

# CENTER OF GRAVITY (CG) FOR LARGE PLANES

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## PART I: Measuring Scale Method

For those wondering or looking for a method to check the CG on large aircraft (too large for a CG stand) or if you want to find out exactly where your CG is on your plane regardless of size, the excerpt below is provided. I hope this will be an easy reference for people so they don't have to search all over trying to find information.

I'll explain the measuring scale method below. This is compiled from various threads. I'm not sure who originally wrote it all down but this is my version I use and can also be found in handbooks for the full scale flier from the FAA.

First, I'll outline a few different options to measure CG. There are various methods for large planes and these below are only a few I have experience with, but by no means is all inclusive.

1. Get a friend or get underneath the plane and balance on your fingers if you can. I personally don't like that on larger planes. This is kind of the "TLAR" principle (That Looks About Right) 😊. Have I done this before? No comment. (Not preferable) 😊
2. Use an expensive CG stand built for large scale planes. It's kind of a uni-tasker and sits around the shop a lot...but an option which works well.
3. Use a Vanessa rig. (This is another good lesson for a Part II.) If you are interested, here's a [LINKY](#) to a website which covers it. Many people like this method and it works well. Some people find it initially complicated and it can take a bit of fussing with the ropes initially if you are unfamiliar. But I think it is valuable to know, it's very accurate, many people swear by it, there are different ways of routing the rope so you don't damage the thin trailing edge of your wings, is very inexpensive and is effective once you get the hang of it. (Caveat; as long as you have an overhead with a hook or something to suspend the model from) I

personally use both a Vanessa rig and the scale measurement method below. Then I compare the measurements.

4. If you are building a (plug in wing type) aircraft, many will locate the wing tube at the CG. This allows a person to loop a line around the wing tube and quickly check balance. Easy and convenient but you need to figure this out during the building process.

5. Another practice is to locate an eyehook location on the CG that can be screwed into a plate on the fuse or upper wing of a Bi-plane. Simply attach a line and hang the model. Another quick and easy way to check, but you generally need to figure this out during the build as well, so it can be built to support the weight of the plane.

6. Or you can measure you plane the way the real, planes are done. I prefer this method and it is "spot on". Math doesn't lie. However, don't let math scare you. If you can remember you primary school days and you can add, multiply, and divide, then that is all that is required. There are some drawbacks. This method doesn't work well if you want to find the CG with the gear up (But the Vanessa rig does), and it takes a little extra math to re-calculate after you adjust the weight (CG).

This is generally the same way full scale planes are balanced. You can't lift a full scale plane by your fingers! 😊

Let's Go give it a go!

1. Ready the plane assembled as RTF, minus fuel, gear down etc.
2. Find a place where you can put the nose of the plane up against a wall. It makes everything easier with a wall as a reference point.



3. Prop up the tail wheel until the fuselage is sitting level. Bottom line is you want it in the level flight attitude. Refer to 3 views and your blue prints.



4. The wall is the DATUM reference for measuring. With the forward part of the plane (In this case the spinner) up against the wall, measure directly back from the wall to each axel center on the landing gear. Mains and tail/nose wheel.

Once again, you are looking for the distance from the wall to each wheel axel center. I use a long straight-edge to get the distances or a tape measure.

For example, let's say you come up with these numbers called the **ARM**.

LH main = 22 inches

RH main = 22 inches

Tailwheel = 70 inches

It's also a good time to measure from the wall, to the point where the **recommended/desired CG** is on your wing. Save that number for later so you can compare to your **Calculated CG** number. For comparison sake, let's say the desired **CG is 32.75** inches from the wall.

Next we will use a scale. I recommend using a digital kitchen scale that can handle up to the maximum weight per tire. A 20 lbs weight limit will handle up to about a 50 lb plane. Either steal the wife's from the kitchen (which I just did 😊) or you can get them on the internet for \$15-20. I use them all the time to weigh Epoxy for mixing, weigh parts that are going in the tail of a plane, etc. A multitude of uses, so money well spent. If you feel you really want to splurge, you can have a scale for each wheel to make it quick and easier, however, I only have one. Therefore, I made wooden blocks that are the same height as the scale when on the floor. That way, when one wheel is on the scale the other wheels are level too. (see picture below)

Now, place a scale under each wheel individually. You will have to re-adjust the height of the other wheels with the blocks when you swap the scale to the other tire for the individual weight readings while keeping the plane sitting level. You will wind up with three weight readings, one for each wheel. You can use metric (kg or grams) or Standard (lbs or ounces). Whatever you are comfortable with, just use the same units. (all ounces or all grams etc.) Don't mix the units.

The picture below shows the scale under one wheel with a wood block to keep the plane level.



For example, let's say you come up with these numbers (**Weight**).

LH main = 9 lbs

RH main = 9 lbs

Tailwheel = 5 lbs

Now it's just a simple math problem to find where the CG sits right now on the plane. Use the **ARM** measurements from the wall you had earlier.

LH main = 22 inches

RH main = 22 inches

Tailwheel = 70 inches

**ARM x Weight = Moment**

22 x 9 = 198 in/lbs

22 x 9 = 198 in/lbs

70 x 5 = 350 in/lbs

Now add the total of all the moments and the total of all the weights.

**Moments**     $198+198+350 = 746$

**Weights**     $9+9+5 = 23\text{lbs}$

Then divide the total moments by the total weights above.

$746 / 23 = 32.43$

That number, (32.43) is "inches" from the tip of the spinner (wall) to where the plane CG balances right now. This is the **Calculated CG**.

Compare that to the distance that you measured earlier to the **recommended/desired CG** (32.75 inches) location on your wing. In this example 32.43 inches is forward (closer to the front of the plane by roughly 1/4" inch) than 32.75 inches, so your plane would be slightly nose heavy. For a warbird, that's probably a good thing.

If you are off one way or another, adjust weight in the tail or cowl, then recalculate the weights. The distances or ARM from the wall won't change so you already have those numbers. Just weigh again on the scales, then multiply to get the new moments. Add them up and divide again. Now you have your new CG.

Hope this helps balance those larger planes. This is a good check for confirming other methods of checking CG to boost your confidence in your measurements.

For those more motivated modelers, this can be entered into an excel spreadsheet, and the computer will do the math to speed the process and make it easier.