintains cabin altitude as close to sea level as possible or at an altitude equal to the altitude of the flight destination.



Pressurization system consist of pressurization control system and backup control system.

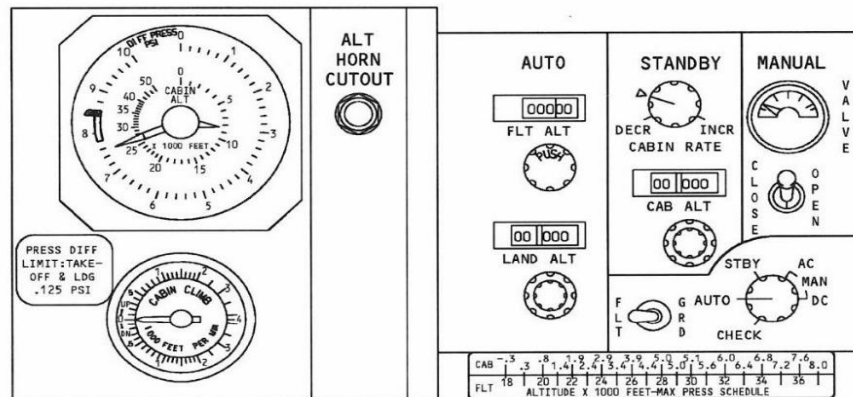
1.18.3.1 Pressurization Control System (Boeing 737 AMM)

The pressurization control system is an electrically operated and electronically controlled system, which meters the exhaust of ventilating air to supply controlled pressurization of the passenger and control cabins, the electronic compartment, the two cargo compartments and the lower nose compartment. The pressurization control system has a pressure control panel, a pressure controller, and a cabin pressurization outflow valve. The pressurization control system characteristics are as follows:

1. The system has four operating modes; automatic, standby, ac manual and dc manual. Automatic is the normal operating mode standby is the semiautomatic backup. The ac manual and dc manual modes are backups for automatic and standby modes. Normal operation is automatic and normally

requires no adjustment by the flight crew throughout the flight except for barometric correction.

2. The ac manual mode and the dc manual mode supply direct control to the outflow valve through separate electrical actuators. The manual modes backup the automatic and standby systems.
3. In the automatic mode, the system accepts manual inputs of planned flight altitude and landing altitude before takeoff. It then finds the lowest possible cabin pressure that can be maintained during airplane high altitude flight and schedules any necessary change in cabin pressure during the flight without any action by crew.
 - a) The system can also be rest if a change in planned flight altitude or landing field altitude is made.
4. Cabin pressure rate of change is automatically controlled in AUTO. Rate of change may be manually controlled in STBY.
5. Barometric correction for automatic and standby pressure control assures that cabin pressure and landing field pressure and approximately the same landing.
6. A mode selector switch on the control panel permits selection of four modes of operation plus a check position for system test.
7. The STANDBY system automatically takes over to control cabin pressure according to cabin altitude and rate of cabin pressure change settings if certain limits are exceeded in AUTO. In addition, a manual transfer can be made from AUTO to STBY, if desired, by use of mode selector switch.



FORWARD OVERHEAD PANEL (P5)

Figure 7: Pressurization panel

1.18.3.2 Backup Control System (Boeing 737 AMM)

1. Two Safety relief valves are installed in the fuselage skin aft of the aft cargo compartment, one on each side of the aft outflow valve.
2. The negative relief valve is installed in the fuselage skin on the right side of the aft cargo compartment.
3. The cabin altitude warning horn is in the control stand.
4. The cabin pressure switch is located in the ceiling area of the lower nose compartment.

1.18.4 Crew Resource Management

CRM is a methodology in which resources of equipment, procedures and people are collectively utilized as needed to safely complete every flight task. The individual components of CRM are communication, situation awareness, problem solving, decision making and teamwork. CRM can also be said to be the effective use of all

available resources, for flight crew personnel to ensure safe and efficient aircraft operation, reading error, avoiding stress and increasing efficiency.

The goal of CRM is to reduce accidents or occurrences due to pilot error. It encourages Co-pilots and other crewmembers to respectfully question the Pilot. It also encourages flight crews to work as a team, rather than separate units, with one decisive leader.

The following are CRM skills, which flight crews should possess.

- Communication and interpersonal skills
- Situation awareness
- Problem solving, decision making and judgment
- Leadership and followership
- Stress management
- Critique and self-critique.

CRM teaches pilots to act calmly and appropriately when decisions need to be made, and not to panic. Pilots should recognize their peculiar hazardous attitude, which might interfere with good decision-making and manage risk appropriately.

Pilots are now being taught that the only way to mitigate risks associated with flight operations is to manage them appropriately. This involves knowing the associated risk to start with.

1.19 Useful or effective investigation techniques

Nil

2.0 ANALYSIS

2.1 General

The aircraft documents and records available to the Bureau shows that the aircraft was certified and maintained in accordance with approved procedures and existing NCAA regulations. There was no evidence of defects or malfunction in the aircraft that could have contributed to the incident at the time of departure from Lagos GAT, MMIA. However, the flight was operated without observing certain operational and procedural limitations of the air conditioning and pressurization system in accordance with the requirements of the Minimum Equipment List (MEL).

