PRELIMINARY SERIOUS INCIDENT REPORT

Accident and Incident Investigations Division

Serious Incident
- Preliminary Report -
AIID Ref No: CA18/3/2/1336

Figure 1: The ZS-SJF aircraft. (Source: https://www.jetphotos.com)

Description:

On 25 January 2021, a Boeing 737-800 aircraft with registration ZS-SJF operated by Mango Airlines departed O.R. Tambo International Airport (FAOR) on a scheduled flight to King Shaka International Airport (FALE). On-board the aircraft were eight crew (two pilots and six cabin crew) members and 117 passengers. Before take-off, pressurisation and air-conditioning system switches were set in accordance with (IAW) pre-take-off checks. The aircraft climbed and levelled off at flight level (FL) 350. During descent to FALE and after passing FL270 at 1232Z, a “Cabin Altitude” warning light illuminated, followed by an aural warning. The crew declared an emergency by broadcasting a MAYDAY call to the area controller who had the aircraft on primary surveillance radar. The crew promptly donned their oxygen masks and manually deployed the passengers’ oxygen masks. The captain called for Cabin Alt warning checks as stipulated in the aircraft’s Quick Reference Handbook (QRH). The aircraft levelled off at FL090 and a normal landing was carried out on Runway 24 at FALE.

Reference Number	**:** CA18/3/2/1336
Name of Owner/Operator	**:** Mango Airlines SOC (Ltd)
Manufacturer	**:** Boeing Aircraft Cooperation
Model	**:** Boeing 737-800
Nationality	**:** South African
Registration Marks	**:** ZS-SJF
Place	**:** In-flight
Date	**:** 25 January 2021
Time	**:** 1232Z

Purpose of the Investigation:

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to apportion blame or liability**.*

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Investigations process:

The Accident and Incident Investigations Division (AIID) was notified of an in-flight cabin decompression serious incident involving a Boeing 737-800 aircraft with registration ZS-SJF, which occurred en route to King Shaka International Airport (FALE) from O.R. Tambo International Airport (FAOR) on 25 January 2021. The serious incident was reported to the AIID on 25 January 2021.

The AIID has appointed an investigator-in-charge (IIC). Notifications were sent to the State of Registry, State of Operator, and State of Manufacture and Design. The information contained in this preliminary report is derived from the initial factual information gathered by the investigating team during the on-site investigation.

The AIID reports are made available to the public at:

http://www.caa.co.za/Pages/Accidents%20and%20Incidents/Aircraft-accident-reports.aspx

Notes:

1. Whenever the following words are mentioned in this report, they shall mean the following:

- Incident – this investigated serious incident
- Aircraft – Boeing 737-800 involved in this serious incident
- Investigation – the investigation into the circumstances of this serious incident
- Pilot – the pilot involved in this serious incident
- Report – this serious incident report

2. Photos and figures used in this report were obtained from different sources and may be adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or the addition of text boxes, arrows or lines.

Disclaimer:

This report is produced without prejudice to the rights of the AIID, which are reserved

ABBREVIATION	DESCRIPTION
AIP	Aeronautical Information Publication
APU	Auxiliary Power Unit
ASU	Air Start Unit
AOC	Air Operating Certificate
AMO	Aircraft Maintenance Organisation
ARFF	Aircraft Rescue and Fire-Fighting
ASI	Air Speed Indicator
AMSL	Above Mean Sea Level
ATPL	Airline Transport Pilot Licence
AIMS	Aircraft Information Management System
AD	Advisory Circular
AME	Aircraft Maintenance Engineer
AOC	Air Operating Certificate
ATO	Aviation Training Organisation
ATC	Air Traffic Controller
CPC	Cabin Pressure Controllers
CAR	Civil Aviation Regulations
CVR	Cockpit Voice Recorder
DCPCS	Digital Cabin Pressurisation System
FAA	Federal Aviation Administration
FALE	King Shaka International Airport
FAOR	O.R. Tambo International Airport
FO	First Officer
FL	Flight Level
FMC	Flight Management System
FDR	Flight Data Recorder
IWA	In Accordance With
IFR	Instrument Flight Rules
MEL	Minimum Equipment List
MCP	Mode Control Panel
NTSB	National Transportation Safety Board
NM	Nautical Mile
OFV	Outflow Valve
PF	Pilot Flying
PM	Pilot Monitoring
PSI	Pressure Square Inch
PSU	Passenger Service Unit
QRH	Quick Reference Handbook
SACAA	South African Civil Aviation Authority
SCCM	Senior Cabin Crew Member
SAAT	South African Airways Technical
TL	Technical Logbook
TUC	Time of Useful Consciousness
TGV	Tango, Golf, Victor
TUC	Time of Useful Consciousness
VNAV	Vertical Navigation
VOR	Omni Directional Range

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On 25 January 2021, the crew (pilots) reported for duty at O.R. Tambo International Airport (FAOR) terminal in preparation for flight JE251 on a Boeing 737-800 aircraft with registration ZS-SJF, operated by Mango Airlines. The aircraft was scheduled for a flight to King Shaka International Airport (FALE) at 0925Z. The aircraft was operated under Instrument Flight Rules (IFR) and the flight plan was filed with Johannesburg briefing. The crew (before the flight preparation) were joined in their briefing in the aircraft by the operator’s technical representative, who was a licensed Aircraft Maintenance Engineer (AME). The AME was on standby to assist the crew using his headset during the engine start-up process. The crew, during the technical logbooks (TL) examination, noticed that the aircraft had two snags that were differed as per the minimum equipment list (MEL). The differed snags were the auxiliary power unit (APU) which was inoperative, and the No. 1 engine nose cowl anti-ice valve which was defective.

1.1.2 The aircraft was, therefore, delayed for about 32 minutes. The crew briefed on the differed snags and the aircraft was to be dispatched in accordance with (IAW) MEL 30-03-03B. The captain, after examining the aircraft’s TL, decided that he would be the pilot monitoring (PM) and the first officer (FO), the pilot flying (PF). Meanwhile, the six cabin crew members prepared the aircraft for a total of 117 passengers. The captain, after finishing examining the logbooks, walked out of the aircraft using the stairs to perform a walkaround pre-flight inspection and, later, the preparation in the cockpit. The preparation included programming the flight management computer (FMC) and setting up the mode control panel (MCP) for the expected departure routing. The captain then communicated with air traffic control (ATC) to find out the runway in use and the weather conditions. Using the passenger and baggage figures from the ground handling company and the weather information from the control tower, the captain completed weight and balance, as well as performance calculations before the information was captured in the FMC.

1.1.3 The crew then completed taxi and take-off briefing, covering items such as taxi and departure routing, including a discussion on the handling of emergencies during take-off. Once the passengers had boarded the aircraft and final preparations were completed, doors were closed and armed. Normal communication between the AME and the captain took place, followed by clearance from ATC to start the engines. A systematic engine start was done using bleed air from the air start unit (ASU). A tow bar was connected to the nose gear and the aircraft was pushed to the taxiway using a tug. Thereafter, a tow bar was disconnected, and the nose gear steering bypass pin was connected. As part of the pre-flight checks, the air-conditioning packs were switched to AUTO position. The cabin pressurisation was configured with the cruise altitude (FL350) and destination airport altitude (304 feet above mean sea level) was set. The pressurisation mode selector was set to AUTO for normal operation. The captain informed the AME (via headsets) that they were ready to taxi.

