AIRCRAFT INCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference	CA18/3/2/1278		
Aircraft registration	**ZS-JRM**	**Date of incident**	20 August 2019		**Time of incident**	1825Z	
Type of aircraft	Boeing 737-400		**Type of operation**		Air Transport Operation (Part 121)		
Pilot-in-command licence type	Airline Transport		**Age**	31	**Licence valid**	Yes	
Pilot-in-command flying experience	Total flying hours		5 703.2		Hours on type	3 535.7	
Last point of departure	Cape Town International Aerodrome (FACT), Western Cape						
Next point of intended landing	King Shaka International Aerodrome (FALE), Kwa-Zulu Natal						
Location of the incident site with reference to easily defined geographical points (GPS readings if possible)							
En route from FACT to FALE abeam Montagu (GPS position: South 33°46'30.20" East 020°06'56.82")							
Meteorological information	Surface wind: 220°/12kts; temperature: 14°C: dew point: 12°C: CAVOK						
Number of people on-board	2 + 4 + 134	**No. of people injured**	0	**No. of people killed**	0		

Synopsis

On the evening of 20 August 2019 at approximately 1810Z, a Boeing 737-400 aircraft with registration marking ZS-JRM departed Cape Town International Aerodrome (FACT) using Runway 19 on a scheduled domestic flight to King Shaka International Aerodrome (FALE) with two pilots, four crew members and 134 passengers on-board.

The aircraft was cleared to climb to flight level (FL) 330 [33 000] feet (ft) above mean sea level (AMSL) by the radar controller. At approximately 1825Z with the aircraft climbing through flight level 310, the crew declared an emergency by broadcasting a Mayday, requesting an emergency descent. Both pilots indicated that they heard two loud thuds originating from the rear of the aircraft. Thereafter, the pressurisation gauge indicated a gradual climb in the cabin altitude and, a few seconds later, it became uncontrollable. This led to the Cabin Altitude Warning System activating automatically. The aircraft was cleared for an unrestricted descent with no conflicting traffic. The oxygen masks deployed automatically in the cabin and both cockpit crew members fitted their oxygen masks. At approximately 1831Z, the crew levelled the aircraft off at FL100 (10 000ft) above mean sea level (AMSL) and was given vectors back to FACT where it landed safely on Runway 19 at approximately 1857Z.

The aircraft was brought to a stop on the runway and the crew requested that an external inspection of the aircraft be conducted. Following the inspection, no external damage was observed, and the crew taxied to the allocated parking bay.

The investigation revealed that the rapid decompression was a result of the failure of the lower part of the aft cargo door pressure seal. This caused the pressurised air from the cabin area to leak into the atmosphere to an extent that the aircraft pressurisation system could not keep up with the supply to maintain a safe and comfortable environment for the pilots, passengers and the crew members.

SRP date	21 January 2020	Publication date	14 February 2020

Reference number	**:** CA18/3/2/1278
Name of the Owner	**:** Safair Operations (Pty) Ltd
Name of the Operator	**:** FlySafair
Manufacturer	**:** Boeing Aircraft Company
Model	**:** 737-400
Nationality	**:** South African
Registration markings	**:** ZS-JRM
Place	**:** After take-off from Cape Town International Aerodrome (FACT)
Date	**:** 20 August 2019
Time	**:** 1825Z

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.

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****.*

Any person who has information concerning this incident should contact the Accident and Incident Investigation Division (AIID) on AIIDinbox@caa.co.za

Investigation process:

The AIID of the South African Civil Aviation Authority (SACAA) was informed about an aircraft incident involving a Boeing 737-400 that occurred after take-off from Runway 19 at FACT on 20 August 2019. The incident was reported to AIID via the Mandatory Occurrence Reporting (MOR) system on 21 August 2019 at 0700Z.

The AIID has appointed an investigator-in-charge with an investigation team. Notifications were sent to the State of Manufacture and Design, namely, the United States of America. The State has not appointed an accredited representative to the investigation. The AIID will lead the investigation and issue the final report.

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

- *Incident — this investigated incident*
- *Aircraft — Boeing 737-400 involved in this incident*
- *Investigation — the investigation into the circumstances of this incident*
- *Pilot — the pilot/s involved in this incident*
- *Report — this incident report*

2. Photographs and figures used in this report were obtained from different sources and may be adjusted 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 SACAA, which are reserved.

Abbreviations	
AD	Airworthiness Directive
AMSL	Above mean sea level
AMO	Aircraft Maintenance Organization
AOC	Air Operating Certificate
APU	Auxiliary Power Unit
ARFF	Aerodrome Rescue and Fire-fighting
ATNS	Air Traffic and Navigation Services
ATPL	Airline transport pilot licence
BKN	Broken (cloud layer)
CAA	Civil Aviation Authority
CAT II	Precision instrument approach and landing with a decision height lower than 200 feet (60 metres) but not lower than 100 feet (30 metres)
CAVOK	Ceiling and visibility OK
C of A	Certificate of airworthiness
C of R	Certificate of registration
CVR	Cockpit voice recorder
DME	Distance measuring equipment
DVOR	Doppler VHF Omni Directional Range
FACT	Cape Town International Airport
FALE	King Shaka International Airport
FDR	Flight data recorder
FL	Flight level
ft	feet
GP	Ground proximity
kt	Knot
ILS	Instrument landing system
LOC	Localiser
METAR	Meteorological aeronautical report
PIC	Pilot-in-command
QNH	Query: Nautical height
SAWS	South African Weather Services
SB	Service Bulletin
SSR	Secondary Surveillance Radar
UHF	Ultra-high frequency
VHF	Very high frequency
Z	Zulu (Term for Universal Coordinated Time - Zero hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On the evening of 20 August 2019 at approximately 1810Z, a Boeing 737-400 aircraft with registration marking ZS-JRM departed Cape Town International Aerodrome (FACT) on a scheduled domestic flight to King Shaka International Aerodrome (FALE) with two pilots, four crew members and 134 passengers on-board. The aircraft was flown under instrument flight rules (IFR) by night and the weather conditions were reported to be fine at the time of the incident. This domestic flight was conducted under the provisions of Part 121 of the Civil Aviation Regulations (CAR) of 2011 as amended.

1.1.2 After take-off from Runway 19, the aircraft with call sign Safair 461 (FA461) turned out left. At approximately 1815Z, whilst the aircraft was passing 10 500 feet (ft) above mean sea level (AMSL), the aircraft was cleared by radar control to climb to flight level 330 (FL330), which was acknowledged by the crew.

1.1.3 At approximately 1824Z, the aircraft was climbing through FL310 and about 33 seconds later at 1825Z, the crew declared an emergency by broadcasting a Mayday. Both pilots indicated that they heard two loud thuds originating from the rear of the aircraft. Immediately afterwards, the pressurisation gauge indicated a gradual climb in the cabin altitude and, a few seconds later, the cabin pressure became uncontrollable. A Cabin Altitude Warning System activated automatically. The crew then initiated the *memory items for an emergency descent* as contained in Figure 1.

