Mountain Flying Qualification Course

Civil Air Patrol

Auxiliary of the United States Air Force

DENSITY ALTITUDE

Pressure Altitude

Pressure Altitude: Absolute altitude corrected for non-standard atmospheric pressure. It's the indicated altitude when the altimeter setting window is adjusted to 29.92. This is the altitude above the standard datum plane where air pressure equals 29.92 (approximately sea level). It is primarily used in aircraft performance calculations and in high-altitude flight.

If the altimeter setting is lower than standard 29.92 inches Hg, the pressure altitude is higher than indicated altitude. If the altimeter is setting is higher than 29.92, the pressure altitude is lower than indicated altitude.

Calculating Pressure Altitude

PA = H - 925 x (S - 29.92), *where*

PA = Pressure Altitude
H = Indicated Altitude
S = Altimeter Setting

Example:

9,000 indicated altitude & altimeter setting 28.50

PA = 9,000 - 925 x (28.50 - 29.92)

PA = 9,000 - 925 x (-1.42) *Watch your ± sign!*

PA = 9,000 + 1,313

PA = 10,313

Measuring Pressure Altitude

Altimeter Setting: 30.06 inch Hg
Field Elevation: 1,600 Feet

Altimeter Setting: 29.92 inch Hg
Pressure Altitude: 1,480 Feet

Altimeter Settings Greater Than Standard --- Pressure Altitude Less Than Indicated Altitude

Density Altitude

Density altitude is pressure altitude corrected for variations from standard temperature. High density altitude means that the air has a lower than standard density. Density altitude has a significant influence on aircraft and engine performance. Hot, high, and humid weather conditions can cause a routine takeoff or landing to become an accident.

The formal definition of density altitude is certainly correct, but the important thing to understand is that density altitude is an indicator of aircraft performance. The term comes from the fact that the density of the air decreases with altitude. A “high” density altitude means that air density is reduced, which has an adverse impact on aircraft performance. The published performance criteria in the Pilot’s Operating Handbook (POH) are generally based on standard atmospheric conditions at sea level (59F / 15C and 29.92 inches of mercury). Your aircraft will not perform according to “book numbers” unless the conditions are the same as those used to develop the published performance criteria. For example, if an airport whose elevation is 500 MSL has a reported density altitude of 5,000 feet, aircraft operating to and from that airport will perform as if the airport elevation were 5,000 feet.

Density Altitude

High density altitude corresponds to reduced air density and thus to reduced aircraft performance. Altitude, Temperature, and Humidity three important factors that contribute to high density altitude.

The higher the altitude, the less dense the air. At airports in higher elevations high temperatures sometimes have such an effect on density altitude that safe operations are impossible. In such conditions, operations between midmorning and midafternoon can become extremely hazardous. Even at lower elevations, aircraft performance can become marginal and it may be necessary to reduce aircraft gross weight for safe operations.

The warmer the air, the less dense it is. When the temperature rises above the standard temperature for a particular place, the density of the air in that location is reduced, and the density altitude increases. When performance is in question, it is advisable to schedule operations during the cool hours of the day when forecast temperatures are not expected to rise above normal. Early morning and late evening are sometimes better for both departure and arrival.

Humidity is not generally considered a major factor in density altitude computations because the effect of humidity is related to engine power rather than aerodynamic efficiency. At high ambient temperatures, the atmosphere can retain a high water vapor content. For example, at 96 F, the water vapor content of the air can be eight times as great as it is at 42 F. High density altitude and high humidity do not always go hand in hand. If high humidity does exist, however, it is wise to add 10 percent to the computed takeoff distance and anticipate a reduced climb rate.

Density Altitude

Whether due to high altitude, high temperature, or both, reduced air density (reported in terms of density altitude) adversely affects aerodynamic performance and decreases the engine's power output. Takeoff distance, power available (in normally aspirated engines), and climb rate are all adversely affected. Landing distance is affected as well. Indicated airspeed (IAS) remains the same, but true airspeed (TAS), and in turn ground speed, increases.

From the pilot's point of view, therefore, an increase in density altitude results in the following: Increased takeoff distance.

- Reduced rate of climb.
- Increased TAS (but same IAS) on approach and landing.
- Increased landing roll distance.

Because high density altitude has particular implications for takeoff and climb performance and landing distance, pilots must be sure to determine the density altitude and check the appropriate aircraft performance charts carefully during preflight preparation. A pilot's first reference for aircraft performance information should be the aircraft owner's manual or the Pilot's Operating Handbook. A pilot who is complacent or careless in using the charts may find that density altitude effects create an unexpected element of suspense during takeoff and climb or during landing.

If the airplane flight manual (AFM)/POH is not available, use the Koch Chart to calculate the approximate temperature and altitude adjustments for aircraft takeoff distance and rate of climb.

Density Altitude

At power settings of less than 75 percent, or at density altitude above 5,000 feet, it is essential to lean normally aspirated engines for maximum power on takeoff. Otherwise, the excessively rich mixture is another detriment to overall performance. Turbocharged engines need not be leaned for takeoff in high density altitude conditions because they are capable of producing manifold pressure equal to or higher than sea level pressure.