1.1.4 The AME disconnected his headset and waited on the left-side of the aircraft where he subsequently received a thumbs up. The aircraft was taxied to the holding point for Runway 03L departure. At that time, the cabin crew carried out the safety briefing and demonstration to the passengers in the aircraft. Passengers in the seats next to the over-wing emergency exits were given a short briefing on their role in the event of an emergency and were asked to study the information in the safety briefing card. In the cockpit, the PF advanced the thrust levers forward and stabilised the engines at 95% N1. Take-off roll was normal with moderate weather conditions prevailing; the aircraft rotated without incident. The aircraft climbed and levelled off at FL350. The aircraft standard cabin pressure was normal. During the descent phase to FALE at 1232Z and after passing FL270, the "Cabin Altitude" rapid decompression warning light illuminated followed by an aural warning. The captain then took over control of the aircraft. The crew promptly donned their oxygen masks and manually deployed the passengers' oxygen masks.

Figures 2 & 3: An illustration of a B737 aircraft animation snap shot showing the illuminated "Cabin Altitude" warning and the Cabin Altitude at 10000 feet (left); and a picture of ZS-SJF aircraft showing the deployed oxygen masks (right).

1.1.5 The captain made an announcement via an intercom to confirm with cabin crew whether the masks had dropped. The senior cabin crew member (SCCM) reported that some oxygen masks did not drop, and they had to move some passengers to the seats where the masks had dropped. The crew declared an emergency by broadcasting a MAYDAY to the area controller who had the aircraft on primary surveillance radar; FALE Aircraft Rescue and Fire-Fighting (ARFF) team was put on standby. The captain called for the "Cabin Altitude Warning" emergency descent checklist as stipulated in the Quick Reference Handbook (QRH). Passengers were instructed to remain calm and seated. The crew continued with the descent at a maximum airspeed of 330 knots to FL110 and then to 7000ft. After passing FL100, the crew reduced the airspeed to 250 knots before removing the oxygen masks. Once below 10000ft, the captain reduced the airspeed again and reviewed the situation. The captain made a request to ATC to hold at LE2T1 at 3000ft. The crew reviewed the cabin altitude warning and emergency descent procedures and checked the pressurisation panel to see if they could manually control pressurisation, but this was not possible. The captain called the SCCM to the cockpit through an intercom system and, after having established the wellbeing of the passengers and cabin crew members, explained the nature of the problem at hand, his intentions, and that there were no special requirements. The SCCM relayed the information to the rest of the cabin crew. The captain later briefed the passengers about the nature of the problem and requested them to remain calm on their seats. The aircraft made a straight-in-approach and a normal landing was carried out on Runway 24 at FALE. After exiting the active runway, the aircraft was brought to a stop so that the ARFF personnel could inspect the aircraft from the outside. No structural damage was reported by ARFF. The captain, for the second time, briefed the passengers before taxiing the aircraft to parking stand A16.

1.1.6 After parking and shutting down the engine, the SCCM made an announcement to the passengers and asked them if they needed medical assistance. An adult female passenger reported that her child could not hear properly, and the matter was handed over to the ramp agent. Most of the passengers were happy that they were able to use the oxygen masks without difficulty as they had watched the pre-take-off video explaining how to use them. The SCCM stated that apologies were made to the passengers, and that most of them were happy that they were safe and had expressed their gratitude to the crew. All passengers disembarked using the forward entry door. During a post-flight visual inspection by the operator’s engineers, no structural damage was noticed on the aircraft. Most of the oxygen masks in the cabin had dropped when the crew deployed them, and all of their oxygen generators had activated. The aircraft was grounded for further engineering investigation. The flight was conducted under the provisions of Part 121 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.7 The serious incident occurred during a descent en route to FALE, approximately 70 nautical miles (nm) north of Tango, Golf, Victor (TGV) - very high frequency omni directional range (VOR) beacon.

1.2. Injuries to Persons

Injuries	Pilot	Cabin crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	2	6	117	125	-
Total	2	6	117	125	-

1.3. Damage to Aircraft

1.3.1 The aircraft sustained no damage during the serious incident.

1.4. Other Damage

1.4.1 None.

1.5. Personnel Information

Captain (Pilot-in-command):

Nationality	South African	Gender	Male	Age	50
Licence Number	0272448499	Licence Type	Airline Transport Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument and Grade II Flight Instructor				
Medical Issue Date	5 October 2020				
Medical Expiry Date	31 October 2021				
Restrictions	Nil				
Previous Accidents	None				

Flying Experience of the Captain:

Total Hours	11 261.4
Total Past 90 Days	103.2
Total on Type Past 90 Days	103.2
Total on Type	1 841.2

*NOTE: The hours shown above were obtained from the pilot's questionnaire. Scrutiny into the captain's records kept at the South African Civil Aviation Authority (SACAA) showed that he had a Boeing 737-800 aircraft endorsed on his licence. His last proficiency check on B737-800 was provided by Mango Airlines Aviation Training Organisation (ATO) No. CAA/0307 on 26 and 27 October 2020 and the candidate was assessed as competent in all aspects. The Boeing 737-800 pilot proficiency check has a validity date until 30 April 2021. His previous experience included a Boeing 737-100/200/300/900 series, Boeing 777-200, Beechcraft Baron 55/58, Cessna Caravan C206/C208, Pilatus PC-12 Eagle/Spectre, Piper single/multi-engine series aircraft and varied operations, including charter and instructional flights.

First Officer (FO):

Nationality	South African	Gender	Male	Age	26
Licence Number	0271012940	Licence Type	Airline Transport Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instruments and Grade II Flight Instructor				
Medical Issue Date	7 October 2020				
Medical Expiry Date	31 October 2021				
Restrictions	Nil				
Previous Accidents	None				

Flying Experience of the First Officer:

Total Hours	3 362.5
Total Past 90 Days	77.2
Total on Type Past 90 Days	64.9
Total on Type	724.1

*NOTE: The hours shown above were obtained from the pilot's questionnaire. Scrutiny into the FO's records kept at the South African Civil Aviation Authority (SACAA) showed that he had a Boeing 737-800 aircraft endorsed on his licence. His last proficiency check on B737-800 was provided by Mango Airlines, ATO No. CAA/0307 on 15 July 2020 and the candidate was assessed as competent in all aspects. The Boeing 737-800 pilot proficiency check had a validity date until 30 January 2021. His previous experience included a Boeing 737 300-900 series, Beechcraft Super King Air B200/300, Cessna Caravan C206/C208, Cessna single reciprocating-engine aircraft and varied operations, including instructional flights.

1.6 Aircraft Information

1.6.1 Aircraft description:

The Boeing 737-800 is a low-wing, narrow body, single-aisle jet transport aircraft powered by two high bypass CFM56-7B26 turbofan engines. The aircraft is designed to operate with two pilots and six cabin crew. The aircraft was configured with 186 economy class seats.

