Cancelled See 14A

Federal Aviation Agency

ADVISORY CIRCULAR

FEDERAL AVIATION AGENCY · UNITED STATES OF AMERICA

AC NO: AC 90-14

AIR TRAFFIC CONTROL AND GENERAL OPERATIONS

EFFECTIVE: 5/7/64

SUBJECT: ALTITUDE - TEMPERATURE EFFECT ON AIRCRAFT PERFORMANCE

1. PURPOSE. This circular is to re-emphasize the importance to pilots of being aware of altitude-temperature effects on aircraft performance.

2. CANCELLATION. Flight Standards Service Release No. 463, Altitude - Temperature Effect on Airplane Performance, dated June 19, 1962, 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 and less thrust being created by the 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 in the standard atmosphere corresponding to a particular pressure. It is the indicated altitude 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 in standard atmosphere corresponding to a particular value of air density. It is pressure altitude corrected for temperature. The higher the temperature, the higher the density altitude.

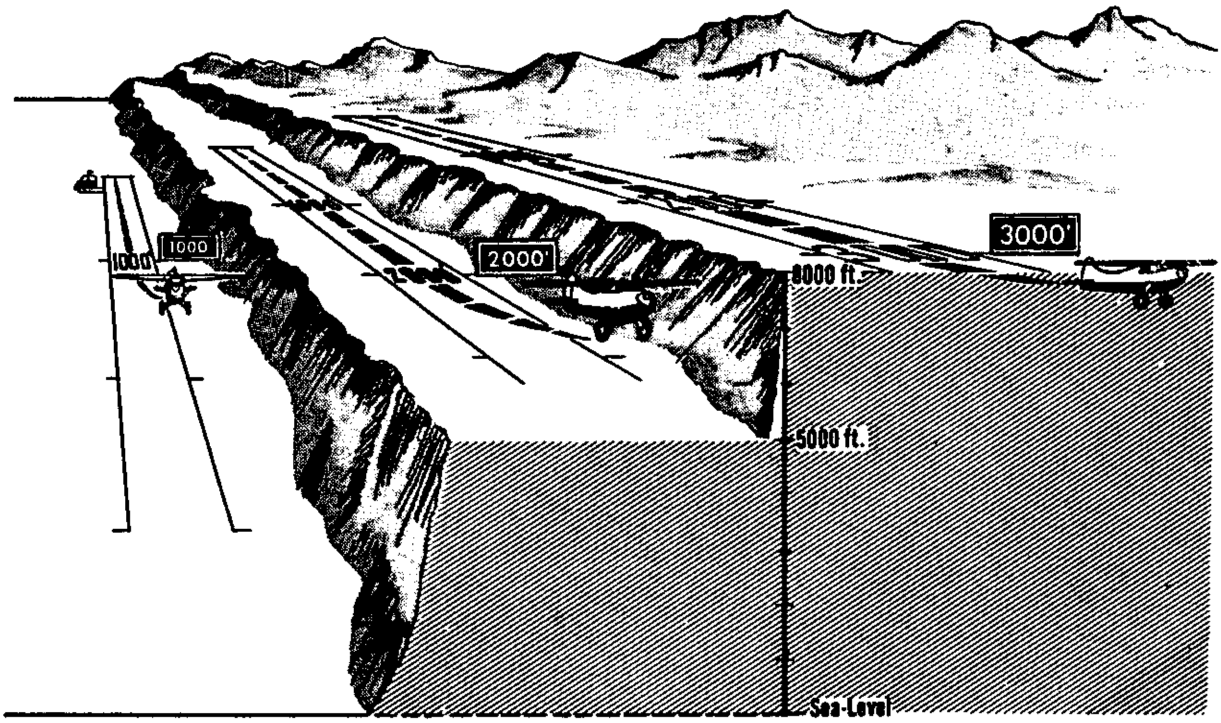
5. CONCLUSIONS.

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.

