Pressurization emergency, Boeing 737-204 (ADV) EI-CJC, 70 nm south of Spanish/French Pyrenees border, November 8, 2004

Micro-summary: **Pressurization emergency resulting from bleed air being turned off for takeoff.**

Event Date: **2004-11-08 at 1330 UTC**

Investigative Body: **Air Accident Investigation Unit (AAIU), Ireland**

Investigative Body's Web Site: **http://www.aaiu.ie/**

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FINAL REPORT

AAIU Synoptic Report No: 2005-009
AAIU File No: 2004/0060
Published: 23 May 2005

In accordance with the provisions of SI 205 of 1997, the Chief Inspector of Accidents, on 9 November 2004, appointed Jurgen Whyte as the Investigator-in-Charge to carry out a Field Investigation into this occurrence and prepare a Synoptic Report.

Aircraft Type and Registration:	Boeing 737-204 ADV, EI-CJC
No. and Type of Engines:	2 x P & W (JT8D-15)
Aircraft Serial Number:	22640
Year of Manufacture:	1982
Date and Time (UTC):	08 November 2004 @ 13.30 hrs
Location:	Cruise Flight Level (FL320) Approx 70 nm south of Spanish/French Pyrénées border
Type of Flight:	Scheduled Public Transport
Persons on Board:	Crew - 5 Passengers - 111
Injuries:	Crew - Nil Passengers - Nil
Nature of Damage:	Nil
Commander's Licence:	IAA issued JAA ATPL (A)
Commander's Details:	Male, aged 39 years
Commander's Flying Experience:	5,251 hours, of which 2,600 were on type
Information Source:	The Operator, AAIU Pilot Report Form submitted by Flight Crew, AAIU Field Investigation.

SYNOPSIS

Following a "BLEEDS OFF" take-off (See 1.2.2.2) from Runway (RWY) 25 at Reus Airport (LERS), Spain, the aircraft climbed to its cruising level of FL320 enroute to Dublin Airport (EIDW). Shortly after becoming established in the cruise, the "Cabin Altitude (CAB ALT)" horn sounded. Unable to control the cabin altitude rising further the Captain initiated an emergency descent. During this descent, the flight crew discovered that the engine bleed switches were selected in the "OFF" position. The aircraft diverted to Biarritz (LFBZ), in France, where it landed without further incident.

FINAL REPORT

NOTIFICATION

The AAIU received notification of this event at 11.00 hrs on the 9 November 2004 from the Operator. While the event occurred in Spanish Airspace (State of Occurrence), the aircraft diverted to Biarritz, in France. Further inquires by the AAIU to the investigative authorities of France, the Bureau Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA), determined that they would not investigate the event and thus delegated the investigation to the State of Registry, Ireland.

1. FACTUAL INFORMATION

1.1 History of the Flight

1.1.1 General

EI-CJC originally took-off from Dublin at 09.50 hrs on the 8 November 2004 and landed without incident at Reus in Spain at 12.16 hrs. Earlier that morning the Captain of EI-CJC had completed a company revenue return flight from Dublin to East Midlands (EGNX).

Departure time from Reus was scheduled for 13.00 hrs. However, the Captain was asked by the company ground-handling agent at Reus to expedite his departure due to the imminent arrival of a company aircraft from Frankfurt Hahn (EDFH). This request was not related to the need for a vacant stand, rather the personnel required for the physical handling of the aircraft.

1.1.2 Flight Deck Events

The Captain, who was the designated Pilot Flying (PF), started the aircraft engines approximately 18 minutes ahead of schedule and prepared for a departure off RWY 25. As the aircraft was at maximum weight and RWY 25 is classified as a limiting runway (incorporating an early procedure turn shortly after take-off), the aircraft was configured with the Auxiliary Power Unit (APU) "ON" and the Engine Bleeds "OFF". While the PF indicated this configuration to the Pilot-non-Flying (PNF), no formal briefing took place between the flight crew regarding the Engine "BLEEDS OFF" take-off.

