FINAL INVESTIGATION REPORT ON

SERIOUS INCIDENT TO M/S JET AIRWAYS BOEING 737-800 AIRCRAFT VT-JGS AT MUMBAI ON 20th SEPTEMBER 2018

AIRCRAFT ACCIDENT INVESTIGATION BUREAU
MINISTRY OF CIVIL AVIATION
GOVERNMENT OF INDIA

FOREWORD

This document has been prepared based upon the evidences collected during the investigation and opinion obtained from the experts. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 11 of Aircraft (Investigation of Accidents and Incidents), Rules 2017 of India. The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this incident which may help in preventing such incidents in future.

ABBREVIATIONS

ATPL	Airline Transport Pilot Licence
CPL	Commercial Pilot Licence
IST	Indian Standard Time
PM	Pilot Monitoring
PF	Pilot Flying
IRS	Inertial Reference System
CDU	Control Display Unit
ATC	Air Traffic Control
FL	Flight Level
MCP	Mode Control Panel
VS	Vertical Speed
NNC	Non Normal Checklist
FMC	Flight Management Computer
RWY	Runway
ALTN	Alternate
MAN	Manual
ILS	Instrument Landing System
VOR	Very High Frequency Omni Range
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
SOP	Scheduled Operators Permit
DGCA	Director General of Civil Aviation
MRO	Maintenance and Repair Organisation
CAR	Civil Aviation Requirements
AME	Aircraft Maintenance Engineer
MIAL	Mumbai International Airport Limited
CRM	Crew Resource Management
ARC	Airworthiness Review Certificate
JCC	Joint Control Centre
ANTS	Automated Notification and Transmission System

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1.0 FACTUAL INFORMATION

1.1 HISTORY OF FLIGHT

Boeing 737-800 aircraft was involved in a Serious Incident while operating a scheduled flight from Mumbai to Jaipur on 20th September 2018. The aircraft was under command of an ATPL holder with a CPL holder as first officer. There were 166 passengers on board. 21 passengers reported bleeding either from the nose or the ear. The incident occurred at 06:30 hours IST. There was no fire.

Scheduled time of departure of flight was 05:55 hours. The flight crew reached dispatch section of the operator at 04:35 hours and had undergone pre-flight medical including Breath Analyser. PM carried out walk around inspection and had not observed any abnormality. PF had aligned the IRS (Inertial Reference System) and the PM did rest of the pre-flight scan. After getting the weather and clearance, CDU (Control Display Unit) pre-flight procedures were completed.

Cabin Crew briefing was carried out by PF. Before Start Checks (challenge and response) were carried out as per the checklist. After starting the engines successfully, Ground Equipment was disconnected. Before Taxi, scan and checklist was carried out. On request, ATC gave permission to line up and instructed to wait behind another departing aircraft. "Before Take-off" scans and checks were carried out while entering runway but PM did not verify the Engine Bleeds Switch position, when covering “Air Conditioning" as a part of checklist.

The aircraft took off from runway 27. At 1000' Mumbai approach radar cleared the aircraft to FL90 (unrestricted). "After take-off checklist" was carried out but PM did not notice that both Engine Bleeds Switches were in off position. The aircraft was cleared to Climb to FL110.

PF updated the altitude on MCP (Mode Control Panel) to FL110 and used V/S (Vertical Speed) mode for climb. Passing FL100, the PM while scanning the pressurization panel noticed that the Cabin Rate of Climb was showing 2000 ft/min and the cabin altitude was also increasing. The same was discussed amongst the

flight crew members (PF & PM). In between, Approach Radar asked them to change over to 133.85 MHz (Mumbai Radar), to which the PM replied “stand-by”. After sometime, Cabin Altitude warning and horn came on. The aircraft was approaching FL110 at that time. PF called to don oxygen Mask which both flight crew members did.

