Final Investigation Report on Serious Incident to M/s SpiceJet Ltd. Aircraft VT-SYZ (Boeing 737-800) in PATNA Airspace on 17 November 2021

Gp Capt Rajendra Pratap Singh VSM (Retd.)
Investigator-in-Charge

(Ajendra Singh)
Investigator

FORWORD

In accordance with Annex13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with the provisions of the above said rules shall be separate from any judicial or administrative proceedings to apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

CONTENTS

GLOSSARY

AAIB	Aircraft Accident Investigation Bureau
APP	Approach Control
ATC	Air Traffic Controller
ASR	Approach Control Surveillance Approach Radar
ATPL	Airline Transport Pilot License
ADIRU	Air Data Inertial Reference Unit
AME	Aircraft Maintenance Engineer
BITE	Built in Test Equipment
B1	Mechanical stream
B2	Avionics stream
CPC	Cabin Pressure Controller
CPL	Commercial Pilot License
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
Ft	Feet
FC	Flight Computer
FIM	Fault Isolation Manual
ICAO	International Civil Aviation Organization
LAV	Lavatory
LRU	Line Replacement Unit
LSU	Lavatory Service Unit
MSG	Message
NM	Nautical Miles
NNC	Non Normal Checklist
OFV	Outflow Valve
PSU	Passenger Service Unit
PA	Passenger Announcement
PIC	Pilot in Command
PZTC	Pack Zone Temperature Controller
QDM	Quick deployment mask
RSR	Route Surveillance Radar
SCC	Senior Cabin Crew
SLFPM	Sea Level Feet Per Minute
TUC	Time of Useful Consciousness
UTC	Co-ordinated Universal Time
VMC	Visual Meteorological Conditions
VHF	Very High Frequency

SYNOPSIS

M/s SpiceJet Ltd., Boeing 737-800 aircraft (VT-SYZ) on 17th November 2021, was operating flight no. SG-391, sector Ahmedabad (AMD) – Patna (PAT). This was second sector of the day for the aircraft and cockpit crew. The aircraft was chocks off at 03:02:00 UTC. The flight was uneventful till cruise. However, during descent the MASTER CAUTION along with **AUTO FAIL LIGHT** of pressurization system illuminated. The crew did not execute the NNC actions in the prescribed order and commanded the outflow valve open in manual mode leading to annunciation of **MASTER CAUTION** and **CABIN ALTITUDE** warning. The delay by the PIC to don oxygen mask during the decompression event probably resulted in momentary incapacitation (Hypoxia) of PIC for a short duration while in command of a passenger aircraft. The crew initiated rapid descent and thereafter MAYDAY was declared, which was cancelled during final approach. The aircraft landed safely at Patna at 04:57:46 UTC.

The occurrence was classified as a 'Serious Incident' in accordance with the Aircraft (Investigation of Accidents and Incidents) Rules, 2017. DG, AAIB ordered an investigation into this occurrence vide order no INV: 12011/7/2021-AAIB, dated: 24 Nov 2021. Corrigendum dated 11th Jan 2022 appointed Gp Capt Rajendra Pratap Singh VSM (Retd), as Investigator-in-Charge and Mr. Ajendra Singh, as an Investigator to investigate into the cause of the Serious Incident.

Unless otherwise indicated, recommendations in this report are addressed to the regulatory authorities of the State having the responsibility for the matters with which the recommendation is concerned. It is for those authorities to decide what action is taken.

Aircraft and Incident details of M/s SpiceJet Ltd Aircraft (BOEING 737- 800) VT-SYZ on 17 November 2021

1.	Aircraft	Type	Boeing 737-800
		Nationality	Indian
		Call Sign / Registration	VT-SYZ
2.	Owner		SASOF III A19 Aviation Ireland DAC
3.	Operator		Spice jet Limited India
4.	Country of manufacture		USA
5.	Pilot–in –Command		APTL Holder
	Extent of Injuries		No Injuries
6.	Co-Pilot		CPL Holder
	Extent of Injuries		No Injuries
7.	No. of Persons on board		184+06
8.	Date & Time of Incident		17/11/2021 at 04:34:32 UTC
9.	Place of Incident		Patna Airspace
10.	Incident Site (Location)		108 nautical mile from Patna during descent
11.	Last point of Departure		Ahmedabad
12.	Intended place of Landing		Patna
13.	Type of Operation		Scheduled Passenger Operation
14.	Phase of Operation		Descent from FL 350
15.	Type of Occurrence		Component failure or malfunction (Non-power plant)
16.	Extent of Injuries		No Injuries

(All the timings in this report are in UTC unless otherwise specified)

1. FACTUAL INFORMATION

1.1 History of Flight

On 17 November 2021, the first sector of the flight of VT-SYZ from Delhi to Ahmedabad was uneventful. In second sector SG-391, VT-SYZ was scheduled to operate flight from Ahmedabad to Patna with 184 passengers along with 02 cockpit crew and 04 cabin crew on board. The aircraft departed from Ahmedabad at 03:02:00 UTC. The climb and cruise phase of the flight was uneventful. At 03:50:58 UTC, aircraft levelled off at FL 350. After the cruise phase, the aircraft started descending from FL350 at 04:34:05 UTC in coordination with ATC. At 04:34:32 the Master Caution came on for 08 second at altitude of 34292 Ft (Baro) along with auto fail light of pressurization system. Without following memory action, non normal checks (NNC) were initiated by the PIC and cabin altitude started climbing from 8000 Ft. to higher cabin altitude. The Co-pilot moved the pressurization control system mode selector switch control module from AUTO to ALTN. However, alternate system did not take over and auto fail light remained illuminated. The cabin altitude kept on climbing abruptly at the rate of approximately 4000 Ft/min.

The Co-pilot after moving the pressurization mode selector switch to Manual, continued with the NNC check list to move the outflow valve switch to open or close as needed to control cabin altitude and rate, the Co-pilot announced that I am closing it captain. PIC requested the Co-pilot to read the checklist again. Co-pilot read the checklist again and stated 'outflow valve switch moves to open or close as needed to control cabin altitude and rate'. The PIC told Co-pilot to slowly open the out flow valve and match with the cabin altitude as per the table given at control panel. The Co-pilot said that she is just flicking the out flow control valve, however PIC stopped the Co-pilot and advised to go little down. The Co-pilot informed the PIC that cabin altitude is climbing. At 04:37:07 UTC the cabin altitude warning light came on at altitude of 28207 Ft (Baro) and remained on for 05 min and 10 seconds. The cabin altitude warning horn also got activated, which was deactivated by the crew at 04:37:57. The PIC moved the out flow valve from partially open position to fully open position in one go (kept the outflow valve switch pressed for 20 seconds) which resulted in total loss of aircraft pressurization.

At 04:37:07 UTC, the PIC declared emergency and gave a MAYDAY call at flight altitude of 28207 Ft and requested for emergency descent. The ATC enquired about the reason for MAYDAY which was confirmed by the PIC that they have pressurization issues. Emergency descent was coordinated by crew with Patna control. Due to rapid depressurization and high rate of descent the passengers reported pain in ear, dizziness and headache.

The Co-pilot don the mask as per SOP and advised PIC to wear the oxygen mask. After that at 04:37:43 UTC, the Co-pilot deployed the passenger mask manually at an altitude of 26565 ft. The oxygen mask of seat number 5A, 5B, 5C and lavatory failed to deploy. As per cabin crew statement they used manual release tool for releasing the passenger mask of seat 5A, 5B, 5C, but did not succeed. The cabin crew shifted the passenger of seat 5A, 5B, 5C to seat 1A, 1B and 1C. As per the Co-pilot statement, the PIC delayed the donning of mask by 3 to 4 minutes, which probably lead to momentary incapacitation (Hypoxia) of PIC for 60 to 90 seconds. At 04:39:28 UTC, senior cabin crew was called by the PIC to flight desk to brief her about the emergency. At 04:39:57 UTC, when the aircraft was descending passing FL180 for FL 090, the Senior Cabin Crew (SCC) entered the cockpit without oxygen mask, where she was briefed by the PIC about the aircraft pressurization issue and emergency

descent. The cabin crew left the cockpit at 04:40:08. At 04:40:19 at an altitude of 17126 Ft the emergency descent call was given by PIC to the passenger and requested them to return to their seats. The auto fail light came on at an altitude of 34292 Ft, the cabin altitude warning came on an altitude of 28207 Ft. When cabin altitude increased from 8000 Ft to 10000 Ft, Mayday was declared at 28207 Ft.

At 04:40:28 UTC, emergency descent non normal checklist was read out by the Co-pilot, and aircraft was cleared for ILS approach on Runway 25 at Patna. At 04:41:15 UTC, at an altitude of 14535 ft the SCC announced on PA system to passenger for wearing of oxygen masks. Aircraft was further cleared for descent to FL60 at 04:42:20 UTC. At 04:42:50 UTC, the PIC reported that cabin altitude is around 7000 Ft and requested the Co-pilot to remove the oxygen mask if she is ok. At 04:43:38 PIC removed the oxygen mask.

At 04:44:07 on 7661 Ft the crew carried out the rapid depressurization check list and there after aircraft was further cleared for descent to 3000 Ft. The Patna ATC requested the crew to inform in case any other assistance is required. The Co-pilot checked with the cabin crew, the conditions of the passengers, to which the cabin crew replied that all passenger are screaming and they have not been able to check the condition of all the passengers as cabin crew were told to occupy their seats by the PIC. Further, the cabin crew requested the Co-pilot for the permission to go to cabin to secure it. The Co-pilot after checking with the PIC informed the cabin crew to come back and sit as aircraft will be landing in a short while. By this time (04:46:27) the aircraft descended to 5000 Ft altitude.

At 04:46:27 UTC, the crew started doing descent checks, approach briefing, emergency descent check list, deferred items, rapid descent checks, recall checks, approach checklist etc. At 04:52:01 UTC, the PIC made an announcement on PA that aircraft had some pressurization issue which is under control now and that aircraft is going to land at Patna in about 05 to 07 minutes. He requested the crew for prepare the cabin for landing. At 04:52:55 UTC, after the aircraft reached at safe altitude of 3000 Ft, the PIC cancelled the MAYDAY call. The crew after making an ILS approach for runway 25 landed safely at Patna at 04:57:46 UTC. On landing the Co-pilot enquired from the senior cabin crew regarding any medical assistance required for any passenger. The cabin crew informed that they have not been able to check all the passengers and requested the permission from the PIC to go and check the passengers, which was denied by the PIC and cabin crew were told to wait as the aircraft was about to park.

Post landing and shut down of aircraft during disembarking of passengers, the PIC stood next to SCC to check the condition of the passengers. No passenger reported any need for medical assistance. Thereafter, the PIC contacted the Aircraft Maintenance Engineer (AME) and briefed him about the occurrence during the flight.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
None	06 (02+04)	184	---

1.3 Damage to the Aircraft

There was no damage to the aircraft.

1.4 Other Damages

There was no other damages.

1.5 Personal information

Flight Crew held valid licenses and were qualified to operate the flight.

1.5.1 Pilot-in-Command

Nationality	Indian
Date of Joining to the Organization	01 Jun 2011
Age	33 Years
License	ATPL
Date of Issue	20-01-15
Valid up to	19-01-22
Category	Aeroplane
Date of Class I Med. Exam.	26-10-21
Class I Medical Valid up to	02-11-22
Date of issue FRTOL License	16-02-14
FRTO License Valid up to	15-02-24
Endorsements as PIC	C-152A, P-68C, B737 700-900, MAX
Total flying experience	8037.02 Hrs.
Total flying experience on type	7812.20 Hrs.
Last Flown on type (Boeing 737-800)	17.11.2021
Total flying experience during last 01 year	471.10 Hrs.
Total flying experience during last 06 Months	167.54 Hrs.
Total flying experience during last 30 days	58.22 Hrs.
Total flying experience during last 07 Days	18.28 Hrs.
Total flying experience during last 24 Hours	01.40 Hrs.(first flight of the day)
Rest period before first flight on 17.11.2021	30 Hrs.
Whether involved In Accident/Incident earlier	No
Date of latest Flight Checks, Ground Classes and Refresher	Route Check (29/9/2021), Annual Ground Refresher (05/04/2021 -10/04/2021)

1.5.2 Co-Pilot

Nationality	Indian
Date of Joining to the Organization	02 Jun 2018
Age	26 Years
License	CPL
Date of Issue	28-12-2016
Valid up to	27-12-2021
Category	Aeroplane
Date of Class I Med. Exam.	11-06-21
Class I Medical Valid up to	15-06-22
Date of issue FRTOL License 20554	28-12-16
FRTO License Valid up to	27-12-21
Endorsements as PIC	C-172
Total flying experience	1788.00 Hrs.
Total flying experience on type	1586.45 Hrs.