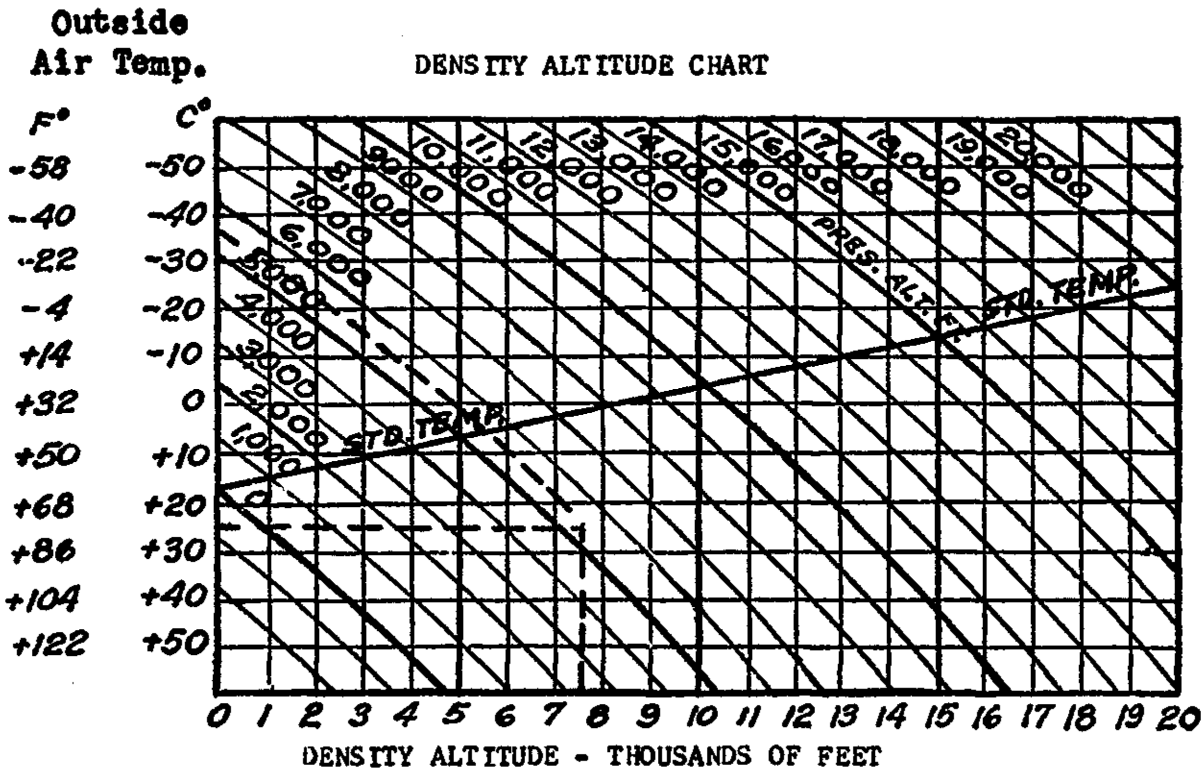
b. Data in the Airplane Flight Manual or owner's handbook should be used, if available, as this information will show the performance to be expected under various atmospheric conditions.

If these data are not furnished or available, the Koch Chart for Altitude-Temperature Effects on Airplane Performance (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 chart. The use of this chart will lead to safer flight procedures and to the avoidance of many dangerous situations.