As per the PM, he had selected the Pressurization Mode Selector to Manual, Outflow valve to fully closed position, passenger oxygen Switch to ON and checked the Cabin Altitude as a part of the recall items. PF called for the Cabin Altitude warning NNC (Non Normal Checklist) followed by rapid depressurization NNC. At that time, PF noticed that the Bleed switches were OFF which he then switched to ON position. The crew had not declared emergency. The aircraft was descending to FL100. After completing the checklist, ATC was informed about return back to Mumbai due Technical. After removing the masks, the flight crew checked with the cabin crew for any injuries. None was reported at that time.

Landing back to Mumbai was planned in FMC. During descent, there was Master Caution warning for Equipment cooling. The aircraft after landing on RWY 27 taxied via N10 to Bay K1. During taxiing, PM informed PF that the Outflow valve is closed, which was then opened. PF then selected Pressurization Mode selector to Auto which caused condensation smoke in cockpit for a few seconds. At that time, Cabin crew informed that there is condensation smoke (disappeared soon) in the cabin and some of the passengers were bleeding from their nose and also having ear pain.

The flight crew asked for medical assistance on bay. All passengers were deplaned and injured passengers were attended to at bay.

1.2 INJURIES TO PERSON

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	Nil	Nil	Nil
SERIOUS	Nil	Nil	Nil
MINOR	Nil	21	Nil
NONE	07	145	

1.3 DAMAGE TO AIRCRAFT

Nil

1.4 OTHER DAMAGE

Nil

1.5 PERSONNEL INFORMATION

DETAILS	PIC	FIRST OFFICER
Lic Type/No.	ATPL - 3887	CPL-13454
Date of issue	15.09.2009	13.11.2014
Valid Up to	14.09.2020	12.11.2019
Date of Medical Exam	01.08.2018	13.03.2018
Medical Validity	31.08.2019	12.03.2019
Total Flying Experience	9767:12	835:39
Hours Flown on Type	7424:24	635:39
Date of Last Flight	20.09.2018	20.09.2018
Experience as PIC on Type	5936:37	NIL
Hours flown in last 365 days	574:57	634:21
Hours flown in last 180 days	315:29	384:36
Hours flown in last 30 days	69:22	64:23
Hours flown in last 7 days	18:59	14:29
Hours flown in last 24 Hrs.*	00:00	00:00

