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Cabin Pressurization

UNIT 4

FLIGHT SURGEON QUALIFICATION COURSE

Unit 4 Objectives

Objective: Understand the types of USAF aircraft pressurization systems. Define pressurization

- **Describe the types of pressurization systems to include their advantages and disadvantages (sealed and pressurized).**
- **Describe pressurization schedules (isobaric and isobaric differential).**
- **Identify the characteristics and hazards of cabin decompression.**
- **Identify factors controlling the rate of a decompression.**
- **Determine the physical indications and physiological effects of gradual and rapid decompression.**
- **Identify the oxygen equipment emergency procedures following a rapid decompression.**

Definition

- **Pressurization is a mechanical means of maintaining interior (cabin) pressure at a greater than ambient (outside) pressure.**
  - **Remember, as altitude increases, the ambient pressure decreases.**
- **Pressurization also ensures the comfort and safety of the crew and passengers by limiting gas expansion and the chances of hypoxia and decompression sickness.**
  - **Also, a pressurized cabin means that no oxygen equipment is needed, the cabin temperature can be controlled, and since masks or helmets are not required, communication is much easier.**

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Pressurization Systems

Sealed cabin and Pressurized cabin are two types of pressurization systems.

A sealed cabin contains an on-board life support system which mixes liquid oxygen and Nitrogen or Helium.

A sealed cabin does not allow any gaseous exchange between the ambient atmosphere and the atmosphere within the cabin.

Flight in the Space-Equivalent Zone (which begins at FL 500) requires a sealed cabin pressurization system.

vs.

A pressurized cabin is often necessary for altitudes below FL 500.

A pressurized cabin uses a cabin pressurization system to force the ambient air into the cabin by means of a compressor.

This system is comprised of several elements.

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Pressurized Cabin

This system is comprised of several elements.

Air Intake port: Air gets pulled into the system here.

- Compression: Since air is brought in at a reduced pressure, the compressor compresses it.
- Refrigeration Unit: Compression causes friction of molecules.
- Friction causes heat. This unit cools the air.
- Pressurized Aircraft Area: This consists of the cabin of the Aircraft.
- Outlet: Where air exits the cabin.
- Overboard Port: Where air is returned to the atmosphere.

NOTE: The compressor and Outlet Valve work together to maintain cabin pressure. As the cabin altitude increases, the pressure decreases. The Outlet Valve then closes to let more pressure into the cabin. However, on descent, as outside pressure increases, the Outlet Valve will open to allow pressure out of the cabin.