Last Flown on type	17-11-21
Total flying experience during last 01year	397.21 Hrs.
Total flying experience during last 06 Months	148.59 Hrs.
Total flying experience during last 30 days	37.55 Hrs.
Total flying experience during last 07 Days	05:00 Hrs.
Total flying experience during last 24 Hours	01:40 Hrs. (Previous Leg)
Rest period before first flight on 17.11.2021	72:00 Hrs.
Whether involved in Accident/Incident earlier	No
Date of latest Flight Checks, Ground Classes & Refresher	ALRC-12/01/2021 and Annual Refresher-17/07/2021

1.5.3 Cabin Crew Information

Cabin Crew	Date of Joining	Total experience as on 17 Nov 2021	Last recurrent training
SCC	01 Aug 2014	7.3 Years	16 Jul 21
Crew 1	22 May 2019	3.5 Years	26 Apr 21
Crew 2	04 Jun 2019	3.5 Years	26 Apr 21
Crew 3	22 May 2018	4.5 Years	21 Mar 21

1.6 Aircraft Information

1.6.1 Aircraft VT-SYZ Information

Aircraft Model	Boeing 737-800
Aircraft S/N	34803
Year of Manufacturer	2007
Name of Owner	SASOF III A19 Aviation Ireland DAC
C of R	5121/2 Validity: 07-02-2023
Airworthiness Review Certificate	4-98/2019-AI (1)/ARC/7224
Category	A
C of A Validity	Valid -Subject to validity of ARC
ARC issued on	05-02-2021
ARC valid up to	07-02-2022
Aircraft Empty Weight & Empty weight CG	43159.35 Kg // 659.52 Inch (16.75 meter) aft of datum. (CG=20.81 %MAC)
Maximum Take-off weight	79,015 KG
Date of Aircraft Weighment	19-May-21
Empty Weight	43159.35 Kg
Max Usable Fuel	22137 Kg
Max Payload with full fuel	12662.65 Kg
Next Weighing due	18-May-26
Total Aircraft Hours	53527:14
Last major inspection	10 Yearly Check done on 21 July 2021
List of Repairs carried out after last major inspection till date of incidence	C Check was done in July 2021
Engine Type	CFM
Engine Sl. No.(LH)	LH 892825
Date of Manufacture (LH)	13-Mar-2006
Last major inspection (LH)	OVH
List of Repairs carried out after last major inspection till date of incidence(LH)	Engine Shop Visit dated 16-Apr-2017

Total Engine Hours/Cycles (LH)	40994:02 hrs. /28771 cycles
Engine Sl. No. (RH)	890427
Date of Manufacture (RH)	14-Apr-2014
Last major inspection (RH)	OVH
List of Repairs carried out after last major inspection till date of incidence(RH)	Engine Shop Visit dated 02-Oct-2018
Total Engine Hours/Cycles(RH)	52314:49 hrs./31465 cycles
Aero mobile License	A-010/148/RLO(NR)
AD, SB, Modification	Complied with

The details of outflow valve, Part no. 21230-03 AC, Serial No. 07101936 are as follows:

- TSN – 53528.56
- CSN – 25420
- Date of Manufacture – 01.01.2007
- Date of removal from aircraft – 17.11.2021

1.6.2 Air Pressurization System Description (Aircraft Maintenance Manual Chapter 21-30-00)

Introduction

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 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.

Pressure Relief Valves – Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum valve. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

Cabin Pressure Controller – Cabin altitude is normally rate–controlled by the cabin pressure controller up to a cabin altitude of 8,000 Ft at the airplane maximum certified ceiling of 41,000 Ft. The cabin pressure controller controls cabin pressure in the following modes:

- AUTO – Automatic pressurization control; the normal mode of operation; uses DC motor.
- ALTN – Automatic pressurization control; the alternate mode of operation; uses DC motor.
- MAN – Manual control of the system; uses DC motor.

The Air Data Inertial Reference Units (ADIRUs) provides ambient static pressure, BARO corrected altitude, non-corrected altitude and calibrated airspeed to both automatic controllers. The ADIRUs receive barometric corrections from the PIC's and Co-pilot's BARO reference selectors.

The automatic controllers also receive throttle position from both stall management computers and signals from the air/ground sensors.

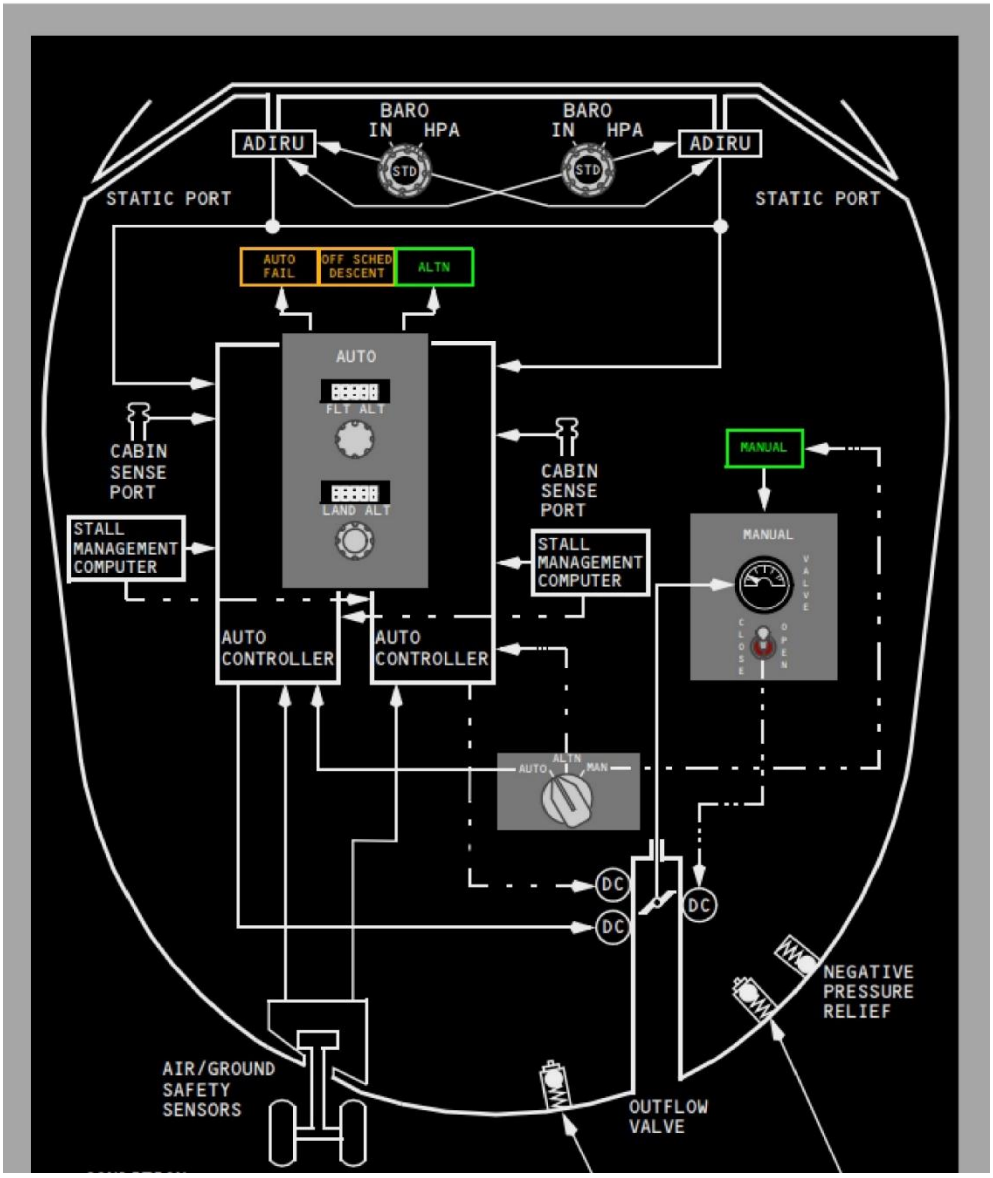

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Fig 1: Cabin Pressure Control System Schematic

Pressurization Outflow – Cabin air outflow is controlled by the outflow valve (OFV) and the overboard exhaust valve. Under normal conditions, a small amount of air is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by fuselage/door seal leakage.

Outflow Valve (OFV) – The OFV is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the outflow valve.

Overboard Exhaust Valve – On the ground and in flight with low differential pressure, the overboard exhaust valve is open and warm air from the E & E bay is discharged overboard. In flight, at higher cabin differential pressures, the overboard exhaust valve is normally closed and exhaust air is diffused to the lining of the forward cargo compartment. However, the overboard exhaust valve is driven open

if either pack switch is in high or the right recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

Auto Mode Operation – The AUTO system consists of two identical controllers, with one controller alternately sequenced as the primary operational controller for each new flight. The other automatic controller is immediately available as a backup. In the AUTO or ALTN mode, the pressurization control panel is used to preset two altitudes into the auto controllers:

- FLT ALT (flight or cruise altitude)
- LAND ALT (landing or destination airport altitude)

Takeoff airport altitude (actually cabin altitude) is fed into the auto controllers at all times when on the ground. The air/ground safety sensor signals whether the airplane is on the ground or in the air. On the ground and at lower power settings, the cabin is depressurized by driving the outflow valve to the full open position.

Manual Mode Operation – A green MANUAL light illuminates with the pressurization mode selector in the MAN position. Manual control of the cabin altitude is used if both the AUTO and ALTN mode are inoperative or during a non-normal situation. In the MAN mode, the Flight Crew changes the position of the outflow valve using the Outflow Valve switch.

In MAN mode, a separate DC motor, powered by the DC standby system, drives the outflow valve at a faster rate than during AUTO or ALTN modes. In MAN mode, the outflow valve full range of motion takes up to 20 seconds. This faster movement of the outflow valve allows the crew to quickly depressurize the airplane during certain non-normal situations, including following a tail strike event. Flight Crew can verify the position of the outflow valve by monitoring the cabin altitude panel and valve position on the outflow valve position indicator.

Non-normal situations that direct the flight crew to manually control the aircraft pressurization system, the caution mentioned below should be followed by the flight crew.

CAUTION**: **A small movement of the outflow valve can cause a large change in cabin rate of climb or descent. Manual actuation of the outflow valve can produce large, rapid changes in cabin pressure which could result in passenger and crew discomfort and/or injury.

1.6.3 Aircraft Maintenance Manual

As per Boeing 737-800 Aircraft Maintenance Manual Chapter 21-30-00 these conditions cause the auto fail function.

- High rate of descent initiated by the PIC which was beyond the controlling capability of pressurization system
- Power loss
- Cabin altitude rate of change is too high (> 2,000 Sea Level Feet Per Minute)
- Cabin altitude is too high (> 15,800 ft.)
- Wiring failures
- Outflow valve component failures
- CPC1 & CPC2 failure
- Cabin differential pressure is too high (> 8.75 psi)

- Cabin pressure selector panel fault, P5

Note: In case of dual channel failure i.e. when both the CPC system fail.

1. The auto fails and master caution light comes on.

2. The flight ALT and land ALT display shows five dashes (- - - - -)

If both CPC fail, the ALTN light does not come on. This indicates that the system cannot transfer control to an operative automatic controller.

1.6.4 Maintenance Actions by AME post Serious Incident

Post landing it was found that the outflow valve selector switch was in manual position and the out flow valve was in fully open position.

B1 & B2 AME were detailed by SpiceJet for snag rectification of pressurization system. Replacement of OFV of pressurization system was under taken based on the fault message shown during CPC BITE check. The complete BITE check as per FIM 21-31 task 801 was not undertaken by AME before replacement of OFV.

Fig 2: Selection of manual mode

Fig 3: LRU Fail Message before replacement of OFV

As OFV LRU FAIL MSG was stored in CPC, respective FIM task 21-31, task-801 was referred and as per the FIM, the possible cause for the fault code was Cabin Pressure Outflow Valve V48. Hence, the outflow valve was replaced and post installation checks, the system was found working satisfactory.

After change of OFV the CPC BITE test was carried out and the ground test passed. Further, pressurization system manual mode test & cabin pressure control system ground aircraft was carried-out and the same were found satisfactory.

Cabin galley and LAVS were checked and found that all PSU panels were in dropped condition. However, during LAV A inspection it was observed that latch door was getting stuck during deployment.

Chemical oxygen generators were checked and found that all chemical oxygen generators fired except for seat 5A, 5B & 5C.

Seat 5A, 5B & 5C oxygen mask did not deploy as the door latching spring was found faulty.

All three LAVS and control cabin oxygen masks were also found removed from stowage box.

Fig 4: Seat no. 5 mask did not deploy (above); LAV A mask did not deploy (below)

Fig 5: Crew oxygen pressure level after occurrence

The crew oxygen bottle pressure was checked and found that the cockpit crew oxygen pressure was sufficient (approx. 1500 PSI).

1.6.5 Pilot defect report and history of outflow valve removal from operator fleet

Investigation Team scrutinized operator records for the period January 2021 to August 2022 and found that

- A total of 661 pilot defect reports had been recorded with respect to snags relating to air-conditioning and pressurization system on Boeing 737-800 fleet.
- Total 07 outflow valve have been removed from the operator's fleet of 42 Boeing 737-800 aircraft between Apr 2021 and December 2021.

1.6.6 Snag related to pressurization system on VT-SYZ

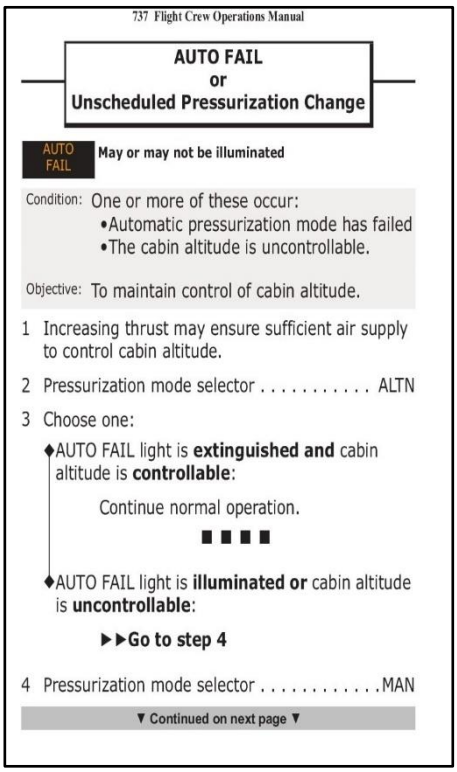
Total eight snags pertaining to pressurization system had been recorded on VT-SYZ aircraft from 10 Jan 2021 to 29 Dec 2021 and one snag pertaining to high rate of Cabin descent occurrence recorded on 26 Mar 2022.

