DENSITY ALTITUDE

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The **density altitude** is the altitude relative to standard atmospheric conditions at which the air density would be equal to the indicated air density at the place of observation. In other words, the density altitude is the air density given as a height above mean sea level. The density altitude can also be considered to be the pressure altitude adjusted for a non-standard temperature.
Both an increase in the temperature and a decrease in the atmospheric pressure, and, to a much lesser degree, an increase in the humidity, will cause an increase in the density altitude. In hot and humid conditions, the density altitude at a particular location may be significantly higher than the true altitude.
In aviation, the density altitude is used to assess an aircraft's aerodynamic performance under certain weather conditions. The lift generated by the aircraft's airfoils, and the relation between its indicated airspeed (IAS) and its true airspeed (TAS), are also subject to air-density changes. Furthermore, the power delivered by the aircraft's engine is affected by the density and composition of the atmosphere.

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Throughout a pilot's flight training, there is instruction, and likely some experience of the detrimental effect high density altitude has on aircraft performance. But when the sky is blue and the summer sun is hot, even seasoned pilots can forget to carefully calculate takeoff, climb, cruise, and landing performance during preflight planning, sometimes resulting in accidents. Density altitude is often not understood and its effects on flight can be unanticipated, resulting in takeoff and landing accidents. This subject report explains what density altitude is and briefly discusses how it affects flight. Further information, including the Air Safety Institute's free online interactive Mountain Flying course, is listed at the end of the report.

Density altitude is pressure altitude corrected for nonstandard temperature. As temperature and altitude increase, air density decreases. In a sense, it's the altitude at which the airplane "feels" its flying.

On a hot and humid day, the aircraft will accelerate more slowly down the runway, will need to move faster to attain the same lift, and will climb more slowly. The less dense the air, the less lift, the more lackluster the climb, and the longer the distance needed for takeoff and landing. Fewer air molecules in a given volume of air also result in reduced propeller efficiency and therefore reduced net thrust. All of these factors can lead to an accident if the poor performance has not been anticipated.

Tips for Flying in High Density Altitude Areas

- Fly in the evening or early in the morning when temperatures are lower.
- Call a local instructor at your destination airport to discuss density altitude procedures at that airport.

- Before flying to a high-elevation airport, know whether your aircraft climbs more efficiently with the first increment of flaps. Many aircraft do, but results vary and that first notch of flaps may add more drag than lift.
- Be sure the aircraft's weight is below 90 percent of maximum gross weight.
- Don't fill the tanks to the top (see previous tip).
- Fly shorter legs and make extra fuel stops (tough suggestion to accept, but it results in less exciting takeoffs).
- Be ready to ferry one passenger to an airport with a lower density altitude, then come back for the other. If you are unsure of conditions, fly around the pattern once alone without baggage to test your aircraft's performance.
- Have 80 percent of your takeoff speed at the runway's halfway point, or abort. That means having 48 knots IAS in a Cessna 172 at the halfway point.

Calculating Density Altitude

Density altitude in feet = pressure altitude in feet + (120 x (OAT - ISA temperature))
* **Pressure altitude** is determined by setting the altimeter to 29.92 and reading the altitude indicated on the altimeter.
*** OAT** stands for outside air temperature (in degrees Celsius).
*** ISA** stands for standard temperature (in degrees Celsius).

Keep in mind the standard temperature is 15 degrees C but only at sea level. It decreases about 2 degrees C (or 3.5 degrees F) per 1,000 feet of altitude above sea level. The standard temperature at 7,000 feet msl, therefore, is only 1 degree C (or 34 degrees F).

For example, the density altitude at an airport 7000 feet above sea level, with a temperature of 18 degrees Celsius and a pressure altitude of 7000 (assuming standard pressure) would be calculated as follows.

- 18 – 1 = 17
- 17 x 120 = 2040
- 2040 + 7000 = **9040** feet Density Altitude

This means the aircraft will perform as if it were at 9,040 feet.

