Civil Aviation Authority
Safety Investigation Board
(SIB)

Investigation Report of Boeing 737-340 Aircraft Pressurization Failure

Authority: Director General of Civil Aviation Authority
Memo No. HQCAA/1901/285/SIB dated 17 -06-03

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1. Aircraft Information

1.1 Aircraft type: Boeing 737-340

1.2 Registration Mark: AP-BCD

1.3 Year of construction of airframe: June 1985

1.4 Weight of Aircraft: 69981 kg

1.5 C of G: Within limits

1.6 Owner & address: M/s PIAC, Jinnah Int'l Airport, Karachi, Pak.

Airframe details:

1.5 Airframe serial number: 23297

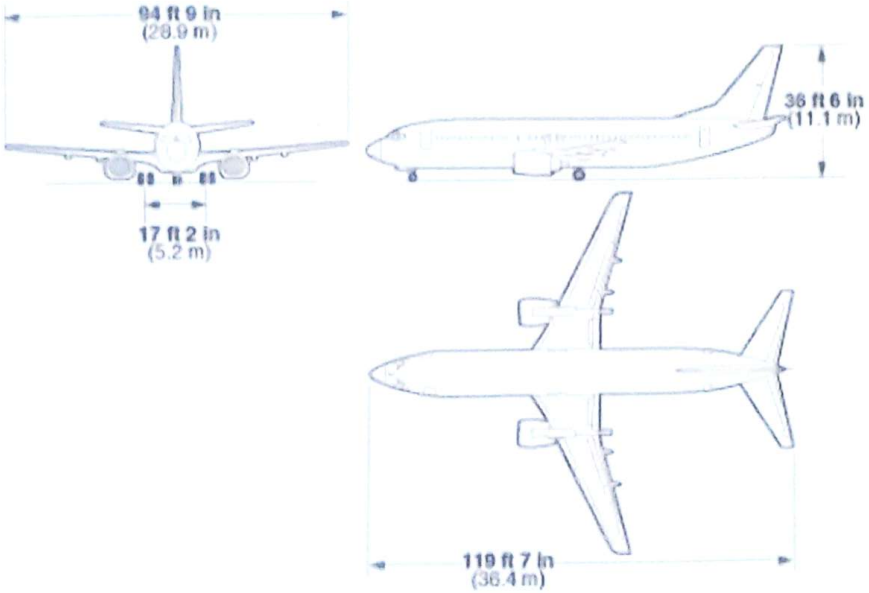
1.6 Airframe flying Hours Since New: 43120:30 hrs

1.7 Airframe cycles / landings: 38056 / 37945

1.8 Year of Manufacturer: June 1985

1.9 Design Service Objective (DSO): 51,000 FH / 75,000 Cycles (Appendix 'A')

Dimensions:



Engine details:

1.10 Engine types: CFM56-3B2

1.11 Engine serial No.: Eng No. 1 (720241) and Eng. No. 2 (720231)

Aircraft Documentation:

1.12 Air Operating Certificate No.: AOC-003/96 AL dated 01.01.03 / Valid up to 31st Dec 2003 (Appendix 'B').

1.13 Certificate of Registration No.: 579 (Appendix 'C').

1.14 Certificate of Airworthiness No. / date of expiry: 532 / 24.06.2004 (Appendix 'D').

1.15 Radio Installation Cert No.: RC/AP-BCD/AW (Appendix 'E').

1.16 Mobile License No.: W.16-1/55 dated 21.10.85 / Valid up to 31st Dec 2003 (Appendix 'F').

1.17 Weight & Balance Schedule Approval No.: CAW/BCD-II/ACFT dated 15.02.97 / Valid up to 12.01.05 (Appendix 'G')

2. Crew Information:

2.1 Number of Crew: 02 Cockpit crew and 06 Cabin crew

Pilot in Command:

Date of Joining PIAC:	Feb 1988
Position in Cockpit:	Left side
Medical Status:	Fit
Date of Birth:	14th July 1954
Type of Licence:	ALTP
Licence Number:	907
Ratings:	
Type/s Held:	Cessna 150, F-27, A310 and B737
Type Current:	Boeing 737-340
Assist/Flt Instr. Rating:	Fokker F-27
Check Rating:	Fokker F-27
Flying Experience:	
Grant Total:	10,500 hrs (approx)
Total in Command:	6500 hrs
Total in Command on B737:	600 hrs (P2) and 700 hrs (P1)
Where Trained:	Technical (Pakistan) / Simulator (UK)
Last Training (Name of Equip):	August 2001 on Fokker F-27

First Officer:

Date of Joining PIAC:	Mar 1996
Position in Cockpit:	Right side
Medical Status:	Fit
Date of Birth:	02nd Jan 1962
Type of Licence:	CPL
Licence Number:	2123
Ratings:	
Type/s Held:	Cessna 172 and Fokker F-27
Type Current:	Boeing 737-340
Assist/Flt Instr. Rating:	-
Check Rating:	-
Flying Experience:	
Grant Total:	2860 hrs (approx)
Total in Command:	163 hrs
Total in Co-pilot on B737:	1100 hrs
Where Trained:	Simulator (UK)
Last Training (Name of Equip):	Mar 2003 on Boeing 737-340

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3. History of Flight

3.1 On 14th June 2003 Boeing 737-340 aircraft (AP-BCD) departed from Islamabad to Lahore. During cruise, the crew experienced an increase in the left duct pressure (60 psi), whereas the right duct pressure was within the limits (40 psi). The crew kept the air mixture valve on maximum (full cold position), but the cabin temperature continued to increase. Ventilation of the cabin was normal with both the air conditioning packs on 'High' position. On ground, the heat exchanger was serviced and then the packs performances were checked as per maintenance manual. Both packs were found to be satisfactory by the Aircraft Maintenance Engineer. The aircraft flew 05 sectors flight without encountering any problem related to the air conditioning and pressurization system.