EMERGENCY DESCENT PROCEDURES (FL100 or MORA / MSA)

Captain	First Officer
RAPID OR EXPLOSIVE DECOMPRESSION	
➢ Don oxygen masks and set regulators to 100% ➢ Establish crew communication	
	Attempt to control the cabin pressure ➢ Pressurisation mode – MAN AC ➢ Outflow Valve – CLOSE
If cabin is uncontrollable	
➢ "This is the Captain speaking, Rapid Descent Be Seated, Rapid Descent Be Seated." ➢ Altitude Select – SET ➢ LVL CHG (Mmo / Vmo) or (current KIAS if structural damage) ➢ Thrust Idle ➢ Speedbrake – FLIGHT DETENT	➢ PASS OXYGEN – ON ➢ Passenger signs – ON ➢ ENGINE START switches – CONT ➢ ATC – Advise and obtain QNH ➢ Tx – 7700
	During Descent: ➢ CABIN ALTITUDE WARNING NNC ➢ Emergency Descent NNC to appropriate point.
➢ Approaching level off Altitude Smoothly lower speedbrake and level off. ➢ Below FL100: "THIS IS THE CAPTAIN SPEAKING, FLIGHT ATTENDANTS RESUME YOUR DUTIES"	
Continue with Assess, Action, Manage and RMM Give specific consideration to Barotrauma.	

Figure 1: Memory items as per emergency descent procedure.

1.1.4 The aircraft was cleared for an emergency descent and commenced with a right descending turn to FL100. At approximately 1831Z, the crew levelled off the aircraft at FL100 and was given vectors back to FACT by the radar controller. During the emergency descent, oxygen masks deployed automatically from the service panels in the cabin for passengers, and the cockpit crew donned their respective oxygen masks manually. This was confirmed by the cabin crew members. The cabin crew members then assessed the incident but could not determine exactly what had happened at that stage.

1.1.5 The aircraft landed safely on Runway 19 at approximately 1857Z. No one on-board the aircraft was injured. The crew brought the aircraft to a stop on the runway and requested that the external fuselage be inspected before they proceed taxiing to the parking bay. The aerodrome rescue and fire-fighting (ARFF) personnel inspected the aircraft and no external damage was observed. The crew was advised accordingly, and they taxied the aircraft to the parking bay.

1.1.6 From the radar data depicted in Figures 2 and 3, the aircraft could be seen taking off from Runway 19 in a southerly direction (blue line) and was cleared to climb to FL330 en route to FALE. At approximately 1825Z, as they were passing FL310, the crew declared an emergency by broadcasting a Mayday and the emergency descent followed. At approximately 1831Z, the aircraft was observed levelling off at FL100. Shortly after, the Secondary Surveillance Radar (SSR) track changed colour from blue to red. That was when the crew changed the squawk code from the allocated code of 1561 to 7700, which is the emergency code.

1.1.7 The crew encountered the decompression incident overhead the town of Montagu, which was at a Geographical Positioning System (GPS) determined to be South 33°46'30.20" East 020°06'56.82", while flying at an altitude of approximately 31 000ft (FL310).

Figure 2: Google Earth overlay of the aircraft flight path after take-off from Runway 19 at FACT.

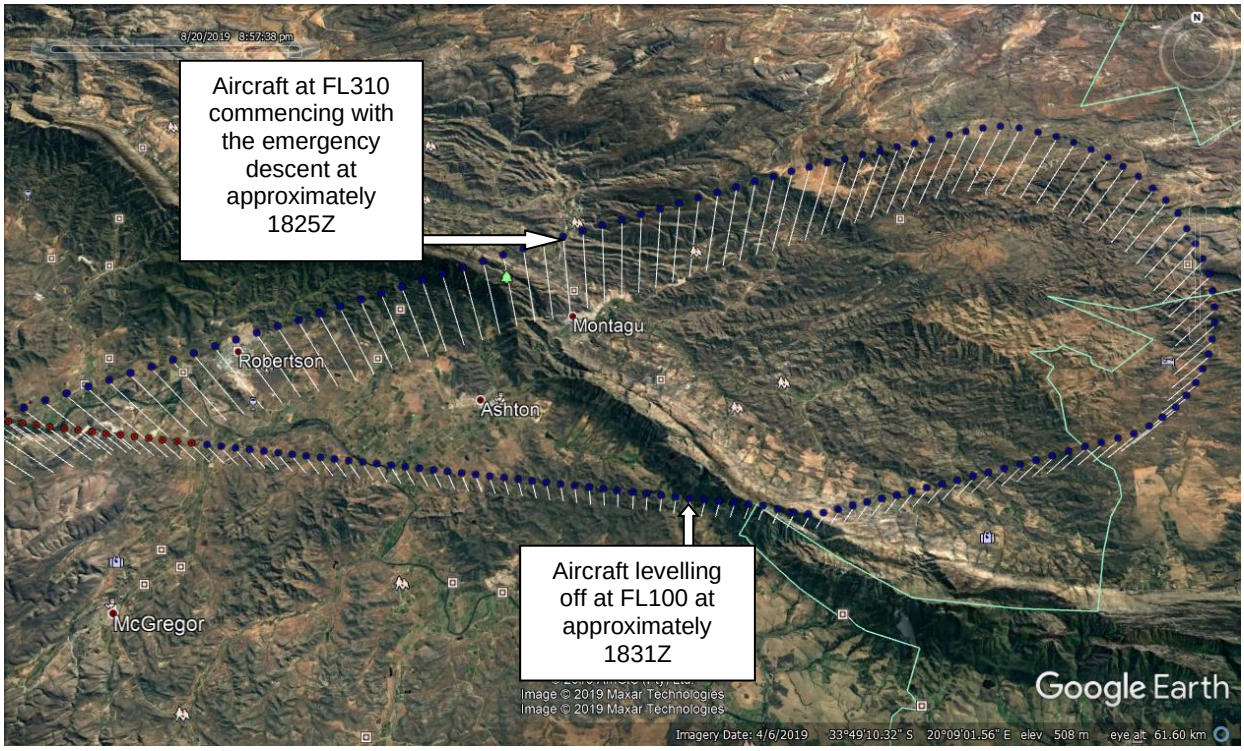


Figure 3: Google Earth overlay (radar data) indicating the emergency descending turn to the right.

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	2	4	134	-

1.3. Damage to Aircraft

1.3.1 The aircraft sustained minor damage to the aft cargo door seal, as well as a partially collapsed sealing in the cargo hold, which had to be replaced.

1.4. Other damage

1.4.1 None.

1.5. Personnel information

1.5.1 Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	31
Licence number	**********	Licence type	Airline Transport Pilot		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Instrument				
Medical expiry date	30 April 2020 (Class 1)				
Restrictions	None				
Previous incidents	None				

Flying experience:

Total hours	5 703.2
Total past 90 days	142.8
Total on type past 90 days	142.8
Total on type	3 535.7

1.5.2 First Officer (FO)

Nationality	South African	Gender	Male	Age	40
Licence number	**********	Licence type	Commercial Pilot		
Licence valid	Yes	Type endorsed	Yes		
Ratings	Instrument				
Medical expiry date	31 January 2020 (Class 1)				
Restrictions	To follow melanoma protocol				
Previous incidents	None				

Flying experience:

Total hours	5 420.8
Total past 90 days	115.5
Total on type past 90 days	115.5
Total on type	451.8

1.6. Aircraft Information

1.6.1 The Boeing 737

Source: https://en.wikipedia.org/wiki/Boeing_737_Classic

The Boeing 737 are short- to medium-range, narrow-body jet airliners. Produced by Boeing Commercial Airplanes from 1984 to 2000, the 737 Classic includes three variants, comprising the -300, -400, and -500 series, and can seat between 145 and 188 passengers. Improvements over the previous generation of 737 aircraft included CFM International CFM56 high-bypass-ratio turbofan engines, upgraded avionics, and increased passenger capacity (in the -300/-400 models). The first model of the Classic series, the 737–300, entered service in 1984. It was followed by a stretched model, the 737-400, which entered service in 1988.