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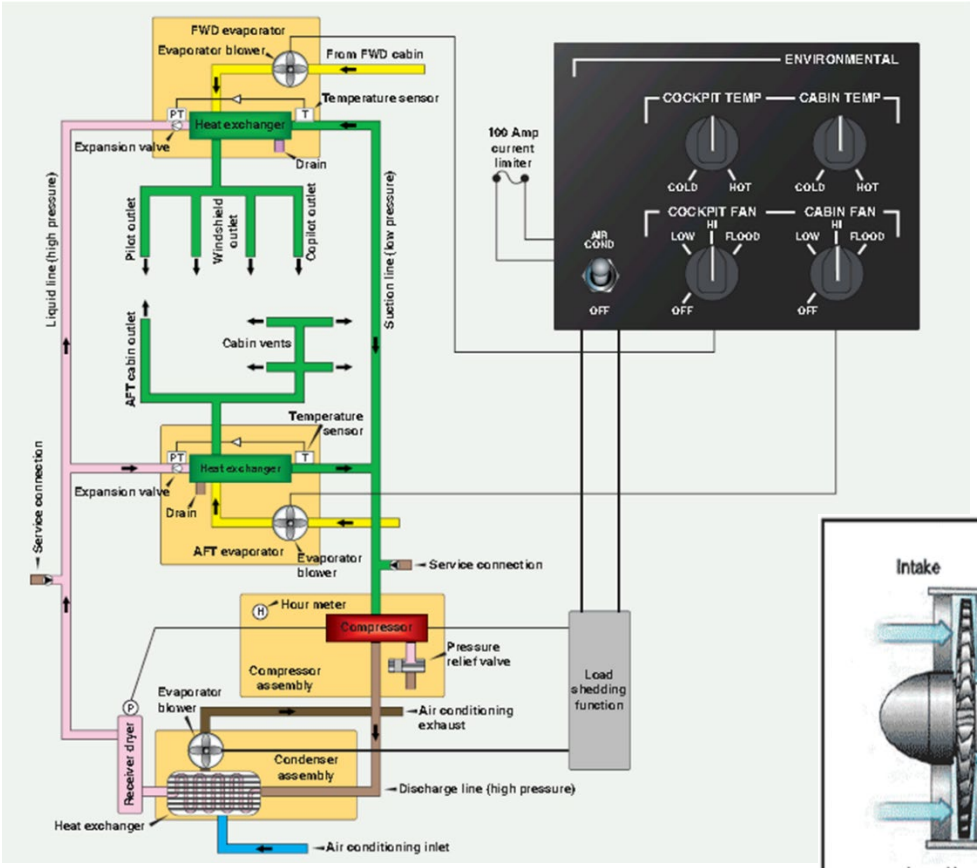
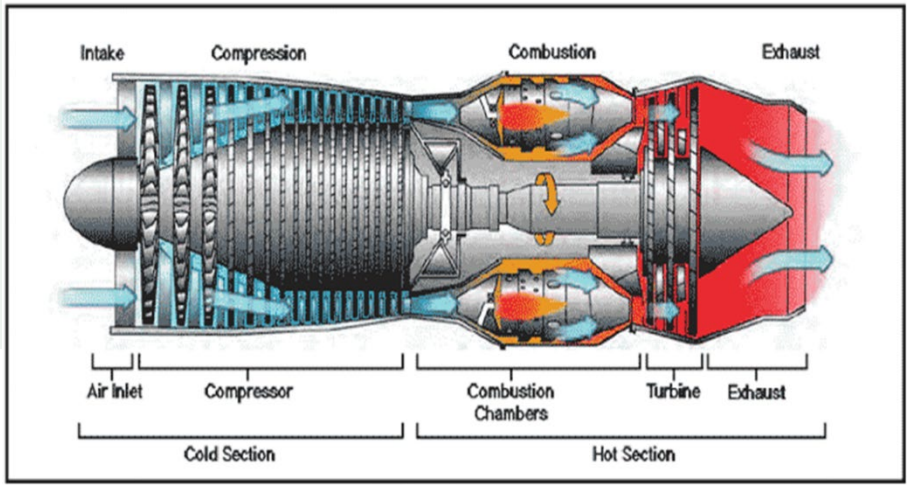
Pressurization

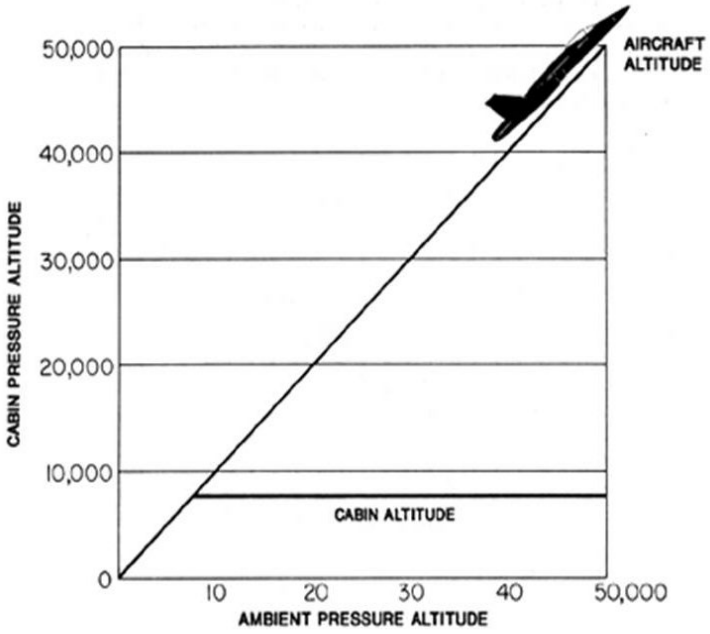




Cabin Pressurization

There are two primary types of cabin pressurization; Isobaric and Isobaric Differential