3.2 On 15th June 2003, the aircraft took-off from Islamabad International Airport for Quetta. At Quetta International Airport, the concerned Aircraft Maintenance Engineer carried out the routine transit check and released the aircraft for its return journey to Islamabad. A load sheet (Appendix 'H') indicating details of the total load, zero fuel weight, take-off weight, souls onboard, center of gravity limits, etc was prepared by the traffic staff and signed by the pilot in command. Based on the total traffic load and the fuel onboard, the aircraft was cleared to operate at a fuel efficient flight level, which was FL370 (Appendix 'J'). At 1027 UTC, the aircraft departed Quetta for Islamabad with 127 passengers and 08 crew members onboard.

3.3 The aircraft took 27 minutes to reach its assigned ceiling. At 1054 UTC, when the aircraft reached FL 370, the cockpit crew requested for flight level 230 due to technical problem (Appendix 'K'). The time duration of different flight segments is given below in tabular form:

S.No	Segments of Flights	Time in UTC	Time consumed
1.	Take off to FL 370	1127 - 1054	27 minutes
2.	Level maintained at FL 370	1054 - 1057	03 minutes
3.	Descended from FL 370 – FL 130	1057 – 1107	10 minutes
4.	Level maintained at FL 130	1107 – 1119	12 minutes
5.	Descended from FL 130 – FL 90	1119 - 1122	03 minutes

Note – As per CAR 94 rule no. 249, Oxygen is required above FL 100

3.4 The cockpit crew had experienced a pressurization failure at FL 370 and reported that the left bleed trip off light had come 'ON', for which the checklist (Appendix 'L') regarding the bleed trip off light was carried out. Despite carrying out the checklist, the cabin altitude started climbing at a rate of 500 ft/min, then 1000 ft/min and finally 2500 ft/min. The pilot reported that the manual mode was found to be unserviceable due to which the pressurization could not be manually controlled, hence rapid de-pressurization occurred (Appendix 'M'). The emergency descend checklist (Appendix 'N') was carried out before descending to a safe altitude.

3.5 In the passenger cabin, the oxygen masks dropped. Cabin crew log book stated that the oxygen masks at seat number 28JKL, 41BC, 42JKL, 45ABCJKL, 46ABC, and 51ABCJKL were unserviceable. At 1140 UTC the aircraft landed at Islamabad International Airport.

4. Maintenance and operational checks at Islamabad

4.1 On arrival, no external abnormality was observed by the ground engineer. All doors including E/E door were found closed. Outflow valves were found in full open position. Oxygen generator checked and found used, except for seat No. 28JKL.

4.2 Ground run with both the engines were carried out. At the same RPM, No 1 engine bleed pressure was unregulated. No 1 engine bleed pressure was 60 psi and No 2 engine bleed pressure was 40 psi. Performance of both the air conditioning packs were checked and found satisfactory. Pressurization in Auto, Standby and Manual modes were checked and found satisfactory. Pressurization checks and oxygen mask function check were carried out and found satisfactory. Bleed No. 1 was carried forward to base as per MEL Chapter 36-01, Item 05, Category 'C'. Passenger oxygen system carried forward to base as per MEL Chapter 35-02, Item 05, Category 'B'. Aircraft was released for ferry flight to Karachi (Refer item 36 to 39 of Appendix 'O').

5. Ferry Flight from Islamabad to Karachi

5.1 The aircraft ferried by a different cockpit crew. During the ferry flight, the pilot reported that at FL240, the pressurization did not hold the required cabin altitude in any mode (out flow valve was fully closed). The cabin altitude reached 7800 ft and was still climbing at a rate of 200 – 300 ft/min. The duct

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pressure was fluctuating between 34-40 psi, with the air conditioning pack at 'High' position.

5.2 A descent was made to FL 180. The cabin altitude remained at 7800 ft with the duct pressure fluctuating between 34-40 psi and the air conditioning pack at 'High' position. When the aircraft descended from FL 180 the cabin did not descend. The cabin started descending simultaneously with the aircraft altitude below 3000 ft (Refer item 44 to 47 of Appendix 'P').

6. Maintenance at Karachi Base

6.1 On 16 June 2003 left engine bleed regulator was replaced by AME No. 1676. The pneumatic system leak check was carried out by the same AME and was found to be satisfactory. The bleed air operation check during ground run was carried out by AME No. 1505 which was also found to be satisfactory. The details given in technical log for this particular check were very sketchy with no exact parameter (tech log Refer item 48 of Appendix 'Q'). This was compared to the defect entered by the AME at Islamabad which was carried out under the supervised of an Airworthiness official (Refer items 44 to 47 of Appendix 'P').