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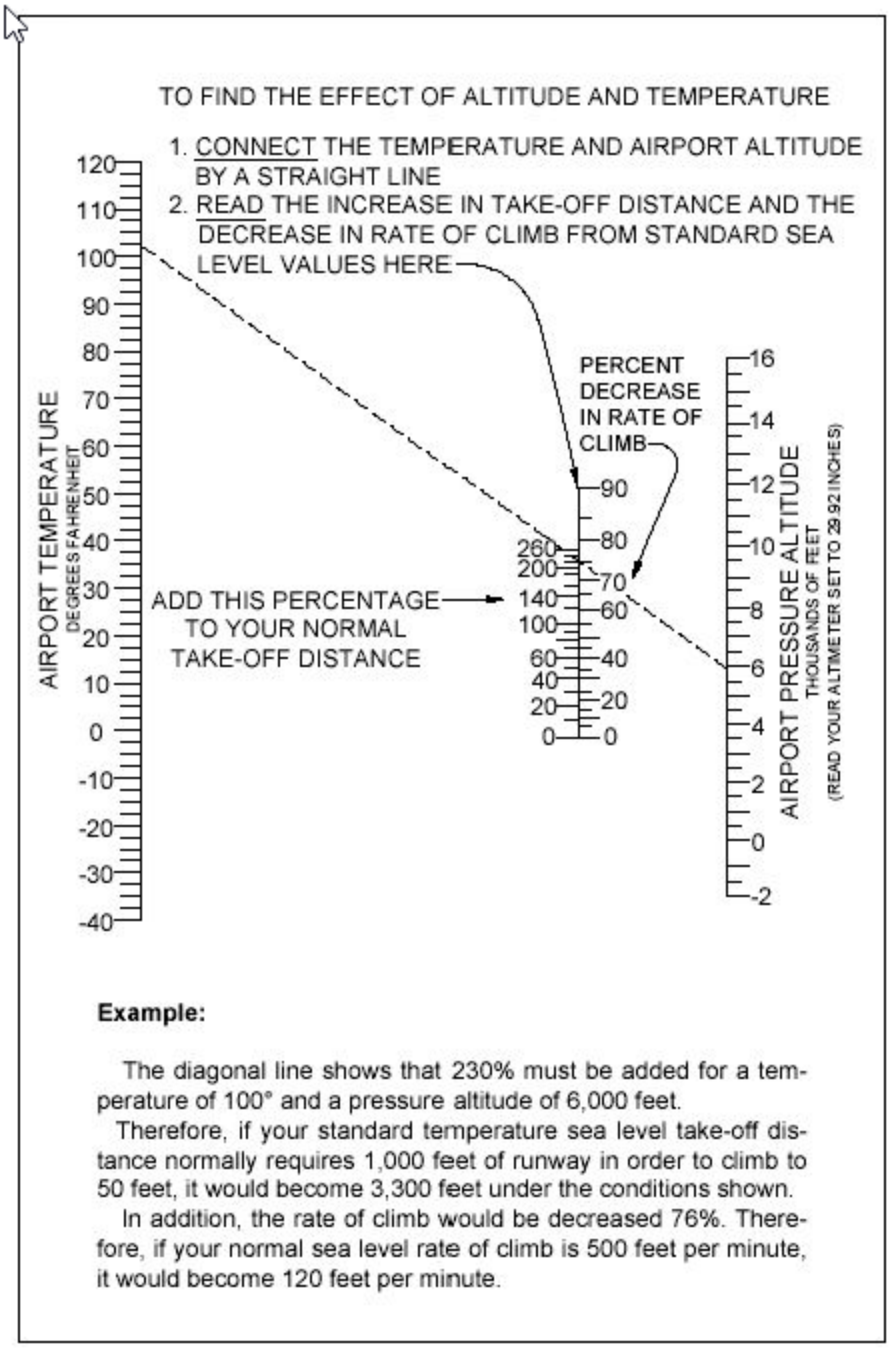

Example:

The diagonal line shows that 230% must be added for a temperature of 100° and a pressure altitude of 6,000 feet.

Therefore, if your standard temperature sea level take-off distance normally requires 1,000 feet of runway in order to climb to 50 feet, it would become 3,300 feet under the conditions shown.

In addition, the rate of climb would be decreased 76%. Therefore, if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

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