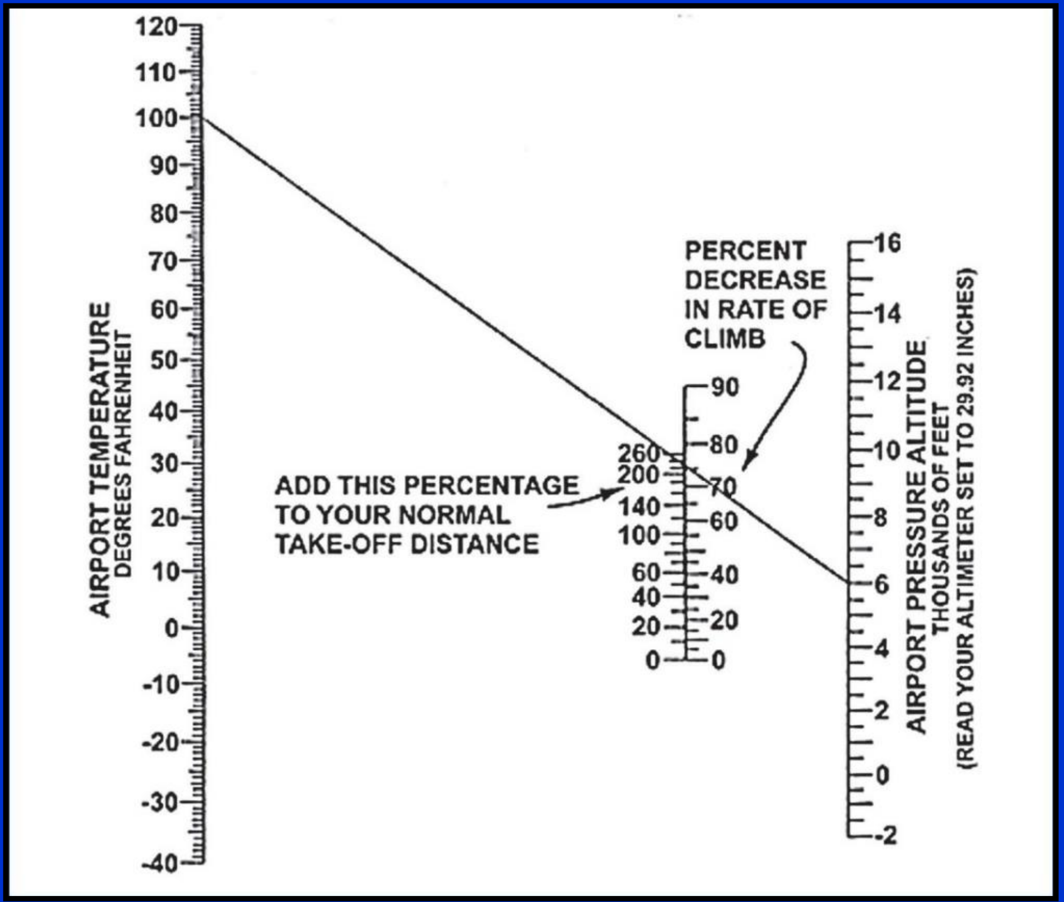
The chart below illustrates an example of temperature effects on density altitude.

STD TEMP	ELEV/TEMP	80 °F	90 °F	100 °F	110 °F	120 °F	130 °F
59 F	Sea level	1,200	1,900	2,500	3,200	3,800	4,400
52 F	2,000	3,800	4,400	5,000	5,600	6,200	6,800
45 F	4,000	6,300	6,900	7,500	8,100	8,700	9,400
38 F	6,000	8,600	9,200	9,800	10,400	11,000	11,600
31 F	8,000	11,100	11,700	12,300	12,800	13,300	13,800

Density Altitude

To find the effect of altitude and temperature, connect the temperature and airport altitude by a straight line. Read the increase in takeoff distance and the decrease in rate of climb. For example, the diagonal line shows that 230% must be added for a temperature of 100 F and a pressure altitude of 6,000 feet. Therefore, if your standard temperature sea level takeoff distance normally requires 1,000 feet of runway to climb to 50 feet, it would become 3,300 feet under the conditions shown in the chart. In addition, the rate of climb would be decreased by 76%. So, if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

This chart indicates typical representative values. For exact values, consult the AFM/POH. Also, remember that long grass, sand, mud, or deep snow can easily double your takeoff distance.



KOCH CHART

Calculating Density Altitude

DA = PA + 66 x (T - TS), *where*

T = Actual Temperature (F) at indicated altitude

TS = Standard Temperature (F) = 59 – (0.003566 X PA)

PA = Pressure Altitude

Example: 60 F at 9,000 feet indicated altitude. Altimeter = 28.50 in. Hg

DA = PA + 66 x (60 F - 22.2 F)

DA = PA + (66 x 37.8)

DA = 10,313 (from previous example) + 2,495

DA = 12,808 feet

Predicting Density Altitude

- Methods of determining altimeter setting
  - ATIS or AWOS for closest airport
  - Surface observations.
- Methods of determining temperature aloft
  - Consult Winds and Temperatures Aloft forecast
  - Obtain local surface temperature, then subtract 3.5°F for each 1,000 feet of altitude above reporting point

Effects of Density Altitude

1. High density altitude means the air is less dense than standard conditions
2. As density altitude increases, the difference between indicated and true airspeed increases.
3. True airspeed increases with increasing density altitude.
4. True air speed increases over indicated air speed at approximately 2% per 1000 feet MSL
5. As density altitude increases, available horsepower decreases.

Horsepower – Cessna 192P

Density Altitude	Manifold Pressure	Horsepower Available
8,000 ft	20”	65%
10,000 ft	19”	62%
12,000 ft	17”	55%

END