6.2 On the same day during the defect rectification a second ground run was carried out and the following anomalies were observed by the Aircraft Maintenance Engineer (Refer item 58 to 60 of Appendix 'R'):

6.2.1 Engine No. 1 bleed pressure was crossing limits and was 62 psi.

6.2.2 After putting engine No. 1 bleed switch to 'Off' position, engine No. 1 bleed did not turn off.

6.3 As a result of the above, the cabin pressure controller and temperature sensor were replaced and cabin pressure decay rate was checked by AME and found satisfactory (Refer item 61, 62 and 69 of Appendix 'S').

6.4 AME No. 1679 carried out Pneumatic system leak check and found PRSOV leaking at Diaphragm. The leak check of pneumatic system was carried out again after replacing PRSOV and found satisfactory. AME No. 1681 carried out the bleed system operation checks and found following readings (Refer item 83 of Appendix 'T'):

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6.4.1 At idle RPM the No. 1 bleed pressure was 22 psia.

6.4.2 AT 80% N1 the No. 1 bleed pressure was 50 psia.

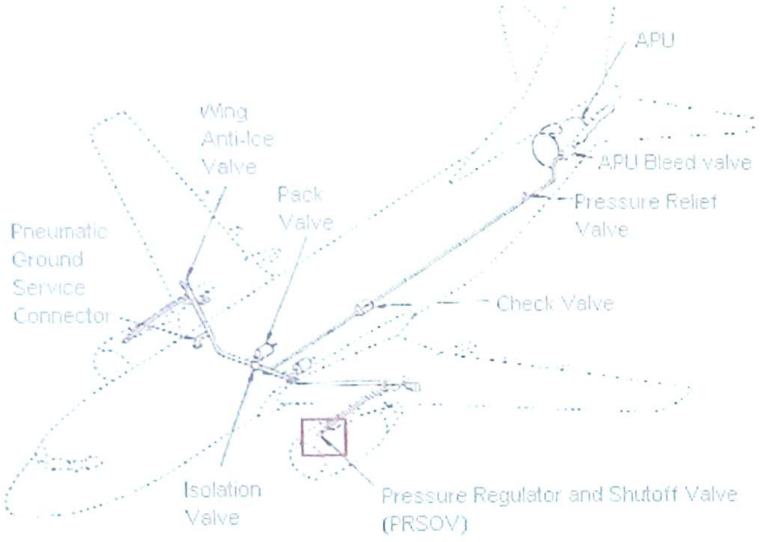
7. Shop check at Base

7.1 The bleed air regulator (Time Since Installed: 6402 hrs), Shut of Valve (Time Since Installed: 563 hrs) and Cabin pressure controller (Time Since Installed: 243 hrs) were all found satisfactory (Appendix 'U'). This was witnessed by the investigating team.

8. Brief description of the air conditioning and pressurization system:

8.1 The air conditioning system provides conditioned air to the control cabin, passenger cabin, electronic equipment compartment, forward cargo compartment, air conditioning distribution bay and aft cargo compartment. The air supply to the air conditioning system is furnished by the pneumatic system from either engine bleed air or auxiliary power unit (APU) in flight and conditioned by two separate and independent cooling packs.

8.2 Conditioned air pressurizes the aircraft. The rate of air exhausted from the airplane is controlled by the pressurization system. The pressurization system controls altitude by regulating air flow from the fuselage through the outflow valves.



Pneumatic System Location

8.3 The pressurization control system includes pressurization control, pressurization relief valves, and pressurization indicators and warning. Cabin

pressure is controlled by positioning a cabin pressurization outflow valve to meter the cabin air exhaust. The valve operates electrically from three control systems.

- AUTO- Automatic, fully automatic, normal mode
- STBY- Standby, semi-automatic , in case of AUTO failure
- MAN AC- Manual AC, manual control using AC power
- MAN DC- Manual DC, manual control using DC power

8.4 Auto mode provides automatic pressure control of cabin altitude and rate of altitude change based on settings made to the pressurization control panel (P5). Standby mode provides semi-automatic control of cabin altitude and rate of altitude change, based on the settings of the pressurization control panel (P5) of cabin altitude and rate selected. Manual mode provides control of cabin altitude and rate of altitude change by selecting MAN AC or MAN DC and operation of a three position (CLOSE-OFF-OPEN) manually operated toggle switch.

8.5 Normal control is from the AUTO system. Pressurization relief valves include two safety relief valves, which prevent over pressurizing the airplane, and a vacuum relief valve which prevents pressure inside the airplane becoming appreciably less than ambient pressure. In addition to the relief valves, pressure equalization valves are installed in both cargo compartments to provide a quick method of allowing cargo compartment pressure to vary with cabin pressure. Blowout panels are used in both cargo compartments to protect against a sudden differential in pressure between the cargo compartment interior and exterior. Indicators are provided to allow monitoring cabin altitude, differential pressure, and rate of pressure change. A cabin altitude warning system sounds a horn if cabin altitude exceeds approximately 10,000 feet.

