OXYGEN
ATMOSPHERE AND PHYSIOLOGICAL REQUIREMENTS

- Air at sea level contains about 21% of oxygen at a pressure of 14.7 psi
- Air above sea level contains the same percentage of oxygen but at a reduced pressure; it also contains less mass of oxygen
- This has a serious effect on the body’s ability to function effectively as there is less oxygen available for the body to absorb into the blood stream and the reduced pressure reduces the rate of absorption
- 8,000 feet (cabin) altitude is widely regarded as the maximum altitude at which flying ability is not affected by the lack of oxygen; 10,000 feet is the level above which the use of supplementary oxygen becomes mandatory
- Above this altitude, supplementary oxygen must be provided for flight crew, cabin crew and passengers to cater for the following:
  - Rapid decompression
  - Smoke and fumes (flight deck only)
<table>
<thead>
<tr>
<th>Physiological Effects of Altitude</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum altitude without oxygen at which flying efficiency is not seriously impaired</td>
<td>8,000</td>
</tr>
<tr>
<td>Altitude at which the incidence of decompression sickness increases rapidly with exposures exceeding ten minutes</td>
<td>25,000</td>
</tr>
<tr>
<td>Maximum altitude at which sea level conditions can be maintained by breathing 100% oxygen</td>
<td>33,000</td>
</tr>
<tr>
<td>Maximum allowable altitude without pressure breathing</td>
<td>40,000</td>
</tr>
</tbody>
</table>
SOURCES OF OXYGEN SUPPLY

- Oxygen can be obtained in flight from the following sources:
  - Gas bottles (always used for Flight Deck supply, may be used for cabin supply)
  - Chemical generator (used for cabin supply in commercial aircraft)
  - Liquid oxygen (never used in commercial aviation, still used in some military aircraft)
  - Catalytically split from atmosphere (too expensive and bulky for large numbers, used in some single seat military fighters)

- We will be considering only the first 2 of these supply sources
JAR OPS 1 REQUIREMENTS - NON-PRESSURISED AIRCRAFT

• Flight Deck Crew
  - \(O_2\) for the entire flight time the cabin is above 10 000 feet

• Cabin Crew
  - For cabin altitudes between 10 000 and 13 000 feet, \(O_2\) after 30 minutes; \(O_2\) for entire flight above 13 000 feet

• 10% of passengers
  - For cabin altitudes between 10 000 feet and 13 000 feet, \(O_2\) after 30 minutes

• 100% of passengers
  - \(O_2\) for entire flight time above 13 000 feet
JAR OPS 1 REQUIREMENTS - PRESSURISED AIRCRAFT

- **Flight Deck Crew**
  - For cabin altitudes between 10 000 and 13 000 feet, $O_2$ after 30 minutes
  - $O_2$ whenever cabin above 13 000 feet
  - Supply not less than:
    - 30 min for aircraft certified to fly up to 25 000 feet
    - 2 hours for aircraft certified to fly above 25 000 feet

- **Cabin Crew**
  - For cabin altitudes between 10 000 and 13 000 feet, $O_2$ after 30 minutes
  - $O_2$ whenever cabin above 13 000 feet
  - Supply not less than 30 minutes

- **Passengers**
  - 10% of passengers for cabin altitudes between 10 000 and 14 000 feet, $O_2$ after 30 minutes
  - 30% of passengers whenever cabin above 14 000 feet
  - 100% of passengers whenever cabin is above 15 000 feet
  - Minimum passenger supply is always 10 minutes (allows for descent to 15 000 feet)
JAR OPS 1 - $O_2$ Requirements

Non-pressurised aircraft

- **Flight Deck**
  - $O_2$ for the entire flight
  - 10,000'

- **Cabin Crew**
  - $O_2$ for the entire flight
  - 13,000'

- **Passengers**
  - $O_2$ for the entire flight for 100% of passengers
  - 13,000'

  - $O_2$ after 30 minutes for 10% of passengers
  - 13,000'

  - 10,000'
JAR OPS 1 - $O_2$ Requirements

**Pressurised aircraft**

- **Flight Deck**: $O_2$ for the entire flight
  - 13,000’
  - $O_2$ after 30 minutes
  - 10,000’

- **Cabin Crew**: $O_2$ for the entire flight
  - 13,000’
  - $O_2$ after 30 minutes
  - 10,000’