Figure 4: The ZS-JRM aircraft. (Picture: www.airliners.net)

1.6.2 Airframe

Type	Boeing 737-400	
Serial number	28890	
Manufacturer	Boeing Aircraft Company	
Year of manufacture	1998	
Total airframe hours (at time of incident)	62 678.50	
Last A-check inspection	62 581.00	8 August 2019
Hours since the last A-check inspection	97.5	
C of A (issue date)	2 September 2016	
C of A (expiry date)	30 September 2019	
C of R (issue date) (Present owner)	24 August 2016	
Operating category	Standard Transport (Aeroplane)	

Engine No. 1

Type	CFM56-3C-1
Serial number	858856
Hours since new	41 166.29
Hours since overhaul	Modular assembly

Engine No. 2

Type	CFM56-3C-1
Serial number	857322
Hours since new	48 764.54
Hours since overhaul	Modular assembly

1.6.3 Aft cargo door pressure seal

The forward and aft cargo door pressure seals are on conditions items, which means that they are changed only when required (i.e. when damaged). According to the aircraft manufacturer, there were no Service Bulletins (SBs) or Airworthiness Directives (ADs) issued on the cargo door pressure seals prior to this incident.

1.7. Meteorological Information

1.7.1 The weather information below was obtained from the Meteorological Aeronautical Report (METAR) that was issued by the South African Weather Service (SAWS) for FACT on 20 August 2019 at 1830Z.

Wind direction	220˚	Wind speed	5kts	Visibility	CAVOK
Temperature	14˚C	Cloud cover	Nil	Cloud base	Nil
Dew point	12˚C	QNH	1027		

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 was no record indicating that the navigation system was unserviceable prior to or during the incident.

1.9. Communication

1.9.1 The aircraft was equipped with standard communication equipment as per the minimum equipment list approved by the Regulator. There were no recorded defects prior to or during the incident.

1.9.2 The aircraft was in radio communication with Cape Town West radar on the very high frequency (VHF) 125.10 Megahertz (MHz) when the crew declared the Mayday. A transcript of the communication between the aircraft (ZS-JRM) and the radar controller is attached to this report as Annexure A.

1.10. Aerodrome Information

Aerodrome location	Cape Town International Aerodrome (FACT)	
Aerodrome co-ordinates	South 33°58'16.93" East 018°36'15.45"	
Aerodrome elevation	151 feet above mean sea level	
Runway designations	01/19	06/24
Runway dimensions	3 201 x 61m	1 701 x 46m
Runway used	19	
Runway surface	Asphalt	
Approach facilities	DVOR; UHF DME; ILS LOC; ILS GP CAT II; ILS/DME, Runway lights	
Aerodrome status	Licensed	

Note: The aerodrome chart for FACT is attached to this report as Annexure B.

1.11. Flight recorders

1.11.1 The aircraft was equipped with flight data recorder (FDR) and a cockpit voice recorder (CVR). None of these units was removed from the aircraft for the purpose of downloading.

1.12. Wreckage and Impact Information

1.12.1 The aircraft maintained flight and, following the Mayday call, the crew assessed the situation and informed radar control that they will be returning to FACT.

1.13. Medical and Pathological Information

1.13.1 The pilot-in-command (PIC) held a valid class 1 aviation medical certificate, which was issued on 12 April 2019 with an expiry date of 30 April 2020.

1.13.2 The FO held a valid class 1 aviation medical certificate, which was issued on 29 January 2019 with an expiry date of 31 January 2020.

1.14. Fire

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

1.15. Survival Aspects

1.15.1 The incident was considered survivable as no damage was caused to the cockpit or cabin structure of the aircraft. Oxygen masks deployed automatically from the service panels in the cabin, and the cockpit crew donned their respective oxygen masks manually. Figure 5 depicts the cabin (actual aircraft) following the incident.

Figure 5: Deployed oxygen masks in the cabin. (Photograph courtesy of the Operator)

1.16. Tests and Research

1.16.1 Cargo doors

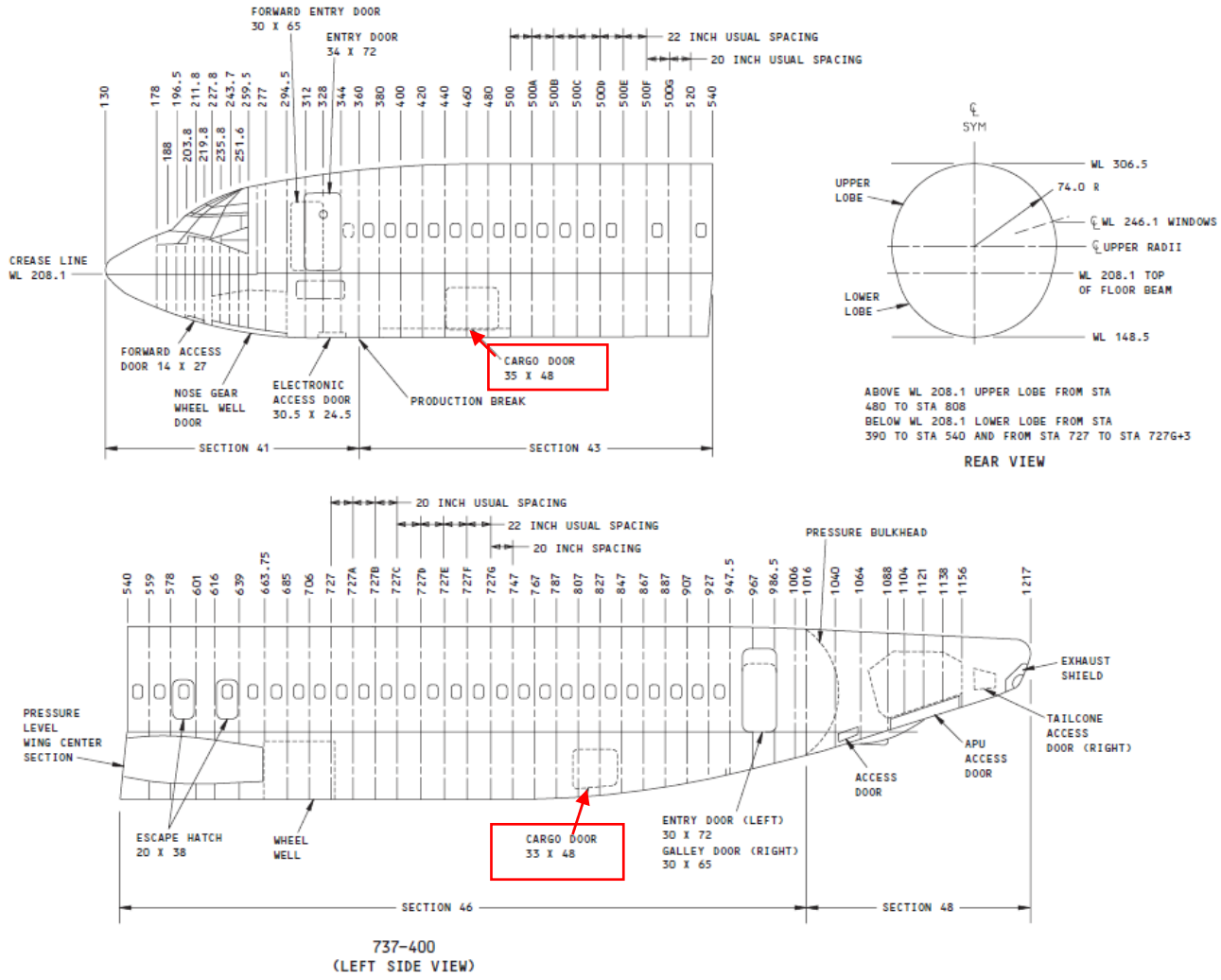


Figure 6: The dimension of both the forward and aft cargo doors (measurements in inches).