The work order related to these event has been scrutinized and found that different components have

been replaced during snag rectification to clear the defects. No defect has been confirmed in certain cases during fault isolation as per laid down procedure given in the AAM & FIM.

1.6.7 NNC Procedure for Auto Fail as per FCOM

As per B737 Flight Crew Operations Manual following NNC procedure is to be followed in event of Auto Fail.



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AUTO FAIL or Unscheduled Pressurization Change

AUTO FAIL — **May or may not be illuminated**

Condition: One or more of these occur:
- Automatic pressurization mode has failed
- The cabin altitude is uncontrollable.

Objective: To maintain control of cabin altitude.

1 Increasing thrust may ensure sufficient air supply to control cabin altitude.

2 Pressurization mode selector . . . . . ALTN

3 Choose one:

♦AUTO FAIL light is **extinguished and** cabin altitude is **controllable**:

Continue normal operation.

■ ■ ■ ■

♦AUTO FAIL light is **illuminated or** cabin altitude is **uncontrollable**:

►►**Go to step 4**

4 Pressurization mode selector . . . . . MAN

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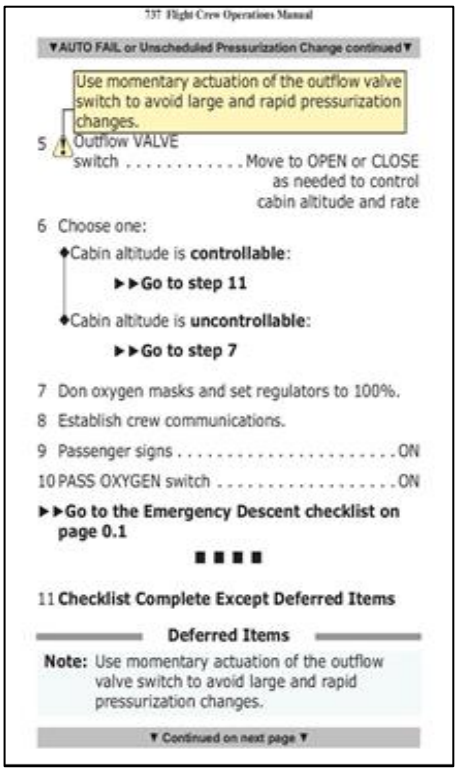


737 Flight Crew Operations Manual

▼AUTO FAIL or Unscheduled Pressurization Change continued▼

Use momentary actuation of the outflow valve switch to avoid large and rapid pressurization changes.

5 ⚠ Outflow VALVE switch . . . . . Move to OPEN or CLOSE as needed to control cabin altitude and rate

6 Choose one:

♦Cabin altitude is **controllable**:

►►**Go to step 11**

♦Cabin altitude is **uncontrollable**:

►►**Go to step 7**

7 Don oxygen masks and set regulators to 100%.

8 Establish crew communications.

9 Passenger signs . . . . . ON

10 PASS OXYGEN switch . . . . . ON

►►**Go to the Emergency Descent checklist on page 0.1**

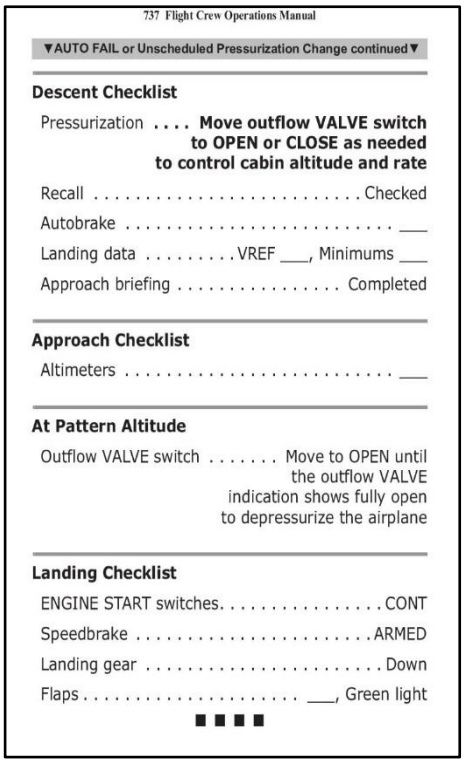
■ ■ ■ ■

11 **Checklist Complete Except Deferred Items**

Deferred Items

Note: Use momentary actuation of the outflow valve switch to avoid large and rapid pressurization changes.

▼ Continued on next page ▼



737 Flight Crew Operations Manual

▼AUTO FAIL or Unscheduled Pressurization Change continued▼

Descent Checklist

Pressurization . . . . **Move outflow VALVE switch to OPEN or CLOSE as needed to control cabin altitude and rate**

Recall . . . . . Checked

Autobrake . . . . . ___

Landing data . . . . . VREF ___, Minimums ___

Approach briefing . . . . . Completed

Approach Checklist

Altimeters . . . . . ___

At Pattern Altitude

Outflow VALVE switch . . . . . Move to OPEN until the outflow VALVE indication shows fully open to depressurize the airplane

Landing Checklist

ENGINE START switches. . . . . CONT

Speedbrake . . . . . ARMED

Landing gear . . . . . Down

Flaps . . . . . ___, Green light

■ ■ ■ ■

1.6.8 Pilot seat oriented action as per FCOM

Actions for this serious incident demand that both pilots perform the actions in a coordinated manner. PIC is overall responsible to ensure that the memory items are completed correctly. The switches are operated by the pilots as per the area of responsibility. In this case, since the overhead panel falls under the area of responsibility of the First Officer, the pressurisation panel switches are operated by the First officer as PM under instructions of the PIC. The Emergency or Rapid Descent actions are carried out by the PIC as PF.

1.6.9 Emergency Descent procedure as per FCOM

As per B737 Flight Crew Operations Manual following procedure to be followed in event of emergency descent.

Condition: One or more of these occur:

- Cabin altitude cannot be controlled
- A rapid descent is needed

1. **Announce the emergency descent**. The pilot flying will advise the cabin crew, on the PA system, of impending rapid descent. The pilot monitoring will advise ATC and obtain the area altimeter setting.

2. **Passenger signs** . . . . ON
3. **Without delay**, descend to the lowest safe altitude or 10,000 feet, whichever is higher.
4. **Engine Start** switches (both) . . . . . CONT
5. **Thrust levers (both)** . . . . . Reduce thrust to minimum or as needed for anti-ice
6. **Speed brake** . . . . Flight Detent

If structural integrity is in doubt, limit speed as much as possible and avoid high manoeuvring loads.

7. **Set target speed** to Mmo/Vmo.
8. **When** approaching the level off altitude: Smoothly lower the SPEED BRAKE lever to the DOWN detent and level off. Add thrust and stabilize on altitude and airspeed.
9. **Crew oxygen regulators** . . . . . Normal

Flight crew must use oxygen when cabin altitude is above 10,000 feet. To conserve oxygen, move the regulator to Normal.

10. **Engine Start** switches (both) . . . . . As needed
11. The new course of action is based on weather, oxygen, fuel remaining and available airports. Use of long range cruise may be needed.

1.7 Meteorological Information

As per Indian Metrological Department (IMD) Metrological (MET) office situated at Patna The weather (METAR) on 17 Nov 2021 at Patna Airport (VEPT) is as followed. The weather was not a cause of serious incident.

Met Report at VEPT	At 04:30	At 05:00
Wind	060 Degrees 3Kt	080 Degrees 3Kt
Temperature	22^0 C	23^0 C
Dew Point	11^0 C	10^0 C
QNH	1017 hPa	1016 hPa
QFE	1011 hPa	1011 hPa
Visibility	2500 M	2500 M
Trend	NOSIG(No significant change)	BECMG 3000 HZ

1.8 Aids to Navigation

All Navigational Aids available at Patna airport were reported to be serviceable.

1.9 Communication

At the time of incident, the aircraft was in contact with Patna Approach on frequency 121.1 MHz and then with tower on frequency118.3 MHz. A positive two-way communication was always maintained between ATC unit and involved aircraft as per the ATC tape and CVR recording.

1.10 Aerodrome Information

Airport Name	:	Jay Prakash Narayan International Airport, Patna
IATA code	:	PAT
ICAO code	:	VEPT
Airport Elevation	:	170 ft.
Hours of Operation	:	H24
Aerodrome Category	:	B

Patna Air Traffic controlling unit is divided mainly into Tower, Approach, and Area etc.

1.11 Flight Recorders

1.11.1 FDR – Flight data recorder was installed on aircraft. FDR PN 2100-4043-00, OEM L-Communications, Model - FDR 2100. DFDR data was made available to investigation team. Using altitude and time.

Using FDR data following graph has been drawn to know rate of descent, vertical speed with reference to altitude and time.