8.6 *Pressure Regulator / Shutoff Valve (PR/SOV):* A regulated pressure of 25 psi is supplied to the chamber 'A' to overcome the spring force which further opens the butterfly valve. Downstream pressure applied to the actuator chamber 'B' modulates the butterfly valve towards closed until chamber 'A' is balanced by chamber 'B' pressure plus the spring force. This occurs at a downstream pressure of 45 plus minus 4 psi. The butterfly valve

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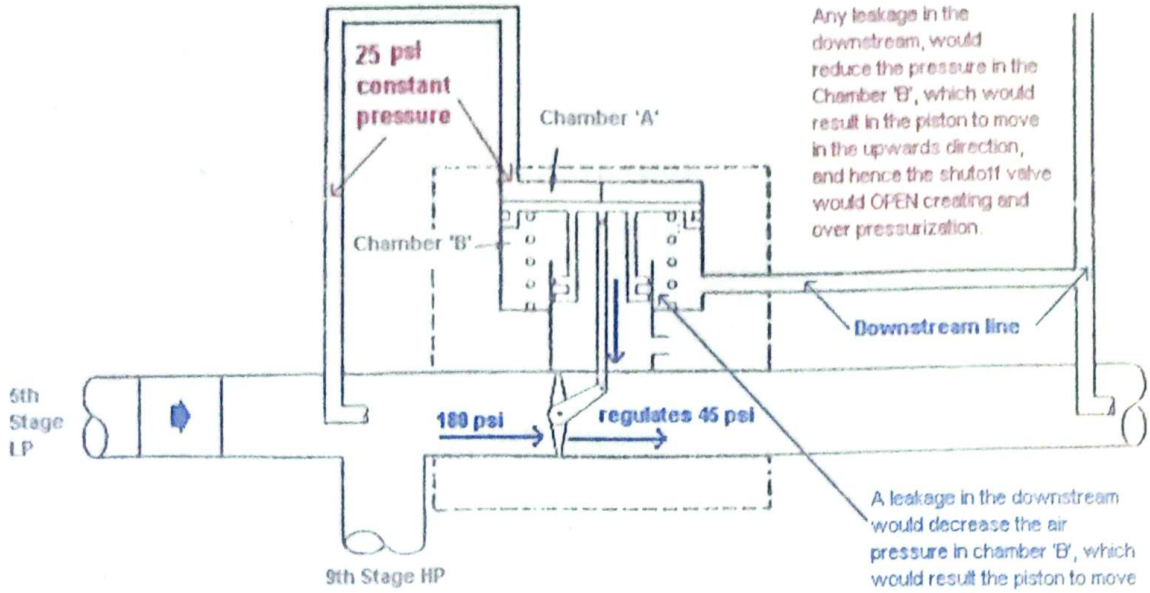
automatically compensates for the upstream fluctuations or downstream flow demand. The latching solenoid controls bleed air flow from the engine by directing pneumatic pressure to chamber 'A' to open the butterfly valve or venting the chamber 'A' to the atmosphere to close the butterfly valve (Refer figure below).



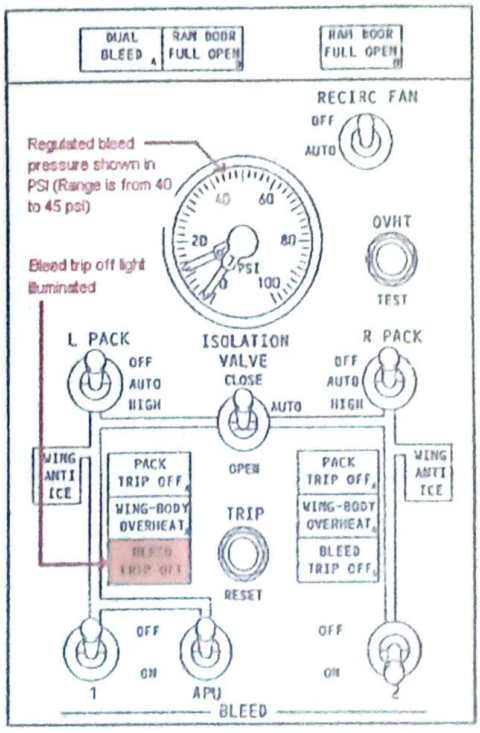
Pressure Regulator and Shutoff valve

9. Investigation / Findings:

9.1 The aircraft was manufactured in June 1985 and has a design service objective (DSO) (set by the manufacturer) up to 51,000 flight hours for Boeing 737 aircraft. The design service objective (DSO) is a reference point used by the designer with the goal of the structure being essentially free of detectable fatigue cracks up to the DSO. The aircraft has flown a total of 43120:30 hours and has consumed 84.5% of its DSO (Appendix 'A').

9.2 At FL 370, the crew experienced pressurization problem. The left bleed trip off light illuminated, which indicated that the related engine bleed air temperature or pressure had exceeded its limits. To establish the fact whether the light illuminated due to high temperature or over-pressurization, the reset switch is first pressed as per checklist. By pressing the reset switch, the bleed air temperature cools below limits. In this case, after pressing the reset switch, the bleed trip off light did NOT extinguish which indicated that the pressure regulator / shutoff valve (PR/SOV) automatically closed due to over pressure. The upstream bleed air had exceeded 180 psi and the pressure regulator could not regulator 45 psi.