Both the Captain (PF) and the PNF had completed a number of Engine "BLEEDS OFF" take-off's within the past year and had both recently flown out of Reus. The flight crew advised the Investigation that they carried out the "After Take-off" checks (which is a silent checklist) and the "Passing FL100". No abnormalities were noted during the climb to FL320 and the pressurization panel showed a positive cabin "Rate of Climb" and an increasing "Cabin Differential Pressure". Approximately 10 – 15 minutes into the FL320 cruise the "CAB ALT" horn sounded. The flight crew immediately donned their oxygen masks, established communications and switched on the Seat Belt sign. The PF called for the "CABIN ALTITUDE WARNING" checklist. Completion of the checklist determined that the cabin altitude was at approximately 11,000 – 12,000 ft and the cabin altitude was still climbing at a rate slightly less than 2000 ft/min. Unable to arrest the cabin rate of climb, the Captain (PF) called for the "EMERGENCY DESCENT" checklist and initiated an emergency descent. After advising and receiving clearance from Air Traffic Control (ATC), the aircraft was descended initially to FL140 and onward to level at FL100.

During the early stages of the emergency descent, a further scan of the forward overhead panel determined that the APU was "ON" and the Engine Bleeds were selected in the "OFF" position. Both Engine Bleeds were returned to the normal in-flight configuration by the PNF and the PF switched off the APU. The PNF considered that the maximum cabin altitude achieved during the event was approximately 15,000 feet.

Once level at FL100, contact was made with the Cabin Services Supervisor (CSS) who informed the flight crew that none of the cabin crew or passengers appeared injured.

Initially, ATC offered EI-CJC a diversion to Bordeaux or Mont de Marsan (LFBM), in France. However, after some consideration of the fact that, a) the emergency situation was stable, b) there were no reported injuries, c) the airport was familiar to the flight crew (Company destination) and d) more fuel would be burnt off (to reduce landing weight), the Captain (PF) decided to divert to Biarritz. EI-CJC landed at Biarritz at approximately 14.04 hrs without further incident. No emergency services were requested or required for the landing.

A short time later, all the passengers disembarked normally to the terminal building. While it was offered by the airport authority, no medical assistance was sought by the passengers or crew. Later in the day the passengers and crew boarded a company flight to Dublin, where it landed at 21.00 hrs.

1.1.3 Cabin Events

The Cabin Crew consisted of a Cabin Services Supervisor (CSS) No 1 and two Cabin Crew Members (CCM's) No 2 and No 3. Having completed the first bar service the No 1 was in the process of closing her bar trolley when the fasten seatbelts sign came on. The No 1 took this as a turbulence warning[1] and therefore made a turbulence public address (PA) to the cabin. As she then went about preparing the gifts trolley she felt a sudden sharp pain in her ears. Feeling somewhat confused she looked into the cabin and saw that the cabin passenger oxygen masks had deployed. In the rear of the cabin the No 2 and No 3, who had just closed their bar service, both experienced a sharp pain in their ears. The No 2 brought to the attention of the No 3 the fact that the cabin masks had deployed. All of the cabin crew then went to their respective crew seats, strapped in and went on oxygen. Both the No 1 and the No 3 observed that a number of passengers were attempting to put on the masks without first pulling them down, so they motioned the action of pulling down the masks to the passengers a number of times.

The No 1 remained in her seat awaiting the PA of, "*No 1 to the flight deck*", however, all she heard was the crew bell chime. A short time later (aircraft in level flight) the No 1 left her seat and went on the interphone to the flight deck. The PNF asked about the condition of the cabin crew and passengers (which was responded to by the No 1 as all ok) and advised that a PA would be made soon. On contacting the rear cabin crew, the No 1 was advised by the No 3, that she had listened in on the interphone and was aware of the situation. The No 2 and No 3 then went forward through the cabin to check on the passengers and then met up with the No 1 for a briefing in the forward galley.