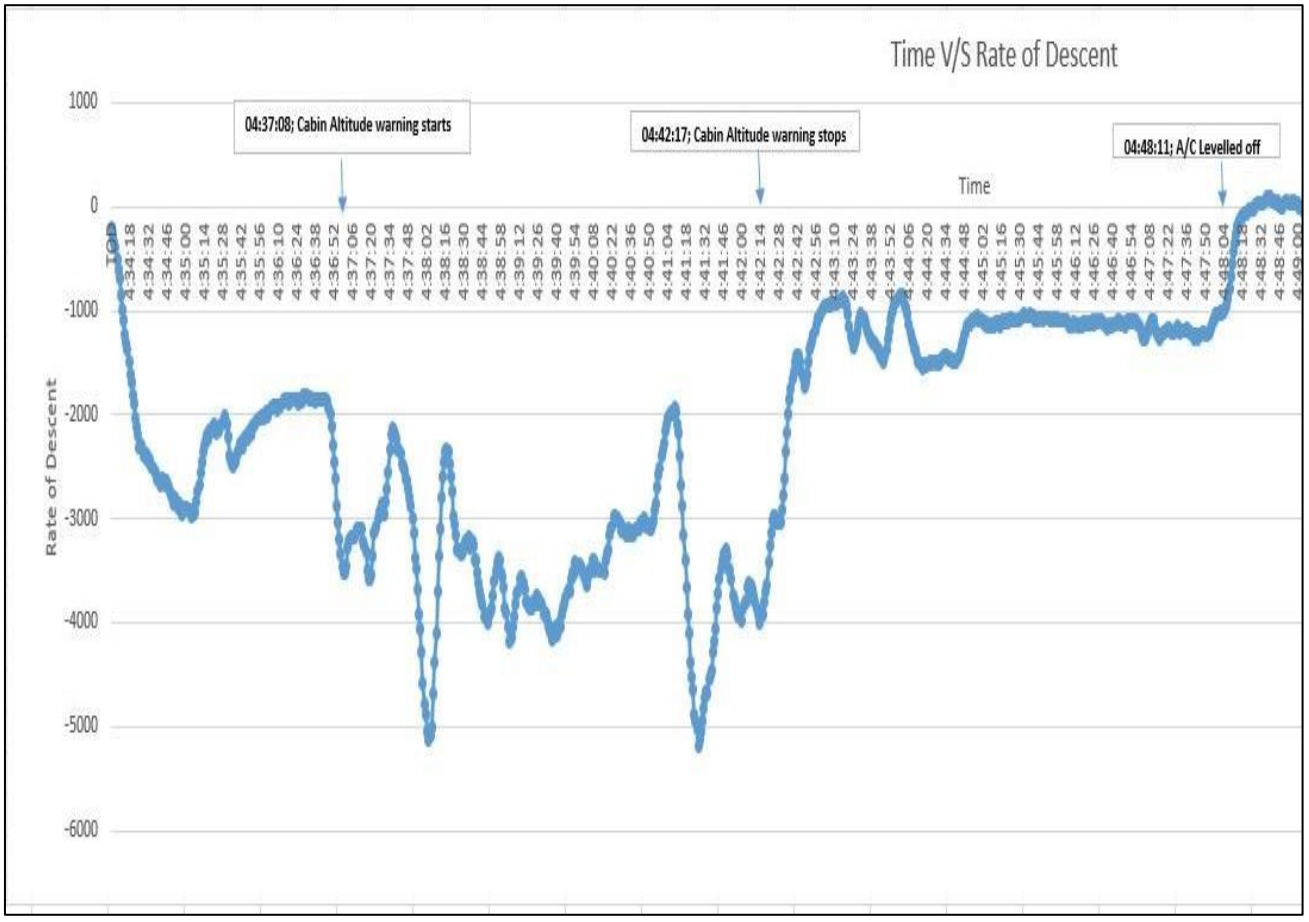


Fig 6: Graph Time v/s Rate of Descent

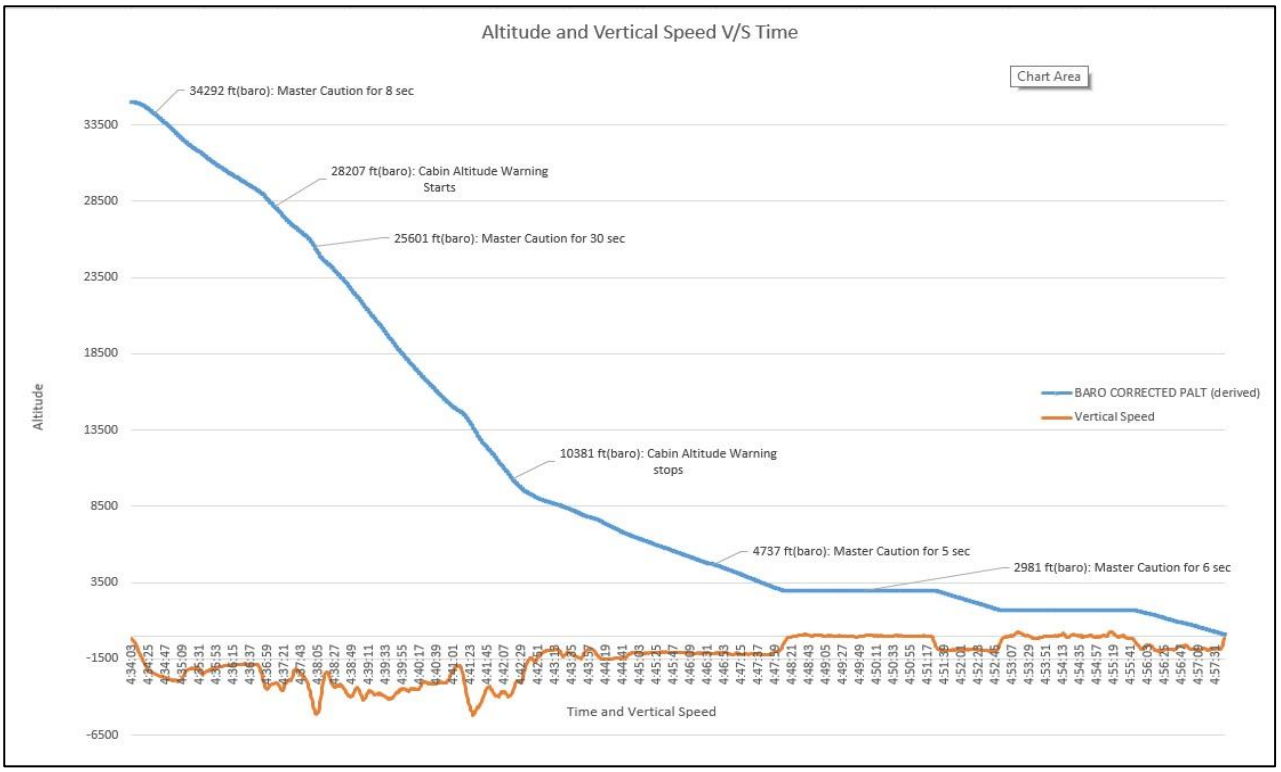


Fig 7: Graph Altitude and Vertical Speed v/s Time

The aircraft rate of descent from top of the climb (35004 ft at 04:34:01UTC) to the point of annunciation of Master Caution and Auto Fail light on (34292 ft at 03:34:32UTC) was approx. 1378 Ft/min.

The DFDR read out indicate that there was no power loss.

Engine parameter during Serious Incident							
Time	**BARO CORRECTED PALT (derived)**	**SELECTED TRA FILTERED #1**	**SELECTED TRA FILTERED #2**	**LEFT ENG N1 TACHO**	**RIGHT ENG N1 TACHO**	**LEFT ENG N2 TACHO**	**RIGHT ENG N2 TACHO**
04:34:01	35004	62.8	62.6	89.75	89.10	93.88	93.75
04:34:38	34040	35.5	36.2	40.13	40.50	75.25	76.13
04:35:00	33025	35.7	36.2	39.44	39.80	74.63	75.25
04:35:24	32017	35.7	36.2	38.69	39.10	74.13	74.75
04:35:51	31008	47.1	47.5	59.81	60.70	83.25	83.50
04:36:22	30004	52	52.2	71.25	71.40	87.38	87.50
04:36:53	29017	35.9	36.6	54.53	52.10	83.38	83.00
04:37:12	28000	38.5	39.2	41.56	42.10	77.50	77.63
04:37:30	27043	49.4	50.1	64.00	65.50	85.00	85.63

The throttle position and engine RPM indicate that the air was being delivered to the pressurization system.

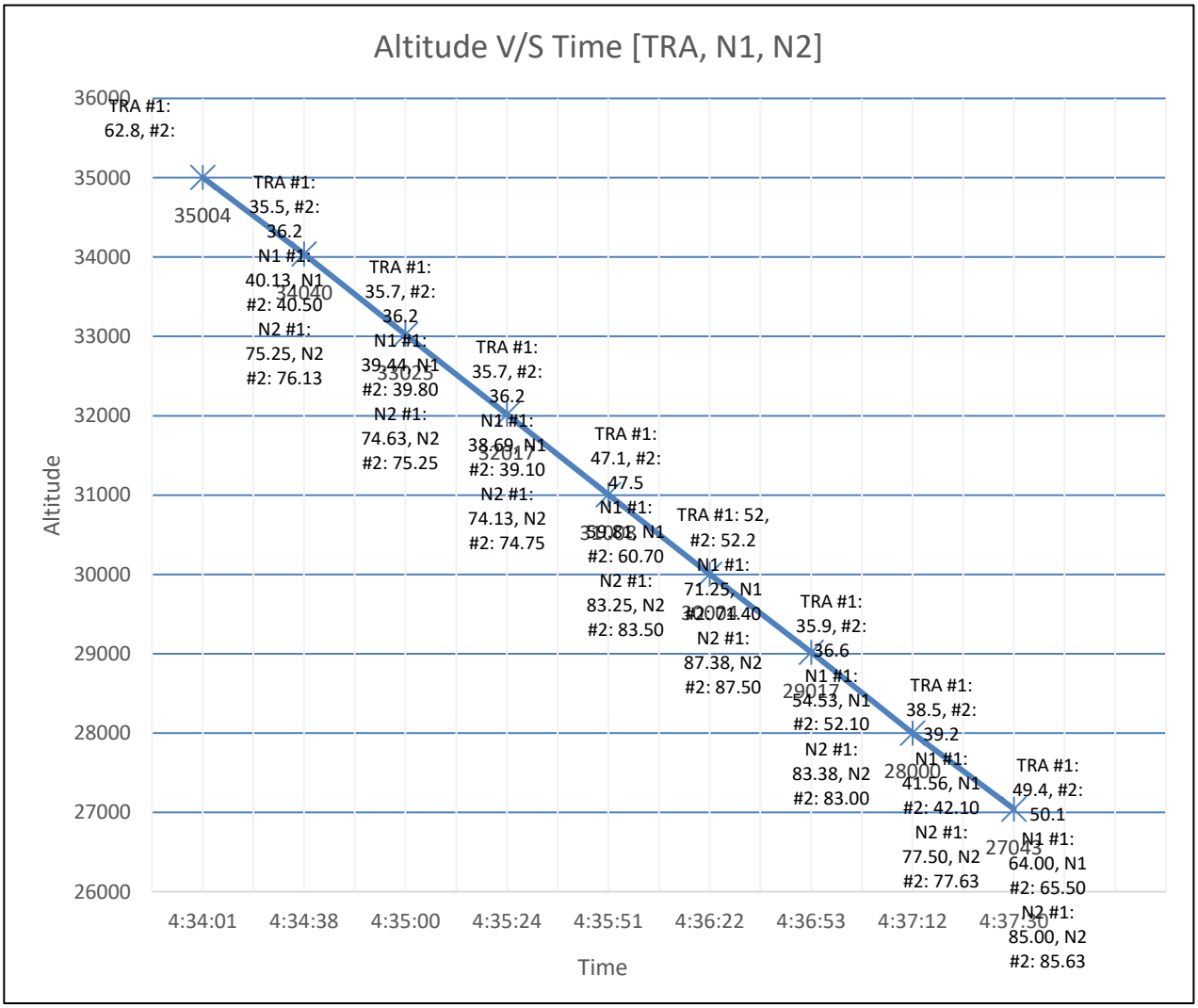


Fig 6: Aircraft parameter Altitude V/S Time [TRA, N1, N2]

1.11.2 CVR – PN 2100-1020-00, OEM L- 3 Communications, Model CVR 2100.Four channel recording- First observer, Co-pilot, PIC and Area Mike. The complete CVR has been analyzed from beginning of the flight to top of descent and communication was normal. CVR data of VT-SYZ reveals that the flight had read back correctly to the instructions given by Controller. The relevant portion of the CVR recording is as follows:

Timing (UTC)	From	Text
4:34:33	P1(PIC)	Master Caution air conditioning….ahhh Auto Fail…
	P2(Co-pilot)	Auto Fail
	P1	Auto Fail light non normal checklist
	P2	2.4
4:34:56	P2	Okay…Auto Fail non normal checklist or Unscheduled Pressurization Change Auto may or may not be illuminated Condition: One or more of these occur: • Automatic pressurization mode has failed

		• The cabin altitude is uncontrollable.
	P1	Yeah its climbing…
	P2	It's climbing…
	P1	Okay okay…
	P2	Okay. Cabin altitude is uncontrollable
	P1	Controlled he….
	P2	Increase thrust may ensure sufficient air supply to control cabin altitude. Pressurization mode selector – ALTN Pressurization mode selector alternate PIC
4:35:31	P1	Yeah Check
	P2	Check Choose one: AUTO FAIL light is extinguished and cabin altitude is controllable Negative….Not extinguished
	P2	AUTO FAIL light is illuminated or cabin altitude is uncontrollable – Go to step 4 Pressurization mode selector – MAN Going manual
4:35:41	P1	SG-391, request further descent
	ATC	SG-391 roger, contact VNS control 128.15
	P1	VNS control 128.15, SG-391
	P2	Outflow VALVE switch - Move to OPEN or CLOSE as needed to control cabin altitude and rate I'm closing it PIC
	P1	Sorry read it again…
	P2	Outflow VALVE switch move to OPEN or CLOSE as needed to control cabin altitude and rate
4:36:07	P1	Yes…. slowly you have to open…slowly…. keep on flicking and match with the…..slowly kardo (do it slowly)
	P2	Haan ji (Yes)…30… 6000 ft. chahiye na (6000 feet is required?)
	P1	Slowly
	P2	Yeah…I'm just flicking….
4:36:31	P1	Rukh jao..rukh jao (stop stop)..So let us go little down…
	P2	Yeah…cabin altitude climb is increasing PIC
4:36:41	ATC	SG-391 descent to FL150
	P1	150 SG-391
	P2	Check
4:37:06	P1	Radar SG-391
4:37:07	Cabin Altitude Warning horn activated	
	ATC	SG-391, radar
	P1	**MAYDAY MAYDAY MAYDAY**, SG-391, we have pressurization issue, request further descent
	ATC	SG-391 roger MAYDAY, request say again….report reason

	P1	Pressurization issue SG-391
	ATC	SG-391 roger MAYDAY, report reason for MAYDAY
	P1	We have a pressurization issue, SG-391
	ATC	Roger continue descent to FL90, report preferred RWY
4:37:42	Crew donned oxygen mask	
4:37:56	Cabin chime annunciated	
4:37:57	Cabin Altitude Warning horn deactivated	
4:38:03	ATC	SG-391 radar if ready contact PAT 121.1
4:38:07	Cabin chime annunciated	
	P2	121.1 SG-391
	ATC	SG-391 radar
	P2	SG-391 sir how do you read?
	ATC	SG-391, if ready contact PAT 121.1, RWY 25, use any convenient RWY
	P2 to P1	How do you read sir? How do you read sir? How do you read sir? Can you hear me??
	P1	All good all good….
4:38:54	P1	Emergency descent non normal checklist
	ATC	SG-391 radar…
4:39:24	Cabin chime annunciated	
4:39:28	P1	SCC to flight deck
4:39:34	ATC	SG-391, radar
	P2	How do you read sir
	ATC	Contact PAT 121.1
	P2	121.1, SG-391
	ATC	Confirm all OPS normal now.
	P2	Negative sir, we are in emergency descent, descending to FL90, MAYDAY only
	ATC	Roger report in contact with PAT, RWY 25
	P2	Copied sir copy….
	P2	Continue descent FL70, SG-391
4:39:57	SCC enter cockpit	
	SCC	Yes PIC
	P1	Pressurization issue
	SCC	Sorry
	P1	Emergency descent
	SCC	Emergency descent
4:40:08	SCC leaves cockpit	
4:40:19	P1 on PA	**Emergency Descent Emergency Descent Emergency Descent**, return to your seats.
4:40:25	P2	Can you read me now

	P1	Yeah…
4:40:28	P2	**Emergency Descent non normal checklist** One or more of these occur: • Cabin altitude cannot be controlled • A rapid descent is needed.
	P1	Check
4:41:15	SCC on PA	**Yathriyon se nivedan he apne mask pehan le** (Passenger are requested to wear their masks)…
4:42:50	P1	Okay…cabin altitude is around 7000…. You can remove your mask if you are okay…
4:43:13	P2	(P2 removed her oxygen mask) Stable….okay I'm good….
	P1	Check your controls
4:43:38	P1	Removed his oxygen mask
4:44:07	P1	All checklist complete right??
	P2	Rapid depressurization checklist nahi ki(Not done)….
	P1	Tumne dekha tha na (didn't you see?)…
	P2	Pehle kar diya tha (had done before)…..oxygen is donned, passenger sign is ON
4:44:20	ATC	SG-391, report total persons on board
	P2	Standby sir…..184 total POB
	ATC	Roger, any other assistance required, please advised
	P2	Will let you know sir
4:44:44	ATC	SG-391, descent to 3000ft , QNH 1017, TL FL 50
	P2	3000ft, 1017, TL 50, SG-391
	P2	3000 Ft. set
4:45:02	P2	I will ask the cabin attendant….
4:45:08	SCC	PIC
	P2	Is everything alright?
	SCC	Bache kafi roo rahe he ma'am (The kids are crying a lot ma'am)
	P2	Uncha bolo kya (speak loudly, what)???
	SCC	Bache kafi roo rahe he ma'am ((The kids are crying a lot ma'am) …we are not able to listen to you ma'am because kaan pore bandh ho gaye he (because Ears are blocked.)…
	P2	Everybody is fine at the back?
	SCC	No ma'am, all are screaming….passengers
	P2	All are screaming…but kisi ko chott ayi he (anyone got hurt)???
	SCC	Ma'am cabin me abhi tak gaye hi nahi na…PIC ne bol diya bet jao(Ma'am not been to the cabin yet, the PIC told go and sit)…
	P2	Loud bolo ma'am loud bolo(speak Loud ma'am speak Loud)
	SCC	PIC ne bola tha bet jao aaram se (The PIC had told to sit comfortably)
	P2	Acha…chalo….(All right) we are landing, cabin galley secure just confirm me once
	SCC	Ma'am, can we go in the cabin?
	P2	Say again
	SCC	Can we go in the cabin?
	P2	Yeah you guys are same, you can go cabin, secure it and come back and sit. We are landing in another….very quickly we are landing…
	SCC	Okay mask is required now?

