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Federal Aviation Agency

ADVISORY CIRCULAR

FEDERAL AVIATION AGENCY · UNITED STATES OF AMERICA

AC NO: AC 90-14A
AIR TRAFFIC CONTROL AND GENERAL OPERATIONS
EFFECTIVE: 1/26/68

SUBJECT: ALTITUDE - TEMPERATURE EFFECT ON AIRCRAFT PERFORMANCE

1. PURPOSE. This circular introduces the Denalt Performance Computer and re-emphasizes the hazardous effects density altitude can have on aircraft performance.

2. CANCELLATION. AC 90-14 dated 5/7/64 is cancelled.

3. DISCUSSION.

   a. Much educational effort has been directed at informing pilots of the effects of temperature and altitude on aircraft performance. In spite of this continuing campaign, temperature-altitude effects are at least partially responsible for many light aircraft accidents.

   b. We all know that the density of our atmosphere decreases with altitude. A given volume of air of a particular temperature and humidity at sea level will support more weight than the same volume at higher altitude. This reduced density of the atmosphere in which an aircraft operates will result in less lift being created by the wings for the same true airspeed and less thrust being created by the engine and propeller. The aircraft's takeoff run will be increased proportionately. Because of the lower pressure and lower oxygen content of the air at higher altitudes, engine efficiency is also reduced. Higher temperature and higher humidity have similar effects on aircraft and engine performance. (See Figure 1.)

   c. The performance figures listed in the manufacturer's manual for length of takeoff run, horsepower, rate of climb, etc., are generally based on standard atmosphere (Temperature 59 degrees Fahrenheit, Pressure 29.92 inches of mercury) at sea level. However, since standard atmosphere is the exception rather than the rule, inexperienced pilots as well as experienced pilots may run into trouble when they encounter an altogether different set of conditions. This is particularly true in hot weather. When the temperature becomes higher than standard for a certain locality, the density of the air for that locality is reduced. This in turn aerodynamically affects the aircraft performance. The horsepower output is decreased and the propeller loses some of its efficiency from the loss of power and because the blades, being airfoils, do not obtain as much thrust from a bite of the less dense air. Since the propeller may not pull or develop its maximum force, it will take longer for the aircraft to obtain the necessary forward speed to produce the required lift for takeoff. Thus, the takeoff distance will be increased. The loss of horsepower and propeller efficiency will also result in a decrease of the climb performance.

d. It is possible to fly from a field at sea level, and have the temperature high enough to give the airplane operational performance that could be expected at 3,000 feet above sea level. Under similar conditions, airplane performance on an airport at 2,000 feet elevation could be reduced to the performance expected at 5,000 feet elevation. An average small airplane requiring 1,000 feet for takeoff at sea level under standard atmospheric conditions will require a takeoff run of approximately 2,000 feet at an operational altitude of 5,000 feet. (See Figure 1.)

4. DEFINITIONS.

a. Pressure altitude is the altitude read on the altimeter with 29.92 inches of mercury set in the barometric scale window. This indicated pressure altitude may not be the actual height above sea level due to variations in temperature, lapse rate, and atmospheric pressure. (See Figure 3.)

b. Density altitude is the altitude as determined by pressure altitude and existing ambient temperature. In standard atmosphere, density and pressure altitude are equal. For a given pressure altitude, the higher the temperature, the higher the density altitude.

5. CONCLUSIONS.

a. Airplane performance, as published, is with respect to standard atmospheric conditions. Thus, certain corrections must be applied to the airplane performance figures if the operating conditions do not fit the standard conditions. Density altitude is used to correlate airplane performance in nonstandard atmosphere. Therefore, it must be considered in determining an airplane's capability for a specific situation. See the Density Altitude Chart (Figure 2) for combining pressure altitude and temperature to find density altitude.

b. Data in the Airplane Flight Manual or owner's handbook should be used, if available, as this information will show the performance to be expected under various atmospheric conditions.

c. If these data are not furnished or available, the Denalt (Density Altitude) Performance Computer (Figure 3) can be used for determining operational performance of a particular airplane. The manufacturer's performance figures for standard conditions should be corrected in accordance with the instructions on the computer. Information contained in the Denalt Computer is based on current aircraft performance for single engine aircraft without supercharged engines.

d. The ultraconservative information provided by the Koch Chart shown in Advisory Circular AC 90-14 has been superseded by the Denalt Performance Computer.