- **Passengers**: $O_2$ for the entire flight
  - 15,000’
  - For 30% of passengers
  - 14,000’
  - $O_2$ after 30 min for 10% of passengers
  - 10,000’
JAR OPS 1 - $O_2$ Requirements

Supply availability

**Flight Deck**
Not less than 30 mins for aircraft certified to fly up to 25,000'
Not less than 2 hrs for aircraft certified to fly above 25,000'

**Cabin Crew**
Not less than 30 mins

**Passengers**
Always 10 mins (this allows for a descent to 15,000')
CONTINUOUS FLOW SYSTEM

1800 PSI

Mask connection points

Low pressure gauge
High pressure gauge

Low pressure
High pressure

Cylinders

Line valve
Pressure reducing valve

Filter

Non-return valve
Shut-off valve

Filter

Charging valve
Charging connection

40 psi - cabin
250-350 psi - flight deck
BOTTLE INSTALLATION (SHUT OFF VALVES)
FLIGHT CREW DEMAND REGULATOR - CONTROL FUNCTIONS

- **ON/OFF lever**
  - Controls supply to regulator

- **Normal/100% lever**
  - Shuts off cabin air to regulator
  - Supplementary $O_2$ valve opens
  - 100% $O_2$ supplied on demand

- **Emergency lever**
  - Used in the event of smoke/fumes
  - Biases demand valve towards open
  - Gives slight (1 or 2 psi) overpressure to ensure any mask leaks are outwards

- **Relief valve**
  - Relieves excess pressure

- **Test button (not shown)**
  - Supplies mask at a pressure higher than emergency to test mask for leaks
FLIGHT CREW MASKS (QUICK-DON)

- Flight crew must have both speech and listen capability when wearing mask
- Need to wear a headset, as mask only gives speech capability
- Same system used for smoke/fumes protection
- Quick-don masks mandatory if aircraft certified above 25,000 feet
- Mask must be able to be donned one-handed, over any glasses, within 5 seconds without interfering with primary duties
- Above 41,000 feet, one pilot must wear an $O_2$ mask at all times
FLIGHT CREW MASKS (QUICK-DON)
PASSENGER OXYGEN SYSTEM

- Low pressure continuous flow
- Either gaseous or chemical supply
- Masks deploy either:
  - automatically at 14,000 feet and must be fully deployed (½-hung) by 15,000 feet
  - Via pilot operated switch
- Solenoid lock on door (gaseous system is pneumatic; chemical is electrical)
- No flow in ½-hung position
- Only get flow when pull down towards face
- 100% O₂ is supplied to mask; this is then mixed with cabin air through holes in mask and this is what passengers breathe
ADVANTAGES AND DISADVANTAGES OF A CHEMICAL GENERATOR

• Advantages:
  - Saves weight; no large oxygen bottles
  - Less complicated; no regulation required
  - Easier to distribute
  - Improved reliability and safety
  - Any fault would only affect a limited number of seats
  - Simple to maintain
  - Easy replacement of units
  - Oxygen released at a steady rate

• Disadvantages:
  - Oxygen produced is smelly and unpleasant
  - Generates a lot of heat
  - 12 to 15 minutes only (10 as a minimum)
  - One shot only
CHEMICAL GENERATOR

Also called a 'sodium chlorate candle' or a 'chemical candle'

Sodium Chlorate reacts with iron powder to give off $O_2$
CHEMICAL GENERATOR - INSTALLATION

• Each installation supplies between 1 and 5 seats
• Must be enough to supply at least 110% of the passenger seats fitted (for infants, cabin staff moving about cabin when problem occurs, minimum of 2/toilet for mother and baby)
PROTECTIVE BREATHING EQUIPMENT

- 3 Settings:
  - NORMAL; 2 ltrs/min; 60 minutes
  - HIGH; 4 ltrs/min; 30 minutes
  - EMERGENCY; 10 ltrs/min; 12 minutes
- Available to crew for fire fighting
THERAPEUTIC (FIRST AID) OXYGEN

- Must have sufficient on board for 2% of passengers carried but never less than 2 units
SAFETY ASPECTS OF OXYGEN USE

- Bottle colour
  - Green in USA and Europe
  - Black with white neck in the UK
- Oxygen bottles have different connectors from other gas containers but have been filled with the wrong gas!!!
- Oxygen must be free from oil, grease, fuel or other contaminants
- Oxygen is an agent required for combustion and increased concentrations of it can render material more liable to burn