[1] The No 1 was familiar with flying over the Pyrénées where turbulence occurs quite frequently.

While waiting for the PA from the flight deck, the cabin crew went about securing the cabin. The Captain then informed the No 1 on the interphone, that they had experienced a depressurisation and were diverting to Bordeaux. He also made a PA to the passengers advising them of the situation and this was followed by a safety/security PA by the No 1. The No 1 then went through the cabin to check on the passengers.

A company positioning CCM seated at 11C informed the No 1 that some of the passengers showed signs of hypoxia – some appeared to be dizzy and laughing and some did not bother to put on their oxygen masks.

The Captain made contact with the No 1 on the interphone again and advised that they now intended to divert to Biarritz and that they would be landing in approximately 15 – 20 minutes. This was followed up by a further PA by the Captain advising the passengers of the new diversion destination. After landing at Biarritz, the Captain made a final PA advising the passengers that they would be disembarking the aircraft shortly for the terminal building.

1.2 Aircraft Environmental Systems

1.2.1 General

In basic terms, as an aircraft climbs through altitude the atmosphere becomes thinner and thus less air is available to breathe. A typical altitude at which an aircraft will cruise is 35,000 ft. The atmosphere at 35,000 ft is only sufficient to sustain life for approximately 30-50 seconds (see Section 1.7.3.1). Therefore, in order to maintain a life-supporting atmosphere for both the crew and passengers throughout the entire envelope of the flight, the aircraft interior must be pressurised and air and temperature conditioning must be provided.

1.2.2 Air Supply System

1.2.2.1 Bleed air is required for the operation of the following aircraft systems:

Air Conditioning and Pressurization;
Engine and wing thermal anti-icing;
Engine start;
Hydraulic reservoirs pressurization; and
Water tank pressurization.

Air for the bleed air system can be supplied by the engines, the auxiliary power unit (APU) or an external aircart/source. The APU is a self-contained gas turbine engine installed within a fireproof compartment located in the tail of the aircraft. The APU supplies bleed air for the engine starts and air conditioning. The APU starts and operates up to the aircraft maximum certified ceiling. After engine start, air for the bleed air system, is normally supplied by the engines (See section 1.2.2.2). The APU is capable of supplying bleed air for one air conditioning pack on the ground and one air conditioning pack in flight, up to 17,000 ft.

1.2.2.2 Bleeds-off configuration

Drawing bleed air from both engines, in order to supply the bleed air duct, will (depending on ambient conditions) reduce available thrust by approximately 0.9%. A percentage drop in available thrust will have a bearing on the maximum weight that can be lifted. Initial weight and performance calculations are based on both engine bleeds being selected "ON" for take-off. If aircraft weight, the ambient conditions and/or a limiting runway are such that the maximum available thrust is insufficient to achieve the required take-off performance, the flight crew can opt to configure for an Engine "BLEEDS OFF" take-off. In the absence of these engine bleeds, the APU bleed air is required to supply the bleed air supply duct, until the engine bleeds can be re-configured shortly after take-off.

1.2.3 Air Conditioning System

1.2.3.1 General

Conditioned air for the cabin comes from either the aircraft air conditioning system or a preconditioned ground source. The air conditioning system provides temperature-controlled air by processing bleed air from the engines, the APU or a ground source in the air conditioning packs.

Conditioned air from the left pack flows directly to the flight deck. Excess air from the left and right pack is distributed through the left and right side wall risers to the passenger cabin.

1.2.3.2 Air Conditioning packs

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. Normally the left pack uses bleed air from the left engine and the right pack uses bleed air from the right engine. A single pack is capable of maintaining pressurization and acceptable temperature throughout the aircraft up to the maximum certified ceiling (37,000 ft). Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

1.2.4 Pressurization.

1.2.4.1 General

Cabin pressurization is controlled during all phases of aircraft operation by the cabin pressure control system (CPCS). The CPCS includes a controller that will control cabin pressure in AUTO or STANDBY, or MAN AC or MAN DC pilot-controlled modes.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valves. Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 8.65 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure. The cabin altitude is normally rate controlled by the cabin pressure controller up to a cabin altitude of 8,000 ft at the aircraft maximum certified ceiling.

