P-2011

DISCUSS THE EFFECTS OF DENSITY ALTITUDE ON AIRCRAFT PERFORMANCE

CONDITIONS

You are a Mission Observer trainee and must discuss how density altitude affects aircraft performance.

OBJECTIVES

Describe the factors that are used to determine density altitude, and discuss the effect of high density altitude on aircraft performance and strategies to deal with high density altitudes during search operations.

TRAINING AND EVALUATION

Training Outline

1. As a Mission Observer trainee, knowing how density altitude affects aircraft performance is very helpful.

2. *Atmospheric pressure*. Pressure at a given point is a measure of the weight of the column of air above that point. As altitude increases, pressure diminishes as the weight of the air column decreases. This decrease in pressure has a pronounced effect on flight. The aircraft's altimeter is sensitive to these changes in pressure, and displays this pressure as altitude. When the altimeter is set to the current reported altimeter setting it indicates the aircraft's height above mean sea level (MSL). [If a local altimeter setting is unavailable, pilots usually set the altimeter to indicate the airport's MSL elevation.]

Changes in pressure are registered in inches of mercury: the *standard* sea-level pressure is 29.92 inches at a *standard* temperature of 15º C (59º F). If CAP aircraft always operated at standard conditions, the altimeter would always be accurate. An aircraft with an indicated (on the altimeter) altitude of 5,000' MSL will really be 5000' above the ground (AGL). However, these standard conditions rarely exist because the density of the atmosphere is always changing as altitude and temperature changes. [The third factor - humidity - also effects density, but the effect is smaller and its very hard to determine.]

3. *Pressure altitude*. Pressure altitude is an altitude measured from the point at which an atmospheric pressure of 29.92 inches of mercury is found. A good rule of thumb is that a 1,000' change of altitude results in a 1-inch (mercury) change on a barometer. Another way to determine pressure altitude is to enter 29.92 into the altimeter's window and read the resulting altitude indication.

4. *Density altitude*. When pressure altitude is corrected for non-standard temperature, *density altitude* can be determined.

5. *Effects*. The combined effects of high altitude and temperature (high density altitude) can have a significant effect on performance of aircraft engines, wings, propellers, and the pilot and crew. If all missions were conducted on cool, low humidity days along the Gulf coast there would be no concern with air density and its implications on flight safety. Obviously, this isn't the case. In fact, these conditions have often been primary factors in aircraft accidents, and may result in loss of the search aircraft, unless you pay careful attention.

The most noticeable effect of a decrease in pressure (increase in density altitude) due to an altitude increase becomes evident during takeoff, climb, and landing. An airplane that requires a 1,000' run for takeoff at a sea-level airport will require a run almost twice as long at an airport that is approximately 5,000' above sea level. The purpose of the takeoff run is to gain enough speed to generate lift from the passage of air over the wings. If the air is thin, more speed is required to obtain enough lift for takeoff- hence, a longer ground run. It is also true that the engine is less efficient in thin air, and the thrust of the propeller is less effective. The rate of climb is also slower at the higher elevation, requiring a greater distance to gain the altitude to clear any obstructions. In landing, the difference is not so noticeable except that the plane has greater groundspeed when it touches the ground.

6. *Strategies*. The mission staff can make a number of decisions to help minimize the effects of high density altitude operations and thus maximize flight safety. If aircraft having turbo-charged or super-charged engines are available, the incident commander may assign their crews that part of the search over the high terrain. Supercharging or turbocharging regains some of the engine performance lost with the decrease in air density, but cannot improve upon that lost from the wings or propeller.

Incident commanders may schedule flights to avoid searching areas of high elevation during the hottest times of the day. This is a tradeoff though, in that the best sun angles for good visibility often coincide with the hot times of the day. The incident commander may also elect to limit crew size to minimize airplane total weight. Instead of dispatching a four-seat aircraft with a pilot, observer, and two scanners aboard, he may elect to send a pilot, observer and single scanner only. Again, this represents a tradeoff, where some search capability is sacrificed for a higher margin of safety.

The pilot may decide to takeoff on a mission with only the fuel required for that mission and the required reserve, rather than departing with full fuel tanks. Each crewmember can help by leaving all *nonessential* equipment or personal possessions behind. In areas of high density altitude, airplane performance can be improved significantly by simply leaving nonessential, excess weight behind.

To help remember these conditions and their effects, an observer should remember the four "H's." *Higher Humidity, Heat, or Height all result in reduced aircraft performance*. Available engine power is reduced, climb capability is reduced, and takeoff and landing distances are increased.

