



Flight Operations Briefing Notes

Cabin Operations

Cabin Decompression Awareness

I Introduction

Aircraft have cabin air systems that control pressurization, airflow, air filtration, and temperature. The purpose of these systems is to provide a safe and comfortable cabin environment, and to protect all cabin occupants from the physiological risks of high altitudes. Modern aircraft are now operating at increasingly high altitudes. This increases the physiological risks that are associated with decompression.

In the case of decompression, there is a risk that not enough oxygen will be supplied to the body. This condition, hypoxia, is the greatest threat to both crewmembers and passengers.

A recently published accident report, involving a case of slow decompression, suggested that the overall aviation industry does not provide sufficient training to flight crew and cabin crew on the identification and effective management of decompression.

The objectives of this Flight Operations Briefing Note are, therefore, to:

- Review the different types of decompression
- Enhance cabin and flight crew awareness of the importance of rapidly taking appropriate actions to successfully manage decompression.

II Types of Decompression

The risk of a pressurized cabin is the potential for cabin decompression. This can occur due to a pressurization system malfunction, or damage to the aircraft that causes a breach in the aircraft structure, enabling cabin air to escape outside the aircraft, for example loss of a window, or a breach in the aircraft fuselage due to an explosion.

The loss of pressurization can be slow - in case of a small air leak - while a rapid or explosive decompression occurs suddenly, usually within a few seconds.

The consequences of decompression, and its impact on cabin occupants, depend on a number of factors, including:

- The size of the cabin: The larger the cabin, the longer the decompression time
- The damage to the aircraft structure: The larger the opening, the faster the decompression time
- The pressure differential: The greater the pressure differential between the cabin pressure and the external environmental pressure, the more forceful the decompression.

When cabin pressure decreases, cabin occupants are no longer protected from the dangers of high altitudes, and there is an increased risk of hypoxia, decompression, illness, and hypothermia. It is, therefore, important that crewmembers recognize the different types of decompression, react effectively to overcome the difficulties associated with a loss in cabin pressure.

II.1 Rapid/Explosive Decompression

Rapid/Explosive decompression results in a sudden loss in cabin pressure, and can be recognized by the following signs:

- A loud bang, thump or clap that is the result of the sudden contact between the internal and external masses of air
- Cloud of fog or mist in the cabin that is due to the drop in temperature, and the change of humidity
- Rush of air, as the air exits the cabin
- A decrease in temperature, as the cabin temperature equalizes with the outside air temperature
- The release of the cabin oxygen masks, when the cabin altitude reaches 14 000 feet.

If a breach in the aircraft structure is the cause of the decompression:

- Unsecured items in the immediate area are ejected from the aircraft
- Debris may fly around the cabin
- Loose items may become projectiles
- Dust particles may limit visibility.

In the case of rapid/explosive decompression, there may be a lot of confusion due to the high noise level and fog that makes it difficult to communicate in the cabin.

II.2 Slow/Insidious Decompression

Slow/Insidious decompression involves a very gradual decrease in cabin pressure. Slow decompression may be the result of a faulty door seal, a malfunction in the pressurization system, or a cracked window.

Slow decompression may not always be obvious. The cabin crew may not notice the changes in the cabin, until the oxygen masks drop down from the Passenger Service Units (PSUs). Therefore, the cabin crew must be aware of signs that could indicate a slow decompression. In some cases an unusual noise, such as whistling or hissing sound around the door areas, may be an indication of a slow decompression, therefore the flight crew should be notified immediately.

One of the first physiological indications of a slow decompression may be ear discomfort or 'popping', joint pain, or stomach pain due to gas expansion.

III Hypoxia

As mentioned, the greatest danger during decompression is hypoxia. To prevent crewmembers from becoming significantly impaired or incapacitated, the cabin crew must continuously observe passengers and crewmembers for the signs and symptoms of hypoxia. The effects of hypoxia (lack of oxygen) cannot be over emphasized. It is important for the cabin crew to realize that even mild hypoxia, though not fatal, can have fatal results. This is because hypoxia can significantly reduce the crewmembers ability to perform, and consequently lead to errors that may be fatal.