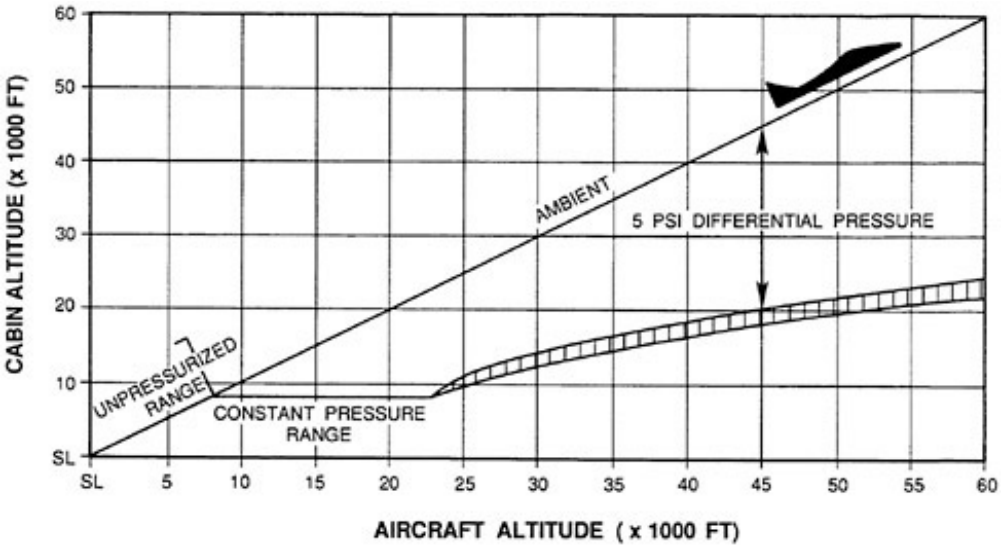
- Isobaric means constant cabin attitude pressure despite aircraft altitude
- This is generally the type of pressurization use in commercial aircraft, which are designed to maintain the pressure difference between the cabin and the ambient environment.



Isobaric Pressurisation System
(Diagrammatic Representation)

Cabin Pressurization

- Isobaric Differential pressure systems provides a lower cabin altitude (higher pressure) environment relative to the ambient pressure.
- Cabin altitude pressure will increase with aircraft altitude, but to a lesser degree.
- Isobaric differential systems, common to military training aircraft, maintain isobaric pressure up to a point and then a differential pressurization thereafter.



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Advantages and Disadvantages of Cabin Pressure

Advantages

- Reduces the possibility of hypoxia, decompression sickness, and trapped gas problems.
- Makes flying conditions more comfortable.
- Allows for cabin temperature control.
- Eases communication.

Disadvantages

- Increases aircraft operational cost.
- Adds weight from additional equipment.
- Reduces aircraft performance due to increased weight.
- Adds risk of accidental pressure loss.