This analysis will focus on crew qualifications and competency, engine bleed air distribution system and pressurization control system, descent, approach and landing phases of flight.

2.2 The crew

The crew were certified and medically fit to operate the flight, the incident flight was the first flight of the day and hence the crew rest period was adequate and not considered a contributory factor in this incident.

2.3 Conduct of the flight

During cockpit crew pre-flight checks, it was noticed that left bleed switch was in the OFF position and placarded "INOP" (inoperative) with pressurization mode selector knob in "STBY" (standby) position. The Pilot invited the engineer to the cockpit, who reset the system, selected pressurization mode to "AUTO" and advised crew to monitor during the flight. After engine start No. 1 engine bleed air indication was 18 psi.

The minimum requirement for bleed air duct pressure for air conditioning pack operation is 18 psi (with Anti-ice OFF) (Aircraft Maintenance manual Boeing 737-300/400/500 Section 36-11-05 pages 112, 514 and 515), with one bleed switched OFF, placarded and hence considered inoperative, maximum flight altitude is limited to 25,000 ft AMSL in accordance with MEL.

According to the cockpit crew statement, while cruising at FL310 about 20 miles to top of descent (TOD), the Co-pilot noticed BLEED TRIP OFF light on No. 2 engine, which is an indication of a failure in the bleed air system which could be due to excessive bleed air temperature, excessive bleed air pressure or under-pressure.

At high altitude with increased bleed air demand for air conditioning and pressurization, one bleed source is not recommended as standard practice to hold pressurization beyond 25,000 ft. Hence at FL310, the bleed air supply was inadequate and could not hold a cabin altitude of 5,600 ft according to pressurization schedule as compared with cabin altitude of 3,400 ft at FL250. Therefore strict adherence to limitations of the MEL under this conditions should have been applied.

The cabin altitude warning horn indicates cabin altitude of 10,000 ft, thus showing that cabin altitude on this flight exceeded 8,000 ft limit (Airplane Flight Manual ,Section 08-23-11), which trend was not monitored by the flight crew. The cabin climb rate of 3,500 ft/min observed by the crew on completion of the BLEED TRIP OFF checklist far exceeds normal cabin rate of climb and should have prompted the crew to initiate immediate rapid descent.

The Rapid Depressurization checklist also requires crew to deploy passenger oxygen masks when cabin altitude is uncontrollable. It is unlikely this was accomplished as the masks deployed automatically on descent past 12,000 ft. Since maintenance action had already commenced on the aircraft prior to the arrival of AIB-N investigators, the position of the PASS OXYGEN switch on landing is uncertain.

2.4 Crew Resource Management

The no. 1 bleed switch was placarded inoperative (INOP), hence the crew should have adhered to the limitations for one air conditioning pack inoperative in the MEL, for departure.

Flight crew are required to a scan flow pattern in order to monitor flight instruments and parameters at all times during flight. The flight crew in this occurrence did not detect the continuous climb of the cabin during cruise in order to arrest increasing cabin altitude.

The CRM in this flight was thus inadequate.

3.0 CONCLUSION

3.1 Findings

1. The flight crew were qualified and certified to fly the aircraft.
2. The Co-pilot was the Pilot Flying (PF) and the Pilot was the Pilot Monitoring (PM).
3. The aircraft had a valid certificate of airworthiness at the time of the incident.
4. On 12th December, 2018, a defect was recorded in the tech log as follows: 'LARGE DIFFERENCE IN L & R DUCT, INDICATOR IN CLB & CRZ, L- 18 PSI, R-48 PSI'. The action taken was 'ADD 076 RAISED IAW MEL 36-05 CAT C'.
5. During cockpit crew pre-flight checks, the left bleed switch was in the OFF position and placarded "INOP" (inoperative) with pressurization mode selector knob in "STBY" (standby) position
6. The engineer reset the system, selected pressurization mode to "AUTO" and advised crew to monitor during the flight.
7. The take off and climb phases of the flight were normal.
8. While cruising at FL310 about 20 miles to top of descent (TOD), the Co-pilot noticed BLEED TRIP OFF light on No. 2 engine.
9. The crew requested and were cleared to FL110 by the Lagos ATC although they did not disclose any emergency or operational difficulty to the ATC.
10. The pressurization warning horn sounded at FL165.
11. The passenger oxygen masks deployed automatically at FL120.
12. The aircraft touched down at 11.30 h.
13. The crew and passengers disembarked normally without any injury.
14. Maintenance action was ongoing on the aircraft before the arrival of AIB-N investigators.
15. During post incident inspection, the passenger oxygen switch in the cockpit was found in the NORMAL position and wire-locked.

3.2 Causal Factor

Non-adherence of the cockpit crew to the one air-conditioning pack dispatch limitations and requirements in accordance with the MEL (Minimum Equipment List).

3.3 Contributory Factors

1. Ineffective monitoring of the air conditioning and pressurization system.
2. Inadequate Crew Resource Management.

4.0 SAFETY RECOMMENDATIONS

4.1 Safety Recommendation 2021....013

Air Peace Limited should ensure that flight crew training includes additional aircraft technical knowledge of air conditioning and pressurization system.