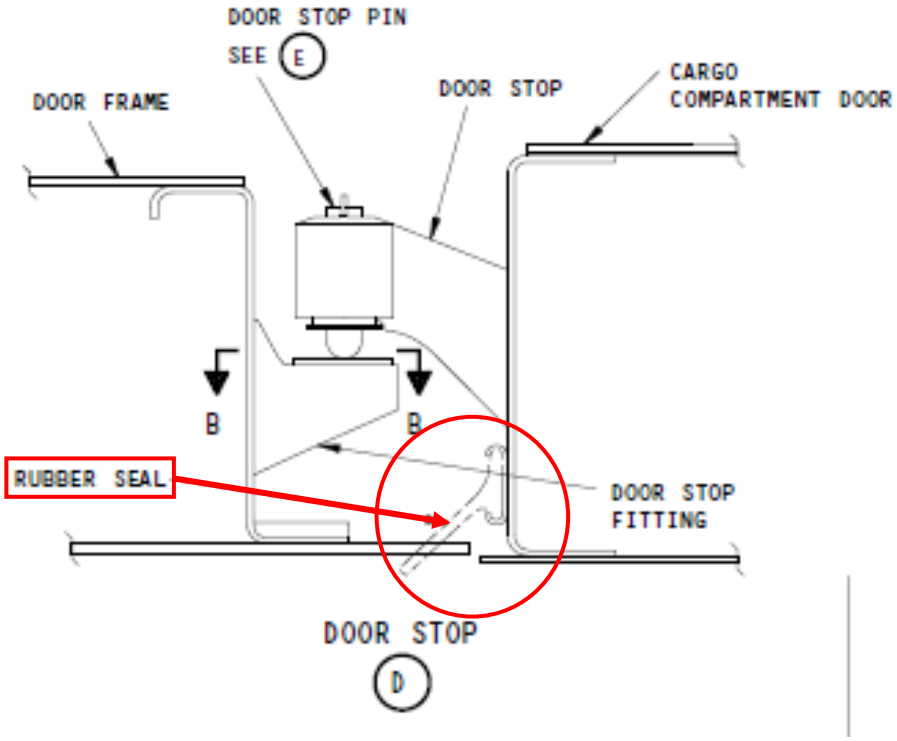


Figure 7: Schematic indicating the position of the cargo door pressure seal.

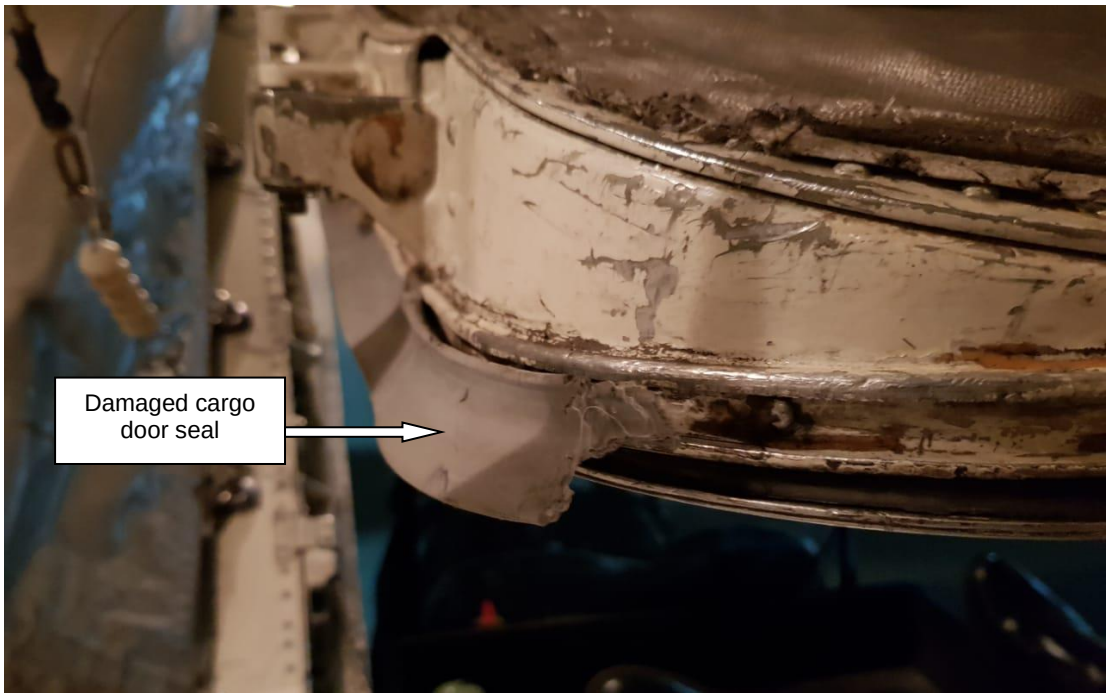


Figure 8: A section of the aft cargo door pressure seal (with the door in the open position).

Figure 9: A section of the damaged aft cargo door pressure seal.

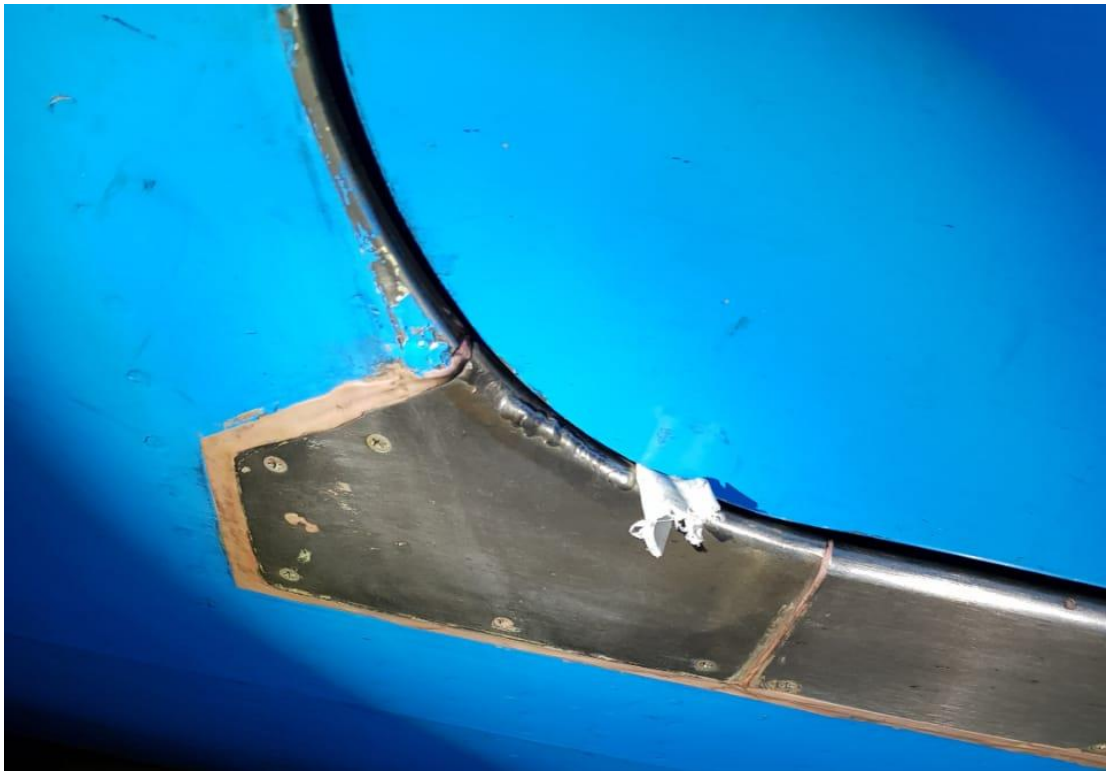


Figure 10: A section of the aft cargo door pressure seal protruding from the closed cargo door.