Airframe:

Type	Boeing 737-800	
Serial number	30006	
Manufacturer	Boeing Aircraft Corporation	
Year of manufacture	2000	
Total airframe hours at the time of Incident	49930.41	
Last scheduled A-check inspection (Hours & Date)	49912.20	21 January 2021
Hours since last a-check	18,21	
Hours since the last c-check inspection	49584.47	03 December 2020
Hours since last C-check inspection	345.94	
C of A (Issue Date)	25 October 2004	
C of A (Expiry Date)	31 October 2021	
C of R (Issue Date) (Present owner)	9 October 2018	
Maximum take-off weight	79 015kg	

Maximum landing weight	66 360 kg
Airworthiness directive status	Complied With
Type of fuel recommended	Jet A1
Fuel used	Jet A1
Operating categories	Standard Part 121

Engine No.1:

Type	CFM 56-7B26
Serial number	876396
Hours since new	48 226
Maintenance concept	A-check

Engine No.2:

Type	CFM 56-7B26
Serial number	877632
Hours since new	46 714
Maintenance concept	A-check

1.6.2 Aircraft Systems Description according to the Boeing 737-600/700/800/900 Aircraft Maintenance Manual (AMM):

Description of the aircraft pressurisation system:

The aircraft is equipped with two air-conditioning packs, which are independently controlled and provide conditioned, pressurised air to the cabin. The cabin pressure is regulated by the position of the outflow valve, which allows air in the cabin to vent to atmosphere. This valve, and hence the cabin pressure, is controlled by one of two redundant Cabin Pressure Controllers (CPC) when the automatic mode is used and directly by flight crew when the manual mode is used. Each pack is provided with bleed air taken from the 5th and 9th stages of the engine compressor, with the 9th stage providing compressed air at low engine speeds and the 5th stage at high engine speeds. The high stage regulator automatically opens a valve to switch between the two sources of air. The air then passes through the pressure regulating and shut-off valve, which controls the flow of air to the pneumatic manifold (duct). An isolation valve in the duct isolates the left and right side of the duct such that in normal operation the left engine provides air to the left pack and the right engine to the right pack. A flow control and shut-off valve allows pressurised air in the duct to enter each pack. The air-conditioning packs can operate in one of two modes, 'Low' and 'High flow'.

Normally the packs are selected on auto and will operate in 'Low flow'. If one pack fails, or is selected to 'Off' position, then the remaining pack will automatically switch to 'High flow' provided the flaps are not extended. The flight crew can also switch each pack manually to 'High flow'. The pneumatic manifold runs from each engine, along the wing leading edge to the air-conditioning packs, which are located at the bottom of the fuselage, outside the pressure hull. The cabin pressurisation controller normally controls the cabin altitude rate of climb as well as the cabin altitude up to a cabin altitude (equivalent) of 8000 ft at the maximum certified aircraft ceiling of 41 000 ft. The system has both an aural and visual warning for cabin altitude rising above 10 000 ft. Above 10 000 ft, flight crew are required to use supplementary oxygen. The system will also automatically deploy passenger oxygen masks once the cabin altitude rises above 14 000 ft.

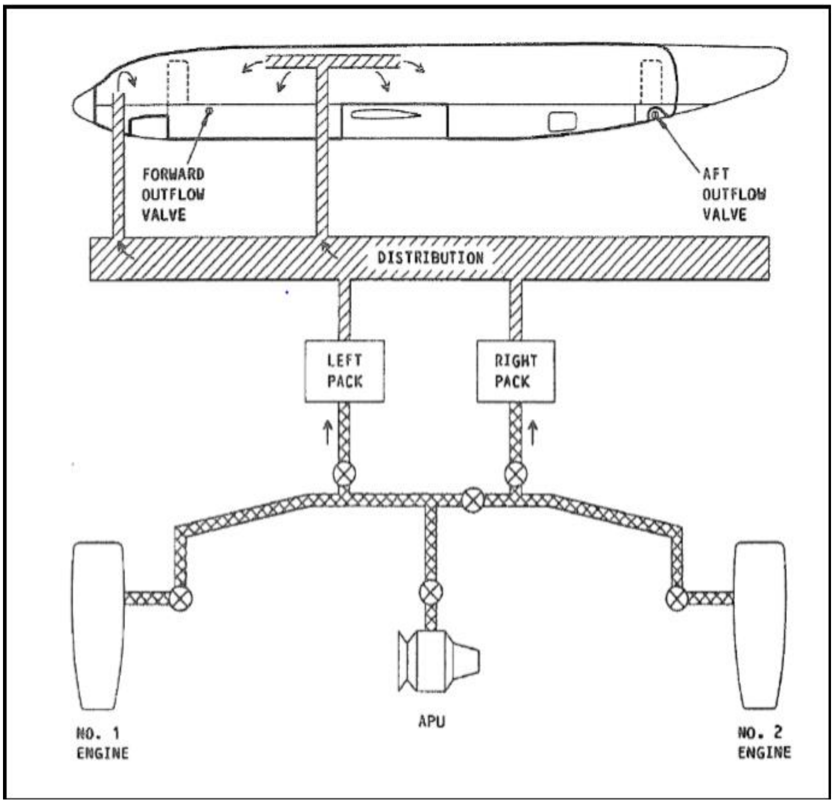


Figure 4: Schematic of Boeing 737 pressurisation system. (Source: Boeing).

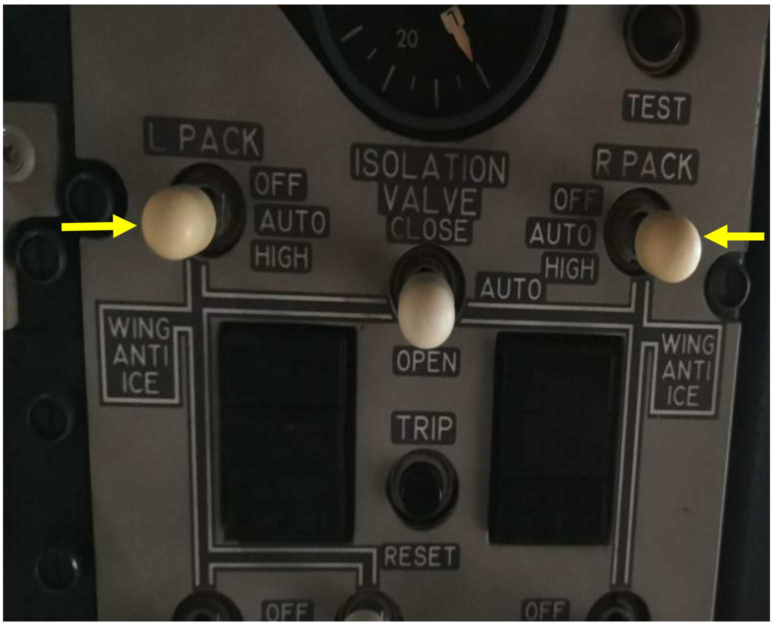


Figure 5: The aircraft pneumatic panel showing the pre-flight set position of the air-condition packs toggle switches (Bleed 1 & 2) on Auto.

