Department of Transportation

FEDERAL AVIATION ADMINISTRATION

IFR PILOT EXAM-O-GRAM* NO. 32

AIRCRAFT PERFORMANCE CHARTS

Applicants for the Instrument Pilot Written Test display a weakness in interpretation of Aircraft Performance Charts. This important knowledge should be fundamental to every Instrument Pilot for the safe and efficient operation of an aircraft.

TYPES OF AIRCRAFT PERFORMANCE CHARTS

TABLES are compact arrangements of conditions and performance values in orderly sequence, usually arranged in rows and columns. These charts require interpolation to determine intermediate values for particular flight conditions or performance.

GRAPHS are pictorial representations of the relationship between at least two variables. Aircraft performance graphs are usually the straight-line or curved-line types. The straight-line graph is a result of two values that vary at a constant rate (Figures 2 & 3), while a curved-line graph is a result of two values that vary at a changing rate (Figures 4 & 5). Like tables, graphs require interpolation to determine intermediate values.

INTERPOLATION OF AIRCRAFT PERFORMANCE CHARTS

To interpolate means to compute intermediate values between a series of given values. In other words, divide the distance or interval into as many units as necessary to include the desired value as one of the values. For example, find the value of X.

U	Z
12	22

U	V	W	X	Y	Z
12	14	16	18	20	22

X = 18

PERFORMANCE TABLE. For a practical problem, determine the take-off distance of a particular light twin from the table in Figure 1. Assume at take-off the pressure altitude is 3,000 feet, OAT is 65° F., and headwind is 10 MPH. Underlined on the table are the given values for altitude and headwind. Circled are the values that need interpolation.

TAKE-OFF DISTANCES - FEET
(Over a 50 Foot Obstacle)

$$\frac{65°-50°}{75°-50°} = \frac{15}{25} \text{ or } \frac{3}{5}$$

Use take-off power on both engines (limiting manifold pressure, 3400 RPM) with mixture in auto-rich position, cowl flaps full open, flaps set at 1/4 (10°). Attain full engine power before releasing brakes. Climb out at 106 MPH (92 knots) CAS. Limit power setting to 2 minutes.

TAKE-OFF GROSS WEIGHT - 8,000 POUNDS

Pressure Altitude Feet	Wind Velocity MPH	OUTSIDE AIR TEMPERATURE - °F					
		-25	0	25	50	75	100
	-10	2053	2282	2535	2808	3098	
	0	1758	1955	2172	2406	2656	
3000	+10	1481	1648	1832	(2030)	(2242)	
	+20	1225	1364	1517	1684	1860	
	+30	990	1104	1230	1365	1510	

65° is the point 3/5 of the interval between 50° and 75°.

3/5 × 212 = 127.2

2242
−2030
212

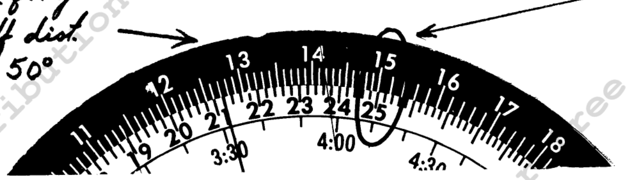
2030 + 127.2 = 2157.2

FIGURE 1

2157.2 is the point 3/5 of the interval between 2030 and 2242 feet.

In the margin to the right of the graph, a position or relationship of 65° with the two given values was determined. This relationship was applied to the two take-off distances given to find the take-off value for a 65° temperature. Under existing conditions, take-off distance is 2,157.2 feet. The same problem can be solved quickly on the computer by setting up a 15 to 25 ratio and observing the proportionate increased take-off distance opposite 212 as shown below.