The insidious nature of hypoxia causes a subtle decrease in individual performance, followed by incapacitation, the symptoms may not be identified until it is too late.

The most common type of aviation hypoxia is "hypoxic hypoxia", that occurs due to low partial pressure of oxygen in the arterial blood. If oxygen is not used immediately in hypoxia cases, it is possible that occupants become incapacitated and lose consciousness in a very short time.

III.1 Physiological and Psychological Effects of Hypoxia

It is important that cabin crewmembers be aware of the symptoms of hypoxia in themselves and in others. During a decompression incident, some of the passengers may show signs of hypoxia: Some may appear to be dizzy and laughing and some may not be bothered to put on their oxygen masks.

It is necessary to remember that each person may not react in the same way, and that the symptoms of hypoxia may manifest themselves differently in each individual.

Initial signs of hypoxia include:

- Stomach pain due to gas expansion
- Tingling sensation in the hands and feet
- Cyanosis (blue discoloration of the lips and fingernails)
- Increased rate of breathing
- Headache
- Nausea
- Light-headedness
- Dizziness
- Sweating
- Irritability
- Euphoria
- Ear discomfort.

These symptoms become more pronounced with the lack of oxygen, for example:

- Impaired vision
- Impaired judgment
- Impaired motor skills (not able to coordinate body movements)
- Drowsiness
- Slurred speech
- Memory loss
- Difficulty to concentrate.

Hypoxia can cause a false sense of well-being. It is possible for a person to be hypoxic and not be aware of their condition. Therefore, it is important that the cabin crew recognizes the signs of hypoxia, and provides oxygen as soon as possible, in order to prevent a loss of consciousness. The affected passenger or crewmember usually recovers a few minutes after receiving oxygen. However, they may not be aware of having lost consciousness.

III.2 Time of Useful Consciousness

The time of useful consciousness refers to the time available to individuals to perform their tasks, after they have been deprived of oxygen, but are still aware of their environment and capable of controlling their actions.

It is important for the cabin crew to realize that the time of useful consciousness is different for each individual, and depends on the:

- Altitude
- Individual's state of health
- Amount of activity.

The cabin crew must remember that, in cases of continued physical activity, the time of useful consciousness (**Table 1**) is significantly reduced.

TIME OF USEFUL CONSCIOUSNESS		
Altitude	Moderate Activity	Sitting Quietly
22 000 feet	5 minutes	10 minutes
25 000 feet	2 minutes	3 minutes
28 000 feet	1 minute	1.5 minutes
30 000 feet	45 seconds	1.25 minutes
35 000 feet	30 seconds	45 seconds
40 000 feet	18 seconds	30 seconds

Carlyle, 1963

Table 1

Time of Useful Consciousness Table at Various Altitudes

Note:

It is important to emphasize that this table is only a guideline, and provides average values that can increase or decrease, depending on the skills needed to accomplish a task, on the individual's health, and on the amount of activity. For example, the time of useful consciousness for a cabin crewmember involved in moderate activity is significantly less, compared to a passenger that is sitting quietly.

The following are some other factors that can contribute to reducing the time of useful consciousness:

- **Fatigue:** A person who is physically or mentally fatigued will have an increased risk of hypoxia
- **Physical effort:** During physical activity, there is an increased need for oxygen, an increased risk of hypoxia and, as a result, a decrease in the amount of useful consciousness time
- **Alcohol:** Alcohol can significantly affect behavior, and can increase the risk of hypoxia, in addition to aggravating some of the behavioral changes resulting from hypoxia.

IV Cabin Decompression Procedure

In 1995, a study conducted by the Civil Aero Medical Institute (CAMI) in the United States, entitled "Flight Attendant Procedures in a Decompression", revealed that accident investigators, and safety inspectors reported that cabin crew did not follow the recommended procedures during decompression. This study resulted in a Flight Standards Information Bulletin (FSIB released by the FAA), that provides the recommended procedures in a cabin decompression event.