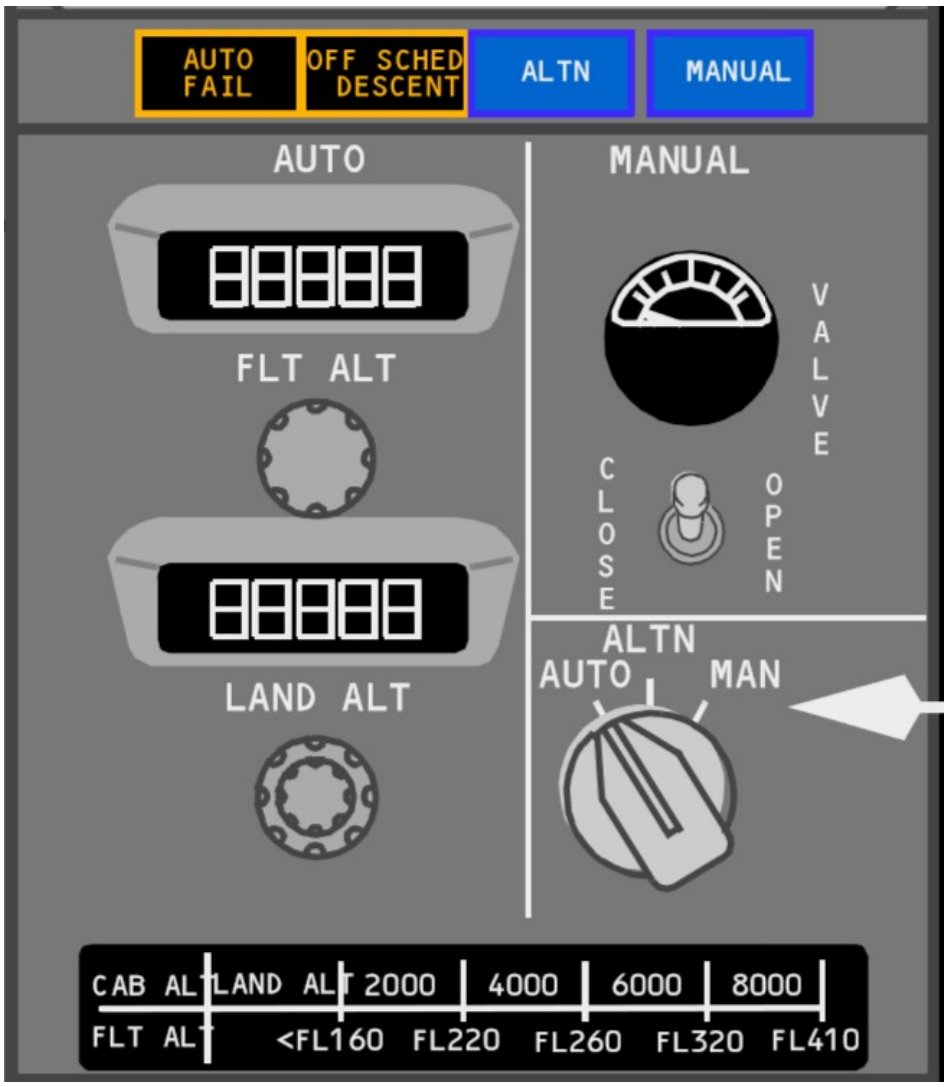
* Excluding incident flight hours

1.6 AIRCRAFT INFORMATION

Aircraft Registration	VT-JGS
Type of Aircraft	BOEING 737-800NG
Airframe Serial No.	34800
Manufacturing Year	2006
Engine Type	CFM56

Engine Serial No.	LH : 894260; RH : 894262
Last C of A done	28. 05. 2012
ARC validity	21. 10. 2018
Airframe Hours	TSN : 47089.20; CSN : 22030
Engine Hours	LH : 38450; RH : 40494
Last Layover Inspection date	BOM / 19. 09.18

1.6.1 Pressurization system



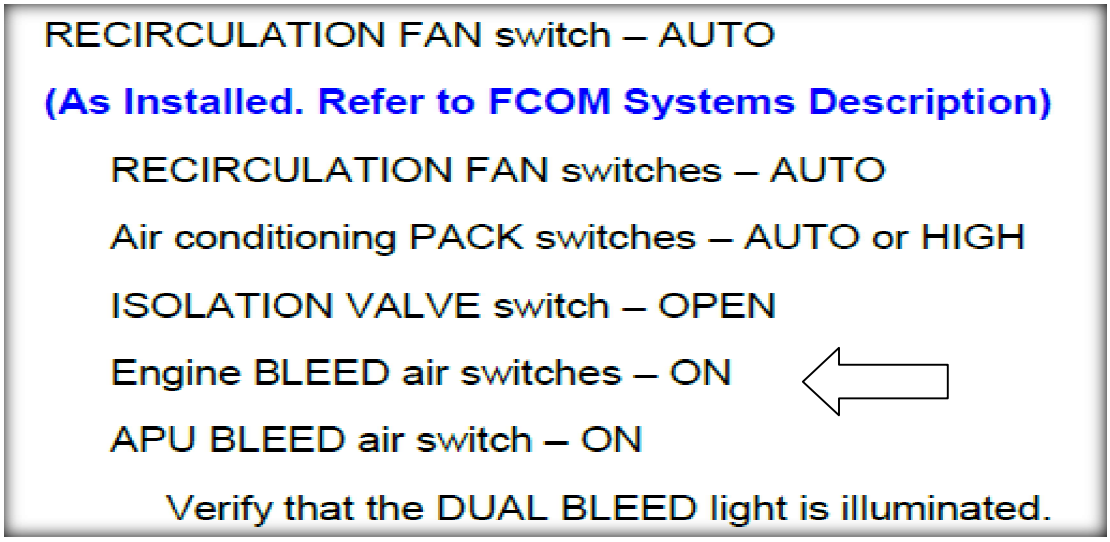
CABIN ALTITUDE PANEL

The pressurization system (mechanical) of B-737 aircraft consists of Air-Conditioning packs, an outflow valve, overpressure relief valve and a negative pressure relief valve. Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system. The cabin pressure control system includes two identical automatic controllers which are available by selecting AUTO or ALTN and a manual (MAN) pilot–controlled mode. The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valve and the overboard exhaust valve. The overboard exhaust valve is open on the ground and closes when cabin differential pressure reaches a certain value except during smoke over ride mode.

Pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 9.1 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

1.6.2 Flight checks

During pre-flight scan, the flight crew is required to check that the position of engine bleed switches is at ON position. Relevant portions are given below: -



1.6.3 Before takeoff checks

BEFORE TAKEOFF <JPL>		
Air conditioning	Bleeds ON / OFF	LHS
Flaps	___Green light	LHS, RHS
Stabilizer trim	___ Units	LHS, RHS

1.6.4 After takeoff checks

AFTER TAKEOFF <JPL>		
Engine bleeds	ON	PM
Packs	AUTO	PM
Engine start switches	As req'd	PM
Landing gear	UP / UP and OFF	PM
Flaps	UP, no lights	PM

1.7 METEROLOGICAL INFORMATION

The weather information available with the crew was winds – 170/10 knots, visibility – 3000 meters, clouds scattered - 020/ broken – 100, temperature 27°C

1.8 AIDS TO NAVIGATION

Mumbai airport is equipped with an ILS and VOR for runway 27. Both were functional at the time of Incident. All onboard navigation equipment was functional and the crew obtained RADAR vectors from Mumbai approach for their return to Mumbai

1.9 COMMUNICATION

The aircraft was in two way communication with ATC throughout.

1.10 AERODROME INFORMATION

Mumbai airport is an International airport with two runways i.e. 09/27 and 14/32.

1.11 FLIGHT RECORDERS

The aircraft was equipped with a CVR and DFDR as per requirements. Both DFDR and CVR were downloaded and analysed for the purpose of investigation.

VT-JGS 20-09-2018 Flight: JAI697-1 BOM-BOM - Cabin ALt > 10k

GMT	BARO ALT	RAD ALT	VERT SPD	N1 # 1	N1 # 2	CABIN ALT > 10K FT	ECS PCK L	ECS PCK ON R	ENG 1 BLD SWTCH	ENG 2 BLD SWTCH	ECS ISO VALVE	MAST CAUT
00:42:44	19	0	59	94.3	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:45	19	0	129	94.4	94.6	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:46	19	0	192	94.5	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:47	22	5	336	94.5	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:48	31	8	459	94.4	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:49	33	17	632	94.5	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:50	46	26	864	94.4	94.6	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:51	74	45	1106	94.5	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:42:52	85	61	1353	94.5	94.8	NO WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN

- **Aircraft took-off with bleeds OFF**

VT-JGS 20-09-2018 Flight: JAI697-1 BOM-BOM - Cabin ALt > 10k

GMT	BARO ALT	RAD ALT	VERT SPD	N1 # 1	N1 # 2	CABIN ALT > 10K FT	ECS PCK L	ECS PCK ON R	ENG 1 BLD SWTCH	ENG 2 BLD SWTCH	ECS ISO VALVE	MAST CAUT
00:48:43	10996	5500	-38	74.1	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:48:44	10995	5500	-60	74.3	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:48:45	10996	5500	-120	74.3	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:48:46	10995	5500	-158	74.3	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:48:47	10993	5500	-188	74.1	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:48:48	10988	5500	-218	74.1	74.4	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN

- **Cabin Altitude Warning**

VT-JGS 20-09-2018 Flight: JAI697-1 BOM-BOM - Cabin ALt > 10k

GMT	BARO ALT	RAD ALT	VERT SPD	N1 # 1	N1 # 2	CABIN ALT > 10K FT	ECS PCK L	ECS PCK ON R	ENG 1 BLD SWTCH	ENG 2 BLD SWTCH	ECS ISO VALVE	MAST CAUT
00:53:19	10002	5500	-30	74	74.1	WARN	OFF	OFF	OFF	OFF	OPEN	NO WARN
00:53:20	10002	5500	-15	73.9	74.1	WARN	OFF	OFF	ON	OFF	OPEN	NO WARN
00:53:21	10001	5500	-15	74	74	WARN	ON	ON	ON	ON	OPEN	NO WARN
00:53:22	10000	5500	-15	74	74	WARN	ON	ON	ON	ON	OPEN	NO WARN