Figure 11: The interior of the aft cargo hold area with a partially collapsed ceiling.

Figure 12: View of the partially collapsed ceiling in the cargo hold.

Figure 13: The aft cargo door in the closed position.

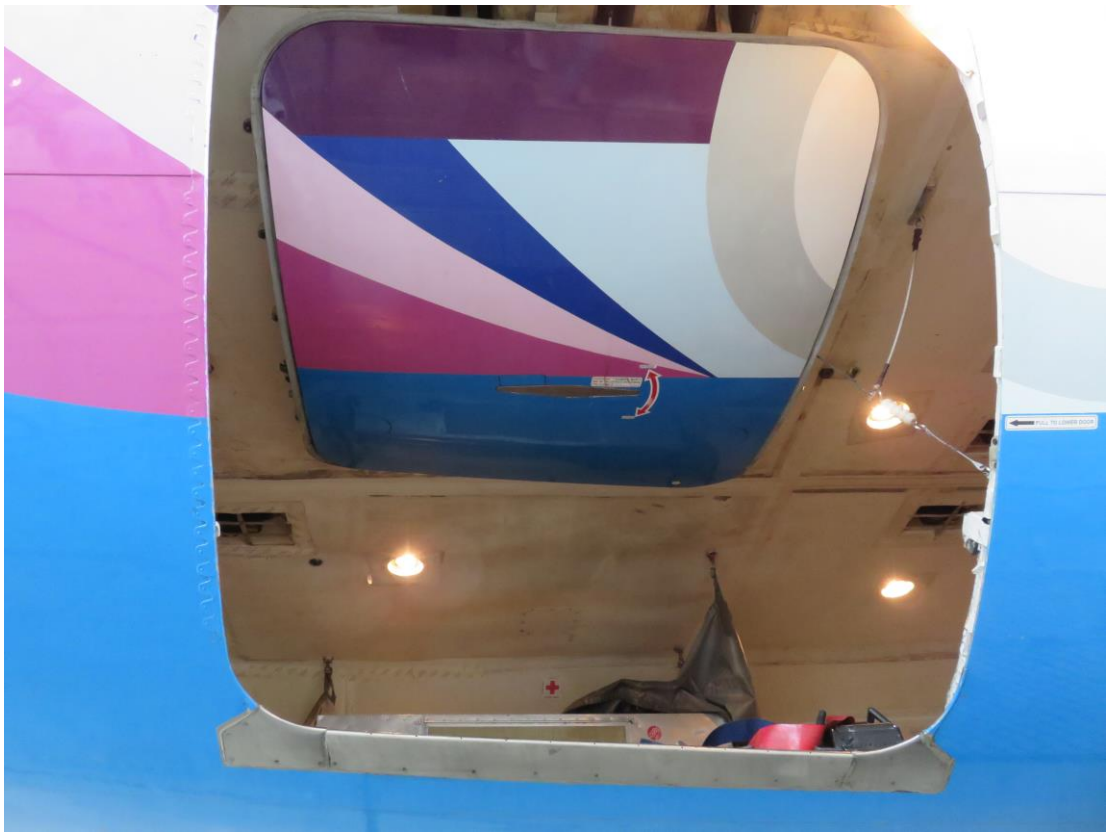


Figure 14: The aft cargo door in the open position. The photograph was taken from outside the aircraft.

Figure 15: The aft cargo door in the open position. The photograph was taken from inside the cargo hold.

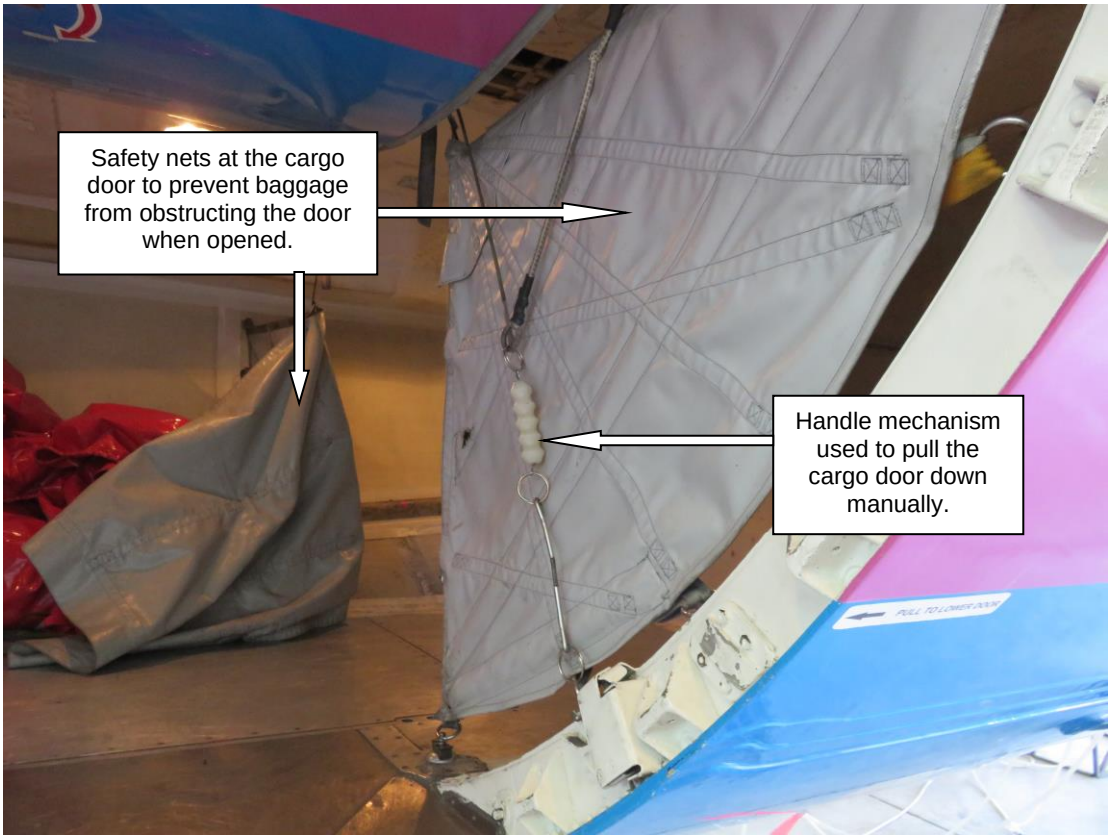


Figure 16: The handle mechanism used to pull the door down into the closed position.

Figure 17: A view of the aft cargo compartment forward section with safety nets removed.

1.17. Organisational and Management Information

1.17.1 The Operator was in possession of a valid Class 1 Air Service Licence No. S941D, which was issued on 26 March 2014 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.*

1.17.2 The Operator was in possession of a valid air operating certificate (AOC) No. CAA/N942D, which was issued on 26 April 2019 by the SACAA with an expiry date of 30 April 2020. The aircraft was duly authorised to operate under the AOC.

1.17.3 The aircraft maintenance organisation (AMO) which carried out the last maintenance inspection (A-check) prior to the incident flight was in possession of an approved AMO certificate number 1165 that was issued by the SACAA on 15 April 2019 with an expiry date of 31 March 2020.