IV.1 Immediate Actions

In the case of decompression the immediate use of oxygen is critical. Therefore, the first actions to be performed by the cabin crew are:

- **Immediately don the nearest oxygen mask**
- **Sit down fasten your seat belt, or grasp a fixed object**
- **Hold on.**

If the cabin crew is not able to sit down or grasp a fixed object, they should wedge themselves between passengers and ask passengers for assistance. For example, in one cabin decompression event, a cabin crewmember was saved from ejection out of the aircraft, because a passenger was holding on to the cabin crewmember's ankle.

The priority of the cabin crew is to consider their personal safety.

Incapacitated or injured cabin crewmembers will not be able to assist other cabin crewmembers and passenger during the post-decompression phase.

V Cabin - Cockpit Communication

During any emergency, effective crew communication is critical to a successful outcome. Effective Crew Resource Management (CRM) involves cooperation and

communication between the flight and cabin crew. In many abnormal and emergency situations, the cabin crew plays an important role in helping the flight crew to identify and resolve developing problems.

Many incident and accident reports have revealed that effective crew communication, between flight and cabin crew, can make the difference between an accident and an incident. It has also been revealed that ineffective communication between the flight and cabin crew has contributed to the severity of an accident.

V.1 When in Doubt

Cabin crew are trained to anticipate the occurrence of specific actions during specific events. In the case of decompression, for example, it would be quite reasonable for the cabin crew to expect the flight crew to make an emergency descent. However, when the expected does not happen, how should the cabin crew react if the oxygen masks deploy and the aircraft continues to climb?

This type of scenario was stated in a recently published accident report involving a slow decompression. In this accident, the aircraft continued to climb.

Today, this type of scenario is rare. However it is important to consider how the cabin crew should react in this type of event.

In this case, the cabin crewmember seated closest to the cockpit, should immediately notify the flight crew of the oxygen mask deployment, and also to confirm that the flight crew have donned their oxygen masks.

This highlights the importance of crew communication. It is vital to the safety of the flight that open communication is maintained between the cabin crew and the flight crew.

When the expected does not happen, the cabin crew must take the initiative to seek and find an explanation.

If the cabin crew suspects that the safety of the flight is at risk, or that there is any indication of an abnormal situation, the cabin crew must immediately notify the flight crew.

V.2 Crew Communication in a Noisy Environment

In the case of rapid/explosive decompression, the level of noise will be very high. Therefore, this makes communication difficult between the flight crew and the cabin crew, and equally between the cabin crew and the passengers. Due to the fact that effective communication is vital during any emergency, the cabin crew should use any available form of communication. For example, in several accidents involving rapid/explosive decompression, cabin and flight crews were forced to communicate via hand signals and gestures. Cabin crewmembers must, therefore, be prepared to improvise and use their imagination!

VI Post Decompression

After a decompression, when the aircraft reaches a safe altitude, the cabin crew can move around the cabin, and should use the portable oxygen cylinders until they are confident that they can breathe without support.

When the emergency descent is completed, and a safe altitude is reached, the cabin crew should consider their oxygen requirements. Due to the physical activity at an increased altitude, the cabin crew may still be exposed to hypoxia. Oxygen deprivation can be insidious and the cabin crew may not be the best judges of their own oxygen intake after decompression.

After cabin decompression, the cabin crew should:

- **Check on the flight crew, and be prepared to assist in the case of pilot incapacitation**
- Check passengers for any injuries
- Check the cabin for any damage
- Provide first-aid and oxygen, as necessary
- Report the cabin status to the flight crew.

VII Oxygen Systems

When the cabin altitude rises above 14 000 feet, the oxygen masks stored above the passenger seats, in the lavatories, galleys, and crew stations will deploy automatically. The flight crew may also manually deploy the oxygen mask system.

Oxygen masks are stowed in groups and have a release pin, connected to a lanyard. Pulling one mask is sufficient to activate the oxygen flow for all the other masks of the same group.

The following two types of oxygen are available on the aircraft:

- Chemical
- Gaseous.

VII.1 Chemically-Generated Oxygen System

As soon as an oxygen mask is pulled down, and the release pin is removed, oxygen begins to flow to the mask. It is not possible to stop the flow of oxygen after it has started.

The chemical generator creates heat, and therefore results in a burning odor where dust has gathered. This is normal, however, passengers may become concerned with the smell of burning associated with the oxygen generators.