- **Engine bleeds put to ON position at an Altitude of 5500 feet**

1.12 WRECKAGE AND IMPACT INFORMATION

Nil

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Both flight crew members and the cabin crew were subjected to pre-flight medical examination including breathe analyser test. The pre-flight medical for all of them was satisfactorily.

21 passengers reported bleeding either from the nose or from the ear or both. Some of the passengers complained of ear pain. The passengers on arrival were attended to by the company doctor and wherever required were referred to hospital for further checks.

1.14 FIRE

There was no fire.

1.15 SURVIVAL ASPECTS

The incident was survivable.

1.16 TEST AND RESEARCH

Nil

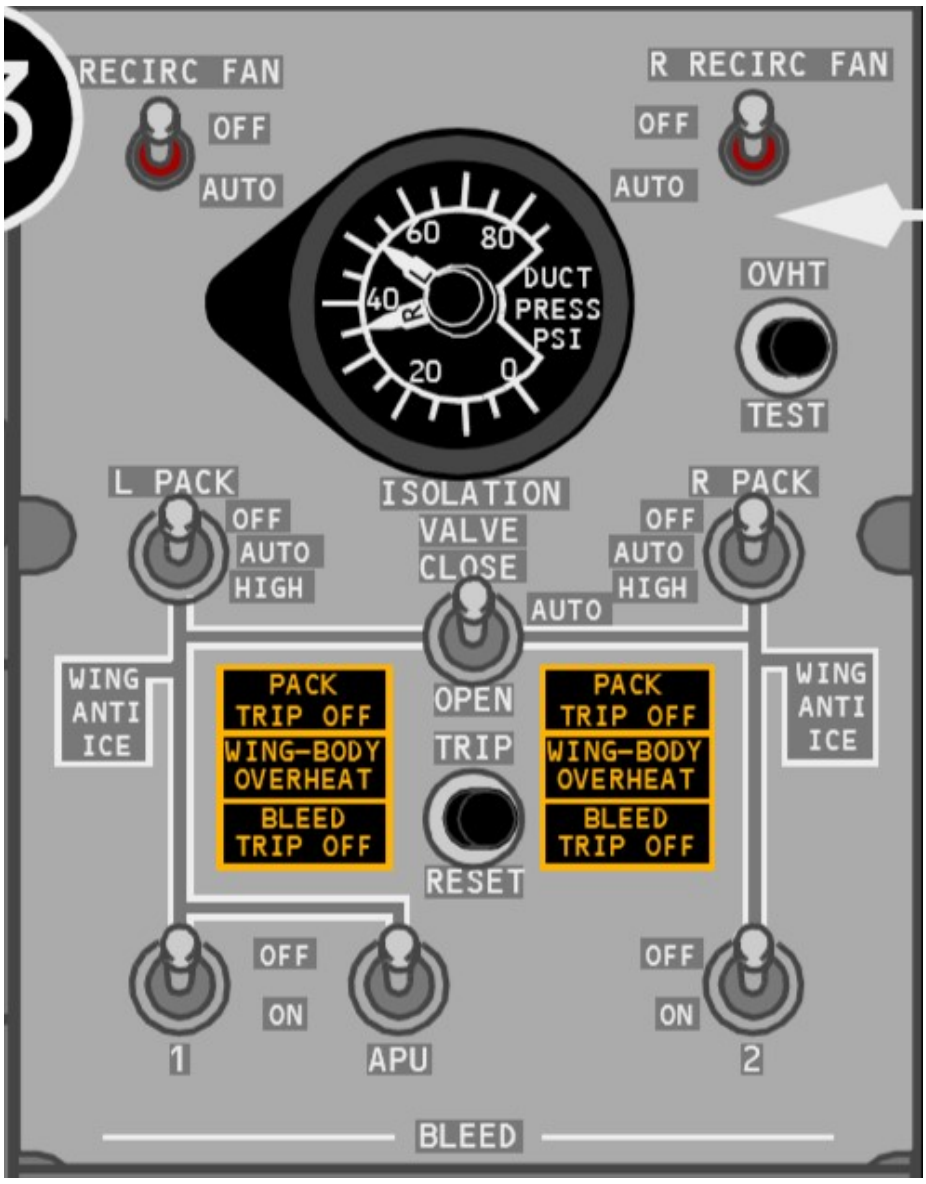
1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION

The airline is a scheduled airline and had a valid Scheduled Operators Permit (SOP) issued by DGCA India. It also had an approved Maintenance & Repair Organisation (MRO) under Indian CAR 145.

1.18 ADDITIONAL INFORMATION

1.18.1 Last layover inspection

The aircraft had undergone layover inspection on 19.09.2018. The work order issued for the aircraft included recording of the pack temperature.



As per the schedule, the AME on duty (night shift) was required to put the bleed switches to the OFF position prior to carrying out the task. After completion of the schedule, he was required to normalise the aircraft switches which required that the bleeds be put to ON position. The AME forgot to put back the bleed switch to ON position. After recording the parameters of pack temperature, the aircraft was released by him for departure.

1.18.2 Cabin Rate of Climb

CABIN Altimeter (ALT) Differential Pressure (DIFF PRESS) Indicator Inner Scale – indicates cabin altitude in feet. Outer Scale – indicates differential pressure between cabin and ambient in psi. **CABIN Rate of CLIMB Indicator** Indicates cabin rate of climb or descent in feet per minute.	

The operating and indication panel system of the digital cabin pressure control system is a part of overhead panel in the cockpit. There are indications for the cabin altitude and differential pressure, the cabin rate of climb indicator (Maximum 4000 ft. /min) and the outflow valve position indicator.

The climb (and descent) rate is usually 300-500 feet per minute. The cabin altitude climbs to 8000 feet while the aircraft's actual altitude is 41,000 feet. Maximum cabin pressure differential (difference between inside and outside pressure) can be 8.35 PSI.

1.18.3 Medical Assistance

In order to find out extremities of the pressure differentials in the cabin which caused nose bleeding/ ear pain, various medical personnel of Mumbai International Airport Limited (MIAL) and operator were interviewed and documents examined. Following are the observations:-

- MIAL doctor on duty received a call from the Terminal Operations about the requirement of medical assistance on board the aircraft at Bay “K1” at 0707 hrs. The medical team reached the location at 0718 hrs and attended to passengers in the transfer bus. Doctor observed that there were 10-15 passengers who had evidence of nose bleeds and ear pain. But there was no active bleeding observed by him. There was no information regarding the nature of medical assistance required or the number of people requiring medical assistance.
- Jet Airways doctor on duty received call at 0730 hrs about return of flight due to medical emergency. At 0745 hrs, medical assistance for passengers was requested at belt no. 1 & 2. Doctor proceeded to Belt No 1 & 2 and reached the location within 6-7 minutes. All passengers were clustered there and waiting. By the time doctor reached there, she could see about 15 Passengers complaining of nose bleed and ear pain. She could see occasional blood spot on their clothing. After interviewing the passengers, it was decided to transfer 06 passengers with severe ear pain to hospital out of which 05 passengers went to the hospital. The Jet doctors had carried a pulse oximeter with them and none of the passengers had any de-saturation. The doctors did not carry out an otoscopic examination due to lack of privacy.
- Documents from hospital revealed that all 5 passengers had evidence of Hemotympanum as a result of Barotrauma (as a result of sudden excessive pressure changes in the cabin of the aircraft). They were put on conservative management and let off with medication.