127.2 ft. greater take-off dist. than for 50°



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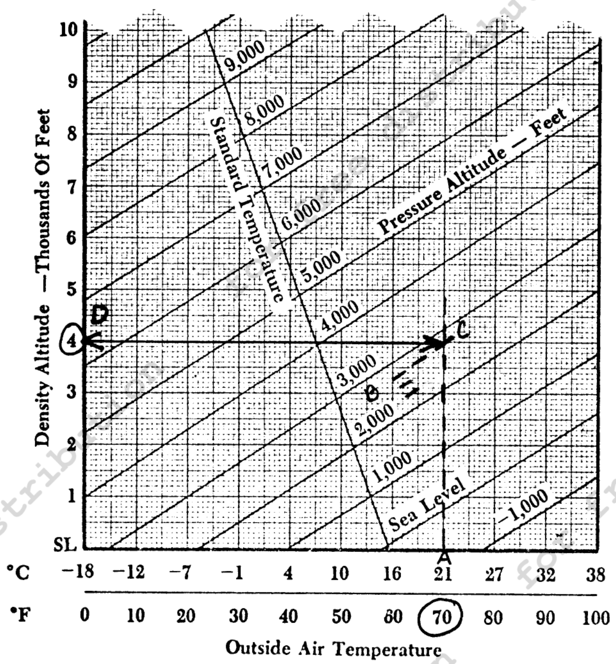
PERFORMANCE GRAPHS. Aircraft Performance Charts which utilize a graph are made up of two components: a basic grid of vertical and horizontal lines, each representing a value of a condition, and either straight or curved lines at an angle to the grid lines representing values of a third condition. By plotting an intersection of known values of two conditions, the value of the unknown condition can be determined at the same intersection.

A practice problem - find the Density Altitude with these existing conditions: (Figure 2)

Airport elevation 2,545 feet, OAT 70° F., and Altimeter Setting 29.70.



PRESSURE ALTITUDE

AND

DENSITY CHART

Altimeter Setting in Hg.	Altitude Addition For Obtaining Pressure Altitude
28.3	1,535
28.4	1,435
28.5	1,340
28.6	1,245
28.7	1,150
28.8	1,050
28.9	955
29.0	865
29.1	770
29.2	675
29.3	580
29.4	485
29.5	390
29.6	300
29.7	205
29.8	110
29.9	20
29.92	0
30.0	−75
30.1	−165
30.2	−255
30.3	−350
30.4	−440
30.5	−530
30.6	−620
30.7	−710
30.8	−805

FIGURE 2

SOLUTION: The chart requires Pressure Altitude which is determined from the conversion table at the right of the graph. 2,545 + 205 = 2,750 feet Pressure Altitude.

Step 1. Draw a line parallel to the vertical lines from the 70° on the Fahrenheit Scale (A) to about the diagonal 3,000 feet Pressure Altitude line.

Step 2. Draw line B representing a value of 2,750 feet (interpolate 3/4 of distance from 2,000 to 3,000) parallel to the pressure altitude lines so that it intersects the line drawn in step 1.

Step 3. The intersection of these two lines (C) lies on the 4,000 foot value of the Density Altitude scale (D). THE DENSITY ALTITUDE IS 4,000 FEET.

COMBINED GRAPHS. Some Aircraft Performance Charts incorporate two or more graphs into one when an aircraft flight performance involves several conditions. A simple combination of graphs is illustrated in Figure 3. Choose the conditions that are appropriate and solve on that portion of the graph. Sample problems for several conditions are solved under the graph.

Another combined graph is illustrated in Figure 4. It requires three functions to solve for take-off distance with adjustments for air density, gross weight, and headwind conditions. The first function converts pressure altitude to density altitude. The right margin of this portion of the graph, even though it is not numbered, represents density altitude and starts the second function, the effect of gross weight on take-off distance. The right margin of this section represents take-off distance with no wind and starts the final phase of correcting for effect of headwind. A sample problem is illustrated below the graph.