1.3 Operators Operations Manual

1.3.1 General

The Operator's Operations Manual, Part A, contains the departmental organisation, authority and responsibility and includes all non type related operational policies, instructions and procedures needed for a safe operation together with general operational guidance/information of value to pilots. The Operations Manual conforms to the JAR-OPS 1 requirements.

1.3.2 Flight Procedures

Flight procedures are covered under section 8.3 of the Operations Manual, Part A. Section 8.3.0 (a)(1) covers the Take-off briefing. In basic terms, the procedures require that, "*Take-off briefing shall be carried out before engine start, when possible for workload convenience.*" ……*"The object of the briefing is to ensure that both pilots are aware of and agree with a proposed plan of action. Briefings should be short as possible but give a clear understanding of the intentions. It is normally unnecessary to reiterate Standard Operating Procedures, but it is vitally necessary to cover any special requirements."*

The take-off briefing shall be given by the Pilot Flying (PF). The procedures list a number of specific items to be covered in the briefing, including at (iv) *Flap settings, power setting and bleed status."*

1.4 Operators 737-200 Flight Crew Operations Manual (Volume 1)

1.4.1 Normal Procedures (NP)

Normal procedures are used by the flight crew to ensure aircraft condition is acceptable and that the flight deck is correctly configured for each phase of flight. These procedures assume all systems are operating normally and automated features are fully utilized. Procedures are performed from recall and follow a panel flow. Checklists are used to verify that the critical items affecting safety have been accomplished. The procedures are designed to minimize crew workload and are consistent with flight deck technology.

1.4.2 Supplementary Procedures (SP)

Supplementary Procedures are accomplished as required rather than routinely performed on each flight. They may be required because of adverse weather, unscheduled maintenance or as a result of a procedure referenced in a non-normal checklist. At the discretion of the Captain, procedures may be performed by recall, by reviewing the procedures prior to accomplishment or by reference to the procedure during its accomplishment. With specific regard to NO ENGINE BLEED TAKE-OFF with the APU operating, the following procedure must be carried out for:

TAKE-OFF

Right PACK switch ……..…..……ON
ISOLATION VALVE switch……..…….....CLOSE

Left PACK switch……..……..……ON
Engine No. 1 BLEED air switch……..…….……OFF
APU BLEED air switch…….…...….ON
Engine No. 2 BLEED air switch…….…….….OFF
WING ANTI-ICE…….…….OFF

AFTER TAKE-OFF

Engine No. 2 BLEED air switch……..…….…..…ON
APU BLEED air switch……...…OFF
When CABIN rate of CLIMB indicator stabilizes:
Engine No. 1 BLEED air switch……..…….…….ON
ISOLATION VALVE switch……...AUTO

1.5 Checklists

1.5.1 General

Checklists contain, in abbreviated form, information required by the flight crew to operate the aircraft in normal situations and to cope with non-normal situations. These checklists are contained in the Quick Reference Handbook (QRH), which forms part of the ship's library and are available on the flight deck for instant use.

1.5.2 Normal Checklist (NC)

The normal checklists (NC) are organised by phase of flight and are used to verify that certain critical procedural steps have been accomplished. Only procedural steps that, if omitted, would have a direct and adverse impact on normal operations are included.

Normal Checklists are used by the flight crew after accomplishing all applicable procedural items. When parked at the gate, the captain calls for checklists. During taxi, the Captain taxiing calls for checklists. After take-off, the pilot flying (PF) calls for checklists. Each crewmember responds for systems and controls in the crewmember's area of responsibility. However, in the BEFORE TAKE-OFF and LANDING checklists, the PF verifies and responds to checklist items.