1.6.3 Purpose of Pressurisation System:

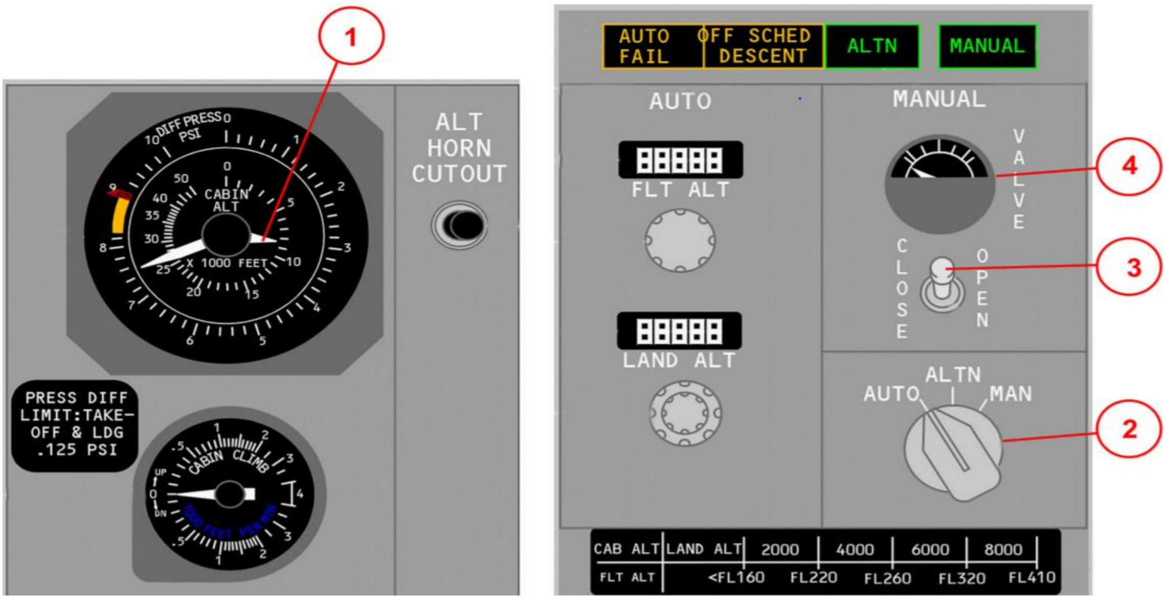
The purpose of the pressurisation system is to provide a safe comfortable cabin altitude at all aircraft altitudes. The air-conditioning system provides a constant flow of pressurised, conditioned air to the cabin. Normally, a small amount of air leaks overboard through door seals and other openings. The pressurisation system meters the amount of air exhausted from the aft outflow valve to control pressurisation to a prescribed schedule depending on the aircraft altitude, cruise altitude, and the altitude of the destination. Cabin pressurisation is controlled during all phases of aircraft operation by the digital cabin pressurisation control system (DCPCS). The system uses bleed air supplied by the engines and distributed to the air-conditioning system. Pressurisation and ventilation is controlled by modulating the outflow valve and the overboard exhaust valve.

1.6.4 A simple explanation of pressurisation system is that it regulates pressure in the aircraft by opening and closing a valve through which air is expelled from the aircraft (outflow valve). This valve can be operated automatically (AUTO and ALTN) by the system through two identical controllers or manually (MAN) by the pilot. In the cockpit, there is a pressurisation panel (Figure 7) where certain system parameters, such as cabin altitude (1 in Figure 7), can be monitored, and the system's mode of operation (manual or automatic) can be selected (2 in Figure 7). The system has two relief valves that limit the maximum differential pressure between the inside and the outside of the aircraft to prevent structural damage. In the automatic mode, the sequence of operation of the system is as follows:

- On the ground, with the aircraft stopped (stationary) and at low power, the outflow valve opens completely to depressurise the aircraft and allow the internal and external pressures to equalise.

- On the ground at high thrust (as the aircraft starts its take-off run), the system starts to pressurise the aircraft by closing the outflow valve.
- In the air, the pressure in the cabin is regulated based on preset conditions.

When the pressurisation system is operated manually, the pressure in the cockpit is regulated by the crew's direct inputs to the outflow valve using associated switch (3 in Figure 7). The switch is located on the cabin pressurisation panel located in the overhead panel. The switch only works when MAN mode is selected (2 in Figure 7). To open the outflow valve, the switch has to be flipped to the right and held until the desired altitude is reached. When the switch is released, it returns to its central position. Manual control of the system requires monitoring the cabin altitude and differential pressure readings (1 in Figure 6) and the position of the outflow valve (4 in Figure 7).



Figures 6 & 7: Pressurisation system panel with cabin altitude and differential indicator shown on the left. (Source: Boeing).

1.6.5 Outflow Valves:

Two outflow valves (OFV), one forward and one aft, are installed in the aircraft which allow the excess air flow out of the cabin. If the OFVs are closed or nearly closed, the cabin pressure will increase. If the OFVs allow air to leave the cabin faster than it enters, the cabin pressure will decrease.

1.6.6 Oxygen System:

To cater for loss in cabin pressure, the aircraft has two separate oxygen systems, one for the crew and one for the passengers. The cockpit and cabin passengers' masks were cleaned and stowed after the serious incident flight and the oxygen generators were replaced.

1.6.7 Cockpit Oxygen System:

The cockpit oxygen system uses quick donning diluter demand masks/regulators located at each crew station. Oxygen is supplied by a single cylinder which is located in the forward cargo compartment. The cylinder has a maximum capacity of 115 cubic feet of free oxygen when pressurised to 1 850 pressure per square inch (psi). Oxygen pressure is displayed on the indicator located on the overhead panel. The oxygen mask/regulator is stored in a box immediately adjacent to each crew station. To remove the mask from its stowed position, the red levers around each mask must be squeezed with the thumb and forefinger. When squeezed, the harness inflates so it can be put easily over the face to allow breathing. During the investigation, it was determined that the captain and FO's oxygen masks were full face with integral goggles fitted on it. Oxygen flow on the face mask is controlled by a regulator that is mounted on the oxygen mask. The regulator may be adjusted to supply 100% oxygen by pushing the Normal/100% selector.

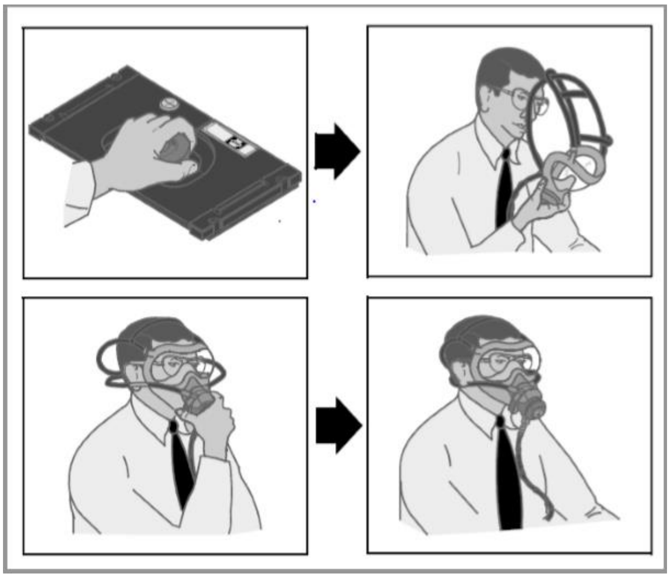
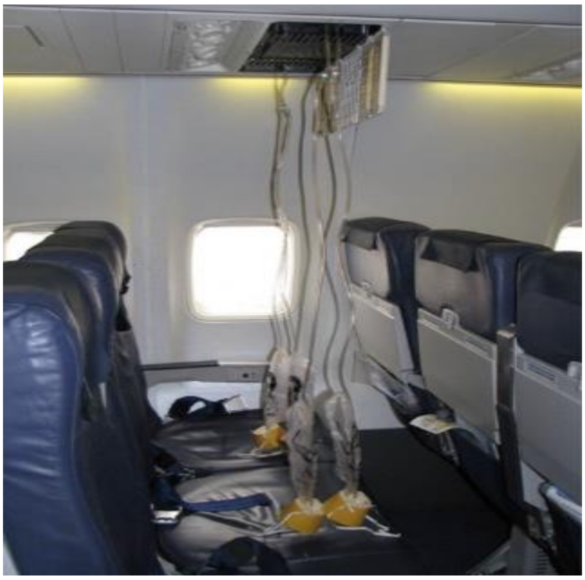
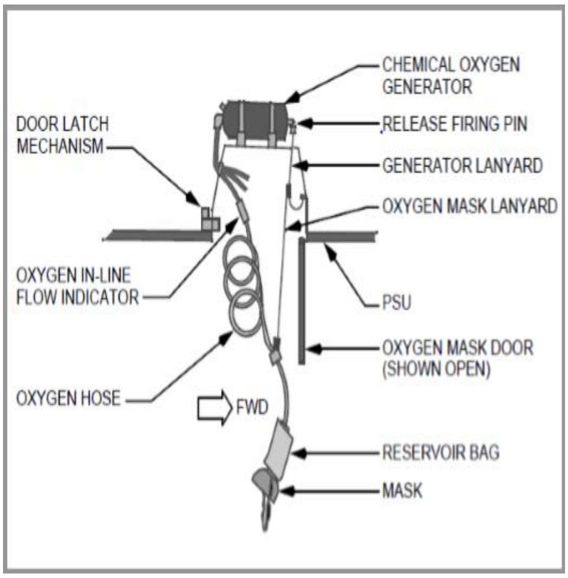