A more complex graph combines many functions intermingled on one basic grid to avoid using several graphs. However complicated a graph may appear, the procedure for solution is the same as for the simple graph. In Figure 5, one grid is used with a choice of three different Altitude Scales. It also accommodates two conditions for oxygen consumption. To solve, construct an intersection using the appropriate altitude scale and the curved line representing the oxygen cylinder pressure for the condition of intended use. Transfer the intersection value to (Continued on page 4)

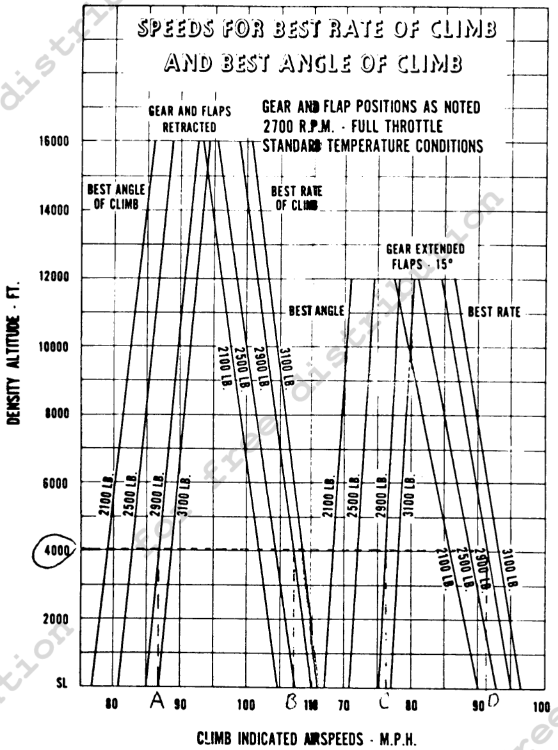


FIGURE 3

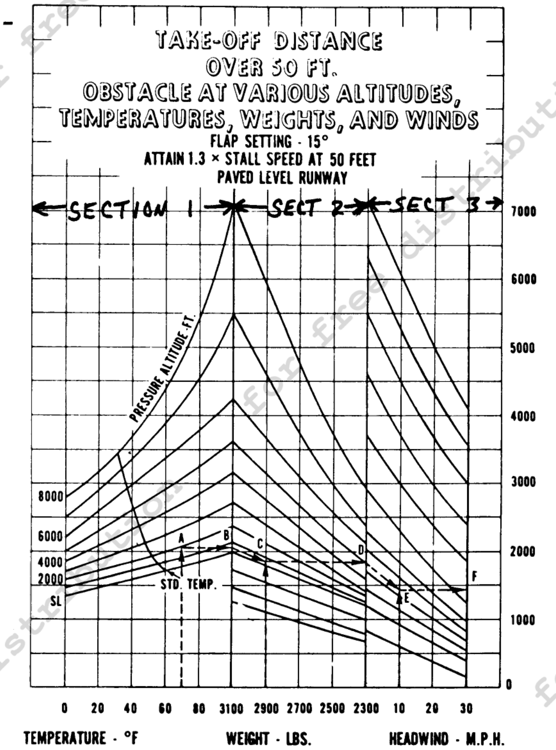


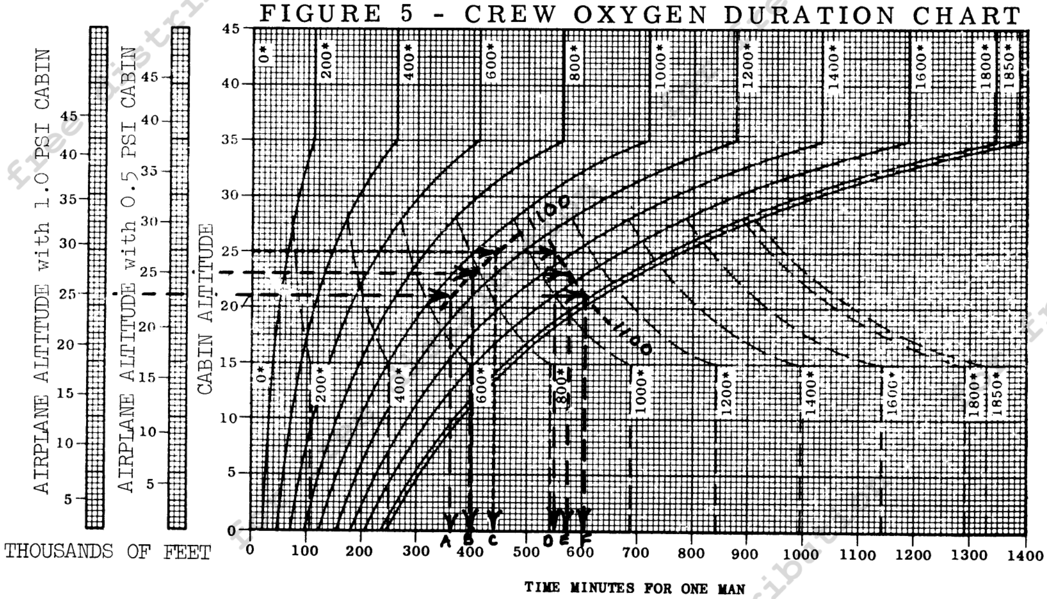
FIGURE 4

Conditions: Density Altitude 4,000 feet
Gross Weight 2,900 lbs.

BEST ANGLE IAS	BEST RATE IAS	GEAR	FLAPS
A - 87 MPH	B - 107 MPH	up	0°
C - 77 MPH	D - 92 MPH	down	15°

A - Conversion to Density Altitude.
B - Carry results to 2nd section of graph.
C - Parallel lines to gross wt. for loading.
D - Carry results to 3rd section of graph.
E - Parallel lines to headwind component.
F - Carry results to edge of graph for take-off distance readout.

FIGURE 5 - CREW OXYGEN DURATION CHART



— — — NORMAL OXYGEN
——— 100 PERCENT OXYGEN

*OXYGEN CYLINDER PRESSURE

CHART BASED ON ONE 111 CUBIC FOOT OXYGEN CYLINDER.

EXAMPLE: C
100 PERCENT OXYGEN
CABIN ALTITUDE = 25,000 FEET
OXYGEN CYLINDER PRESSURE = 1100 PSI
READ TIME FROM CHART = 440 MINUTES FOR ONE MAN
NUMBER OF MEN BREATHING OXYGEN = 3
TIME OXYGEN WILL LAST = 440/3 = 146.7 MINUTES

