Commercial Pilot Flight Lesson: High Altitude Operations

Objectives:

1. To understand subjects pertaining to high altitude operations including environmental systems, emergency procedures, and normal operations
2. To be able to properly react to simulated emergencies specific to high altitude operations

Justification:

1. As a commercial pilot, many opportunities will require high altitude operations
2. in an emergency at high altitude, reaction time is critical to safe recovery from situation
3. Commercial Checkride requires knowledge of high altitude operations

Schedule:

Activity	Est. Time
Ground	1.0
Preflight/Taxi	0.25
Flight	1.5
Debrief	0.25
Total	3.00

Elements Ground:

- high altitude operations overview
- weather considerations
- supplemental oxygen
- pressurization
- emergencies

Elements Air:

- emergency descents
- simulated de-pressurization

Completion Standards:

1. when the student exhibits an understand of high altitude operations
2. when the student is able to properly deal with simulated emergencies specific to high altitude operations

Common Errors:

- ??

Presentation Ground:

high altitude operations overview

1. physiology
   (1) hypoxia *:lack of sufficient oxygen in the body cells or tissues caused by an inadequate supply of oxygen, inadequate transportation of oxygen, or inability of the body tissues to use*
   i. at high altitudes, pressure of oxygen on lungs is reduced, thus, the ability for the body to absorb oxygen is reduced
   (2) time of useful consciousness *:the amount of time in which a person is able to effectively or adequately perform flight duties with an insufficient*

altitude	standard ascent rate	after rapid decompression
18,000	20-30 minutes	10-15 minutes
22,000	10 minutes	5 minutes
35,000	30-60 seconds	15-30 seconds
50,000	9-12 seconds	5 seconds

   (3) prolonged use of oxygen can produce toxic symptoms such as bronchial cough, fever, vomiting, lowered energy
   i. significant periods of time are required before this occurs (usually 1-2 days)
   (4) decompression sickness *:nitrogen in the body changing from liquid form to gaseous state due to a dramatic reduction in surrounding atmospheric pressure*
   i. AIM 8-1-2 recommends for flights below 8000 ft (cabin pressure), minimum 12 hours for non-decompression dives, and 2 hours for decompression dives. for flights above 8000 ft, 24 hours minimum.
2. regulations
   (1) 91.211a - general
   i. minimum crew must *use* oxygen between 12,500 and 14,000 (inclusive) for any period over 30 minutes
   ii. minimum crew must *use* oxygen above 14,000 at all times
   iii. all passengers must be *provided* with oxygen above 15,000
   (2) 91.211b - pressurized cabin
   i. above FL250, minimum of 10-minutes of supplemental oxygen available for each passenger
   ii. above FL350, at least one pilot must be wearing and using an oxygen mask; unless at or below FL410, if there are two pilots at the controls, and both have quick donning type mask that can be put on and working within 5 seconds
   iii.even with quick donning masks, if one pilot leaves, other must wear and use oxygen until other pilot returns

weather considerations

1. jet stream
   (1) travels east at approximately 50-200 kts
   (2) caused by large temperature differences aloft
   (3) has a meandering path that is constantly changing

(4) closer to the equator in the winter, farther in the summer

i. general circulation patterns move south in the winter due to less heating activity

2. clear air turbulence (CAT)

(1) :*phenomenon of turbulence associated with high altitude winds, and not associated with clouds*

(2) can be caused by wind shear, mountain waves, low pressures aloft, etc

(3) difficult to forecast since there are no visual signs of it.

supplemental oxygen

1. overview

(1) whether portable or installed, oxygen is stored in high pressure tanks (usually around 1800-2200 PSI)

(2) 22 cu ft container will supply 4 people at 18,000 ft for up to 1.5 hours

(3) aviation oxygen should be the only oxygen to be used (100% oxygen)

i. industrial oxygen is not made for breathing, and has impurities in it.

ii. medical oxygen may contain to much moisture which could freeze at low temperatures

(4) oxygen systems require periodic refill, inspection, and servicing

i. AF/D tell what airports have oxygen available

(5) oxygen duration charts allow calculations of time available based on passengers and system PSI

2. continuous-flow - most common type of system for piston aircraft as well as for passengers in turboprop and jets.

(1) overview

i.simplicity keeps maintenance costs down, reduces malfunction possibility

ii. not adequate above 25,000 ft. (although certified up to 41,000

iii. designs may include constant-flow, adjustable-flow, altitude-compensated flow

iv. available as built-in system, or portable system

(2) mask styles

i. oronasal rebreather - covers both nose and mouth, and includes a bag to allow reuse of exhaled oxygen

ii. cannula breathing device - oxygen is supplied to the nose only, allowing use of normal communication methods (not certified as high as oronasal rebreathers)

3.diluter-demand/pressure-demand - supply oxygen only when the user inhales through the mask

(1) depending on altitude the supplied mixture of oxygen to cabin-air are automatically adjusted

(2) demand-type masks have a tight seal to avoid dilution by cabin air, and are safe up to 40,000 ft