The Normal Checklist is generally based on the "Challenge and Response" principle. Challenge and Responses are in "Panel Scan" order and the required actions are performed before the specific checklist is called. The AFTER TAKE-OFF checklist is read and actioned silently by the PNF with the exception of the altimeter check, which must be responded to by the PF. The DESCENT and APPROACH checklists are all challenge and response checklists being read and confirmed by the PNF. It is the checklist readers' responsibility to visually check that the action taken agrees with the response.

The position of the control or indication is visually verified and stated in response to a checklist challenge. When disagreement between the response and the checklist answer occurs, it is mandatory that the checklist be discontinued until the item is resolved.

Following the completion of each normal checklist, the crewmember reading the checklist states, "CHECKLIST COMPLETE."

The AFTER TAKE-OFF check, which is contained in the normal checklist (NC.3) and would normally be conducted when flaps are up (approximately 3,000 ft) requires, among other things:

AIR COND(*itioning*) **& PRESS**(*urization*)……**SET.**

1.5.3 Non-normal Checklist (NNC)

The non-normal checklists are used by the flight crew to cope with non-normal situations. The flight crew member detecting an existing or impending emergency or non-normal condition will immediately call out the condition. The Captain, or in his/her absence from the flight deck, the second in command must take the necessary action to ensure that control of the aircraft is established and maintained. The Captain will decide what action to take, bearing in mind the existing circumstances.

A CABIN ALTITUDE WARNING or RAPID DEPRESSURIZATION is covered in the non-normal checklist at NNC.2.4. Where the aircraft is above 14,000 ft mean sea level (MSL) and control of cabin pressure is not possible or cabin pressure is lost, the NNC.2.4. checklist requires the flight crew to accomplish the EMERGENCY DESCENT checklist at NCC.2.6. The EMERGENCY DESCENT (NNC.2.6.) requires that the Captain will advise the cabin crew on the PA system, of impending rapid descent.

1.6 Standard Operation Procedures Manual (SOP's)

The operator has developed and operates SOP's, which expand upon procedures detailed elsewhere in the Operations Manual. Adopting SOP's make it possible to crew any two Pilots together on a non-regular basis without lowering safety standards. In consequence, personal methods or practices should not be introduced. The SOP must be used.

The SOP Manual covers AFTER TAKE-OFF checklist on page 22 and requires that, *"This check will be called for by the PF after flap retraction has been confirmed. The checklist is read by the PNF and the items confirmed* (actioned silently) *by him/her".* CLIMB TO CRUISE on page 22-23 requires that, "*Checks of the Air Conditioning and Pressurisation are desirable every 5,000 ft. Passing 10,000 ft, the PF will perform a complete panel scan.*

1.7 Emergency Procedures

1.7.1 General

The Operator's Safety and Emergency Procedures Manual is a subsidiary manual of Part A and is used to handle emergency situations.

1.7.2 Notification of Emergency to Cabin Crew

Pages 4-8 to 4-10 cover Notification of Emergency to Cabin Crew and states, *"The Captain will say over the PA "No 1 to the flight deck immediately". This will indicate that an emergency has arisen and the CSS will immediately go to the cabin interphone and ask the Captain for "NITS" (***see 1.7.2.1 below***). The Captain at this time may decide to unlock the flight deck door and allow the CSS to enter the flight deck for the NITS briefing or he may decide to keep the door locked and continue all communication via the interphone. This is at the Captain's discretion. All the other cabin crew must re-stow all trolleys and make their way to the forward galley and await instructions from the CSS.*

1.7.2.1 Captains Briefing to CSS - NITS Briefing

NATURE:	Nature of the emergency, i.e. engine fire, decompression, technical problem.
INTENTION:	Intention of Captain, i.e. whether to make an emergency landing or ditching, whether to divert, continue or return to base.
TIME:	Time remaining airborne, e.g. Time Available or Time Available-Short Notice.
SPECIAL INSTRUCTIONS:	Special instructions given by the Captain, i.e. any known factors affecting evacuation and exits to be used. It the aircraft was depressurised ABP's (Able Bodied Passenger) must be placed at exits.