1.18. Additional Information

1.18.1 Cabin Pressurisation

Source: https://en.wikipedia.org/wiki/Cabin_pressurization

Cabin pressurisation is a process in which conditioned air is pumped into the cabin of an aircraft, in order to create a safe and comfortable environment for passengers and crew flying at high altitudes. For aircraft, this air is usually bled off from the gas turbine engines at the compressor stage. The air is cooled, humidified, and mixed with recirculated air if necessary, before it is distributed to the cabin by one or more environmental control systems. The cabin pressure is regulated by the outflow valve.

Pressurisation becomes increasingly necessary at altitudes above 10 000 feet (3000m) above sea level to protect crew and passengers from the risk of a number of physiological problems caused by the low outside air pressure above that altitude. For private aircraft, crew members are required to use oxygen masks if the cabin altitude stays above 12 500ft for more than 30 minutes, or if the cabin altitude reaches 14 000ft at any time. At altitudes above 15 000ft, passengers are required to be provided oxygen masks as well. On commercial aircraft, the cabin altitude must be maintained at 8000ft (2400m) or less. Pressurisation of the cargo hold is also required to prevent damage to pressure-sensitive goods that might leak, expand, burst or be crushed on re-pressurisation.

1.18.2 Cargo door inspection

The forward and aft cargo doors are required to be subjected to an internal and external zonal inspection. The inspections are required to be performed with the cargo door in the open position as per the Boeing zonal inspection programme.

MPD ITEM NUMBER	ZONE	ACCESS	INTERVAL		APPLICABILITY		MAN-HOURS	TASK DESCRIPTION
			THRESH	REPEAT	APL	ENG		
52-828-01	117		4000 FC 18 MO	4000 FC 18 MO	ALL	ALL	0.08	*EXTERNAL - ZONAL (GV)*: Left Emergency Exit Hatch Perform an external zonal inspection (GV) of the left emergency exit hatch.
52-830-01	117	NOTE	18000 FC 8 YR	18000 FC 8 YR	ALL	ALL	0.17	*INTERNAL - ZONAL (GV)*: Left Emergency Exit Hatch Perform an internal zonal inspection (GV) of the left emergency exit hatch. ACCESS NOTE: Liner.
52-836-01	117A		4000 FC 18 MO	4000 FC 18 MO	400	ALL	0.08	*EXTERNAL - ZONAL (GV)*: Left Emergency Exit Hatch Perform an external zonal inspection (GV) of the left emergency exit hatch.
52-838-01	117A	NOTE	18000 FC 8 YR	18000 FC 8 YR	400	ALL	0.17	*INTERNAL - ZONAL (GV)*: Left Emergency Exit Hatch Perform an internal zonal inspection (GV) of the left emergency exit hatch. ACCESS NOTE: Liner.
52-840-01	209 219	NOTE	300 FC 40 DY	300 FC 40 DY	ALL	ALL	0.08	*EXTERNAL - ZONAL (GV)*: Doors Perform an external zonal inspection (GV) of the doors. ACCESS NOTE: From the ground, doors closed.
52-842-01	209	NOTE	1000 FC 100 DY	1000 FC 100 DY	ALL	ALL	0.03	*EXTERNAL - ZONAL (GV)*: Forward Cargo Door Perform an external zonal inspection (GV) of the forward cargo door. ACCESS NOTE: Door open.
52-844-01	209	4401 4402 4403	4000 FC 18 MO	4000 FC 18 MO	ALL	ALL	0.13	*INTERNAL - ZONAL (GV)*: Forward Cargo Door Perform an internal zonal inspection (GV) of the forward cargo door.
52-846-01	219	NOTE	1000 FC 100 DY	1000 FC 100 DY	ALL	ALL	0.03	*EXTERNAL - ZONAL (GV)*: Aft Cargo Door Perform an external zonal inspection (GV) of the aft cargo door. ACCESS NOTE: Door open.

Figure 18: Boeing 737-300/400/500 zonal inspection programme sheet.

1.19. Useful or Effective Investigation Techniques

1.19.1 No new methods were used.

2. Analysis

2.1 Man (Crew)

The crew was properly rated and qualified to conduct the flight. At approximately 1825Z, the crew declared an emergency by broadcasting a Mayday requesting an emergency descent on the VHF frequency 125.10MHz while under radar control due to decompression in the aircraft. Following the decompression incident, the crew manually fitted their oxygen masks and the oxygen masks in the cabin deployed automatically. The crew then followed the memory items as contained in Figure 1 of this report and was accommodated by radar control to conduct a

descending right-hand turn to FL100. The crew levelled off at FL100, 6 minutes and 7 seconds after an emergency was declared. The aircraft was given vectors to return to FACT.

An uneventful landing was executed on Runway 19 at FACT. The crew requested a visual external inspection of the aircraft fuselage after coming to a halt on the runway. No structural damage was noted during the visual external inspection of the aircraft and the crew taxied to the allocated parking bay where the passengers disembarked the aircraft normally.

2.2 Machine (Aircraft)

The forward and aft cargo doors of the Boeing 737 series aircraft open inward as illustrated in Figures 14 and 15. The cargo loaded in these cargo holds are mostly luggage/baggage from travelling passengers. The loading process is conducted manually where people from a baggage handling company (external service provider) physically load the baggage in the cargo hold and unload it after every flight. During the loading and unloading process, the cargo door and, especially, the cargo door pressure seal could get damaged. The pressure seal is an on-condition item that needs to be replaced when any damage is noted which could lead or cause a leakage of pressurised air during flight.

With the cargo door in the open position, the cargo door pressure seal can only be inspected when a person physically climbs into the cargo hold and inspect the door as well as the pressure seal. It is not possible to conduct a detailed inspection of the cargo door pressure seal from the outside (with the door in the closed position).

Both the forward and aft cargo doors close manually on this aircraft type. For this purpose, Boeing has provided a door-closing mechanism on the right side of the door (when standing outside looking into the cargo hold as illustrated on Figure 16), whereby an individual has to physically pull the door down via the handle mechanism provided. It was noted by the investigator during an inspection of the aircraft that to get hold of the handle, a person needs to be relatively tall. A short person will require a stand to elevate him/her from the ground or might have to jump and grab the handle and will then have to apply substantial force to pull the door down. Even for the investigator, who is 1.88m tall (6ft 2 inches) the handle mechanism was just in reach standing on the ground outside the aircraft.

Once inside the cargo hold, the investigator had to be on his knees or had to sit on the floor as there was not adequate space to stand upright. The physical loading process within the cargo hold would most probably be easier for shorter people, the problem then comes when the cargo door needs to be closed. It is possible that the last person to vacate the cargo hold grabbed the door at the bottom by hand, which put pressure on the door pressure seal, and he or she might have physically pulled the door down as he/she exited the aircraft, not making use of the handle mechanism on the right-hand side. The door was then secured (locked) from the outside by means of an external handle mechanism.

Another way the door pressure seal could potentially be damaged is when the safety nets that are required to be installed in the cargo hold to secure the baggage are in a dilapidated state or when the nets are not properly secured prior to the door being closed and during flight baggage obstructing the cargo door path when being opened. The area in the cargo hold where the door opens (directly behind the cargo door) should be free from any obstructions, and no baggage is to be packed/stored in that area. It is highly unlikely that the cockpit crew will be aware if any of the cargo door pressure seals have been damaged during loading or unloading as they do not leave the cockpit to inspect the aircraft during a turnaround. If there is any damage to the door pressure seal and the baggage handling company personnel does not report it via the correct channels during a routine turnaround flight, it is highly unlikely that anybody will notice unless the aircraft is being subjected to a maintenance inspection. It should be noted that the pressure seal is an on-condition item that needs to be physically inspected for degradation. According to the aircraft manufacturer, there were no SBs or ADs issued on the cargo door pressure seals by the time this incident occurred.