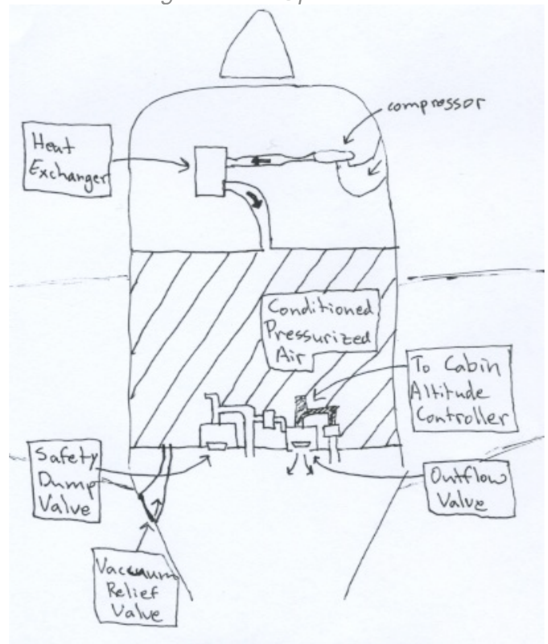
4. oxygen generators

(1) available on airliners, oxygen generators use a chemical reaction to produce oxygen for a set amount of time.

(2) each passenger has an individual “supply” from a generator

pressurization

1. cabin pressurization *:the compression of air in the aircraft cabin in order to maintain a cabin altitude lower than the actual flight altitude*



(1) most light aircraft compress air to the cabin via the turbocharger or an engine-driven pump

(2) <u>components</u>

i. an *outflow valve* keeps pressure constant by releasing excess pressure into the atmosphere

ii.a cabin altitude can be manually selected via a *cabin altitude controller*, and if needed regulated via a backup control to a *safety dump valve*

iii. *vacuum relief valve* prevents cabin pressure from becoming lower than ambient pressure in the case of a rapid descent

iv. a *heat exchanger* conditions the air before entry into the cabin

(3) the lower effective altitude in the cabin eliminates the need for oxygen masks at all times

i. see “regulations” section for supplemental oxygen requirements

(4) <u>maximum pressure differential</u> :*maximum allowable difference between atmospheric pressure and cabin pressure*

i.different for each aircraft (see POH)

emergencies

1. <u>decompression</u> *:the inability of the aircraft’s pressurization system to maintain its designed pressure schedule*

(1) overview

i.can be caused by a malfunction in the system, or by structural damage to the aircraft

ii.may result in cabin fog due rapid cooling of relatively moist air

iii.decompression of small cabins is more critical than large cabins given same hole or conditions

(i) primarily due to differences in cabin volume

(2) 3 types of decompression

i. <u>slow decompression</u> - may be difficult to detect. many systems include audible and visual warnings of high cabin altitudes

ii. <u>explosive decompression</u> - an extremely dangerous condition in which he aircraft decompresses faster than the lungs can decompress.

(i) typically occurs in less than 0.5 seconds

(ii) lung damage can occur

(iii) flying debris may cause further injury

iii. <u>rapid decompression</u> - decompression that occurs quickly, but is slower than the rate at which the lungs can decompress.

(3) recovery

i. use supplemental oxygen as quickly as possible

ii. descend as quickly as possible to a safe altitude

(i) a balance between reaching a safe altitude, and taking care of the engine must be made (most significantly in piston engines)

iii. see emergency descent below for procedure

2. fuel vaporization
   (1) at high altitudes engine driven fuel pumps may be subject to fuel vaporization
      i. boost pumps are typically installed to address this situation
3. severe turbulence
   (1) as with any altitude, if severe turbulence is encountered, maintain appropriate airspeed, and attempt to keep wings level, and heading approximately correct
   (2) accept changes in altitude and airspeed as long as pitch is relatively constant

Presentation Air:

1. Preflight considerations
   (1) when using an oxygen system, ensure properly operation by testing the system before takeoff
   (2) when using a pressurized system, refer to the POH to see what preflight actions are required before operation
2. Emergency Descents
   (1) in an emergency descent, the main objective is to lose altitude as quickly (and safely as possible)
      i. may be due to an inflight fire, cabin depressurization, etc.
   (2) this objective must be balanced with the need to preserve the engine.
      i. especially in Pistons, shock cooling can have significant detrimental effects
   (3) Procedure
      i. if necessary, don oxygen mask as soon as possible
      ii. slow the aircraft to proper speeds to extend gear and flaps
      iii. set propeller to high rpm (to help act as an aerodynamic brake)
      iv. reduce power as much as practicable
      v. if time permits, contact controller and notify of emergency descent for traffic avoidance purposes
      vi. initiate a 30°- 45° turn to allow traffic clearing, reduce vertical component of lift, and maintain positive “G” loading on the aircraft
      vii. through descent, ensure:
         (i) airspeed does not exceed appropriate limitations (Vfe, Vle, Vne)
         (ii) engine temperature does not cool to rapidly
            a. if necessary add power to keep temperature up
3. Simulated de-pressurization
   (1) possible symptoms of a slow leak de-pressurization
   (2) upon simulated depressurization
      i. fly the airplane!
      ii. don oxygen masks asap
      iii. refer to emergency descent procedures