Bleed trip off light



Pneumatic System Controls

9.3 The aircraft has two air conditioning packs, each receives compressed air from both the engine bleed which pass through the pressure regulator and shutoff valve (PR/SOV). The normal downstream pressure setting is 45 psig. Over-pressure protection is provided by the over-pressure switch. If the bleed pressure exceeds 180 plus minus 10 psig, the over-pressure switch activities the PR/SOV shutoff solenoid which causes the PR/SOV to close and the bleed trip light comes 'ON'. Hence the air supply from that engine is stopped. The pressurization is then maintained by a single bleed, which is capable to supply air to both the packs. The pneumatic system is capable to pressurize the aircraft with two packs from a single bleed (Appendix 'V').

9.4 When the air supply from the left bleed was automatically closed due to un-regulator bleed air, the aircraft was flying at FL370. At this altitude, the air density is thin. Initially the cabin altitude climbed since the supply from one bleed was cut off and it would have taken time for the second bleed to maintain pressurization. During this time the cockpit crew switched from Auto mode to manual mode and tried to maintain the pressurization manually. As per ATC readout and DFDR, the cockpit crew took 03 minutes from the time the light came 'ON' till they initialed the descent. By that time the cabin started climbing at a rate of 500 ft/min, which went up to 2500 ft/min during descending to FL 130.

9.5 At FL 370, the bleed trip off light illuminated and the cockpit crew carried out the Bleed Trip Off checklist. As per this checklist, the affected pack was switched 'Off'. After turning the pack, the cabin altitude started climbing at a high rate. The crew tried to control the cabin altitude manually, but could not maintain the pressurization. As per MEL Chapter 21-1 Item 1, the aircraft is allowed to operate with a single pack but is restricted to a lower altitude (i.e. FL 250 max) where the air density is comparatively thicker, then the air density at FL 370.

9.6 The pilot reported that the manual mode was unserviceable, whereas during ground run the pressurization was found satisfactory in all modes. In Auto mode, a single pack can maintain normal cooling and pressurization needs only if the cabin decay rate is within limits.

9.7 The emergency descent was carried out by the cockpit crew. While descending, ATC asked the cockpit crew for any ground assistance, however,

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cockpit crew declined for any ground assistance. As per DFDR, the aircraft reached to FL 9928 ft in 24 minutes. The oxygen available for a passenger is 10 minutes, whereas, the pilot took 24 minutes to reach a safe altitude of 10,000 ft or below (As per emergency decent check list the aircraft should be brought down to lowest safe altitude or 10,000 feet whichever is higher).

S.No	Segments of Flights	Time in UTC	Time consumed
1.	Take off to FL 370	1127 - 1054	27 minutes
2.	Level maintained at FL 370	1054 - 1057	03 minutes
3.	Descended from FL 370 - FL 130	1057 - 1107	10 minutes
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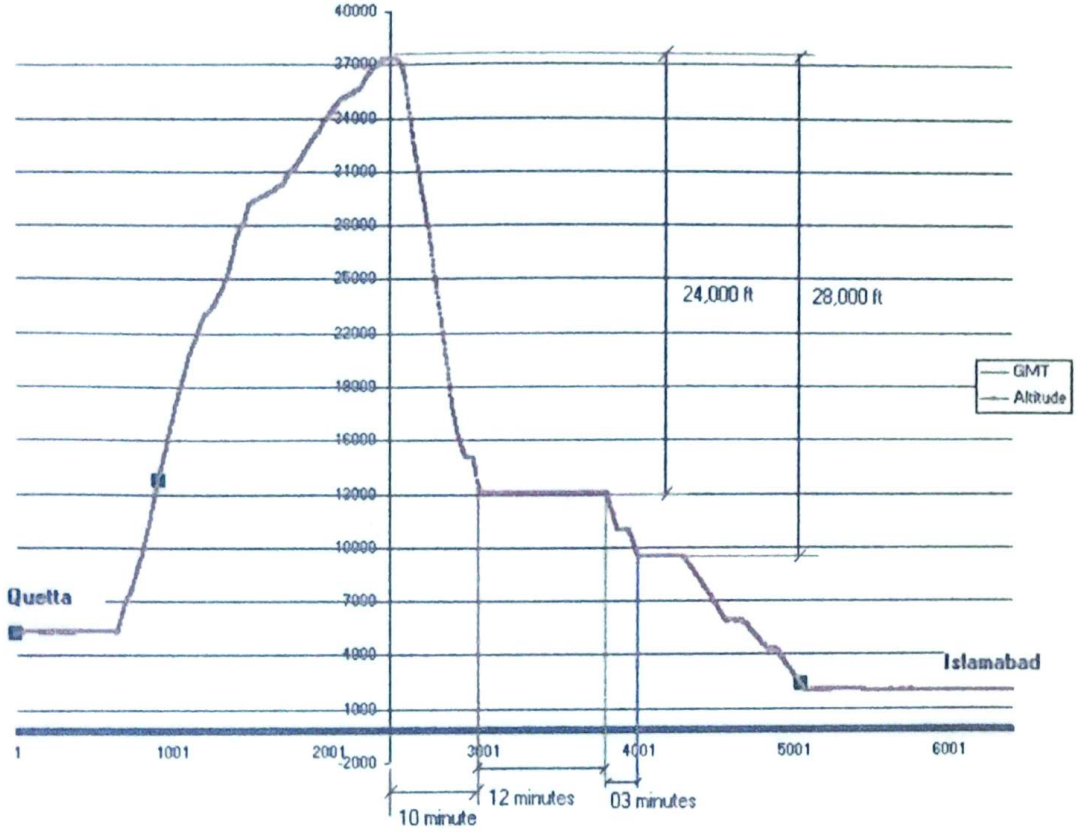
Note - As per CAR 94 rule no. 249, Oxygen is required above FL 100