the bottom scale via the vertical lines. Read the duration of the oxygen for one man and divide the results by the number of users for the total duration of oxygen. Plotted on the graph are six values of oxygen duration obtained with an altitude of 25,000 feet and initial Oxygen Cylinder Pressure of 1100 PSI. The variable conditions are cabin pressure and flow of oxygen (Normal or 100%). Result "A" (360 minutes) is the duration resulting from 1.0 PSI pressurization and 100% oxygen flow. "F" is the duration of oxygen if normal flow is used.

HELPFUL HINTS. Before any attempt is made to interpret a performance chart, carefully check the scales. Sometimes, information you use is given in knots and the chart may be calibrated in MPH. The same warning is appropriate for Celsius (Centigrade) and Fahrenheit. Check the chart for foot notes which might affect the solution you get. Sometimes, it is not necessary to interpolate as closely as was done in this Exam-O-Gram, but you should round-off figures on the safe side.

VALUE OF PERFORMANCE CHARTS. Aircraft performance charts are of great value to determine performance for specific circumstances. Don't overlook the potential of these same charts to reveal and enrich the knowledge of operating characteristics of the aircraft. By plotting as many conditions as you have encountered or anticipate encountering, you will develop a better overall mental image of the operating characteristics and limits of your aircraft and equipment.

Graphs are somewhat like pictures in that a person can retain more knowledge through use of the sense of sight. It is much easier to remember trends of performance or aerodynamic principles through a mental image of a line on a graph than through the printed or spoken word. Like pictures, performance charts are worth a thousand words.

FAA Aeronautical Center
Flight Standards Technical Division, Operations Branch
P. O. Box 25082
Oklahoma City, Oklahoma 73125 11/70