Figure 8: The process of putting on the oxygen face masks designed for the crew. (Source: Boeing).

1.6.8 Cabin Oxygen System:

The passenger oxygen is supplied by individual oxygen generators located at each passenger service unit (PSU). A generator with two masks is located above each cabin attendant station. The system is activated automatically when the cabin altitude climbs above 14 000 ft, or when the switch on the overhead panel is positioned to ON by the flight crew. When the system is activated manually, the masks will drop, and so the passengers has to pull the mask, put it on his/her face and start breathing. Once any of the four masks of a PSU is pulled, a continuous flow of oxygen begins. It lasts approximately 12 minutes and it cannot shut off. When the passenger oxygen system is activated, the following amber indicator lights illuminate on the flight deck: "Master Caution" and "Overhead" on the pilot's glareshield and "Pass Oxy On" on the overhead panel. The cabin oxygen masks were manually deployed and were utilised without struggle.





Figures 9 & 10: The deployed cabin oxygen mask (left), and the passenger oxygen sytem schematic (right). (Source: Boeing)

1.6.9 Passenger Portable Oxygen:

First aid and suplemental portable oxygen cylinders are installed at suitable locations in the passenger cabin. The number and location of portable oxygen cylinders varies with interior configuration. This aircraft is equipped with four cylinders located in the passenger cabin (two opposite the aft service door, and two next to the flight deck door). Each cylinder is fitted with a pressure gauge, pressure regulator and an ‘On/Off’ valve. The cylinders have a maximum capacity of 311 litres (11 cubic feet) of oxygen when pressurised to 1800 pressure square inch (psi). The oxygen could be used either through a four-litre per minute outlet or through a two, two-litre per minute outlet, resulting in an oxygen availability duration of 1 hour 17 minutes, respectively. The cabin crew were moving around the cabin during the serious incident assisting and making sure that passengers, particularly those with childern had their oxygen masks on correctly. During this time they made use of the portable oxygen suppliers until they were confident that they can breath without support.

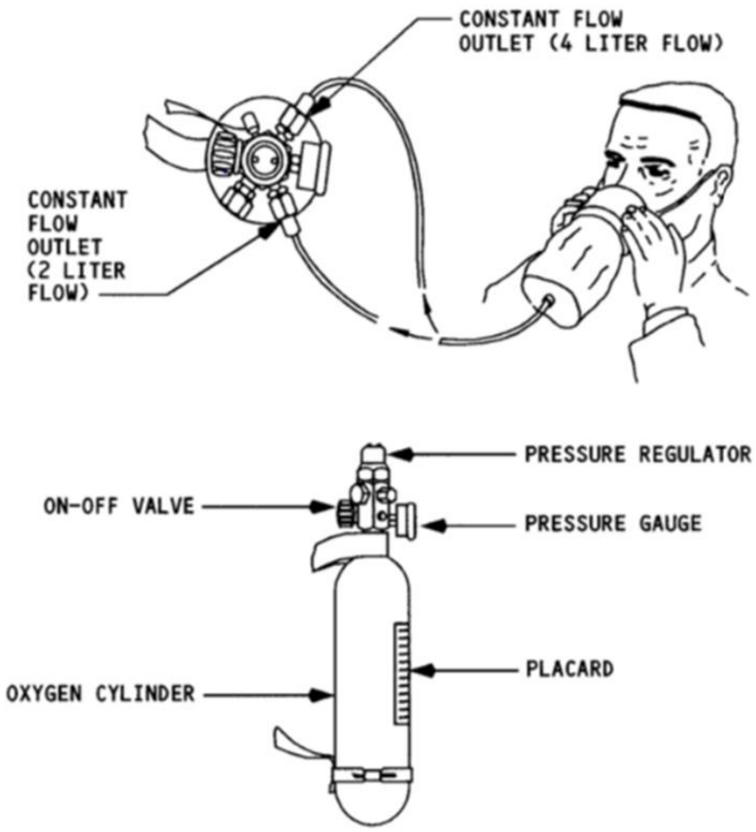


Figure 11: Passenger portable oxygen suppliers schematic. (Source: Boeing)

1.6.10 On-board Warning Systems:

The aircraft is equipped with the required warning systems, among others, a cabin altitude warning horn (signalling cabin altitude above 10000 feet), which was operative during the occurrence.

1.7 Meteorological Information

1.7.1 The weather information below was obtained from the captain's questionnaire.

Wind direction	220°	Wind speed	11kts	Visibility	10KM
Temperature	21°C	Cloud cover	900 ft	Cloud base	900 ft
Dew point	19°C	QNH	Nil		

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There were no records indicating that the navigation equipment was unserviceable prior to or during the flight.

I. Magnetic compass
II. Panel-mounted Garmin GPS
III. Mode S transponder
IV. ADF (automatic direction finder)
V. DME (distance measuring equipment)
VI. VOR (variable omni-range) finder
VII. ILS (instrument landing system)

1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator for the aircraft type. There were no recorded defects with the communication equipment prior to the flight.

1.9.2 The crew broadcasted a MAYDAY to the area controller who had the aircraft on primary surveillance radar on the VHF radio aerodrome frequency 125.75 megahertz (MHz).

1.10 Aerodrome Information

1.10.1 The serious incident occurred during the descent en route to FALE, approximately 70nm north of TGV - VOR beacon.

Aerodrome Location	King Shaka International Airport (FALE)	
Aerodrome Co-ordinates	S29°36'42.38" E031°07'09.53”	
Aerodrome Elevation	304 feet AMSL	
Runway Dimensions	3700 x 60m	
Runway Designations	24/09	
Runway Used	24	
Runway Surface	Asphalt	
Aerodrome Status	Licensed	
Approach Facilities	ILS, DME, VOR, PAPI’s, Runway light	

1.11 Flight Recorders

1.11.1 The ZS-SJF aircraft is equipped with a flight data recorder (FDR) and cockpit voice recorder (CVR) capable of recording a minimum duration of 25 hours of data and 120 minutes of audio, respectively. The FDR, a Solid-State Model, Serial No. SSFDR-19722, was removed from the aircraft and downloaded at South African Airways Technical (SAAT) facility on 28 January 2021. An analysis of the FDR and previous flights showed that the pressurisation and air-conditioning system had functioned normally. In addition, there were no bleed defects reported in the past six months before the serious incident on either engine.