1.18.4 Cabin Pressure v/s Rate of descent

As cabin pressure was not recorded in the DFDR, the flight was simulated on Boeing 737 Simulator at CAE simulator complex, Bangalore as per the profile submitted by the Captain of the flight. It was ensured as far as possible that the exact actions and timings are maintained as per the statement of the captain.
Following table gives the observed approximate values which might have occurred (cabin pressure & Rate of descent) during the flight and gives a fair idea of at what rate the pressures were changing in the cabin.

	Flight Level	$ Pressure	Cabin pressure (psi)	Rate of Descent (ft/min)
1	During take off	1.1	3000	800
2	9000 ft	2.3	4000	850
3	11000 ft	2.3	5000	850
4	11000 ft	1.2	7000	850
	11000 ft	1.2	8000	1100
5	10000 ft	0.2	10000	1100
6	10000 ft	0	10000	-500
7	10000 ft	0	10000	-2500 (bleeds On)
8	7000 ft	4.0	1000	1600
9	7000 ft	7.0	0	1400
10	7000 ft	9.1	0	200
11	3800 ft	8.5	0	900
12	Landing	9.1	0	-
13	Vacating runway	9.1	0	4500 (vents opened)

The human ear drum is a fragile mobile membrane which is affected by the pressure differential inside the middle ear and the external atmospheric pressure. These changes have direct impact on pressure changes across the tympanic membrane (Ear Drum) and in the sinuses.

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

Nil

2.0 ANALYSIS

2.1 GENERAL

- Both operating crew were appropriately licensed and qualified to operate the flight. Their preflight Medicals were valid. They had undergone all refresher trainings and nothing was wanting as per the requirements.
- The aircraft had valid Certificate of Airworthiness at the time of incident. The Aircraft held valid Certificate of Release to service.
- The weather at the airport at the time of incident was fine and is not a contributory factor to the incident.

2.2 CIRCUMSTANCES LEADING TO THE INCIDENT

- Prior to departure of the aircraft, pack temperature monitoring task was carried out by AME on duty as per the work order issued for the aircraft. The task required that the bleed switches be put to OFF position which the AME did prior to performing the pack temperature monitoring. The task card in the end requires that the aircraft be restored back to its normal configuration though no specific steps have been mentioned to bring the system to its original configuration, as were given to be undertaken in the beginning of temperature monitoring task. The AME forgot to put back bleed switches to ON though he normalized other switches.
- The procedure of pre-flight scan by the flight crew requires that engine bleed air switches should be at ON position. The crew did not check the bleed switch position during their pre-flight scan and started push back followed by taxi- out with bleed switches in OFF position.
- The aircraft lined up for departure from runway 27. The before take-off check list required to ensure that the position of bleeds is at ON. This was to be carried out by challenge and response method. The pilot monitoring read out the checklist without verifying the position of the switches and the pilot flying who was supposed to call out the position of the bleed switches gave a call without verifying the position of the bleed switches.
- After take-off, the flaps were retracted and the flight crew carried out “after take-off” checklist which was once again by challenge and response. Again, the flight

crew failed to visually verify position of the bleed switches as was required by the checklist i.e. ON.

While climbing through FL 100, the PM noticed that the cabin altitude was increasing at a rate of 2000 fpm with rise in cabin altitude. While the flight crew was discussing this high rate of climb of the cabin, cabin altitude warning came on as the cabin altitude had reached beyond 10,000 feet. Both flight crew immediately donned the oxygen mask and carried out cabin altitude warning checklist which is recall items. The passenger oxygen switch was put to ON position thereby deploying the oxygen mask. The cabin crew reached to their stations and donned the oxygen masks. The senior cabin crew initiated contact with the cockpit and was told to standby.

Descent to FL 100 was initiated by the PF in coordination with ATC. At FL 100, the PF realized that the engine bleed switches were in OFF position and he turned these ON. With this action, the configuration was both engine bleeds ON, pressurization mode selected to manual and outflow valve at close. This resulted in aircraft getting pressurized causing a rapid drop in cabin altitude and increased pressure differential. The pressure differential might have reached to a higher value leading to activation of pressure relief valve. This could be one of the moments at which some of the passengers felt discomfort in ears and/or bleeding from nose.