The last maintenance inspection that was carried out on the aircraft prior to the incident flight was an A-check inspection that was certified on 8 August 2019. Since the inspection, the aircraft had flown a further 97.5 hours.

Approximately 84 centimetres (cm) of the cargo door pressure seal (entire bottom section – with door in the closed position) had separated during an inspection of the aft cargo door as a section of the seal was found protruding from the door while in the closed position. The ceiling in the cargo hold also displayed evidence of collapse as a result of the air that escaped from the pressurised fuselage when the seal finally failed and the pressure exited (was sucked out) the door structure.

2.3 Environment

Fine weather conditions prevailed at the time of the flight. The weather was not considered to have had any bearing on the incident.

2.4 Mission

This was a scheduled domestic passenger flight from FACT to FALE. Approximately 15 minutes into the flight, the crew heard two loud thuds from the rear of the aircraft, followed by a decompression incident. The crew declared an emergency by broadcasting a Mayday, followed the memory items and descent to FL100. Oxygen masks deployed automatically in the cabin and the cockpit crew members fitted theirs manually.

2.5 Investigation revealed

The aircraft did not suffer from any external fuselage damage that could have caused the rapid decompression incident. Available evidence indicated that the bottom section of the aft cargo door pressure seal, approximately 84cm in length, failed and could not be located, probably sucked out during the flight. A section of the cargo hold ceiling was also found collapsed. It could, therefore, not be ruled out that the cargo door pressure seal was damaged prior to the flight. The cargo door was closed by a member of the baggage handling agent after the baggage was loaded. The person did or maybe did not observed the damage and had proceeded to close the door without reporting it. As a result, pressurised air leaked into the atmosphere to an extent that the aircraft pressurisation system could not keep up with the supply to maintain a safe and comfortable environment for passengers and the crew members.

3. Conclusion

3.1 Findings

3.1.1 The PIC was the holder of a valid airline transport pilot licence; he had the aircraft type endorsed in his licence. He had been issued a class 1 aviation medical certificate on 12 April 2019 with an expiry date of 30 April 2020.

3.1.2 The FO was in possession of a valid commercial pilot licence; he had the aircraft type endorsed in his licence. He had been issued with a class 1 aviation medical certificate on 29 January 2019 with an expiry date of 31 January 2020.

3.1.3 The crew declared an emergency by broadcasting a Mayday approximately 15 minutes after take-off from FACT. At that stage, the aircraft was in radio communication with Cape Town West radar on the VHF frequency 125.10MHz.

3.1.4 Following the Mayday call, the crew requested *"an emergency descent"* and asked to return to FACT. The radar controller cleared the aircraft to commence with a right turn and the crew initiated an emergency descent to FL100.

3.1.5 The aircraft had been issued a Certificate of Airworthiness (C of A) on 2 September 2016 with an expiry date of 30 September 2019.

3.1.6 The aircraft had been issued a Certificate or Release to Service on 8 August 2019 at 62 581.00 airframe hours. The certificate was valid until 62 881.00 airframe hours.

3.1.7 The last maintenance inspection (A-check) that was carried out on the aircraft prior to the incident flight was certified on 8 August 2019 at 62 581.00 airframe hours. Following the inspection, a further 97.5 airframe hours were flown with the aircraft.

3.1.8 The forward and aft cargo door seal can only be inspected if a person physically climbs into the cargo hold as the door opens inward. It is not possible to conduct a detailed inspection of the cargo door seal from the outside with the door in closed position.

3.1.9 No data from the FDR or CVR was downloaded for this investigation.

3.1.10 Fine weather conditions prevailed at the time, which had no bearing on the incident.

3.1.11 The operator was in possession of a valid Air Service Licence No. S941D that was issued by the Department of Transport on 26 March 2014.

3.1.12 The Operator was in possession of a valid air operating certificate (AOC) No. CAA/N942D, which was issued on 26 April 2019 by the SACAA and had an expiry date of 30 April 2020. The aircraft was duly authorised under the AOC.

3.1.13 The aircraft landed safely at approximately 1857Z; no injuries were reported.

3.1.14 The investigation revealed that the rapid decompression was a result of the failed lower part of the aft cargo door pressure seal (approximately 84cm in length). As a result, pressurised air leaked into the atmosphere to an extent that the aircraft pressurisation system could not keep up with the supply to maintain a safe and comfortable environment for the passengers and the crew members.

3.2 Probable Cause

3.2.1 The rapid decompression was caused by the failure of the aft cargo door pressure seal. The failure of the pressure seal was most likely attributed to manhandling of the door during cargo/baggage handling, which is conducted manually (by hand) before and after each flight.

4. Safety Recommendations

Safety actions that were taken by the Operator:

4.1 Following the incident, the operator/aircraft maintenance organisation had implemented the following remedial action to prevent a reoccurrence of this type of incident.

(i) Fleet wide inspection carried out on all forward and aft cargo door pressure seals.

(ii) Implementation of a daily and weekly inspection of cargo door pressure seals.

(iii) All cargo nets, clips and anchor points to be inspected for condition and to ensure the nets provide the necessary protection (prevent baggage within the area where the cargo needs to open and close).

(iv) The cargo door seal will be replaced on every aircraft C-Check inspection.

4.2 Following the incident, the operator consulted with the baggage handling company (external service provider) to ensure they comply with the following:

(i) The cargo door has a specially designed handle on the right side with the door in the open position that should be used to pull the door down into the closed position. Personnel that close the cargo doors need to make use of this handle. Personnel should NOT pull the door down by hand from the inside as this could damage the door pressure seal. (It was noted during an inspection on the aircraft that it might be difficult for 'shorter' people to get a grip of the handle to pull it down unless the person is slightly elevated from the ground).

(ii) The cargo nets used inside the cargo hold need to be correctly fitted and secured by the baggage handlers before the cargo door is closed. This is essential to ensure the cargo door pressure seal, especially the bottom part, does not get damaged by baggage that may move during flight. With the door opening inwards, the immediate area behind the door needs to be free of obstruction to prevent damage to the door pressure seal.