	P2	Yeah what is required
	SCC	Oxygen mask are required otherwise I will use the oxygen cylinder
	P2	Right now it is not required. Right now we are at 5000ft altitude
	SCC	Okay fine ma'am.
	P2	Okay….
4:50:31	P2	Approach checklist Altimeter
	P1	1017…3000
	P2	1017… 3000 check
	P2	Outflow VALVE switch - Move to OPEN until the outflow VALVE indication shows fully open to depressurize the airplane. It is fully OPEN
	P1	Okay
	P2	Standing by for Landing checklist
4:52:01	P1 on PA	**Well this is your PIC from flight deck, we had some pressurization issue and it is under control. Will be landing in PAT in about 5-7 mins from now and cabin crew prepare the cabin for landing. Thank you**
4:59:05	SCC	Ma'am
	P2	Do we need any medical assistance for any passenger
	SCC	Ma'am, I didn't check yet, 4 mins me landing ki he, mid cabin tak tho (Landing was done in 04 minutes, till mid cabin I have checked) I have checked all the passenger, so I will go in the cabin for passenger assistance, if anybody needs help, will inform you.
	P2	Standby give me 1 min
	P2	PIC, she had checked till mid cabin, she has to go right now if anybody need assistance then she will get back to me. Do you want it right now
	P1	No tell her to wait
	P2	Okay… I will tell her to sit
	P2	Ma'am, abhi rehne do….wait karlo abhi (just wait…….wait now) …we are about to park
	SCC	Okay ma'am
5:03:23	Shut Down checklist was carried out as per SOP	
5:03:42	AME	Good morning PIC
	P1	We had a Auto Fail light and then NNC was done which led to Cabin Altitude Warning

1.12 Wreckage and Impact Information

There was no damage to aircraft or any property on ground.

1.13 Medical and Pathological Information

On the day of incident, both crew did not undergo pre-flight medical examination. They signed the declaration form, as per the DGCA requirement, declaring that they are not under the influence of alcohol or psychoactive substance at Delhi Airport in accordance with the DGCA Circular applicable on date of incident issued in view of outbreak of COVID 19 pandemic.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The incident was survivable.

1.16 Tests and Research

1.16.1 Outflow valve tear down report

As per tear down report of the component (**Refer Appendix 01**) received from Nord-Micro Frankfurt, Germany, "the performed potentiometer tests indicate that the removed outflow valve P/N 21230-03AC S/N 07101936 failed in Poti synchronism test (open 4,40V / 115°) on 09 Mar 2022. As per the report, the outflow valve had to undergo major repairs and the defects are as follows: -

a. The Gear box functional incoming test failed, so gear box defective bearings were replaced.
b. Anti-skating foils were damaged/ missing which were replaced
c. Teflon seals were bent and hence replaced
d. Rod ends were found sluggish/ stuck and hence replaced
e. Aumot 1 brake function was defective which was renewed
f. Worn-out bonding cables were replaced
g. Potentiometer was replaced as it was out of tolerance

The cap of the Potentiometer that is assigned to the manual mode of the CPCS showed a feedback voltage of 4.40V DC in fully open position, which is slightly out of tolerance in accordance with CMM 21-31-34. This error leads to an indication of the OFV position in the cockpit which slightly differs from the real OFV fully open position.

As per OEM of the OFV the described damages are normal wear and tear for OFV with +15 year of service. Mechanical wear out of OFV is considered as likely cause of malfunction in auto mode; however, manual operation of the OFV was possible.

1.17 Organizational and Management Information

Spice Jet is an Indian low-cost airline with headquarters in Gurgaon, Haryana. The airline operates 630 daily flights to 64 destinations, including Indian and international destinations from its hubs at Delhi and Hyderabad. The airline operates a fleet of Boeing 737 and Bombardier Dash 8 (Q400) aircraft.

1.17.1 Safety and Emergency Procedures (SEP) Manual of the Company

As per Para 4.3 of the SEM Manual, in case of Rapid Decompression and Cabin Pressurization Problems (Slow Decompression), the undermentioned procedure is to be followed.

a. General

There is insufficient oxygen in the atmosphere at high altitudes to sustain life, therefore the passenger's compartments of an aircraft have to be pressurized. The pressurization system of the aircraft is used to create a dense atmosphere within the cabin so that crew and passengers are kept comfortable and continue to breathe normally. Sudden loss of cabin pressure is termed as decompression. In other words, decompression is increase in cabin altitude and decrease in cabin

pressure. Decompression occurs whenever cabin altitude exceeds the preset altitude in an uncontrolled way. It could be slow, at which time remedial action such as descent to a safe level is taken, with little chance of causing damage to the cabin or its occupants. Cabin Crew may be aware of a slow decompression if the oxygen masks drop down. In this event, it is essential for Cabin Crew members to grab an oxygen mask and put it on regardless of how normal cabin conditions may appear. However, due to various technical, structural reasons, a rapid decompression might occur and will require an emergency descent by the flight deck crew and immediate action by the Cabin Crew.

b. Command from Flight Deck – There can be a command heard from the flight deck - **''Emergency descent, emergency descent, emergency descent**. This is your captain, return to your seats and use your oxygen masks"'.

c. Slow Decompression – Slow decompression is gradual loss of cabin pressure which can be caused by failure or malfunctioning of pressurization system or a slow leak in the fuselage.

Physiological Effects - Physiological effects may include hypoxia, blurred vision, headache, giddiness or impaired judgment.

***Crew Procedure* –** The procedure is a follows:

1. SCC will establish communication with PIC.
2. Flight deck Crew shall advise Cabin Crew of the situation.
3. If time permits, Crew to check Lavatories.
4. PA announcement to be made when the cabin altitude exceeds 14,000 feet and oxygen masks drop down from the PSU.

   Announcement for reference: "Instructing all passengers to don the Oxygen masks immediately".
5. Cabin Crew members to occupy jump seats and engage shoulder harness.
6. Cabin Crew shall don oxygen masks by pulling the lanyard of the oxygen mask as it will lower the mask and activate the flow of oxygen.
7. Await further Instructions from the Flight deck.

d. Rapid Decompression – Rapid decompression is sudden/ rapid loss of cabin pressure. It is caused by structural damage of the fuselage. There is always a remote possibility of a rapid loss of cabin pressure in any pressurized aircraft. The signs of rapid decompression are:

1. A rush of air
2. Loud bang
3. Rapid drop in temperature
4. Cabin filled with dust, debris, loose objects
5. Noise level will increase considerable
6. Moisture will condense in the form of fine mist

Rapid Decompression Physiological Effects - Physiological effects could be serious to crew and passengers in a few seconds. The physiological effects on a person are due to lack of oxygen and the expansion of gases trapped in the body cavities following the fall in pressure. They are usually accompanied by the following signs, which might be of short duration but are still dangerous:

1. There is a sudden expansion of the chest and air is blown out through the nose and mouth causing difficulties in breathing.
2. Cold sensation
3. Sinuses and ears may feel full momentarily
4. Speaking will be more difficult
5. Abdominal distension sufficient to cause discomfort or pain.

Rapid decompression mechanical Signs

1. Automatic illumination of cabin lights to bright mode, if on night mode.
2. Illumination of fasten seat belt sign.
3. Deployment of oxygen masks when cabin altitude reaches 14,000 feet.

Rapid decompression - Crew Procedure

1. Don Oxygen mask immediately and secure self on the nearest seat and fasten seat belt.
2. Make PA if possible: ***'Instructing all passengers to don their Oxygen masks immediately'.***
3. Once the aircraft has reached a safer altitude, flight crew will make PA 'Cabin Crew resume duties'

e. Safe Altitude – It is an altitude at which passengers can breathe normally without the assistance of external aid (Oxygen).

Purpose of rapid descent - The purpose of Rapid Descent is to reach the safe altitude and breathe normally.

f. Post Decompression Duties

1. Cabin Crew shall conduct Post Decompression walk around using portable oxygen bottles.
2. Check Flight deck, lavatories and passenger injuries in cabin.
3. Ensure oxygen masks have deployed and activated
4. Check structural damage in the cabin.
5. Reseat passengers away from structural damage (it possible)
6. Provide First aid and assistance to passengers
7. Inform PIC about injuries to passengers, structural damage and cases of decompression sickness.

1.17.2 Time of useful consciousness (TUC)

As per Para 4.3.1 of SEP Manual, TUC is defined as the amount of time an individual is able to perform flying duties efficiently in an environment of inadequate oxygen supply. It is the period of time from the interruption of the oxygen supply or exposure to an oxygen poor environment to the time when useful function is lost, and the individual is no longer capable of taking proper corrective and protective action, it is not the time to total unconsciousness. At the higher altitude, the TUC becomes very short. The table below reflects various altitudes with the corresponding average TUC:

Time of Useful Consciousness		
Altitude (Ft.)	***Passive Subject***	***Active Subject***
14000	Unlimited	Unlimited
20000	10 minutes	5 minutes
25000	5 minutes	2-3 minutes
30000	75 seconds	45 seconds
40000	20-30 seconds	10-15 seconds
50000	Less than 10 seconds	Less than 10 seconds

Note: A rapid decompression can reduce the TUC by up to 50 per cent caused by the forced exhalation of the lungs during decompression.

Emergency Oxygen System – For Cabin Crew and passenger's safety, aircraft is fitted with emergency oxygen system. Loss of cabin pressure in flight will be sensed by a device which automatically activates a system which supplies oxygen to passenger compartment. Provision is made for manual operation by the flight crew in case the automatic system fails.

If the cabin altitude reaches 14000 feet, the oxygen masks will drop down from:

1. Passengers Service Unit {PSU) above passenger seats.
2. Attendant Service Unit (ASU) above each Cabin Crew jump seat and on the ceiling between G1 and G2 galley.

The flight deck is equipped with a separate oxygen system and a special quick donning mask is installed ready for immediate use at each crew station.

1.17.3 Crew Resource Management

1. While individual error may occur during aviation operations, they seldom propagate to the point of serious incident because of the many safe guards built into these systems. Traditionally, CRM has been defined as the utilization of all resources available to the crew to manage human error.

   ICAO Human Factors Training Manual also states, (Part 1, Paragraph 1.4.25), that

   'Crew coordination is the advantage of teamwork over a collection of highly skilled individuals. Its prominent benefits are:

   - *An increase in safety by redundancy to detect and remedy individual errors; and*
   - *An increase in efficiency by the organized use of all existing resources, which improves the in-flight management.'*

   One of the basic elements of CRM involves checklist discipline. The general concept involves one pilot performing a check, while the other pilot confirms or monitors to ensure that the proper actions have been taken.

2. ICAO Manual further states, (Part 1, Paragraph 1.4.26), that

   'The basic variables determining the extent of crew coordination are the attitudes, motivation, and training of the team members. Especially under stress (physical, emotional, or managerial), there is a high risk that crew coordination will break down. The results are a decrease in communication

(marginal or no exchange of information), and increase in errors (e.g. wrong decisions), and a lower probability of correcting deviations either from standard operating procedures or the desired flight path.'

The Manual further adds (Part 1, Paragraph 1.4.27), that

'The high risks associated with a breakdown of crew coordination show the urgent need for Crew Resource Management training, this kind of training ensures that:

- *The pilot has the maximum capacity for the primary task of flying the aircraft and making decisions;*
- *The workload is equally distributed among the crew members, so that excessive workload for any individual is avoided; and*
- *A coordinated cooperation - including the exchange of information, the support of fellow crew members and the monitoring of each other's performance - will be maintained under both normal and abnormal conditions.'*

3. One of the important reasons for adherence to good CRM practices is to ensure checklist discipline and to make effective use of existing resources to improve safety of flight, by using the "team" approach to overcome inherent human errors. If one of two pilots in a cockpit displays less-than-optimal discipline in performing checklists and is not as effective in dealing with non-normal situations. Good CRM would enable a two-pilot crew to function as a team in order to avoid inadvertent omissions, to rectify them as soon as possible, and to effectively and swiftly manage non-normal situations**.** Good CRM also involves cooperation between the flight crew and cabin crew for certain non-normal events, particularly pressurization problems.