for George S. Moore
Director
Flight Standards Service



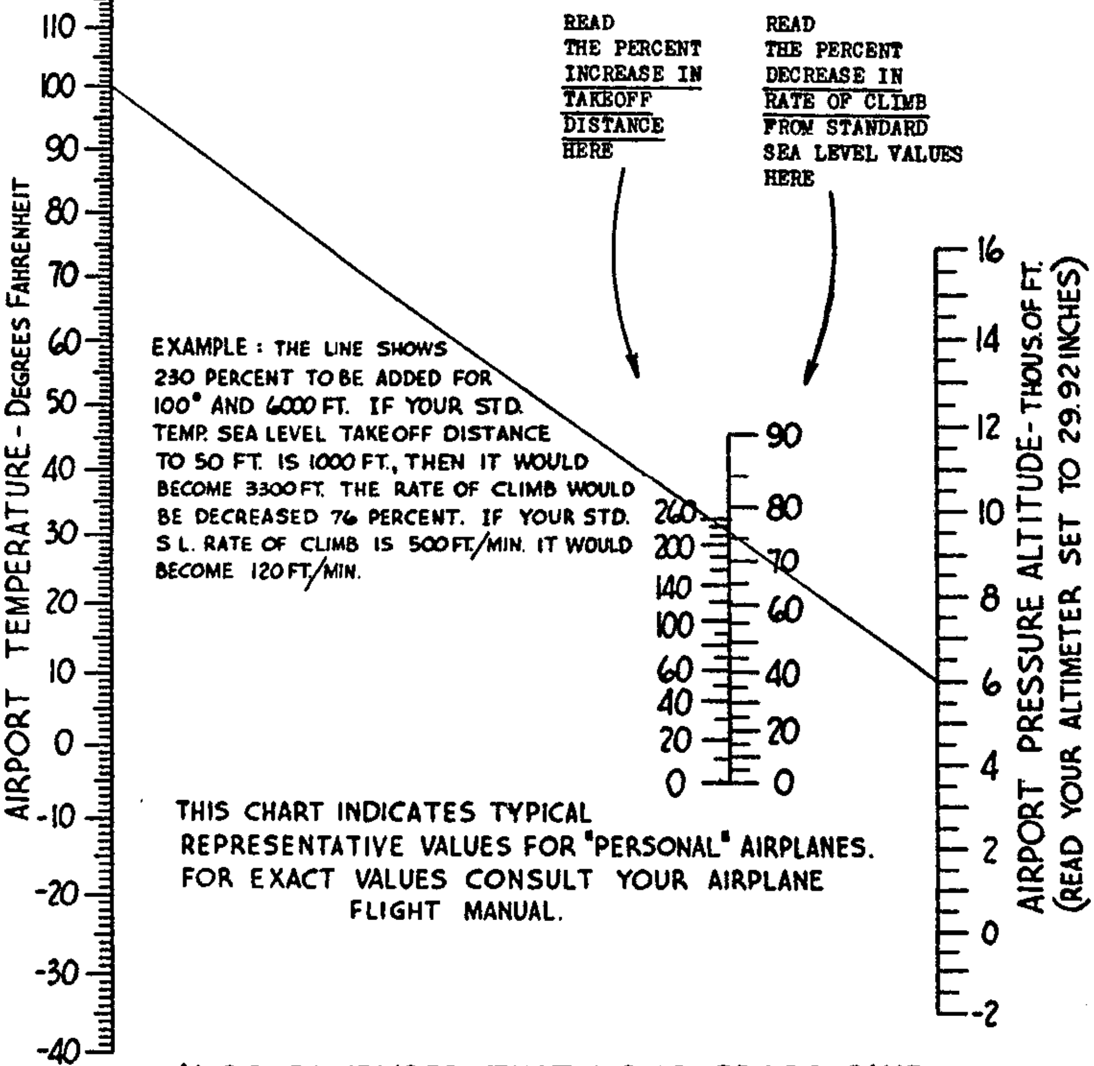
(Fig. 1) Length of Takeoff Run Increases With Altitude


Outside
Air Temp.
DENSITY ALTITUDE CHART
F°
C°
-58
-40
-22
-4
+14
+32
+50
+68
+86
+104
+122
-50
-40
-30
-20
-10
0
+10
+20
+30
+40
+50
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
19,000
20,000
PRES. ALT. FT.
STD. TEMP.
STD. TEMP.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
DENSITY ALTITUDE - THOUSANDS OF FEET

The Koch Chart for

ALTITUDE-TEMPERATURE EFFECTS ON AIRPLANE PERFORMANCE

To find the effect of altitude and temperature on airplane performance, connect the TEMPERATURE and the AIRPORT PRESSURE ALTITUDE by a straight line. Then,



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

(Fig. 3) The Koch Chart

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