The CSS will acknowledge the Captains briefing by repeating back the NITS given and must ask for clarification on anything not understood or omitted. They must synchronise watches.

1.7.2.2 Cabin Crew Emergency Briefing

The CSS will then return to the forward galley to brief the cabin crew on "NITS" and they will in turn repeat the "NITS" back to the CSS. On hearing the Captain's command:

CSS	**All CCM's**
Report immediately to the Captain via the interphone ask for "NITS"	Stow all trolleys and go to forward galley
Receive "NITS" and repeats back to the Captain. Synchronise watches.	Receive NITS from CSS and repeat back. Synchronise watches
Special instructions	

After briefing – carry out procedures relevant to briefing

1.7.3 Decompression

1.7.3.1 General

Section 6 of the Operator's Safety and Emergency Procedures Manual covers decompression in detail and includes guidance on; Cabin Pressurisation, Decompression, Slow Decompression, Rapid Decompression, Material Effects, Physical Effects, The Time of Useful Consciousness (TUC) Rapid Decompression Drill, Passenger and Crew Emergency Oxygen System, Operation of Oxygen Systems and Flight Crew Oxygen System

For an aircraft failing to pressurize in the climb, the passengers and flight crew may show initial symptoms of oxygen starvation (Hypoxia), for example, headaches, yawning, occasional deep breath and nausea. Physical Effects may also include; severe ear and sinus pain, chest and joint pain caused by nitrogen bubbles in the blood expanding, forced expelation of air and a feeling of being very cold. The body will experience different levels of Hypoxia depending on how high one is and one's level of fitness.

The symptoms of Hypoxia and the altitudes at which they occur at are as follows:

At 10,000 ft	–	Mild Hypoxia Headaches, yawning, occasional deep breath.
At 14,000 ft	-	Advanced Hypoxia Headaches, tiredness, blurred vision, loss of muscular co-ordination and possible personality changes.
At 20,000 ft	-	Extreme Hypoxia Convulsions, Collapse, Coma and possible death within minutes.

The time of useful consciousness (TUC) for the altitude in which the cabin interior has reached is as follows:

40,000 ft	-	18 seconds Approx
35,000 ft	-	30-50 seconds Approx
30,000 ft	-	1-2 minutes Approx
28,000 ft	-	2-3 minutes Approx
25,000 ft	-	2-5 minutes Approx
15,000 – 18,000 ft	-	30+ minutes Approx

1.7.3.2 Operation of the Oxygen System

The passenger and cabin crew oxygen system operate in three ways:

Automatically

If the cabin altitude should reach 14,000 ft, the masks should automatically drop down.

Electrically (*In the event that the flight crew want to deploy the system for the cabin crew and passengers prior to the cabin reaching 14,000 ft or if the automatic system fails*).

By a switch on the flight deck. (Switching the passenger oxygen switch from NORMAL to ON).

Manually (*In the event that the electrical deployment of the system fails*)

By pulling the 'T' Handle. The 'T' Handle is located under a flap in the floor of the flight deck behind the Captain's seat. Pulling the 'T' Handle drops all masks in the cabin.

1.8 Previous Incident – Operator's Initiatives

The Operator experienced a similar type incident on 28 September 2002 out of Derry Airport. The Incident was reported on by the AAIU and is available at www.aaiu.ie Report No 2003/010. On foot of the Report and on-going safety training and awareness, the Operator developed a number of initiatives relating specifically to BLEEDS OFF operations.

(a) Recurrent Simulator Training (RST) – The programme is made up of six unique training sessions spread over a three year period designed to cover all aircraft systems. These simulator sessions are referred to as RST 1 – 6 and are fully documented in the Operations Manual, Part D – Crew Training. RST 1 and 4 have elements devoted to the management of the pressurisation system, in particular, BLEEDS OFF take-off and fault errors.