5. Appendices

5.1 Annexure A (Communication between radar controller and SFR461)

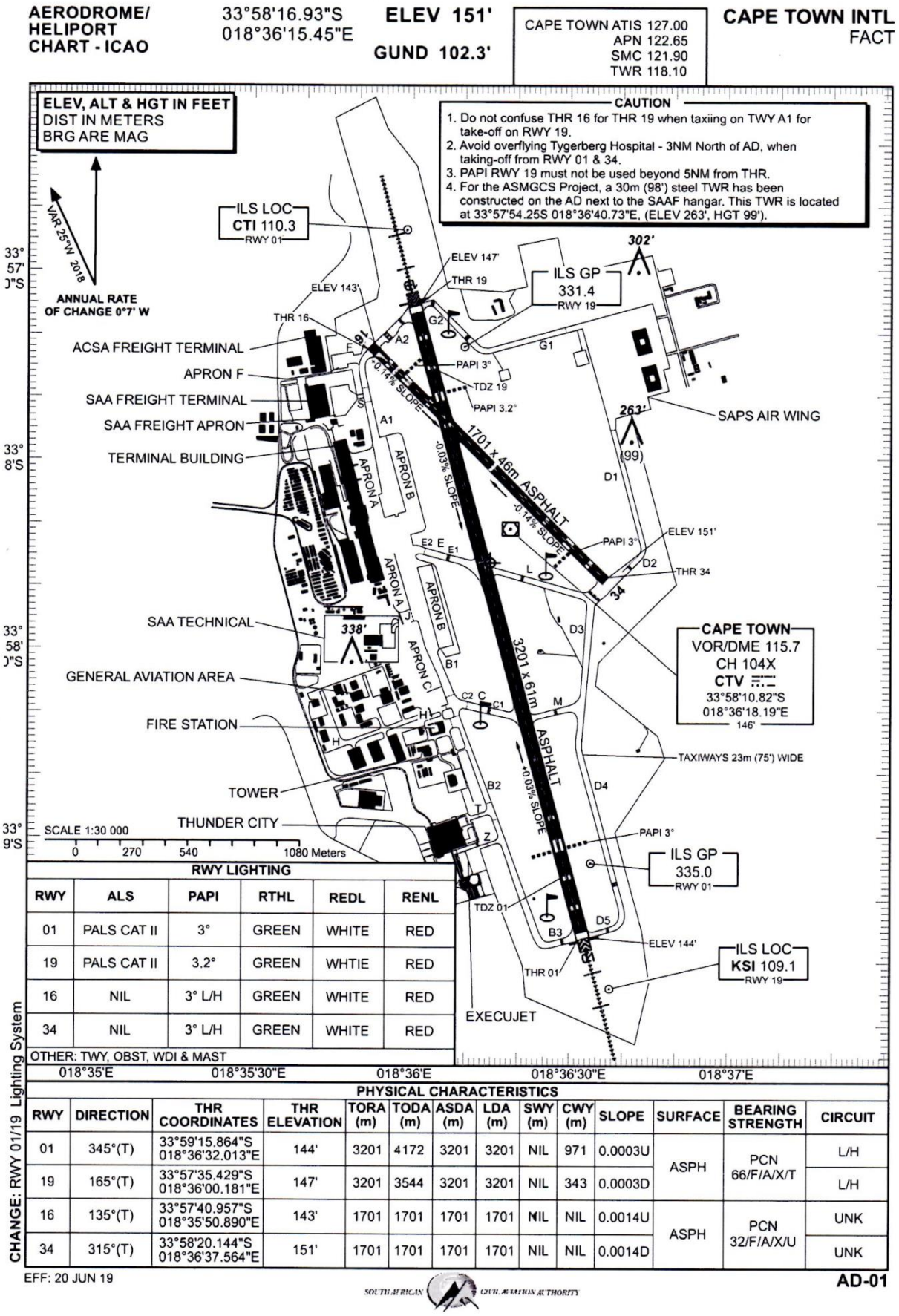
5.2 Annexure B (Aerodrome chart for FACT)

ANNEXURE A

This is a transcript of the communication between Cape Town Radar West and the first officer of the aircraft ZS-JRM (Boeing 737-400). The frequency in use was 125.10 MHz.

Time	From	To	Message
18:15:16	ZS-JRM	Radar	Good evening, Safair 461 climbing flight level 150
18:15:20	Radar	ZS-JRM	Safair 461, good evening, climb to flight level 330
18:15:25	ZS-JRM	Radar	Climbing flight level 330, Safair 461
			---- Intentionally left blank ----
18:25:04	ZS-JRM	Radar	Mayday Mayday …..Mayday, Safair 461, emergency descend
18:25:10	Radar	ZS-JRM	Safair 461 you are cleared for an unrestricted descent, there is no conflicting traffic, report intentions when you ready?
18:25:23	Radar	ZS-JRM	Safair 461 no need to acknowledge once again you are cleared for the descend at your discretion, no conflicting traffic.
18:25:43	ZS-JRM	Radar	Safair 460 descending, …… due to pressurization
18:25:50	Radar	ZS-JRM	Copied, there is no reported traffic outside of controlled airspace, and no reported traffic for the descent to flight level 110 if required.
18:25:58	ZS-JRM	Radar	Descent 110, request vectors back for Cape Town, Safair 461
18:26:02	Radar	ZS-JRM	Any preferred turn, left or right?
18:26:04	ZS-JRM	Radar	Right turn please, Safair 460
18:26:07	Radar	ZS-JRM	Right turn, heading 280, right turn heading 280
18:26:13	ZS-JRM	Radar	Right turn heading 280, Safar 461
18:29:17	Radar	ZS-JRM	Safair 461, is level 110 good for you, or would you like lower, the lowest you can go is probably 90 for the terrain
18:29:26	ZS-JRM	Radar	Okay just confirm level 90, Safair 460
18:29:30	Radar	ZS-JRM	Let's make it level 100 if that is happy with you.
18:29:34	ZS-JRM	Radar	Okay level 100, Safair 461
18:30:11	Radar	ZS-JRM	Safair 461, for positioning vectors runway 19, fly heading 300
18:30:18	ZS-JRM	Radar	Heading 300, Safair 461
18:32:07	Radar	ZS-JRM	Safair 461, no rush when you are ready, your persons on board and fuel please?
18:32:10	ZS-JRM	Radar	Standby, Safair 461
18:32:34	ZS-JRM	Radar	Safair 461, we have 134 souls on board, 6 crew and 7½ tons.
18:32:46	Radar	ZS-JRM	Okay understand, pax on board 134, crew on board 6, and 7½ tons
18:32:51	ZS-JRM	Radar	Affirm, Safair 461. We are off the contingent now and can except the vectors, Safair 461.
18:33:06	Radar	ZS-JRM	Okay Safair 461, are you happy with the Charlie Bravo for the visual or will you prefer the ILS?
18:33:12	ZS-JRM	Radar	Vectors for the ILS please, Safair 461.
18:33:27	Radar	ZS-JRM	Safair 461, that heading is actually perfect you can expect further headings from Approach.
18:33:32	ZS-JRM	Radar	Thank you Sir, Safair 461.

ANNEXURE B



RWY LIGHTING

RWY	ALS	PAPI	RTHL	REDL	RENL
01	PALS CAT II	3°	GREEN	WHITE	RED
19	PALS CAT II	3.2°	GREEN	WHTIE	RED
16	NIL	3° L/H	GREEN	WHITE	RED
34	NIL	3° L/H	GREEN	WHITE	RED

OTHER: TWY, OBST, WDI & MAST

PHYSICAL CHARACTERISTICS

RWY	DIRECTION	THR COORDINATES	THR ELEVATION	TORA (m)	TODA (m)	ASDA (m)	LDA (m)	SWY (m)	CWY (m)	SLOPE	SURFACE	BEARING STRENGTH	CIRCUIT
01	345°(T)	33°59'15.864"S 018°36'32.013"E	144'	3201	4172	3201	3201	NIL	971	0.0003U	ASPH	PCN 66/F/A/X/T	L/H
19	165°(T)	33°57'35.429"S 018°36'00.181"E	147'	3201	3544	3201	3201	NIL	343	0.0003D			L/H
16	135°(T)	33°57'40.957"S 018°35'50.890"E	143'	1701	1701	1701	1701	NIL	NIL	0.0014U	ASPH	PCN 32/F/A/X/U	UNK
34	315°(T)	33°58'20.144"S 018°36'37.564"E	151'	1701	1701	1701	1701	NIL	NIL	0.0014D			UNK

CHANGE: RWY 01/19 Lighting System

EFF: 20 JUN 19

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

AD-01