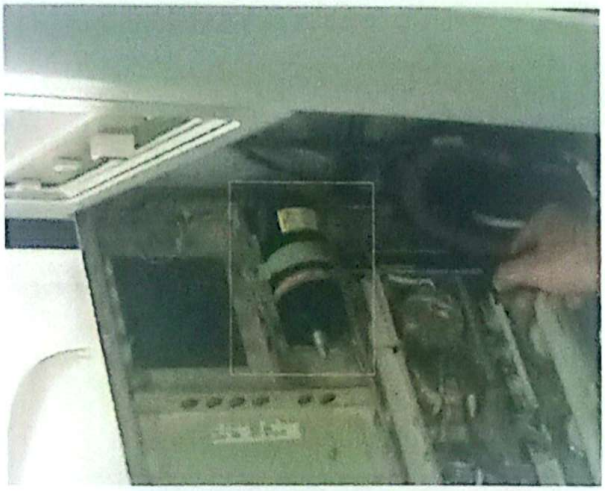


Graph

9.8 Oxygen masks are deployed manually by the cockpit crew or automatically when the cabin altitude exceeds 14,000 ft. Since they were deployed automatically in this incident, the cabin altitude must have crossed 14,000 ft. The purpose of the oxygen system is to provide supplemental 10 minutes of

oxygen to all passengers while the aircraft descends to a safe level. Oxygen is supplied from chemical generators to all passenger seats, attendant seats and lavatories. The generators are manually activated by pulling the mask down. The life of the chemical generators is 15 years from the date of manufacture. The chemical generators installed on this aircraft were manufactured between 1994 and 1995.

9.9 The oxygen mask in the aft 'C' toilet and L2 cabin crew station did not drop. The generator which provides oxygen to seat no 28 JKL (three seats) did not operate. The remaining oxygen generators that were reported as unserviceable by the cabin crew were serviceable and had been used. This was checked by a heat sensitive tape (orange color) on the oxygen generator which turns black when the generator is used.



Oxygen chemical generators. The orange strip turns black when the generator is once used.

9.10 Oxygen of the cabin crew at their station or the portable oxygen was found not used.

9.11 The last major checks which included the operational check of the oxygen mask drop down system and the operational check of the aircraft pressurization system was check 2C1 and 1C, carried out on 27-Oct-01 and 28-May-00. The systems are fully opened during Check 'D' which is carried out after 22,400 flight hours.

9.12 Failure of one engine bleed could not lead to pressurization failure. The cabin decay rate was also checked by the ground engineer and was found to be

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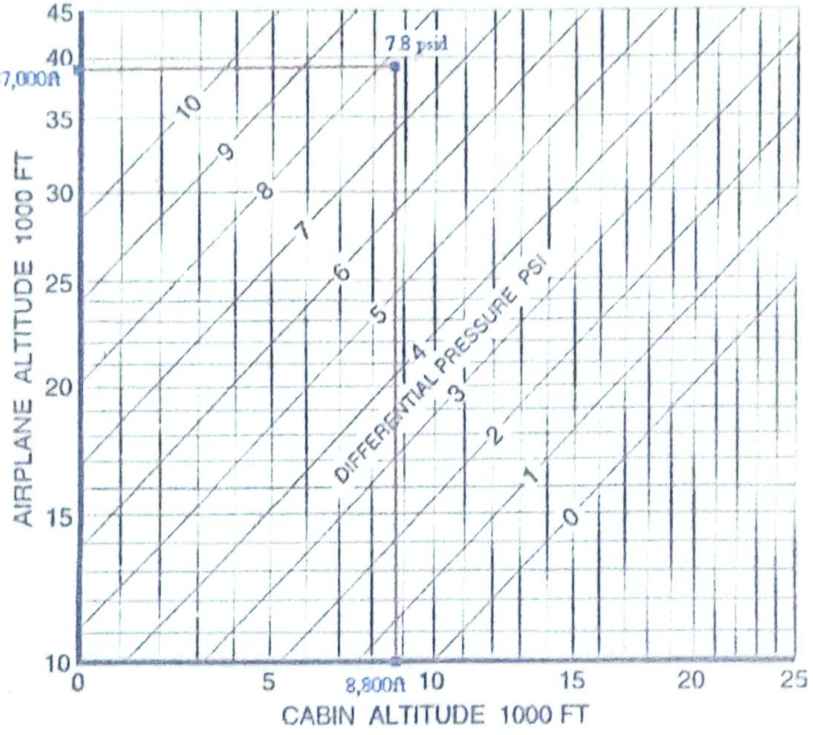
within limits. There is a possibility that the decay rate on the ground may differ from the decay rate during flight, reason being that during flight, different aerodynamic load plus vibrations and temperature could be the reason for leaks.