(b) The Initial Training Programme - Amended - While it was part of simulator training on type to carry out BLEEDS OFF take-off, it is now a record item on line training to conduct a managed demonstration of a BLEEDS OFF take-off using the aircraft flight manual and the supplementary procedures.

(c) Road Show – The annual autumn safety awareness road show, which is given to pilots at all of the operator's bases in the form of presentations on specific features of operations, includes an element on BLEEDS OFF operations and likely traps that may occur.

(d) Handy Dandy - The Operator has developed and introduced (March 2005) a Handy Dandy, which is required to be stowed alongside, and used in conjunction with the Quick Reference Handbook (QRH). The Handy Dandy is a double-sided A4 laminated sheet, which contains additional quick reference material and checks as identified by the operator for use on the flight deck. The Handy Dandy makes specific reference to BLEEDS OFF take-off, with an AFTER START – BLEEDS OFF and AFTER TAKE-OFF – BLEEDS OFF checklist.

1.9 Manufacturer

1.9.1 Checklist Revision

The manufacturer had previously indicated to the AAIU that it was their intention to carry out a general review of the 737 checklists, and that consideration would be given to revising the AFTER TAKE-OFF checklist to explicitly set the proper position of the pack and bleed switches. On the 1 April 2005 the manufacturer published a revised version of the 737 checklists. As part of the AFTER TAKE-OFF checklist challenge it requires:

BLEEDS……ON
PACKS……..ON (For 737-100/200)
PACKS…….AUTO (For 737-300 and later)

2. ANALYSIS

Following a 26 minute turnaround, which included some pressure from the ground handling agent to expedite the departure, the flight crew configured the aircraft for a BLEEDS OFF take-off. No formal briefing took place with regard to the BLEEDS OFF take-off and supplementary procedures, relating specifically to NO ENGINE BLEEDS take-off with the APU operating, were not used in conjunction with the normal checklist.

It is clear that the AFTER TAKE-OFF checklist was not fully accomplished as the engine bleed switches remained in the "OFF" position for the entire climb. The APU did supply bleed air to the bleed air duct and achieved aircraft pressurization up to the very initial stage of the cruising level. It is therefore considered likely that the parameters associated with the pressurization system (Cabin Altitude and Differential Pressure) were scanned during the climb and appeared as if the system was operating normally.

The AFTER TAKE-OFF checklist is read and actioned silently by the PNF, with the exception of the altimeter check, which must be responded to by the PF. This check, in part, requires the following: *AIR COND & PRESS……SET.* This particular check is very general and while it is required and assumed that the PNF checks the entire air conditioning and pressurization system, it does not prompt the individual to check specific critical items on the panel itself. The manufactures recent publication of a general revision of the 737 checklists, where, among other things, the AFTER TAKE-OFF checklist requires a challenge to explicitly set the position of the packs and bleed switches, should serve to resolve this situation.

With the AFTER TAKE-OFF checklist being read and actioned silently by the PNF, the opportunity of, "Challenge and Response," of a critical check item is lost. A brief survey of a number of commercial operators using a similar type aircraft determined that the majority perform the AFTER TAKE-OFF checklist on the basis of "Challenge and Response," with the auto-pilot (AP) engaged. The Investigation, therefore, considers that the entire AFTER TAKE-OFF checklist should be based on, "Challenge and Response." A safety recommendation has been made to this effect to the operator.

The Operator's SOP's require that; *"Passing 10,000 ft, the PF will perform a complete panel scan."* The *"Passing 10,000 ft"* check provides one of the last opportunities in the climb to confirm that the pressurization and air conditioning system is functioning correctly and that the packs and the bleeds are properly configured. The SOP's is a general statement and a more explicit mention of specific checks such as *"Check Pressurization"* and *"Check status of APU"* might create a greater focus on critical items during the check. The Investigation therefore makes a safety recommendation to that effect to the operator.