1.11.2 From the FDR graph (Figure 12), it is evident from the Aircraft Information Management System (AIMS) that the aircraft packs were operating engine 1 Low and engine 2 High, which is in correlation to the aircraft's configuration as it departed FAOR.

1.11.3 At 1232Z, the crew commenced their descent, and while passing FL270, the crew got a "Cabin Altitude Warning" and, according to the captain's written report, declared an emergency. The crew continued with the descent at a maximum of 330kts to FL110 where a deceleration to 250kts was made.

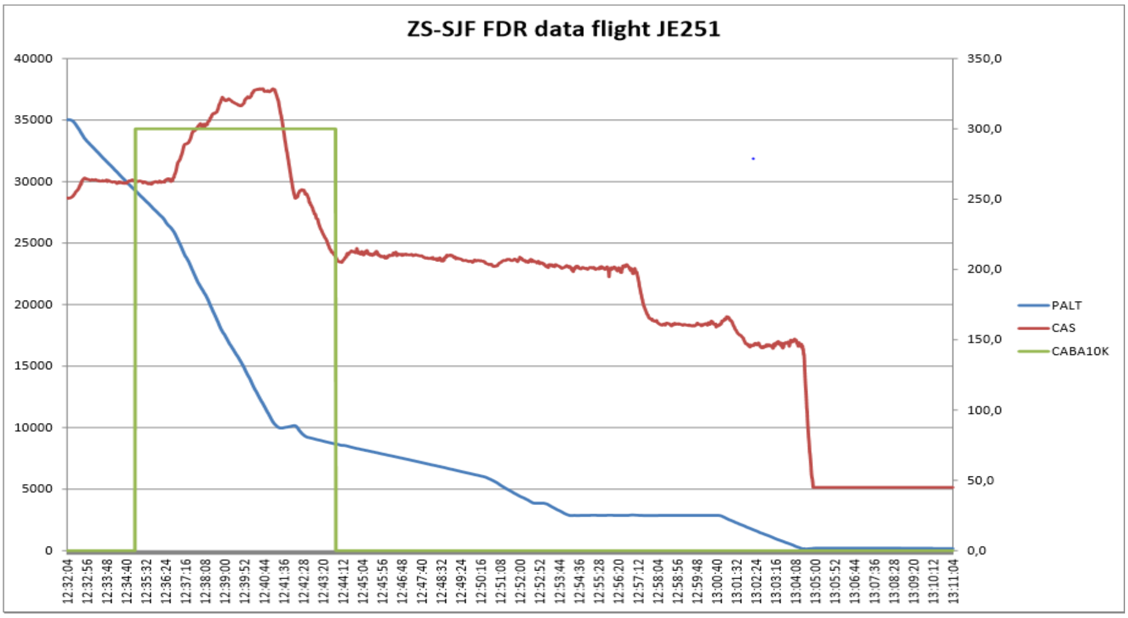


Figure 12: The graph of the serious incident flight with the captured essential data.
(Source: Mango Airlines)

1.12 Wreckage and Impact Information

1.12.1 The aircraft had maintained flight and, following a MAYDAY call, the crew had assessed the situation and landed the aircraft safely at FALE.

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

1.14.1 There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects

1.15.1 The serious incident was considered survivable as no damage was caused to the cockpit and cabin structure of the aircraft. The captain and the FO had donned their oxygen masks and had deployed the passengers' oxygen masks timeously IAW the QRH.

1.16 Tests and Research

1.16.1 To be discussed in the final report.

1.17 Organisational and Management Information

1.17.1 The flight was conducted IAW the provisions of Part 121 of the CAR 2011 as amended.

1.17.2 The aircraft maintenance organisation (AMO) which carried out the last maintenance inspection (A-Check) prior to the serious incident flight was in possession of an approved AMO certificate number 0001 that was issued by the SACAA on 14 January 2020 with an expiry date of 31 October 2021.

1.17.3 The operator was in possession of an approved Class 1 Air Service Licence No. S890D for domestic schedule, which was issued on 18 November 2020 by the Department of Transport. The licence authorised the carrier to operate under the following categories: Type S1 – transport of passengers between two or more specified points, and Type S2 – transport of cargo or mail between two or more specified points. The aircraft used under this operation should meet category A1 provisions – any aircraft, excluding a helicopter, with a maximum certificated mass exceeding 20 000 kilograms.

1.17.4 The operator was in possession of an Air Operating Certificate (AOC) No. CAA/N891D, which was issued on 19 November 2020 by the SACAA with an expiry date of 30 November 2021. The aircraft was duly authorised to operate under the AOC.

1.18 Additional Information

1.18.1 Aircraft operating manual of the Boeing 737-800 aircraft:

The manual specifies that "*in the event of sudden decrease in cabin pressure, oxygen masks should be put on immediately, and if decompression occurs, speed brakes should be fully extended, and an emergency descent made to 10000ft, with the aircraft flown either at maximum airspeed or at an appropriate airspeed (if there are concerns about structural failure, airspeed should be decreased to a suitable value while paying attention to controlling the aircraft).*

ATC should be notified beforehand, with the intentions of the pilot, etc. reported clearly. Further, it is specified that at the time the cabin altitude reaches 13 000ft or below, the cabin crew should be notified that oxygen masks may be released."

1.18.2 Effects of decompression in the cabin on the human body:

According to Aerospace Medicine: Flight and the Human Body (by Haruo Ikeda, published by Houbun-Shorin, November 1971), the effects of cabin decompression on the human body are as follows:

(1) Hypoxia:

The table below summarises the stages of hypoxia in relation to the altitude of occurrence, breathing air and the arterial oxygen saturation.

Altitude (ft)	**Stage**	**Symptoms**
0–10,00	Indifferent	None, but visual sensitivity reduced at night.
10,000–15,00	Compensatory	Major symptoms may not appear due to compensatory mechanisms
15,000–20,00	Disturbance	Hazards of visual disturbance and intellectual impairment, etc
above 20,00	Critical	Danger of rapid loss of consciousness with little or no warning and loss of life.

The Time of Useful Consciousness (TUC) is that period between an individual's sudden deprivation of oxygen at a given altitude and the onset of physical or mental impairment which prohibits his taking rational action. It represents the time during which the individual can recognise his problem and re-establish an oxygen supply, initiate a descent to lower altitude, or take other corrective action. TUC is also referred to as effective performance time.

Altitude (ft)	**Time of useful consciousness**
22,000	5 minutes
25,000	2–3 minutes
28,000	1 minute 30 seconds
30,000	1 minute 15 seconds
35,000	45 seconds

(2) Decompression Sickness

Decompression sickness results from the expansion and contraction of gases trapped in the ears, nasal passages, etc. and from nitrogen and other gases dissolved in the blood, tissues, etc. coming out of solution. Trapped gases cause symptoms of earache, nose ache, stomach ache, etc. Bubbles formed by gases coming out of solution cause symptoms of arthralgia of the shoulders, elbow, hands, etc. and also difficulty in breathing, aching lungs, etc. due to the restriction of blood vessels. Although rare, restriction of blood vessels in the brain by evolved gas bubbles can cause loss of consciousness and visual impairment.