Therefore, the cabin crew should make a passenger announcement, when it is safe to do so, that there is a possibility of a smell of burning associated with the normal operation of chemical oxygen generator systems.

VII.2 Gaseous Oxygen System

The activation of the gaseous system depends on cabin altitude. On the other hand, chemically generated oxygen does not depend on the aircraft altitude.

There are a number/A large amount/A specific amount of high-pressure oxygen bottles that supply gaseous oxygen to the cabin. This gaseous oxygen system does not generate a burning odor, because no heat is generated.

VII.3 Portable Oxygen Cylinders

Oxygen cylinders are located throughout the cabin. The number and location of the oxygen cylinders varies, depending on the aircraft cabin configuration.



Zodiac AVOX Systems

Figure 1

Portable Oxygen Cylinder Assembly

VIII Factors Affecting Compliance with Operational Standards

The analysis of in-service events has revealed that operating standards may not be effective, or applicable, in the following situations:

- The cabin crew does not recognize the indications of slow decompression, and continues to perform their tasks in the cabin as usual
- The cabin crew does not have sufficient hypoxia information and training

- There is a lack of cabin crew procedures, applicable to a loss in cabin pressure, oxygen mask deployment, and aircraft continuation of climb. Often, the procedures do not sufficiently emphasize the importance of immediately donning the nearest oxygen mask
- The cabin crew does not apply the procedures correctly. For example, oxygen masks are removed during decompression, causing incapacitation
- There is a lack of communication between the cabin and flight crew. For example, the cabin crew does not notify the flight crew of oxygen mask deployment in the cabin.

IX Prevention Strategies

It is important for flight and cabin crews to be able to identify the different types of decompression, and immediately react appropriately in order to ensure flight safety and limit the risk of hypoxia. This can be achieved through appropriate training, including:

- Enhanced training which includes, how to identify the different types of decompression
- Developing an increased awareness of the signs and symptoms of hypoxia, the effects of hypoxia on performance, and the importance of immediately using oxygen
- Understanding the need for good communication, coordination and cooperation, between the flight crew and the cabin crew.

X Summary of Key Points

- Operators should stress in their procedures, initial and recurrent emergency training, that the first and immediate action for **all crewmembers** during decompression is to immediately don the nearest oxygen mask
- Operators should incorporate comprehensive guidance material and information on hypoxia in:
 - Flight and cabin crew training manuals
 - Flight and cabin crew initial and recurrent training courses.
- Operators should ensure that these courses emphasize the need for effective communication, coordination, and cooperation between the flight crew and the cabin crew.

XI Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Note can be consulted for additional information about crew communication:

- **Crew Communication**

XII Regulatory References

- FAA Flight Standards Information Bulletin for Air Transportation – Use of Oxygen Mask by Cabin Crew During Decompression - <http://www.faa.gov/>
- FAA Advisory Circular – AC 61-107A - Operations of Aircraft at Altitudes Above 25,000 feet MSL and/or Mach Numbers (Mmo) Greater than .75 - <http://www.airweb.faa.gov/>
- FAA Advisory Circular – AC 120-48 – Communication and Coordination between Flight Crewmembers and Flight Attendants - <http://www.airweb.faa.gov/>
- United Kingdom CAA - Flight Operations Department Communication – FODCOM 1/2003 - <http://www.caa.co.uk>

XIII Airbus References

- A320 Family, A330, A340 & A380 Cabin Crew Operations Manuals
- Getting to Grips with Cabin Safety (Brochure)
- Safety First (The Airbus Flight Safety Magazine) – Issue # 03 – December 2006 – Pages 30-35 - Hypoxia an Invisible Enemy – Cabin depressurization effects on human physiology.

XIV Additional Reading Materials

- Flight Safety Australia Magazine Article – Dizzying Heights - March–April 2004 -
- Flight Safety Australia Magazine Article – November 1999

Note:

These articles can be found on the Australian Civil Aviation Safety Authority website - <http://www.casa.gov.au/>.

This FOBN is part of a set of Flight Operations Briefing Notes that provide an overview of the applicable standards, flying techniques and best practices, operational and human factors, suggested company prevention strategies and personal lines-of-defense related to major threats and hazards to flight operations safety.

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