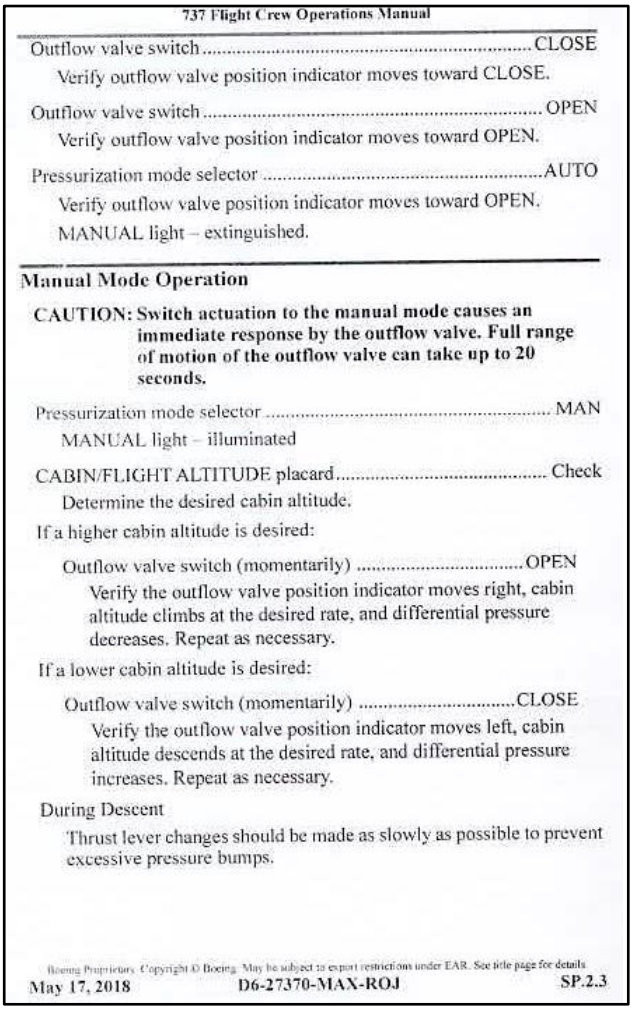
A number of past airline accidents and incidents have been associated with pilots' lack of adherence to proper checklist procedures. If one of two pilots in a cockpit displays less-than-optimal discipline in performing checklists, the team is not as effective in dealing with non-normal situations. In this regard, the Investigation Team observed the following:

- According to training records, the PIC and Co-pilot had received CRM training in Apr 2021 and July 2021, respectively. Records also showed that the all four cabin attendants had received CRM training on 21 Mar 2021, 26 Apr 2021 and 16 Jul 2021 respectively.
- The flight crew were grossly engrossed in handling the emergency and didn't check with the cabin crew about their health and did not given time to the cabin crew to check the condition of the passengers, use of mask and any other physical condition even when the aircraft descended to safe altitude below 10000 Ft. and till the time aircraft landed at Patna.

Good CRM would have enabled a two-pilot crew to function as a team in order to avoid inadvertent omissions, to rectify them as soon as possible, and to effectively and swiftly manage non-normal situations**.**

1.17.4 Pilot training procedure regarding pressurization system in manual mode

In SpiceJet Ltd, prior to the serious incident, the pilot training for manual pressurisation control was being carried out as per the supplementary procedure provided in Boeing Flight Crew Operations Manual (FCOM Vol 1), page SP 2.3 titled Manual Mode Operation. As per regulatory requirement, the



737 Flight Crew Operations Manual

Outflow valve switch ..... CLOSE
Verify outflow valve position indicator moves toward CLOSE.

Outflow valve switch ..... OPEN
Verify outflow valve position indicator moves toward OPEN.

Pressurization mode selector ..... AUTO
Verify outflow valve position indicator moves toward OPEN.
MANUAL light – extinguished.

Manual Mode Operation

CAUTION: Switch actuation to the manual mode causes an immediate response by the outflow valve. Full range of motion of the outflow valve can take up to 20 seconds.

Pressurization mode selector ..... MAN
MANUAL light – illuminated

CABIN/FLIGHT ALTITUDE placard ..... Check
Determine the desired cabin altitude.

If a higher cabin altitude is desired:

Outflow valve switch (momentarily) ..... OPEN
Verify the outflow valve position indicator moves right, cabin altitude climbs at the desired rate, and differential pressure decreases. Repeat as necessary.

If a lower cabin altitude is desired:

Outflow valve switch (momentarily) ..... CLOSE
Verify the outflow valve position indicator moves left, cabin altitude descends at the desired rate, and differential pressure increases. Repeat as necessary.

During Descent
Thrust lever changes should be made as slowly as possible to prevent excessive pressure bumps.

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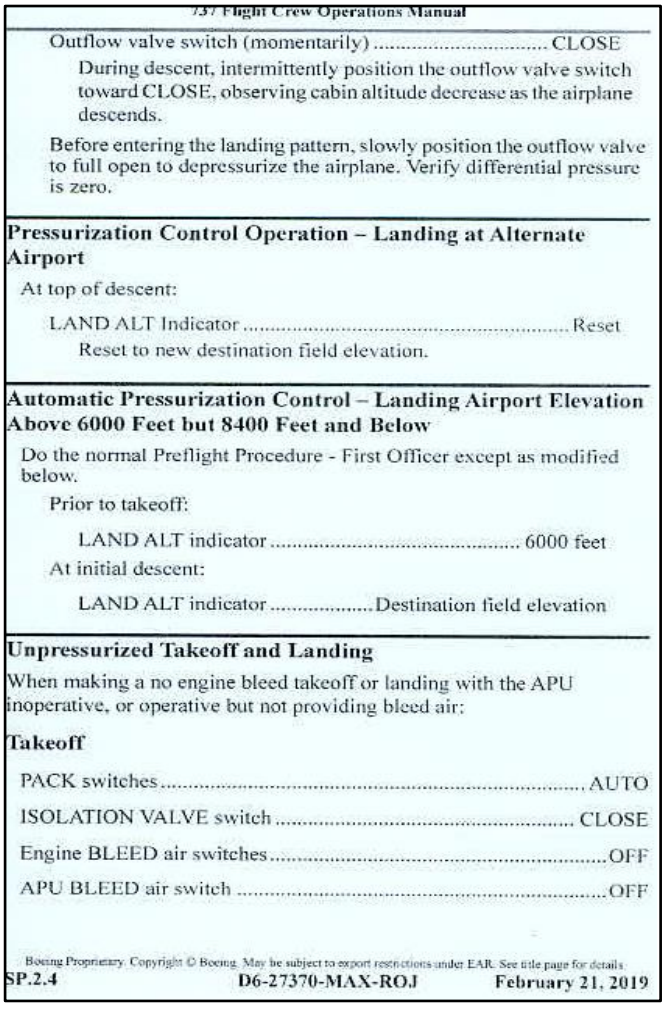

737 Flight Crew Operations Manual

Outflow valve switch (momentarily) ..... CLOSE
During descent, intermittently position the outflow valve switch toward CLOSE, observing cabin altitude decrease as the airplane descends.

Before entering the landing pattern, slowly position the outflow valve to full open to depressurize the airplane. Verify differential pressure is zero.

Pressurization Control Operation – Landing at Alternate Airport

At top of descent:

LAND ALT Indicator ..... Reset
Reset to new destination field elevation.

Automatic Pressurization Control – Landing Airport Elevation Above 6000 Feet but 8400 Feet and Below

Do the normal Preflight Procedure - First Officer except as modified below.

Prior to takeoff:

LAND ALT indicator ..... 6000 feet

At initial descent:

LAND ALT indicator ..... Destination field elevation

Unpressurized Takeoff and Landing

When making a no engine bleed takeoff or landing with the APU inoperative, or operative but not providing bleed air:

Takeoff

PACK switches ..... AUTO
ISOLATION VALVE switch ..... CLOSE
Engine BLEED air switches ..... OFF
APU BLEED air switch ..... OFF

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pressurisation system is to be covered once every year during training of the crew. Both the crew have undergone training prior to the serious incident as per regulations.

However, during the investigation, it has been observed that the training provided to the crew on the manual control of pressurisation system was not elaborate, as this was second back up system after failure of pressurisation control both in AUTO and ALTN mode.

Flight Operations Technical Bulletin issued by Boeing

As per Flight Operations Technical Bulletin (19-01 R1), dated 13.04.2020 issued by Boeing, there have been several reports of flight crew confusion regarding cabin altitude and cabin rate of climb indications that occurred as a result of depressurization events or the flight crew having to manually control cabin pressure. Additionally, there have been some reports where manual control of cabin pressure led to excessively high rates of cabin altitude changes as well as cabin over-pressurization conditions which led to the abnormal indications. This in turn led to flight crew confusion as what was actually occurring with airplane pressurization. Without an understanding of the situation, continued flight crew action led to amplification of the already abnormal situation. Some of these events

reportedly led to passenger injuries, flight with an over-pressurized cabin and landings with a pressurized cabin.

To address these issue, on 13 April, 2020 Boeing issued Flight Operations Technical Bulletin **(**19-01 R1) on Cabin Altitude Indications in Over-Pressure Situation, High Cabin Rate of Climb Indications and Manual Pressurization Control. The reason for issue of Flight Operations Technical Bulletin was to provide information to the flight crew of abnormal cabin pressure indications and techniques for manual pressure control.

Investigation Team observed that this was not made part of any operational documents issued by Spicejet as on date of incident. However, this bulletin was included by Spicejet post this serious incident in their training circular TC 03/22 dated 29.03.2022 and 05/22 dated 05.12.2022 respectively.

1.17.5 On Job Training Syllabus of Aircraft Maintenance Engineer

As per OJT booklets for AME (B1& B2) related to Boeing 737-700/800/900 of M/s SpiceJet Ltd. dated 14 May 2020 approved by DGCA, the OJT on replacement of OFV of pressurization system is the part of OJT syllabus of Chapter 21 applicable for AME (B1). This task is marked as Complex OJT tasks listed in the booklet. However, this activity of Chapter 21 is not applicable for AME (B2) as per approved OJT syllabus by DGCA.

1.18 Additional information

Nil

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS

2.1 General

The incident occurred on 17 November 2021 on Flight VT-SYZ (Type: BOEING 737-800). On the day of incident, VT-SYZ was scheduled to operate its flight from Ahmedabad to Patna. The PIC and Co-pilot were licensed and qualified in accordance with the applicable regulation and operator's requirement. The duty time, flying time, rest time and duty activity pattern were according to the regulations. The cabin attendants were trained and qualified to perform their duties in accordance to existing requirements. Visual meteorological conditions prevailed on departure and along the route of flight, and at destination was not a factor in the serious incident.

The aircraft was certified, equipped and maintained in accordance with regulations and approved procedures. The aircraft did not have any preexisting airframe or power plant problems. It departed with load and trim data within limits and no deferred items were pending in the logbook.

The investigation team examined the evidence to determine the cause of the serious incident and the analysis including examination of under mentioned documents and procedures.

- Pilot training procedure
- Action by Flight Crew
- Factors related to Safety Management System
- DFDR & CVR recordings

- FCOM
- QRH
- Initial Response from OEM, Nord-Micro Frankfurt, Germany
- Teardown report of out flow valve Serial no. 07101936 (work order no. 44754578) received from OEM post incident dated 09 Mar 2022
- Records of the Operator's outflow valve removals Feb 2020 to Nov 2021 prior to the serious incident
- Maintenance records related to the event aircraft air conditioning and pressurization systems from January 2021 through June 2022
- Shop findings of SpiceJet related to outflow valves removals.

2.2 Failure of Pressurization System

The aircraft got airborne from Ahmedabad for Patna at 03:02:00 UTC. The takeoff, climb and cruise segment of the flight was uneventful. However, as soon as the pilot initiated descent from FL 350, the master annunciator came on with air conditioning and pressurization system followed by auto fail light of pressurization system. The crew changed over the mode from AUTO to ALTN, however the alternate system did not take over. Failure of auto pressurization control system could be due to the following reasons (refer B 737-800 AMM Chap. 21-30-00 page 38)

1. **High rate of descent initiated by the PIC beyond the controlling capability of the system –** The aircraft rate of descent from top of the climb (35004 ft at 04:34:01UTC) to the point of annunciation of master caution and auto fail light on (34292 ft at 04:34:32UTC) was approx. 1378 ft/min. This data alone is inadequate to conclude that initiation of warning was due to high rate of descent (Refer Fig 6: Time v/s Rate of descent graph)

2. **Power Loss –** The DFDR read out does not indicate power loss as the reason for failure of auto control system of pressurization. (Refer Fig 8)

3. **Cabin altitude rate of change is too high –** The cabin rate of change could be a reason for failure of auto system if air outflows (through the fuselage, systems, doors/seals, and outflow valve) exceeds cabin air pressurization system requirements resulting in high rate of change of cabin altitude. There was no evidence that cabin altitude rate of climb was too high or evidence of any significant air outflows through the fuselage, systems, doors/seals, etc.

4. **Cabin altitude is too high (> 15000 Ft)** – Cabin altitude reached 15800 ft due to malfunction of out flow valve which was unable to control the cabin pressure.

5. **Wiring failure –** Wiring failure is ruled out, as post change of the outflow valve, the system was found satisfactory.

6. **Outflow valve component failure** – As per tear down report of defective component received from Nord-Micro Frankfurt, Germany, "the performed potentiometer tests indicate that the removed outflow valve P/N 21230-03AC S/N 07101936 failed in Poti synchronism test (open 4,40V / 115°) on 09 Mar 2022.

   As per work performed in teardown report the outflow valve had to undergo major repairs, as follows. (Refer teardown report placed as appendix 01)

a. The Gear box functional incoming test failed, so gear box defective bearings were replaced.

b. Anti-skating foils were damaged/ missing which were replaced.

c. Teflon seals were bent and hence replaced.

d. Rod ends were found sluggish/ stuck and hence replaced.

e. Aumot 1 brake function was defective which was renewed.

f. Worn-out bonding cables were replaced.

g. Potentiometer was replaced as it was out of tolerance.

As per the OEM, the above damages were considered to be normal wear and tear for OFV with +15 year of service but contributed in malfunction of OFV in auto mode operation, however, manual operation of OFV was still possible. This was also confirmed during check of the fault history of outflow valve post landing at Patna during fault rectification. This was further confirmed after replacement of OFV at Patna during snag rectification by AME, after performing full performance checks of the pressurization system post replacement of OFV. The snag was not repeated post replacement of OFV.

7. **CPC1 and CPC2 Failure –** Failure of CPC1 & CPC2 are ruled out because the 5 dashes were not displayed on FLT ALT & LAND ALT display and during post incident BITE test of the system no such fault was noticed.
8. **Cabin differential pressure too high –** Cabin differential pressure was in the normal operating range as per altitude**.**
9. **Cabin pressure control module (P5) selector panel fault –** During BITE test no such fault was noticed.