1.18.3 Classification of “Abnormal drop of cabin pressure in an aircraft” specified by the United States Federal Aviation Administration (FAA):

Advisory Circular (AC) 61-107 issued by Federal Aviation Authority (FAA) of the United States contains the following classification of degrees of decompression rate:

(1) Explosive Decompression

This is a phenomenon in which cabin pressure equalises with ambient pressure in less than 0.5 seconds. There is a high probability of damage to the human body by decompression sickness, etc. Because it is considered that unsecured objects will fly around, all loose items such as baggage should be properly secured before flight. Also, aircraft with smaller pressurised cabin volumes are more prone to this type of decompression.

(2) Rapid Decompression

This drop of cabin pressure is not as abrupt as in the case of explosive decompression, and the likelihood of damage to the human body by decompression sickness, etc. is significantly lower.

(3) Gradual Decompression or Slow Decompression.

This decompression is difficult to perceive by bodily sensations as opposed to cases (1) and (2) above. The consequent possibility that recognition will be late makes this type of decompression dangerous. Generally, automatic visual and aural warning systems provide indication of decompression so that it may be detected even if the pilot does not recognise it through bodily sensations.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. Findings

2.1 General

From the available evidence, the following preliminary findings were made with respect to this serious incident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusions heading:

- **Findings —** are statements of all significant conditions, events or circumstances in this serious incident. The findings are significant steps in this serious incident sequence, but they are not always causal or indicate deficiencies.

2.1.1 The flight was conducted in accordance with the provisions of Part 121 of the CAR 2011 as amended.

2.1.2 Moderate weather conditions prevailed at the time of the flight and had no bearing to this serious incident.

2.1.3 The captain had a valid Airline Transport Pilot Licence (ATPL) and the aircraft type was endorsed on his licence. He also had a valid Class 1 aviation medical certificate issued on 5 October 2020 with an expiry date of 31 October 2021.

2.1.4 The FO had a valid ATPL and the aircraft type was endorsed on his licence. The FO had a valid Class 1 aviation medical certificate issued on 7 October 2020 with an expiry date of 31 October 2021.

2.1.5 Records kept at the SACAA facility showed that the captain's last proficiency check on B737-800 was provided by Mango Airlines ATO No. CAA/0307 on 26 and 27 October 2020, and the candidate was assessed as competent in all aspects. The Boeing 737-800 pilot proficiency check has a validity date of 30 April 2021.

2.1.6 Records kept at the SACAA facility showed that the FO's last proficiency check on B737-800 was provided by Mango Airlines ATO No. CAA/0307 on 15 July 2020, and the candidate was assessed as competent in all aspects. The Boeing 737-800 pilot proficiency check has a validity date of 30 January 2021.

2.1.7 The cabin pressurisation was configured with the cruise altitude (FL350), and the destination airport altitude (304 ft above mean sea level) was set. The pre-flight checklist was executed accordingly.

2.1.8 An emergency was declared by broadcasting a MAYDAY to the area controller who had the aircraft on primary surveillance radar at 1232Z, approximately 70nm north of TGV - VOR on 125.75 MHz frequency.

2.1.9 The cabin oxygen masks were deployed during the serious incident and oxygen generators activated on all the masks that dropped. Some oxygen masks did not drop, resulting in the cabin crew moving the passengers to the unoccupied seats with deployed masks.

2.1.10 The aircraft had a valid Certificate of Airworthiness (C of A), which was initially issued on 31 October 2004 with an expiry date of 31 October 2021.

2.1.11 The last maintenance inspection (A-check) that was carried out on the aircraft prior to the serious incident flight was certified on 21 January 2021 at 49 912.20 airframe hours. Following the inspection, a further 18.21 hours were flown with the aircraft.

2.1.12 The AMO which carried out the last maintenance inspection (A-Check) prior to the serious incident flight was in possession of an approved AMO certificate number 0001 that was issued by the SACAA on 14 January 2020, with an expiry date of 31 October 2021.

2.1.13 The operator was in possession of an Air Operating Certificate (AOC) No. CAA/N891D, which was issued on 19 November 2020 by the SACAA with an expiry date of 30 November 2021. The aircraft was duly authorised to operate under the AOC.

2.1.14 The operator was in possession of an approved Class 1 Air Service Licence No. S890D for domestic schedule, which was issued on 18 November 2020 by the Department of Transport. The licence authorised the carrier to operate under the following categories: Type S1 – transport of passengers between two or more specified points, and Type S2 – transport of cargo or mail between two or more specified points. The aircraft used under this operation should meet category A1 provisions – any aircraft, excluding a helicopter, with a maximum certificated mass exceeding 20 000 kilograms.

2.2 On-going Investigation

2.2.1 The AIID investigation is on-going and will look into other aspects of this occurrence which may or may not have safety implications.

3 Appendices

3.1 Annexure A - Cabin altitude warning checklist.

3.2 Annexure B - FALE Airport layout IAW the Aeronautical information Publication (AIP).

This Report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

Annexure A:

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CABIN ALTITUDE WARNING or Rapid Depressurization

CABIN ALTITUDE (If installed and operative)

Condition: One or more of these occur:
- A cabin altitude exceedance
- In flight, the intermittent cabin altitude/configuration warning horn sounds or a CABIN ALTITUDE light (if installed and operative) illuminates.

1 Don oxygen masks and set regulators to 100%.

2 Establish crew communications.

3 Pressurization mode selector . . . . MAN

4 Outflow VALVE switch . . . . Hold in CLOSE until the outflow VALVE indication shows fully closed

5 **If** cabin altitude is **uncontrollable**:

Passenger signs . . . . ON

PASS OXYGEN switch . . . . ON

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

■ ■ ■ ■

▼ Continued on next page ▼

▼CABIN ALTITUDE WARNING or Rapid Depressurization continued▼

6 **If** cabin altitude is **controllable**:

Continue manual operation to maintain correct cabin altitude.

When the cabin altitude is at or below 10,000 feet:

Oxygen masks may be removed.

7 **Checklist Complete Except Deferred Items**

Deferred Items

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

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 . . . . ___

▼ Continued on next page ▼

▼CABIN ALTITUDE WARNING or Rapid Depressurization continued▼

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

■ ■ ■ ■

Non-Normal Checklists - Miscellaneous

BOEING

737 Flight Crew Operations Manual

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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 Speedbrake . . . . FLIGHT DETENT

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

7 ⚠ Set target speed to Mmo/Vmo.

▼ Continued on next page ▼

▼Emergency Descent continued▼

YC708 - YC711, YC720, YC721, YD023, YD024

Caution! When gross weight is greater than 70,308 kgs, speed brake will autostow to the 50% flight detent if airspeed exceeds 320 knots. Do not override autostow function unless airspeed is less than 320 knots.

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.