9.13 The aircraft operating ceiling is 37,000 ft as per Boeing 737 operation manual (Appendix 'W'). The aircraft fuselage structure is designed for operating at a cabin pressure of 7.8 psid with a maximum of 7.9 psid. A dual differential pressure system controls cabin dual differential pressure to 7.5 psi for flights at altitude of less than FL 280 and 7.8 psi for flights above FL 280. Since the aircraft was flying at 37,000 ft, therefore cabin pressure would be 7.8 psi. Referring to the airplane altitude versus cabin altitude graph, the cabin altitude at FL 370 with 7.8 psi comes to approx 8800 ft, well within limits. Keeping in view the age of the aircraft, the rate of climb of the cabin altitude tends to be more rapid due various leaks. Hence, if the rate of climb of the cabin altitude is 2500 ft/min, then the cabin can reach a dangerous level of 16300 ft in 03 minute.



9.14 The Cockpit Voice Recorder (CVR) records the conversation carried out in the cockpit of the last 30 minutes. In this case, after the incident had occurred,

the recorder's circuit breaker (CB) was not pulled out by the cockpit crew, therefore the conversation carried out in the cockpit during the incident was washed out. The Captain admitted in his statement that he was unaware of any such procedure which gives guidelines for preservation of conversation stored on the CVR.

9.15 While analyzing DFDR read out, a no of errors found in different parameters like packs position, isolation valve position etc. Operator carries out DFDR read out data analysis on every check 'C'.

9.16 During this investigation, while scanning through the aircraft technical logbook, it was noted that the tech log entries made by pilots and AME were not clear in writing as well as in language. Also important parameters were found missing in some occasions, which are useful in troubleshooting.

9.17 Pilots are given refresher training after every six months to keep them current, whereas, there is no refresher training schedule for AMEs and technicians.

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10. Findings:

10.1 Board concludes that:

10.1.1. The aircraft was cruising at FL370, where the cabin altitude was 8800 feet.

10.1.2. The pressurization problem occurred due to over pressurization of bleed No. 1.

10.1.3. A single bleed is sufficient to fulfill pressurization requirement.

10.1.4. The situation was aggravated once cockpit crew switched off No.1 pack as per bleed trip off check list,

10.1.5. Switched off No.1 pack resulted in rapid de-pressurization of the aircraft.

10.1.6. Thereafter, the situation could not be controlled by cockpit crew, resulting in an emergency descent.

10.1.7. During the emergency descent, the cockpit crew took 24 minutes to reach to the safe altitude of 10,000 feet.

10.1.8. The oxygen system supplies oxygen only for 10 minutes.

10.1.9. Cockpit Crew did not ask for any assistance from ATC i.e. did not consider the possible need for medical support after landing for passengers.

10.2 During the course of investigation, following deficiencies were observed:

Maintenance

10.3 On ground PR/SOV was found leaking, however, the overhaul manual allows leak up to 0.32 pounds per minutes (Refer appendix 'X'). Shop check declared the PR/SOV serviceable. During shop check pressurized air is supplied for checking the operation of PR/SOV at comparatively low temperatures and for a very short duration, whereas, in a real scenario, the component is continuously exposed to very high temperature and pressure gases coupled with comparatively high vibration for a longer duration of time, which can result in increase in leak rates.

10.4 The chain of events depicts ineffective maintenance techniques and poor documentation. Exact parameters which help in trouble shooting and maintaining the defect trend analysis have been found missing. A number of technical entries made by the Aircraft Maintenance Engineers in the technical logbook are sketchy and having no exact parameters.

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10.5 No refresher course schedule has been designed for Aircraft Maintenance Engineer and technicians to keep them abreast with latest modification in maintenance procedures and aviation technology.

10.6 This aircraft has consumed 84.5 % of its designed service objective. In case of one bleed or pack failure, the chances of the rate of climb of a cabin altitude tend to be rapid due to various leaks. These leaks occur due to high temperatures, humid weather effects and different aerodynamic loads / stresses which act upon the aircraft during flight and have direct affect on the structure. One such load is due to pressurization cycle (expansion and retraction of the aircraft structure). Hence, if the cabin is flying at an altitude of 8800 ft (corresponding aircraft altitude is FL370 in case of B737, provided the pressurization system is working 100% perfectly) and starts climbs at a rate of 2500 ft/min, the cabin can reach a dangerous altitude of 15,500 ft in a minimum time of 03 minutes.

10.7 To use the oxygen mask, a slight pull is to be given to the oxygen generator. This instruction is not given in the passenger safety card (Appendix 'Y'). A number of useful information were found missing on the passenger safety card. A sample of the passenger safety card used by Gulf Air is also attached at Appendix 'Z' for comparison.

10.8 While analyzing DFDR read out, a number of errors were found in different parameters such as packs position, isolation valve position, etc.

Operational

10.9 As per emergency descent checklist, the first officer was required to take the area altimeter setting from the ATC. In the ATC readouts, no altimeter setting was requested by the first officer. As a result the aircraft was flying at FL130 while altimeter showed FL150, leading to obvious flight safety hazards.