Once the CAB ALT horn sounded, the flight crew responded immediately by going on oxygen and establishing communication with each other. The use of oxygen at this point would have negated against any further risk or actual risk of their suffering from the effects of hypoxia.

Any emergency on the flight deck will greatly increase the workload on the flight crew. First and foremost the safety of the aircraft is paramount and priority is given to flying the aircraft while attempting to resolve the situation. During a rapid descent virtually all activities are related to flying the aircraft and communicating with ATC. On the initial indications that a problem existed, the flight crew carried out immediate actions including the activation of the seatbelt sign. Failure to PA the emergency descent, may have caused some anxiety to the passengers and created some confusion for the cabin crew. However, consideration must be given to the fact the flight crew were actively involved in an emergency descent, where prioritisation was given to ensuring that the aircraft reached a safe operating level, without delay. Once level, a further PA from the flight deck of *"No 1 to the flight deck"* would have clarified the situation for the CSS, thereby allowing her to brief the other cabin members and, if required, to communicate with the passengers.

The response by the cabin crew members, and in particular the CSS, to this emergency situation was both appropriate and professional.

The Operator has been pro-active in developing initiatives to heighten awareness of possible "traps" associated with the operation of the air conditioning and pressurization system.

3. COMMENT

When an un-pressurized aircraft climbs to altitude, the effects of hypoxia can be quite subtle and insidious, as the body will attempt to acclimatize to the altitude change. A flight crew operating under a high workload on the flight deck may not fully appreciate or recognise the initial symptoms of hypoxia. It is therefore possible that judgement may be impaired to such an extent that corrective actions associated with dealing with an emergency situation may lead to incorrect or inappropriate response which could endanger the aircraft. The very nature of hypoxia itself is such that the pilot can become the poorest judge of when he or she is suffering from its insidious effects.

The AAIU has over the years investigated a number of incidents relating to pressurization and air conditioning events on commercial aircraft. Common findings throughout these investigations were, failure to adhere to Standard Operating Procedures (SOP's), non-use or non-accomplishment of checklists, and inadequate vigilance specific to the pressurization and air conditioning panel.

The object of briefing is to ensure that both pilots are aware of and agree with a proposed plan of action. It should also anchor in time the phase of flight in which a particular action, such as a re-configuration, should take place.

Proper utilization of the checklist is one of the most important factors of flight deck management. Reliable normal operations and repeatable success in dealing with abnormal and emergency situations are clearly attributed to the checklist system. The system does, however, depend absolutely on the command being given for the checklist, using the correct and appropriate checklist and ensuring its completion.

SOP's identify mandatory actions or procedures which must always be performed, because the failure to do so has a direct adverse impact on the safety of operations.

Situational awareness and vigilance, together with anticipation of increasing exposure to risks and hazards need to go hand-in-hand with general monitoring and implementation of normal operating procedures. While routine is also essential in establishing the framework of safe operation, it is also possible to succumb to complacency. The modern day commercial aviation concept of repetitive short sector flights with rapid turnarounds, coupled with the commercial pressures associated with ground handling at high activity airports makes for a continued high pressure environment for the flight crews. To guard against risk of error in such an environment, it is essential that the flight crew always comply with the regulatory requirements and adhere to the proper operating procedures and limitations.

4. SAFETY RECOMMENDATIONS

It is recommended that:

4.1 The Operator considers conducting the entire AFTER TAKE-OFF checklist based on "Challenge and Response," rather than a silent checklist. **(SR 05 of 2005)**

Response from Operator

The Operator has accepted Safety Recommendation SR 05 of 2005, in part, and has introduced a change to the AFTER TAKE-OFF checklist, where the challenge AIR CONDITIONING & PRESSURISATION now becomes a challenge and response item.

4.2 The Operator considers amending the SOP for "Passing 10,000 ft," to include a specific check on Pressurization and the APU. **(SR 06 of 2005)**

Response from Operator

The Operator has fully accepted Safety Recommendation SR 06 of 2005.