Pressure Differential

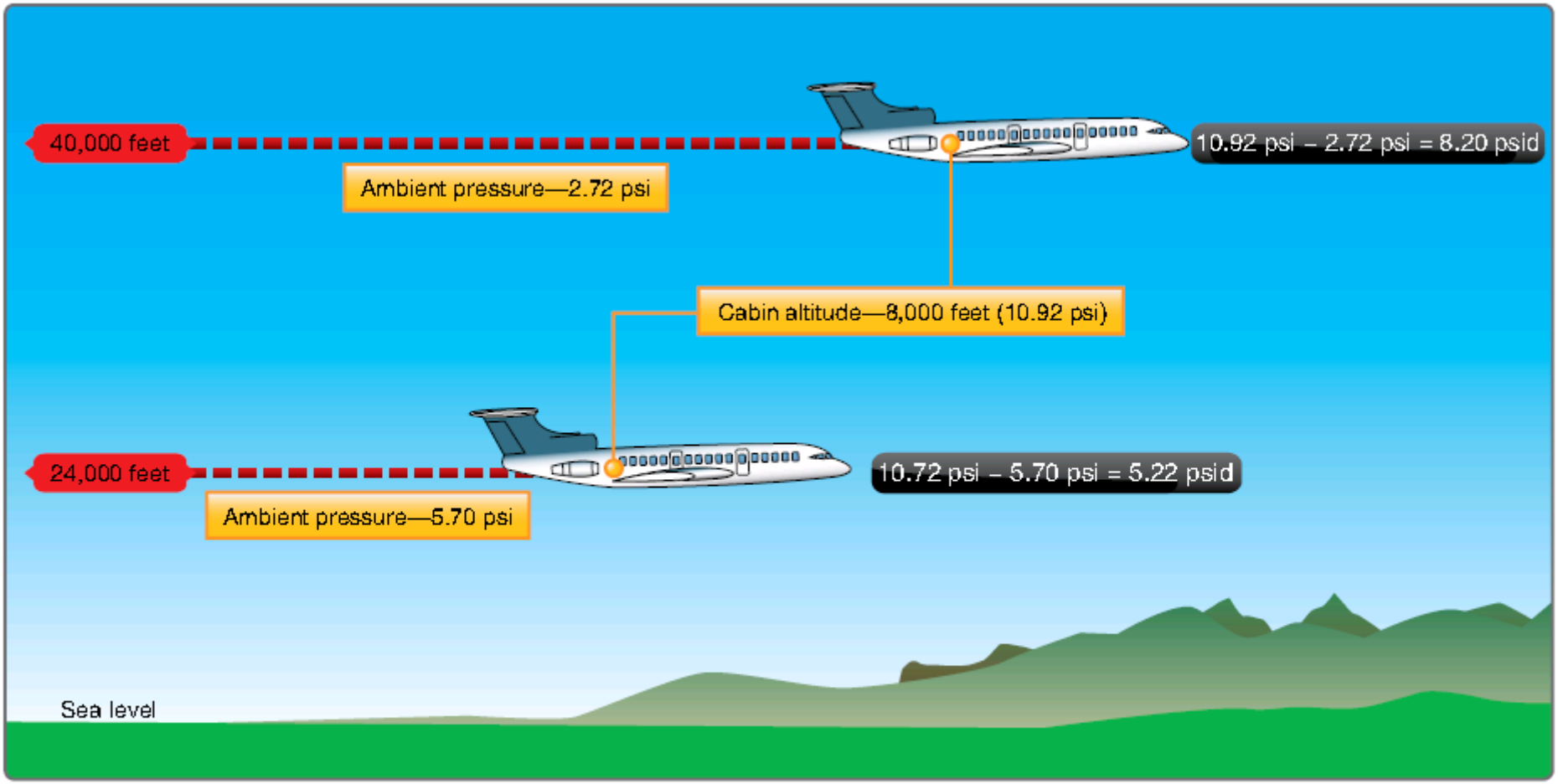

Figure 16-41. *Differential pressure (psid) is calculated by subtracting the ambient air pressure from the cabin air pressure.*

Pressure Differential & Ratio

- **Pressure Differential means the difference between the cabin and ambient pressure.**
  - The larger the difference, the more severe the decompression, and the longer it takes to lose pressure completely.

- **Pressure Ratio is the ratio between cabin pressure and ambient pressure determines the time required for a decompression.**
  - The larger the ratio, the longer it takes for a complete decompression.

Rate of Decompression

The rate of cabin decompression changes based on:

- **Volume of the Cabin**
  - The smaller aircraft would decompress faster because its cabin has less volume. Less volume means it takes a smaller amount of time for pressure to escape.
- **Size of the Opening in the Aircraft**
  - The larger opening allows pressure to escape more rapidly.
- **Flight Altitude**
  - A lower altitude means a smaller ratio between cabin and ambient pressure, thus taking less time to decompress.