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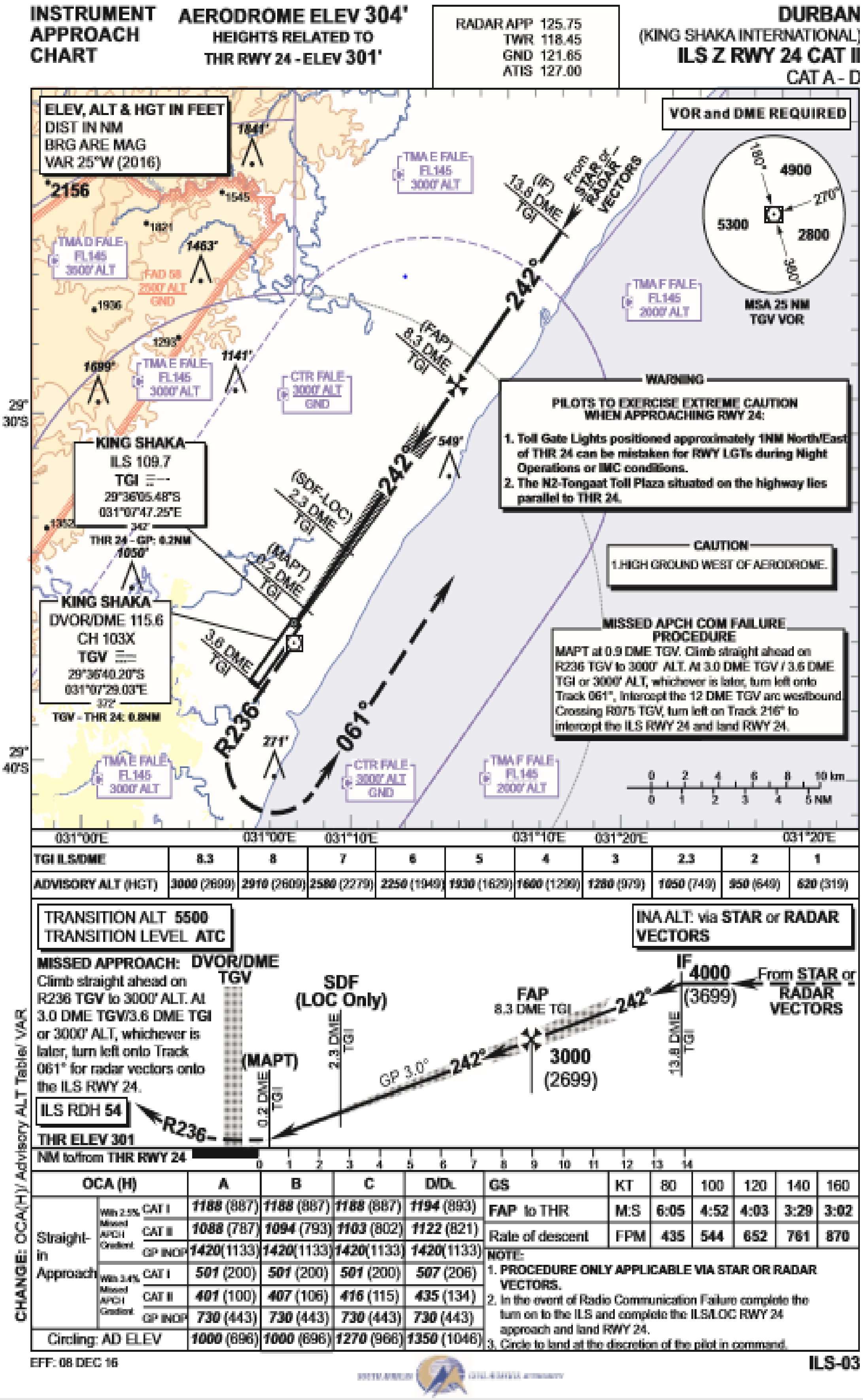
Annexure B


INSTRUMENT APPROACH CHART
AERODROME ELEV 304'
HEIGHTS RELATED TO THR RWY 24 - ELEV 301'
RADAR APP 125.75
TWR 118.45
GND 121.65
ATIS 127.00
DURBAN
(KING SHAKA INTERNATIONAL)
ILS Z RWY 24 CAT II
CAT A - D
ELEV, ALT & HGT IN FEET
DIST IN NM
BRG ARE MAG
VAR 25°W (2016)
VOR and DME REQUIRED
4900
5300
2800
MSA 25 NM
TGV VOR
From STAR or RADAR VECTORS
13.8 DME (IF) TGI
(FAP) 8.3 DME TGI
(SDF-LOC) 2.3 DME TGI
(MAPT) 0.2 DME TGI
3.6 DME TGI
KING SHAKA
ILS 109.7
TGI
29°36'05.48"S
031°07'47.25"E
THR 24 - GP: 0.2NM
KING SHAKA
DVOR/DME 115.6
CH 103X
TGV
29°36'40.20"S
031°07'29.03"E
TGV - THR 24: 0.8NM
WARNING
PILOTS TO EXERCISE EXTREME CAUTION WHEN APPROACHING RWY 24:
1. Toll Gate Lights positioned approximately 1NM North/East of THR 24 can be mistaken for RWY LGTs during Night Operations or IMC conditions.
2. The N2-Tongaat Toll Plaza situated on the highway lies parallel to THR 24.
CAUTION
1.HIGH GROUND WEST OF AERODROME.
MISSED APCH COM FAILURE PROCEDURE
MAPT at 0.9 DME TGV. Climb straight ahead on R236 TGV to 3000' ALT. At 3.0 DME TGV / 3.6 DME TGI or 3000' ALT, whichever is later, turn left onto Track 061°, Intercept the 12 DME TGV arc westbound Crossing R075 TGV, turn left on Track 216° to intercept the ILS RWY 24 and land RWY 24.
TGI ILS/DME 8.3 8 7 6 5 4 3 2.3 2 1
ADVISORY ALT (HGT) 3000 (2699) 2910 (2609) 2580 (2279) 2250 (1949) 1930 (1629) 1600 (1299) 1280 (979) 1050 (749) 950 (649) 620 (319)
TRANSITION ALT 5500
TRANSITION LEVEL ATC
INA ALT: via STAR or RADAR VECTORS
MISSED APPROACH: Climb straight ahead on R236 TGV to 3000' ALT. At 3.0 DME TGV/3.6 DME TGI or 3000' ALT, whichever is later, turn left onto Track 061° for radar vectors onto the ILS RWY 24.
ILS RDH 54
THR ELEV 301
NM to/from THR RWY 24
OCA (H) A B C D/DL
Straight-in Approach
With 2.5% Missed APCH Gradient CAT I 1188 (887) 1188 (887) 1188 (887) 1194 (893)
CAT II 1088 (787) 1094 (793) 1103 (802) 1122 (821)
GP INOP 1420(1133) 1420(1133) 1420(1133) 1420(1133)
With 3.4% Missed APCH Gradient CAT I 501 (200) 501 (200) 501 (200) 507 (206)
CAT II 401 (100) 407 (106) 416 (115) 435 (134)
GP INOP 730 (443) 730 (443) 730 (443) 730 (443)
Circling: AD ELEV 1000 (696) 1000 (696) 1270 (966) 1350 (1046)
GS KT 80 100 120 140 160
FAP to THR M:S 6:05 4:52 4:03 3:29 3:02
Rate of descent FPM 435 544 652 761 870
NOTE:
1. PROCEDURE ONLY APPLICABLE VIA STAR OR RADAR VECTORS.
2. In the event of Radio Communication Failure complete the turn on to the ILS and complete the ILS/LOC RWY 24 approach and land RWY 24.
3. Circle to land at the discretion of the pilot in command.
CHANGE: OCA(H)/ Advisory ALT Table/ VAR
EFF: 08 DEC 16
ILS-03