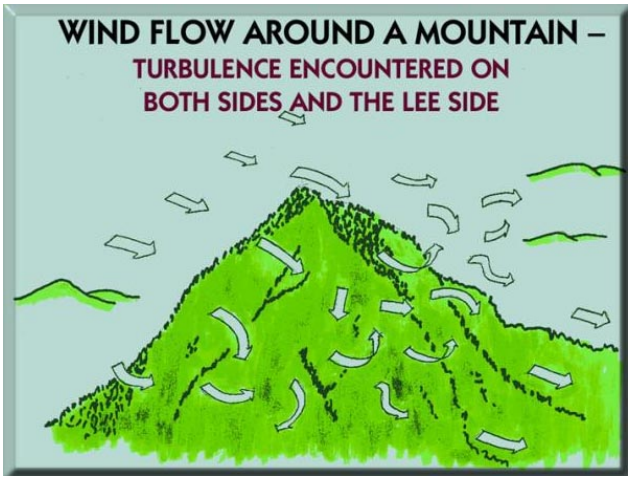
7. *Mountainous terrain*. Aircrews flying the mountains must complete a course such as *Mountain Fury*.

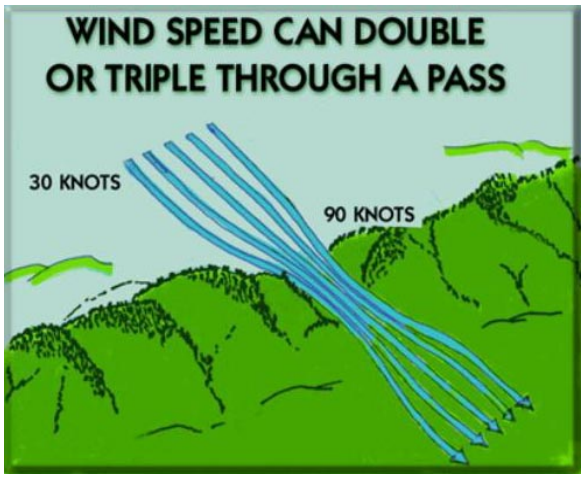
When flying in mountainous areas it is recommended that flights be planned for early morning or late afternoon because heavy turbulence is often encountered in the afternoon, especially during summer. In addition, flying at the coolest part of the day reduces density altitude. Attempt to fly with as little weight as possible, but don't sacrifice fuel; in the event of adverse weather, the additional reserve could be a lifesaver.

Study sectionals for altitudes required over the route and for obvious checkpoints. Prominent peaks make excellent checkpoints, as do rivers and passes. Be aware that mountain ranges have many peaks that may look the same to the untrained eye, so continually crosscheck your position with other landmarks and radio aids if possible. Also, the minimum altitude at which many radio aids are usable will be higher in the mountains. For that reason, low-frequency navigation, such as ADF, LORAN, or GPS tend to work best in the mountains.

A weather check is essential for mountain flying. Ask specifically about winds aloft even when the weather is good. Expect winds above 10,000 feet to be prevailing westerlies in the mountain states. If winds aloft at your proposed altitude are above 30 knots, do not fly. Winds will be of much greater velocity in passes, and it will be more turbulent as well. Do not fly closer than necessary to terrain such as cliffs or rugged areas. Dangerous turbulence may be expected, especially when there are high winds (see figures, below).

Crews must be constantly careful that a search never takes them over terrain that rises faster than the airplane can climb. Narrow valleys or canyons that have rising floors must be avoided, unless the aircraft can be flown from the end of higher elevation to the lower end, or the pilot is *certain* that the aircraft can climb faster than the terrain rises. Careful chart study by the crew prior to flight will help identify this dangerous terrain.





Additional Information

More detailed information on this topic is available in Chapter 7 of the MART.

Evaluation Preparation

Setup: Provide the student with charts and/or a flight computer to compute density altitude.

Brief Student: You are an Observer trainee asked to calculate density altitude and discuss its effects.

Evaluation

Performance measures	Results	
1. Discuss atmospheric pressure, pressure altitude and density altitude.	P	F
2. Obtain the local altimeter setting and enter it into an aircraft altimeter.	P	F
3. Discuss how high density altitude degrades aircraft performance.	P	F
4. Discuss strategies to deal with high density altitude on search operations.	P	F
5. Discuss mountainous terrain precautions and strategies.	P	F

Student must receive a pass on all performance measures to qualify in this task. If the individual fails any measure, show what was done wrong and how to do it correctly.