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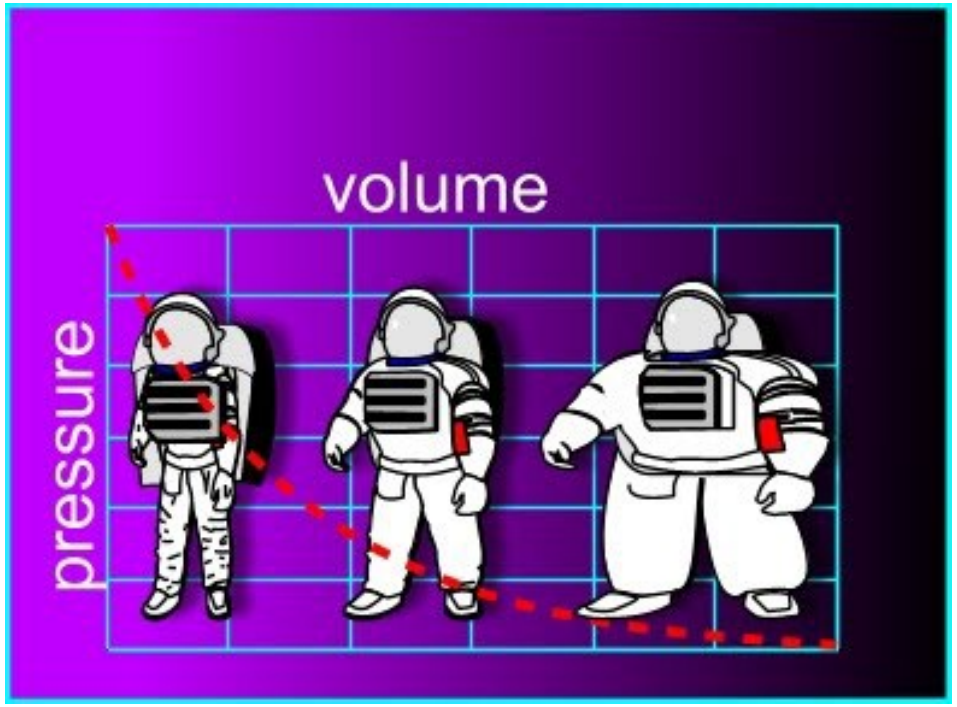
Physiologic Effects of Decompression



- All air cavities within the body are subject to Boyle's law, where a gas expands with decreases in ambient pressure.
- This is can be significant, especially for the middle ear, sinus cavities, GI tract, and teeth.
- Aircrew are trained to recognize that these physiologic changes may be related to cabin depressurization.

Types of Decompression

There are two types of Decompression:

- **Slow decompression**
  - 4 seconds or longer
  - Slow decompression is considered the more dangerous because it can happen without aircrew being aware.

- **Rapid decompression**
  - 1 to 3 seconds
  - Rapid decompression is more noticeable and considered the most violent type of decompression.
  - Rapid decompression has several physical indications:
    - Explosive noise
    - Wind Blast/Flying Debris
    - Fogging
    - Decreased Temperature
    - Decreased Pressure

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Times of Useful Consciousness (TUC)

- **Your Time of Useful Consciousness (TUC) is the amount of time you are able to take emergency action during a decompression event. Your TUC in a rapid decompression is about half of what it would be in slow decompression.**

- **TUC at various altitudes:**
  - **FL 439 and above - 9-12 Seconds**
  - **FL 400 - 15-20 Seconds**
  - **FL 350 - 30-60 Seconds**
  - **FL 300 - 1-2 Minutes**
  - **FL 280 - 2.5-3 Minutes**
  - **FL 250 - 3-5 Minutes**
  - **FL 210 - 8-10 Minutes**
  - **FL 180 - 20-30 Minutes**

- **Rapid decompression reduces these rates by 1/3 to 1/2.**

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Decompression Emergency Procedures

- **Both rapid and slow decompression require the following emergency procedures:**
  - **Gang-load your regulator (Emergency/ 100%/ On).**
  - **Don mask quickly. Remember time of useful consciousness (TUC) is limited.**
  - **Check all your equipment connections.**
  - **Use controlled breathing.**
  - **Ensure the rest of the crew and passengers are OK.**
  - **Seek qualified medical attention if necessary.**

Summary

- Define pressurization.
- Describe the types of pressurization systems to include their advantages and disadvantages (sealed and pressurized).
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