The aircraft initiated return to Mumbai without declaring any emergency. Neither there was any announcement or communication to the cabin crew regarding the non normal situation. Before entering the landing pattern, the flight crew did not put the outflow valve to full open which would have depressurized the aircraft. During taxi, the PM informed the PF that the aircraft was still pressurized as the outflow valve was in closed position. On instruction of PF, it was put to auto.

It can be concluded that this particular incident occurred because there was an oversight at four different occasions in sequence. Investigation is of the view that

such type of oversight was entrenched in complacency, non existence of safety culture in operational training, maintenance and lack of CRM.

3.0 CONCLUSIONS

3.1 FINDINGS

i. The aircraft was having valid Certificate of Registration and Certificate of Airworthiness. The ARC was also valid. All maintenance schedules, mandatory modifications and checks were carried out as per the requirements. There were no defects / snags pending rectification.

ii. The weather reported was fine.

iii. The aircraft was under command of an appropriately licensed ATPL holder with a CPL holder as the First Officer. Their medical was valid and both pilots had undergone pre-flight medical checks including BA test which was negative.

iv. The crew was well rested prior to the operation of flight.

v. After carrying out the work order and prior to offering the aircraft for flight, procedure to normalize all switches post any engineering work completion was not followed, leaving the bleed switches to OFF position.

vi. The crew had not checked the bleed switch position during their pre-flight scan which should have been at ON position.

vii. The PM read out the “Before Take OFF” checklist without verifying the position of the switches and the PF who was supposed to call out the position of the bleed switches gave a call without verifying the position of the bleed switches.

viii. The flight crew failed to visually verify position of the bleed switches as was required by the “After Take Off” checklist i.e. ON.

ix. The PM recognized the emergency only when he observed the Cabin altitude rising at 2000 ft/min. The Cabin Altitude warning was generated as a consequence of bleed switches remaining in OFF position.

x. Cabin Altitude Warning or rapid depressurization quick actions performed were neither in accordance with the Manual nor were these effective as the system switches were not in the normal configuration for the phase of flight.

xi. The action of turning bleeds ON was not in accordance with the operating principle of manual mode operation.

xii. There was lack of clear understanding in respect of the usage of outflow valve switch during manual mode operation. In all probability, the sudden decompression after opening the vent valve led to the sudden misting and nose bleeds.

xiii. Neither emergency was declared nor was any priority landing was requested.

xiv. The excessive pressure fluctuations were the most probable cause for the ear pain and resulting hemotympanum.

xv. There was lack of communication to the cabin during the emergency. The cabin crew carried out all actions expected of them.

xvi. The details of medical assistance required and the number of people requiring assistance was not passed to the medical assistance centres.

xvii. There was communication gap between aerodrome operator and airline because of heavy reliance on the Joint Control Centre (JCC) for the same. The JCC did not activate the concerned airline stationed at JCC. They sent an SMS through Automated Notification & Transmission System (ANTS) without specifying the details.

3.2 PROBABLE CAUSE

Bleed switches left at OFF position by the AME after the maintenance task, which remained at OFF position during the flight also because of Flight Crew missing note of its position during pre-flight scan, not putting it ‘’ON’’ during “Before Take Off” & “After Take Off” checks resulted in the incident of cabin not getting pressurized.

Not handling the situation as per the procedure caused discomfort in ears and bleeding from nose of some of the passengers.

4.0 RECOMMENDATIONS

4.1 Airline Operator should

- During normal trainings/ refreshers, lay greater stress on following of checklists by highlighting the inherent dangers of complacency.
- Stress upon importance and correct work up of CRM.

4.2 All Airport operators should develop communication procedures ensuring that quantum of medical assistance required on ground by the passengers and/ or crew is passed on real time basis to the concerned agencies.

(Dr. K. Nageshwar Rao)
Investigator
Aircraft Accident Investigation Bureau

(R S Passi)
Investigator-in-Charge
Aircraft Accident Investigation Bureau

Date : 27.6.2019

Place : New Delhi