10.10 One of the factors that could have contributed to a poor decision or mishandling of the situation by the pilot is the company's pilot **"change of equipment policy"**. On induction of a pilot, a pilot is taken as a 1st officer of a F-27 aircraft, reletively a small aircraft of the mid 60's technology, then he is sent as 1st officer of B737 and then as 1st officer of Boeing 747 or 1st officer of A310 and then as a 1st officer of A300. The pilot then takes a leap from a wide body high-tech fully automated aircraft to take command of a Fokker F-27 aircraft. From here onwards the pilot is given command till he reaches the A300

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aircraft or Boeing 747 aircraft. During these transition period pilots are given training for the change of equipment which also cost operator a huge amount. A pilot spends approx 2 to 3 years on one equipment before moving on to the other equipment. It may be noted that different equipments of different manufacturer have:

* different technology (systems)
* different cockpit layouts
* different emergency procedures
* different parameter limits

During the period while working on different equipments, the formation of habits by the pilots are developed which eventually affect the decision making at early stages on other equipment.

10.11 The cockpit crew did not ask for any ground assistance during this incident The rapid de-pressurization could have put adverse effects on those passengers having weak health.

10.12 MEL allows the aircraft to fly with one pack receiving air from two bleeds, but restricts the aircraft altitude to FL 250. Whereas, Bleed trip off light checklist states that, in case of one bleed failure, the affected side pack is to be switched off without any instruction to lower the flight altitude to FL250 or below. The relevant statements of checklist and MEL are as under:

Pilot Checklist: **MEL:**

BLEED TRIP OFF If the BLEED TRIP OFF light remains Illuminated: PACK SWITCH (affected side) .....OFF	*Item:* Air-conditioning Packs	*Supplement Procedures:* (O) One may inoperative provided flight altitude remains below FL250

10.13 In the technical logbooks, the cockpit crew does not make proper entries of the defects; most of the defect entries are very brief and are not supported by exact parameter. Furthermore, after entering a defect, the matter is not discussed with the concerned Aircraft Maintenance Engineer.

10.14 The aircraft was cleared by the flight operations to fly at FL370 (max operating ceiling of B737). The flying time from UET to ISB is approx 1 hr and 10 min. The Aircraft took 27 minutes to climb to FL370. It maybe noted that max fuel is used during climb.

10.15 The Cockpit Voice Recorder (CVR) records the conversation carried out in the cockpit of the last 30 minutes. In this case, after the incident had occurred, the recorder's circuit breaker (CB) was not pulled out by the cockpit crew; Therefore the conversation carried out in the cockpit during the incident was washed out.

10.16 The oxygen generators of the cabin crew were found deployed but not used. The cabin crews were required to use the oxygen in such as incident. This shows a poor and casual attitude of the cabin crew during such emergency.

11. Recommendations:

11.1 *The Investigation Broad recommends that the operator may consider the following:*

11.1.1 the cockpit crew did not handle the situation properly, which resulted in creating an emergency situation that could otherwise be avoided if the pilots were conversant with the aircraft and its system. The B-737 refresher co*urse and Pilot's Hand Book may highlight these anomalies.*

Maintenance

11.1.2 Monitor the performance of components, which are declared defective by the Aircraft Maintenance Engineers but are found serviceable in the shop.

11.1.3 Design / develop an aircraft documentation course for AMEs and technician, to create uniformity in writing defects and rectification in the aircraft technical logbooks.

11.1.4 Give frequent refresher courses to Aircraft Maintenance Engineers and technicians to keep them up to date with the latest aviation technology. The Airworthiness Directorate should lay down requirements for an AME to have a refresher course of each endorsement before renewing the AMEs (Note – The AME license is renewed after every two years). The re-fresher course may include; latest CAA regulations, latest aircraft modifications, repetitive defects,

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aircraft incident and accidents within Pakistan and aboard. This rule may only be applied to Airlines and not to the general aviation operators.

11.1.5 Aircraft that have consumed 70 % of their design service object maybe restricted to a lower altitude, so that in case of a bleed or pack failure, the cabin altitude can be controlled by bringing the aircraft to a safe altitude in a short span of time. The operating ceiling may be decided by the operator in consultation with the Flight Standards/Airworthiness Directorate. Reducing the aircraft operating ceiling, would also require a change in MEL Chapter 21-1, Item 01, Category 'C'. This may be reduced with the same ratio.

11.1.6 Change (Not repair) the door seals and seals of other relevant area in the cabin area and cargo compartment if found damaged on all the aircraft those have consumed 70 % of its design service object.

11.1.7 Include cabin decay rate check and bleed system leak check at lower inspection interval in consultation with Airworthiness Directorate.

11.1.8 Carry out DFDR read out data analysis more carefully and Airworthiness Directorate must be involved in those analyses on sampling basis. A record of that analysis should be kept for ready reference.

Operational

11.1.9 Give all the pilots' intensive and frequent ground training, which could include:

- Sufficient technical knowledge of aircraft system and use of checklist; and
- Knowledge of the design philosophies employed by the aircraft system manufacturers;

11.1.10 May review the change of equipment policy in consultation with the Flight Standards CAA with a view that a pilot maybe given command of the same equipment as he flew as a 1st officer. In this manner the pilot will get to know the aircraft and its system much better which will eliminate the chance of confusion. This will result in better decision making during an emergency situation.

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