The aircraft was cleared post incident after replacement of out flow valve of pressurization system. The aircraft VT-SYZ has flown 2128.21 Hrs. and 1015 cycles without encountering similar defect.

2.3 Sequence of events

2.3.1 Pre-Departure

On 17 November 2021, the first sector of the flight from Delhi to Ahmadabad was uneventful for the aircraft and cockpit crew. In second sector, SG-391 VT-SYZ was scheduled to operate its flight from Ahmedabad to Patna. The investigation team reviewed the maintenance records of work performed on the aircraft by the Ground Engineers prior to its departure from Ahmedabad airport, as well as the Aircraft Tech Log entries and the AMM procedures/tasks recorded in the log book. No defect was pending on the aircraft.

2.3.2 Preflight

The investigation team considered various aspects of the flight crew's performance, beginning with the preflight phase and until landing at Patna airport. All available data from the FDR, CVR were used

for analysis of the incident and to gain insight into actions by the flight crew. Preflight actions performed by flight crew were as per procedure and no deviations were noticed.

2.3.3 Takeoff, Climb and Cruise

Take-off, climb and cruise phase of the flight was uneventful.

2.3.4 Descent and Approach

The aircraft was cleared for descent from FL 350 to FL270 initially. During descent the master caution along with auto fail light illuminated at FL340.

a. The crew initiated action as per auto fail Non Normal Checklist (NNC) procedures
   i. The Co-pilot started reading the NNC and started performing action.
   ii. The pressurization mode selector switch was moved from AUTO to ALTN position. However, the auto fail light did not extinguish and cabin altitude was not controllable.
   iii. The pressurization mode selector was moved to MANUAL position.
   iv. The airflow valve control switch was moved to open position by Co-pilot in single flick, which was than fully opened by PIC by pressing the OFV control switch for 20 second. The crew rather than closing the OFV to contain the pressure opened the OFV fully. This led to complete loss of pressurization from the aircraft and the cabin altitude started climbing.

b. Crew action of opening the outflow valve instead of closing led to complete loss of aircraft pressurization. It was assumed by the crew that the pressure is uncontrollable and they left the outflow valve in fully open position till landing and shutdown of aircraft.

c. Post opening of out flow valve, the crew observed that the cabin altitude started increasing rapidly at the rate of 4000 Ft/min leading to Cabin Altitude Warning annunciation. After that copilot deployed the passenger mask at an altitude of 28207 ft. The oxygen mask of seat number 5A, 5B, 5C and lavatory failed to deploy. The cabin crew shifted the passenger of seat 5A, 5B, 5C to seat 1A, 1B and 1C.

d. Co-pilot donned oxygen mask and advised PIC to do the same. However, PIC delayed donning of mask.

e. Instead of performing memory actions for Cabin Altitude warning or Rapid Depressurization, PIC declared MAYDAY and asked for Emergency descent checklist.

f. PIC expedited descent from FL350 to FL100 in 08 min 11 seconds and did not carry out memory actions of Emergency Descent as per procedure.

g. PIC did not announce Emergency Descent on Passenger Announcement (PA) as per NNC (when emergency descent was initiated at 28207 Ft). Emergency descent was announced quite later when aircraft was descending from 17126 Ft. The aircraft descended close to 11000 Ft after cabin attitude warning came on and 17000 Ft from the time auto fail light came on. During emergency descent the PIC directed the SCC to enter flight deck to inform about the occurrence which was to be communicated on PA system as per procedure.

h. As per CVR and DFDR data correlation at an altitude of 17126 Ft, Emergency descent NNC was read and done wherein PIC made a PA to passengers regarding emergency descent and to return back to their seats. However, he did not announce passengers to wear oxygen mask as per procedure.

i. During further descent the crew carried out Cabin Altitude Warning or Rapid Depressurization non-normal checklist.

j. ATC cleared the aircraft to descent to FL60 and when cabin altitude reached 7000 Ft, crew removed their oxygen mask.

k. Co-pilot contacted the SCC through intercom and enquired about the situation in the cabin.

l. Following information was passed on to flight deck by SCC (while in conversation with Co-pilot):

- All passengers in the cabin were screaming
- The cabin crew were not able to check the physical condition of the passengers as they were told to occupy their seats during emergency descent.

m. Co-pilot ordered SCC to go in the cabin for securing the galley equipment as they were about to land.

n. Sequence of the NNC was not maintained and hence descent, approach and landing checklist were carried out as per the deferred items of Cabin Altitude Warning or Rapid Depressurization NNC.

o. PIC cancelled the MAYDAY call after reaching at an altitude of 1588 Ft. and 20 Nm from touchdown.

2.3.5 Landing

- After an ILS approach on runway 25 aircraft landed safely at PATNA (PAT).
- ATC enquired whether any assistance was required, to which the PIC replied in negative.
- During taxi-in, the Co-pilot enquired from SCC about the condition of the passengers, to which SCC replied that the check was carried till mid row only during the descent. If required she will go and check it now which was refused by the PIC as the aircraft was about to be parked.
- Post parking at bay the PIC debriefed the issues to AME.

2.4 Maintenance actions

2.4.1 The AMEs replaced the OFV based on the fault message (OFV LRU FAIL). The complete BITE check was not undertaken as per the procedure laid down in FIM before replacing OFV. Post replacement of OFV, BITE check and Pressurization check of aircraft was undertaken and no leak of pressure was observed from the aircraft.

2.4.2 As per record of on job training submitted to Investigation Team by SpiceJet with respect AME (B1), it is evident that B1 was authorised to the task undertaken. However, during OJT, he had not performed replacement of OFV of pressurization system, since a candidate has an option to complete at least 50% of tasks for each ATA chapter for OJT completion as per DGCA approved syllabus. Whereas this activity was covered in the approved syllabus of OJT.

2.4.3 As per record of on job training submitted to Investigation Team by SpiceJet with respect AME

(B2), it is evident that AME (B2) was authorised to undertaken task related to BITE test. However, he had not performed replacement of OFV of pressurization system during OJT as it not was covered in the approved syllabus of OJT for AME (B2).

2.4.4 From the history of outflow valve removals from April 2021 to Nov 2021 on different aircraft of SpiceJet, it is evident that in all the 07 cases outflow valve have been removed/replaced due to auto fail light coming on.

2.4.5 It has been analyzed with help of PDR that from Jan 2021 to Aug 2022, a total of 661 PDR had been reported on snag related to air conditioning and pressurization system. This reflects poor maintenance standards being followed by the operator. Further, Investigation Team observed that frequent swapping of components is being resorted to, by the operator to undertake defect rectification which is not a healthy maintenance practice.

2.5 Crew Resource Management

2.5.1 It is well established that scores of past airline accidents and incidents have been associated with pilots' lack of adherence to proper checklist procedures. One of the important reasons for adherence to good CRM practices is to ensure checklist discipline and to make effective use of existing resources to improve safety of flight, by using the "team" approach to overcome inherent human errors. If one of two pilots in a cockpit displays less-than-optimal discipline in performing checklists, the team is not as effective in dealing with non-normal situations. Good CRM would have enabled a two-pilot crew to function as a team in order to avoid inadvertent omissions, to rectify them as soon as possible, and to effectively and swiftly manage non-normal situations**.**

2.5.2 The Investigation Team examined the Crew Resource Management issues related to the sequence of events of flight SG-391 in order to understand the underlying reasons for the serious incident.

2.5.3 According to training records, the PIC and Co-pilot had received CRM training in Apr 2021 and July 2021, respectively. Records also showed that all the cabin attendants had received CRM training in year 2021. The circumstances of the serious incident as discussed in paragraphs that follow, indicate a breakdown in crew coordination and inadequate CRM that did not mitigate individual errors made at several stages of the emergency situation.

2.5.4 During the emergency descent the SSC was called by the PIC to the cockpit, the SSC was without portable oxygen bottle when she entered the cockpit. The pressurization failed at altitude 34249 ft. (baro) at 04:34:33 UTC and cabin altitude warning came on at altitude 28207ft (baro) at 04:37:08 UTC. The cabin crew don the mask after cabin altitude warning came on. The PIC & Co-pilot failed to advice the SCC to use the portable oxygen cylinder.

2.5.5 The cabin crew did not insist upon the PIC to allow them for a quick check of passenger condition and donning of mask by them after they were told to occupy their seat during emergency descent, which is required to be undertaken post decompression checks as per NNC. The cabin crew were not at all allowed by the PIC to review the health condition of the passengers till the flight landed which was required as per safety emergency procedure. The shows lack of situational awareness.

2.5.6 As per memory check list, during operation of OFV in manual mode, the crew is supposed to

check the position of outflow valve in case the cabin rate of climb is rising. However, input of Co-pilot requesting to close the outflow valve was not clearly monitored by the PIC and he advised the Co-pilot to open it. When the Co-pilot flicked it open, the cabin rate of climb increased further, which aggravated the situation, when PIC moved the out flow valve to fully open position leading to complete depressurization of aircraft. The Co-pilot also did not advice the PIC to close the out flow valve which was suggested initially during the beginning of the emergency handling.

2.5.7 The aircraft got into non normal situation after 25 seconds from the time the aircraft started descent from FL350, for which both the crew failed to address emergency action by not maintaining the sequence of NNC, leading to selection of manual pressurization control before increasing thrust of the engines to ensure sufficient air supply to pressurization system while carrying out the descent approach and landing check list as defined in climb of cabin altitude warning and rapid depressurization NNC. The thrust was increased only after 63 seconds of auto fail light coming on by the crew as indicated in the DFDR report.

2.5.8 The crew did not inform the passenger and cabin crew about the aircraft pressurization emergency and initiated emergency descent and lost crucial time to be given to the cabin crew to check the condition of the passengers, use of mask and any other physical condition even after aircraft reached safe altitude.

2.5.9 The cabin altitude warning came on above 10000 Ft of cabin altitude, at this stage as per standard operative procedure both the PIC and Co-pilot are supposed to don the oxygen mask, however PIC delayed donning of mask for almost 3 to 4 minutes, which probably led to momentary incapacitation (Hypoxia) for 60 to 90 seconds during the flight (which was also confirmed during CVR analysis and from statement of the crew). The Co-pilot did not impress immediate donning of mask by the PIC at critical stage of flight which could have resulted in serious consequences.

2.6 Pilot training on pressurization system in manual mode before and after subject serious incident

2.6.1 The Investigation Team visited the training facility of SpiceJet where crew undergoes IR, PPC, Refresher, skill test training and other trainings. Investigation Team observed that training in controlling of pressurization in non-normal situation of auto fail/ALTN Fail /Manual mode is being provided to the Flight Crew. However, it was found that not much emphasis was being given during training on the detailed procedure of manipulation of OFV opening and closing to maintain the desired cabin altitude as per the aircraft altitude as redundancies are available in case of failure of normal mode of operation.

2.6.2 On April 13 2020, Boeing issued Flight Operations Technical Bulletin (19-01 R1) on Cabin Altitude Indications in Over-Pressure Situation, High Cabin Rate of Climb Indications and Manual Pressurization Control, which found not complied in the crew training. However, this Flight Operations Technical Bulletin was issued to provide information to the flight crew of abnormal cabin pressure indications and techniques for manual pressure control as well as updated information on the electrical control of the outflow valve. This bulletin was not made part of any operational document issued by operator as on date of serious incident. However, it was circulated for information to all the crew through electronic media.

2.6.3 Post serious incident SpiceJet has issued two new training circulars with special emphasis on

control of aircraft pressurization system in manual mode.

S. No	Date	Subject	Nature
SEJ-OPS-05-TC-B TC 05/22	05 Dec 2022	Management of non-normal situations	Mandatory
SEJ-OPS-05-TC-B TC 03/2022	29 Mar 2022	Improving pilot performance feedback cycle 1	Informatory

SpiceJet has included the Boeing FOTB 19-01 R1 (Flight Operations Technical Bulletin) dated 13/04/2020 in their training circular SEJ-OPS-05-TC-B, TC 05/22 dated 05 Dec 2022. Now training is being imparted as per this circular.

3. CONCLUSION

3.1 Finding

3.1.1 Flight Crew

1. The flight crew were licensed and qualified for the flight in accordance with applicable regulations.
2. The flight crew held valid medical certificates and were medically fit to operate the flight.
3. The flight crew were adequately rested and their flight and duty times were in compliance with DGCA and Operator requirements.
4. After the cruise phase aircraft started descending from FL 350, the Master Caution come on for 08 second at altitude of 34292 Ft along with auto fail light of pressurization system. The crew failed to manipulate the position of outflow valve in manual mode to maintain the cabin pressure/cabin altitude as per cabin requirement mentioned on cabin pressure control module(P5).
5. The Co-pilot had don the mask as per SOP and advised PIC to wear the oxygen mask. However, the PIC delayed the donning of mask by 3 to 4 minutes, which probably lead to momentary incapacitation (Hypoxia) of PIC for 60-90 seconds.
6. PIC after opening the outflow valve manually never made an attempt to close the outflow valve to maintain the cabin pressure, which lead to complete depressurization of aircraft. The PIC also did not adhere to the caution given in FCOM .The serious incident could have been prevented if manual operation of the OFV would have been conducted according to SOP in place.
7. The PIC failed to deploy the QDM (Quick Deployment Mask) in first attempt as soon as the cabin altitude warning came on.
8. After the cabin altitude warning came on, the flight crew did not inform the cabin crew about the problem with pressurization system, which lead to chaos in passenger cabin and lack of situational awareness among the crew members.
9. PIC did not follow seat oriented actions as per non normal procedure given in B737 FCOM and declared MAYDAY. Thereafter, he asked for Emergency Descent Checklist without carrying out memory actions of Emergency Descent NNC. The handling of emergency was not as per laid down SOP.
10. The PIC declared the MAYDAY call and cancelled it later during final approach without knowing the

conditions of passenger in the cabin. This shows lack of situational awareness.

