Chapter 25 Weight and Balance

25.1 Introduction

WARNING: The FAA regulations require that a current aircraft weight and balance sheet be carried in the aircraft at all times.

Proper CG is absolutely critical to safe flight. This is where *NO* exceptions can be considered. You must verify that the center of weight is in the correct position and if it is not, you *MUST* correct it before flight.

Suggestion: Set up the weight and balance on a computer spreadsheet on a computer. Work with different configurations to get a better idea of the center of gravity limitations.

WARNING

Do not attempt to use bathroom scales to calculate the center of gravity as they are not sufficiently accurate. Flying outside of the approved center of gravity envelope is dangerous.

You should rent or borrow a good set of accurate beam scales or equivalent. These scales should be able to handle up to 1500 pounds each. Often your local EAA chapter will have a set, or know the location of a set available for your use. Many FBOs have them also.

The allowable Center of Gravity range is 6.6% MAC to 26% MAC).

25.2 Airplane Weighing Procedure

1. First establish the airframe's empty weight and its empty Center of Gravity (CG).

   The aircraft and the scales must be level while being weighed and preferably in a hangar with the doors closed to eliminate any wind effects. (If weighing outdoors, the wind must be virtually calm.) Shims (1 x 4s or similar boards) may be required under the landing gear to establish this level attitude and these shims become part of the "tare weight". All tare weight is deducted from any scale readings.

   Note: It is preferable to *not* have the battery installed at this point. This will allow you to calculate its optimum longitudinal position in the aircraft and thereby locate the final CG location. The battery position can be adjusted during the weighing process and its position established if time "on the scales" permits.
2. Establish the "Reference datum point" (FS 0) from which ALL measurements can be made. The bottom firewall joggle is FS 51.25 and is easily located adjacent to the nose gear well. Drop a plumb bob line down from that point and mark it on the floor.
3. Establish an aircraft centerline on the floor by dropping a plum bob point from the tail and "chalking" a line between the two points. Continue this line forward to locate FS 0.
4. Drop a plump bob from the center of each wheel axle. Mark the nose gear axle center onto the ground at the centerline position. Mark the two main gear axle centers on the ground and extend a straight line between the two main gear crossing the fuselage centerline previously "chalked" onto the floor.
5. Next measure and record the distance from the Reference datum to the location of the nose and main gear as marked along the fuselage centerline. Log these distances in the appropriate lines of Column D, these are the "arms" or "moment arms".
6. This is a good time to check that the wing is in the right place! The L.E. of the wing at BL 25.5 should be at FS 88 within 1/2" (12 mm).
7. Read and record the actual weights of the leveled aircraft on the three scales. Log these weights in the appropriate lines of the Weight and Balance Sheet.(See blank Lancair ES "Weight and Balance Sheets" provided for recording this data.)
8. Log the weights of any shim stock (the 1 x 4s and any other non-aircraft weight) that is on the scales as tare in Column B.
9. Subtract the tare weights from the measured weights and place those figures in Column C.

You now have all the information required to establish the aircraft's empty Center of Gravity.

25.2.A Moment Weights

1. Now, to arrive at the "moment weights" of the nose gear and the main gear locations simply multiply the weight of the nose gear and main gear by the distance from the datum point and record the values in Column E.
2. Total Column C and Column E separately.
3. Divide Column E by Column C and the result is the empty weight CG expressed as a distance from the datum point.

This empty weight CG must ultimately be forward of the allowable flight CG range since when the pilot gets into the aircraft, he will be aft of this point and that will move the CG aft into the beginning of the allowable range. The empty CG should be such that the plane is in the most nose heavy condition i.e., at the front CG limit.

Note: The allowable Center of Gravity Range is Fuselage Station (FS) 95.4 to FS 105.0. Check the POH for your airplane model to verify this information.

Before removing the aircraft from the scales, it is wise to also establish your exact moment arms for fuel and for front and rear seats. Builder differences in relation to the exact location of the wing can change the CG of the fuel, and the pilot and passenger moment arms are affected by such items as seat back angles, cushions, etc. These are less defined and should be determined, not estimated.

To determine your pilot/front seat passenger moment arm have someone sit in the plane and log the resultant weight changes on the three scales. Make sure the seats are slid forward to their normal "flight" position. Now recalculate the pilot's moment arm. Repeat this process for the rear passenger seats.

To determine the CG of the fuel tanks, simply add 10-20 Gal. of fuel in each tank, log the new weights and calculate the fuel CG.

25.2.B Weighing Example

Let’s say you weigh 170 lbs. The net change on the nose gear was (-50#) and the net gain on the main gear was 220# (170 + 50). Multiply the nose gear weight change (a negative number) and the main gear weight change by their respective moment arm. Combine those two numbers (moment weights) and divide by 170. (Remember that the nose gear number is negative so it will subtract from the other.) The resulting number is the moment arm for your body. Log this dimension as the pilot/front seat passenger moment arm.

This approach can be used to accurately calculate the remaining loading points such as the rear passengers, fuel and baggage. It is recommended that this be done as this is the most accurate means of attaining a true loading analysis for your particular airplane. If you are measuring for fuel loads, use 5.9 lbs/gallon to calculate the weight.

WARNING: The baggage compartment extends all the way aft to FS 185. The hat rack extends another 10" aft of that! The hat rack should only be used for very light items, such as clothes. We suggest no more than 5 lbs be place in this area. We also highly recommend to install a sign stating the weight limitations for the hat rack. (Run through the weight and balance calculations and see what effect 5 lbs. of weight at FS 190 has! The center of the baggage compartment is at FS 165. So if you load something heavy into the baggage compartment, keep it forward and be sure it can't slide aft! As with any other aircraft center of gravity computation, use common sense!

25.3 Balancing the Ailerons