WEIGHT AND BALANCE (chapter 4)

WEIGHT AND BALANCE DEFINITIONS

1. **Empty weight** consists of the airframe, engine, and all items of operating equipment permanently installed in the airplane, including optional special equipment, fixed ballast, hydraulic fluid, unusable fuel, and undrainable (or, in some aircraft, all) oil.

2. Standard weights have been established for numerous items involved in weight and balance computations.

   a. The standard weight for aviation gasoline (AVGAS) is 6 lb./gal.

      1) EXAMPLE: 90 Ib. of gasoline is equal to 15 gal. (90 + 6)

3. The **center of gravity** (CG) is the point of balance along the airplane's longitudinal axis. By multiplying the weight of each component of the airplane by its arm (distance from an arbitrary reference point, called the reference datum), that component's moment is determined. The CG of the airplane is the sum of all the moments divided by the total weight.

CENTER OF GRAVITY GRAPHS

1. The **loading graph** may be used to, determine the load moment. (See top graph in Fig. 35 Appendix 1)

   a. On most graphs, the load weight in pounds is listed on the vertical axis. Diagonal lines represent various items such as fuel, baggage, pilot and front seat passengers, and back seat passengers.

      1) Move horizontally to the right across the chart from the amount of weight to intersect the line, which represents the particular item.

      2) From the point of intersection of the weight with the appropriate diagonal line, drop straight down to the bottom of the chart to the moments displayed on the horizontal axis. Note that each moment shown on the graph is actually a moment index, or moment/1, 000. This reduces the moments to smaller, more manageable numbers.

   b. Then total the weights and moments for all items being loaded.

   c. EXAMPLE: Determine the load (total) momen1/1, 000 in the situation:

	Weight (lb.)	Moment/1.000 (lb.-in.)
Empty weight	1,350	51.5
Pilot & front seat passenger	400	?
Baggage	120	?
Usable fuel (38 gal. x 6 lb./gal.)	228	?
Oil (8 qt.)	15	-0.2

      1) Compute the moment of the pilot and front seat passenger by referring to the loading graph, and locate 400 on the weight scale. Move horizontally across the graph to intersect the diagonal line representing the pilot and front passenger, and then to the bottom scale, which indicates a moment of approximately 15.0.

      2) Locate 120 on the weight scale for the baggage. Move horizontally across the graph to intersect the diagonal line that represents baggage, then down vertically to the bottom, which indicates a moment of approximately 11.5.

      3) Locate 228 on the weight scale for the usable fuel. Move horizontally across the graph to intersect the diagonal line representing fuel, then down vertically to the bottom scale which indicates a moment of 11.0.

4) Notice a -0.2 moment for the engine oil (see note 2 on Fig. 35 Appendix 1). Add all moments except this negative moment, and obtain a total of 89.0. Then subtract the negative moment to obtain a total aircraft moment of 88.8.

    d. Now add all the weights to determine that the airplane's maximum gross weight is not exceeded.

	Weight (lb.)	Moment/1.000 (lb.-in.)
Empty weight	1,350	51.5
Pilot & passengers	400	15.0
Baggage	120	11.5
Fuel	228	11.0
Oil	15	-0.2
	2,113	88.8

2. The **center of gravity moment envelope** chart (see bottom graph in Fig. 35 Appendix 1) is a graph showing CG moment limits for various gross weights. Acceptable limits are established as an area on the graph. This area is called the envelope. Weight is on the vertical axis and moments on the horizontal axis.

    a. Identify the center of gravity point on the center of gravity moment envelope graph by plotting the total loaded aircraft weight across to the right.

    b. Plot the total moment upward from the bottom.

    c. The intersection will be within the CG moment envelope if the airplane has been loaded within limits.

    d. EXAMPLE: Using the data above, locate the weight of 2,113 lb. on the vertical axis, and then move across the chart to the moment line of 88.8. The point of intersection will indicate that the aircraft is within both CG (i.e., normal category) and gross weight (i.e., less than 2,300 lb.) limits.

CENTER OF GRAVITY TABLES

1. Another approach to determining weight and CG limits is to use tables.

2. First, determine the total moment from the Useful Load Weights and Moments Table (Fig. 33 Appendix 1).

    a. Moments can be read directly from the table for a specific weight.
    b. If weight is between values, you can use the basic formula to determine the moment:

$$\text{Weight} \times \text{Arm} = \text{Moment}$$

    1) Then divide by 100 to determine moment/100.

3. Then use the Moment Limits vs. Weight Table (Fig. 34 Appendix 1) to see if the total moment is within maximum and minimum limits for the gross weight.