11. Even after landing when ATC enquired about any assistance required from the aircraft, PIC responded in negative, which showed lack of situational awareness. The passengers had reported ear pain, headache, and dizziness and discomfort due to rapid descent of the aircraft.
12. The PIC did not announce emergency descent on PA system as per NNC and during emergency descent directed the SSC to enter in cockpit to inform about the same.
13. Cabin crew were not given sufficient time to conduct post depressurization check/duties in the cabin and to know about their well-being as the landing was expedited by the flight crew.
14. Sequence of NNC was not maintained and hence the descent, approach and landing check list were carried out as per the deferred items of cabin altitude warning or rapid depressurization.

3.1.2 Ground Engineers

1. The component replacement by the B1 AME was under taken based on fault message displayed in existing fault history and no BITE check was performed to identify the root cause of failure of outflow valve in Auto/ALTN mode. The complete BITE check could have identified the fault code through which the root cause of failure of out flow valve could have been established.
2. B2 AME deployed for fault isolation was authorized to undertake task. However, he had never undertaken the replacement outflow valve before subject serious incident. The procedure followed by AME for fault isolation was not as per laid down procedure in FIM 21-31 task 801.

3.1.3 Operator

1. On April 13, 2020 Boeing issued Flight Operations Technical Bulletin (19-01 R1) on Cabin Altitude Indications in Over-Pressure Situation, High Cabin Rate of Climb Indications and Manual Pressurization Control. The advisory circular issued by Boeing was not incorporated in the training circular prior to the date of incident. However, it was circulated for information to all the crew through electronic media after the serious incident.
2. The training imparted to the crew on manual control of operation of aircraft pressurization system prior to the date of serious incident was not elaborate, as this was second back up system after failure of pressurisation control both in AUTO and ALTN mode. Hence, the crew were not familiar with the manual manipulating of OFV (opening and closing) to maintain the desired aircraft altitude VS cabin altitude and cabin differential pressure.
3. During questioning of B2 AME it was evident that B2 AME deployed for fault isolation and component change had never replaced outflow valve before subject incident and B1 AME was not having sufficient experience of fault isolation and BITE check with respect to pressurisation system snag analysis. The AME did not follow the complete procedure as laid down in FIM 21-31 task card 801 before changing the out-flow valve.

3.1.4 Cabin Crew

1. The cabin crew members were trained and qualified in accordance with existing regulations.
2. The cabin crew members were adequately rested and their duty times were in accordance with

existing regulations.

3. The cabin crew did not play a proactive role in communicating with flight crew about the condition of passengers during emergency and performing post decompression duties.
4. The SCC was without portable oxygen bottle when called by PIC to the flight deck, which is a violation of SOP.

3.1.5 Aircraft

1. The aircraft held a valid Certificate of Airworthiness.
2. The mass and center of gravity (CG) of the aircraft were within prescribed limits.
3. Scrutiny of the tech log pages revealed that no similar snag was reported recently on this aircraft prior to the date of serious incident.
4. From the scrutiny of maintenance record of pressurization system and Cabin high rate of descent occurrence it is evident that frequent swapping of components for fault isolation /snag rectification is being practiced by operator. Swapping is not considered a good maintenance practice from the system reliability point of view.
5. The strip examination report of the OFV from OEM indicated that some components of OFV were found damaged and worn out. These damages were considered to be normal wear and tear for OFV with +15 year of service but contributed in malfunction of OFV in auto mode operation. However, manual operation of OFV was still possible.
6. All the aspects of Auto Fail/ ALTN failure light were analysed including reasons given at para 1.6.2 and it is opined that auto fail light came on probably due to outflow valve malfunctioning in Auto Mode. This is further evident from OFV LRU FAIL message during system test and the fact that after change of OFV, the aircraft has flown over 2000 hrs. without snag being repeated.

3.1.6 Maintenance

1. As high as 661 PDRs related to air conditioning and pressurization have been recorded from Jan 2021 to Aug 2022 which reflects about maintenance standards being followed in the organization.
2. In most of the cases (including this incident) various snag (like auto fail, ROCI fluctuation, cabin attitude warning, etc.) related to pressurization have been rectified by replacement/swapping of out flow valves which is not a healthy maintenance practice.

3.1.7 ATC

1. The MAYDAY call was handled by ATC as per the laid down procedures

3.2 Probable Cause of the Serious Incident

3.2.1 Direct Cause

The PIC did not adhere to the standard operating procedure to maintain cabin pressure during AUTO/ALT FAIL condition due to inadequate knowledge in handling of pressurization system in manual mode.

3.2.2 Latent cause(s)

1. Inadequate application of Crew Resource Management (CRM) principles by the flight crew.
2. Inadequacy of training in handling pressurization control and control of outflow valve in manual mode.

4. SAFETY RECOMMENDATIONS

It is recommended that

4.1 SpiceJet shall reiterate the procedure for handling the pressurization failure/emergency decompression in detail during the training given to the pilots, which includes identification of the fault, knowledge of the system, etc.

4.2 SpiceJet shall review the CRM training being imparted to all crew (including cabin crew) to ensure that the crew follows seat-oriented actions and there is proper co-ordination between the cockpit crew and cabin crew in emergency situations such as these.

4.3 SpiceJet should develop a procedure to ensure that the authorized engineering personnel deputed for the maintenance task have undertaken similar maintenance task in the past.

4.4 SpiceJet should evaluate their maintenance practices to ensure that the maintenance tasks are carried out as per the laid down standards. The practice of swapping of components between airplanes for the purpose of trouble shooting should be strictly avoided.

(Rajendra Pratap Singh)
Investigator-in-Charge

(Ajendra Singh)
Investigator

Date: 21 June 2023
Place: New Delhi

Appendix

Teardown report of OFV from shop

TEARDOWN REPORT

Nord Micro GmbH & Co. OHG
GmbH & Co. OHG
D-60388 FRANKFURT

UTC Aerospace Systems

Customer	TURKISH AIRLINES TECHNIC, INC. MAINTENANCE CENTER	**Cust PO**	16153191		
Input Part	21230-03AC	**Input Serial**	07101936	**Qty**	1.000
Output Part	21230-03AC	**Output Serial**	07101936	**Workscope**	MAJ REPAIR
Cust Part		**Cust Serial**	07101936	**Status/Work**	REPAIRED
Description	OUTFLOW VALVE	**Removal Code**	IRAN	**Failure Date**	17.11.2021
Aircraft	B737 NG	**Engine Type**	CPC VLV Outflow Valve		
Incoming NSN	N/A	**Outgoing NSN**	N/A	**Tail No**	VT-SYZ
Date Rec'd	24.02.2022	**Quote Date**	09.03.2022	**Accept Date**	15.03.2022
Ship Date		**DOM**	01.01.2007	**Last Order Date**	
Sales Order	9057048	**Work Order**	44754578	**Notification**	304582690

Technical Documents :

CMM: CMM 21-33-33 Revision: 10 Rev. Date: 25.09.2013

Customer Reason for Return

FAULTY

FAULTY

Certification Type

EASA/FAA

Customer comments

POS: N/A

Conditions

dirty

Bonding cable damaged, Anti-slip foil on the AFT-Gate missing, Rod Ends knocked out,

Preliminary Inspection

Fail

Poti synchronism test fail
open 4,40V / 115°

Configuration IN

Ebox 1	20995-03AC	0668389
Ebox 2	20995-03AC	0668390
Motor 1	20781-02	0659755
Motor 2	20781-02	0659746

Nord Micro GmbH & Co. OHG
GmbH & Co. OHG
D-60388 FRANKFURT

TEARDOWN REPORT

UTC Aerospace Systems

Work Order	44754578	**Description**	OUTFLOW VALVE	**Date Rec'd**	24.02.2022
Input Part	21230-03AC	**Input Serial**	07101936		
Cust Part		**Cust Serial**	07101936		

GBA	21029-02	0652641
Mmot	20784-01	0775576
Poti	20973-02	06114223
OFV Assy	20208-01	0710706

Configuration OUT

Ebox 1	20995-03AC	0668389
Ebox 2	20995-03AC	0668390
Motor 1	20781-02	2159379
Motor 2	20781-02	0659746
GBA	21029-02	0652641
Mmot	20784-01	0775576
Poti	20973-02	21114439
OFV Assy	20208-01	0710706

Work Performed

Gearbox cleaning required.
-Gearbox cleaned.
Gearbox functional incoming test > failed.
-Potentiometer out of tolerance.
--Potentiometer replaced.
Gearbox opened and inspected > not o.k.
-Found defective bearings.
--Bearings replaced.
Gearbox acceptance test following CMM > passed.
E-Box 1+2 functional incoming test > passed.
E-Box 1+2 bonding and isolation test > passed.
E-Box 1+2 acceptance test following CMM > passed.
OFV cleaning required.
-OFV cleaned.
OFV final mounting.
-Antiskating foils are damaged/missing.
--Antiskating foils replaced.
-Teflonseal from FWD-Gate is bent.
--Teflonseal replaced.
-Rod Ends are sluggish/stuck.
--Rod Ends replaced.
-Initial tension and clearance of the gates adjusted and lockwires
-renewed.
-Aumot 1 brake function is defective.
--Aumot 1 renewed.
-Bonding cables are worn out.
--Bonding cables replaced.
Leakage and pressure test > passed.
Load test on both systems > passed.
OFV acceptance test following CMM > passed.

Test Results

Acceptance Test following CMM > passed.

Nord Micro GmbH & Co. OHG
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D-60388 FRANKFURT

TEARDOWN REPORT

UTC Aerospace Systems

Work Order	44754578	**Description**	OUTFLOW VALVE	**Date Rec'd**	24.02.2022
Input Part	21230-03AC	**Input Serial**	07101936		
Cust Part		**Cust Serial**	07101936		

Inspection/ QA Acceptance
Final Inspection Certifying Staff.

Components :

Order	Material	Description	Req Qty	Issued	Reason Code	Stor Loc
44754578	3010-15978-1	SCREW	1	1	Discard	POUO
44754578	3022-15987-1	NUT	1	1	Discard	POUO
44754578	3022-16085-4	NUT	3	3	Discard	POUO
44754578	3023-14490-8	WASHER	2	2	Discard	POUO
44754578	3023-15973-2	WASHER	2	2	Discard	POUO
44754578	3023-15981-1	WASHER	6	6	Discard	POUO
44754578	3031-15991-1	PIN	1	1	Discard	POUO
44754578	4032-15986-2	ROD,END,RH	2	2	Replacement	POUO
44754578	4032-15986-1	ROD,END,LH	2	2	Replacement	POUO
44754578	5916-15994-1	Jumper cable	2	2	Replacement	POUO
44754578	21990-02	antiskating foil	1	1	Replacement	POUO
44754578	3020-15970-2	NUT, RH	2	2	Replacement	POUO
44754578	3020-15970-1	NUT, LH	2	2	Replacement	POUO
44754578	3010-15969-1	SCREW	8	8	Replacement	POUO
44754578	3023-15972-11	WASHER	4	4	Replacement	POUO
44754578	3015-15935-2	PIN, SCREW	2	2	Replacement	POUO
44754578	3030-16315	BOLT,HEADED	4	4	Replacement	POUO
44754578	3023-15981-1	WASHER	12	10	Replacement	POUO
44754578	3023-15973-1	WASHER	30	30	Replacement	POUO
44754578	3031-15991-1	PIN	8	8	Replacement	POUO
44754578	3023-15973-2	WASHER	16	16	Replacement	POUO
44754578	3022-15987-1	NUT	4	4	Replacement	POUO
44754578	21989-01	FOIL,ANTISKATING,EDGE	1	1	Replacement	POUO
44754578	3022-15987-1	NUT	1	1	Replacement	POUO
44754578	3031-15991-1	PIN	1	1	Replacement	POUO
44754578	20781-02	Motor, auto	1	1	Replacement	TOPH
44754578	3130-17712-3	STRAP,CABLE	1	1	Replacement	POUO

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TEARDOWN REPORT

UTC Aerospace Systems

Work Order	44754578	**Description**	OUTFLOW VALVE	**Date Rec'd**	24.02.2022
Input Part	21230-03AC	**Input Serial**	07101936		
Cust Part		**Cust Serial**	07101936		

44754578	3130-17712-1	STRAP, CABLE	1	1	Replacement	POUO
44754578	5922-14527-4	TUBE	1000	1000	Exchange	POUO
44754578	3210-20602-01	LABEL, ID	1	1		POUE
44757324	21817-01	CAP,PROTECTION,WARN-KIT	1	1	Replacement	POUE
44757322	21817-01	CAP,PROTECTION,WARN-KIT	1	1	Replacement	POUE
44757325	20973-02	ASSY,POTENTIOMETER AND CABLE	1	1	Replacement	TOPH
44757325	3031-15991-3	PIN,COTTER	3	3	Discard	POUO
44757325	3015-15935-3	SCREW,SET	1	1	Discard	POUO
44757325	23231-01	RING,SEAL,SHAFT,RADIAL	1	1	Discard	POUO
44757325	3130-17712-1	STRAP, CABLE	3	3	Discard	POUO
44757325	3130-17712-3	STRAP,CABLE	1	1	Discard	POUO
44757325	3023-17482-2	SHIM,LAMINATED	1	1	Replacement	POUO
44757325	3155-17508-1	BEARING,NEEDLE	1	1	Replacement	POUO
44757325	3155-17513-1	WASHER,THRUST	2	2	Replacement	POUO
44757325	21558-01	LABEL,IDENTIFICATION	1	1	Replacement	POUE
44757325	3155-17509-1	BEARING,NEEDLE	3	3	Replacement	POUO
44757325	20686-01	LABEL,AMEND	1	1	Replacement	POUE
44757325	3031-15991-4	cotter pin	1	1	Replacement	POUO