James F. Rudolph
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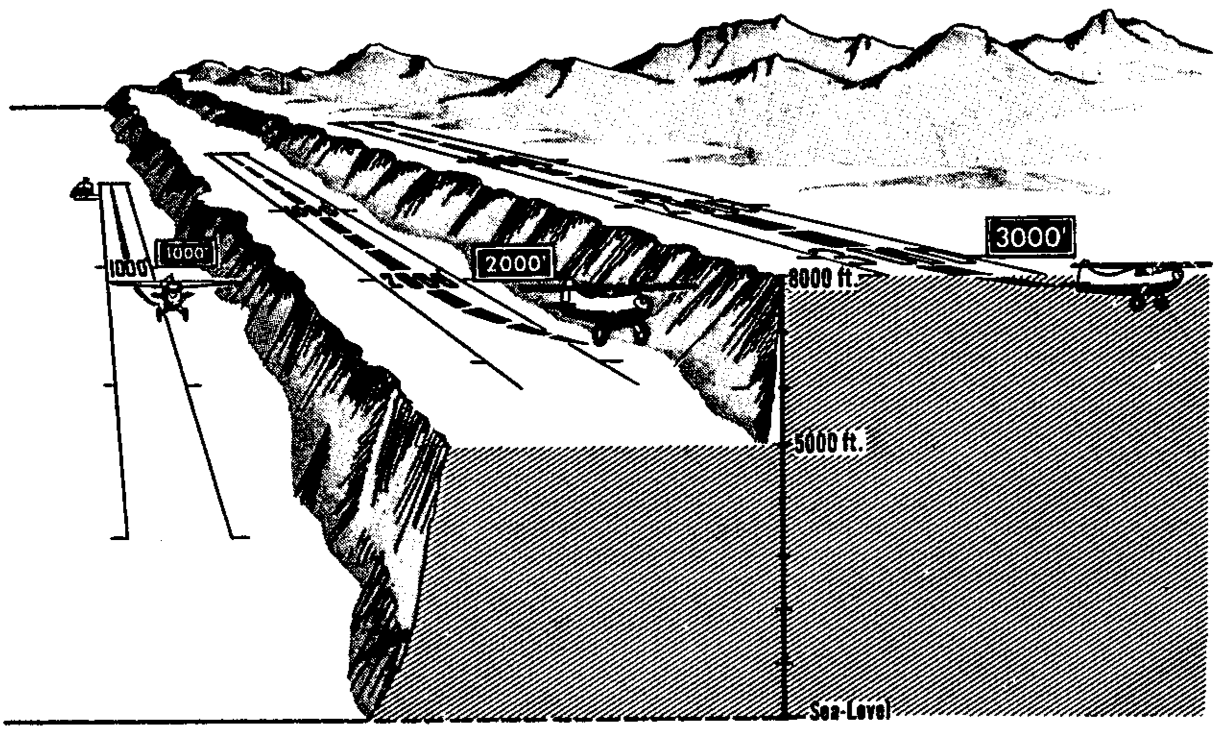
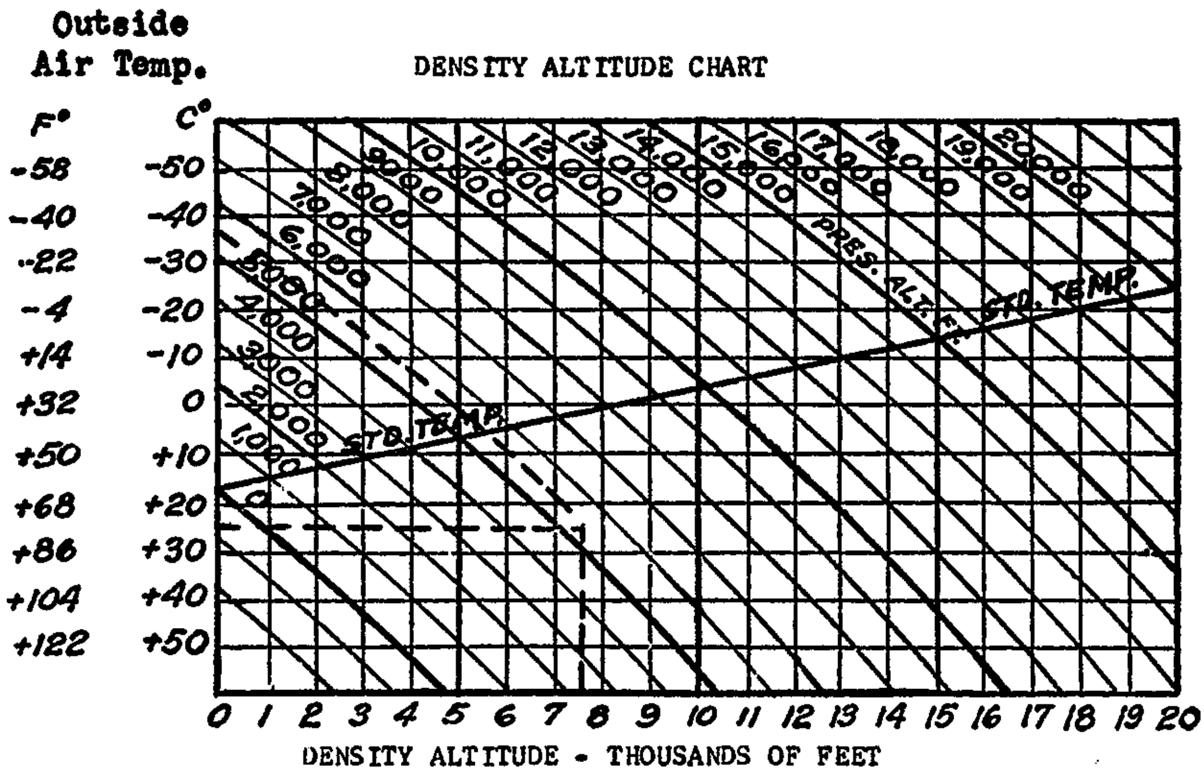


(Fig. 1) Length of Takeoff Run Increases With Altitude

<u>ALSO REMEMBER</u> THAT LONG GRASS, SAND, MUD OR DEEP SNOW CAN EASILY DOUBLE YOUR TAKEOFF DISTANCE.



The following example illustrates the use of this chart to determine the approximate density altitude conditions at the airport which you plan to use:

(1) Obtain from the U.S. weather forecaster the anticipated temperature and pressure altitude for the time of takeoff as an alternate procedure. To find pressure altitude, set your altimeter to 29.92 inches in the altimeter setting window and read the pressure altitude as indicated on the altimeter.

(2) Select the pressure altitude to be used on the diagonal lines marked "Press. Alt. Ft."

(3) Select the obtained temperature. (Example: 77 deg. F.)

(4) Follow the temperature line to the right until it crosses the diagonal line of pressure altitude.

(5) From the point where these two lines cross, follow a line to the bottom of the chart and observe the density altitude. (Example: 7,700 ft.)

(6) This determination of density altitude will allow you to compare your approximate takeoff distance and climb performance with what they would be at sea level under standard atmospheric conditions. (Temp. 59 deg. F., Press. 29.92 in.)

FIGURE 2. <u>DENSITY ALTITUDE CHART</u>