

General

With the large size of many jet aircraft, it is difficult and time consuming to hang models or utilize balance devices to find the CG. Often times, it is also advantageous to have a capability to do “what if” calculations, before installing components such as batteries, to avoid having to redo locations.

The answer to these issues is to utilize the method commonly employed to accurately find the CG of full scale aircraft. In short, this method employs formulas based on the weight of the aircraft at each wheel to determine the location of CG relative to some datum point, in this case, the tip of the nose of the aircraft.

The JPO has embedded these formulas in a blank Excel spreadsheet that may be downloaded from the JPO website www.jetpilots.org . The spreadsheet is located under the members tab in the weight and balance section. You will also find a number of pre-filled worksheets for various aircraft, though it is recommended you use these for reference only and complete a new spreadsheet on your specific model.

The spreadsheet is color coded. Green fields are for the purpose of data entry, while gray fields contain calculations. An abbreviated set of instructions is also included on the right side of each cell in the spreadsheet, explaining its purpose.

The spreadsheet will accept either metric or inch measurements, as long as you are consistent throughout.

Measurements

The spreadsheet requires four primary measurements:

- tip of the nose to the nose wheel center axel
- tip of the nose to the factory recommended CG
- nose wheel center axel to main wheel center axel
- main wheel center axel to opposite main wheel center axel

To accurately obtain these measures, begin by laying out masking paper or newsprint in a T shape as shown.



Make sure to tape the paper so it will not shift during the measurement process.

JPO Weight and Balance Instructions

Position the aircraft as shown on the paper. The mains should be on the upper part of the "T" while the nose (all the way to the tip) is positioned over the base of the "T". The leading edge of the wing should also be positioned over the paper ... if needed, tape additional sheets under the point where the leading edges meet the fuselage. This is necessary if your manufacturer specifies CG as a distance aft of the leading edge/fuselage reference point, as most kits do.

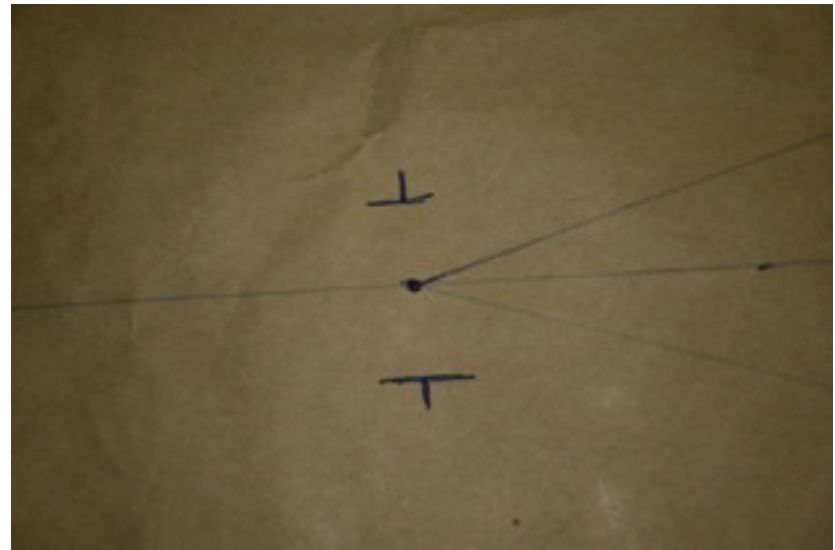


Using a large T Square, mark the position of the tip of the nose on the paper. Also, mark the both sides of each wheel and the axel point as shown in the following pictures. If you are doing this for a tailwheel aircraft, make sure the plane is in a level flight position, that is, with a wing incidence of zero. This will require that you block up the aft end of the aircraft.



JPO Weight and Balance Instructions

As you did with the tip of the nose, mark the location of the leading edge on the paper with a T Square. Do this on both sides of the aircraft.



Remove the aircraft from the paper, and mark a dot at the exact center of each wheel, where the axel line would bisect the two wheel edge lines. Using a long straight edge, connect the three dots, forming a triangle. Also draw a line between the two marks you made to identify the leading edge.

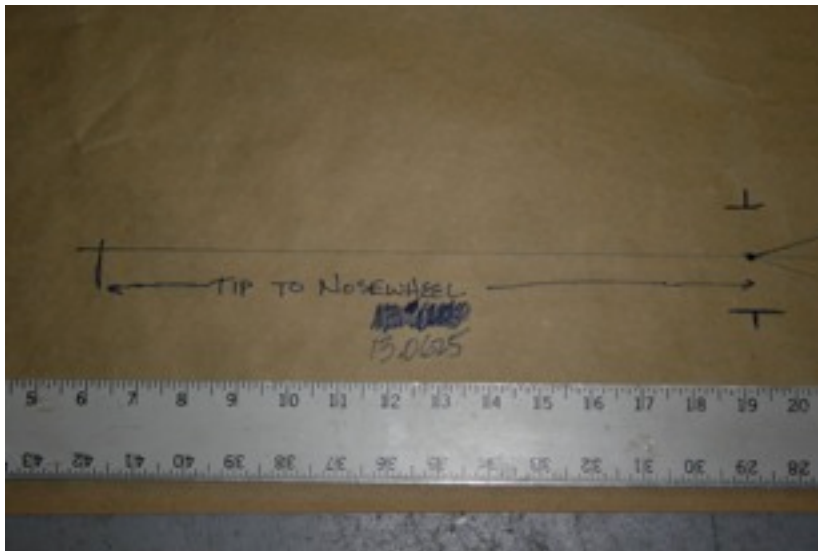
Find the midpoint of the line connecting the two main wheels and mark this spot. Draw a line from the dot at the tip of the nose to this spot, defining the longitudinal axis of the aircraft. See photos at right.



JPO Weight and Balance Instructions

The next step will be to capture the measurements. As mentioned previously, you can record data as inches, millimeters or centimeters, as long as you are consistent. The spreadsheet will compute the CG using the measure you have selected. This same principal will apply as you capture weights as well.

The first measure to capture is the distance from the tip of the nose to the center of the nose wheel.



Next, capture the measure from the nose wheel to the main, and then from one main to the next. See photos at right



JPO Weight and Balance Instructions

Lastly, capture the distance from the tip of the nose to the leading edge line. To this, add the measure the manufacturer has specified as “CG aft of leading edge”. This defines the distance from the tip of the nose to the manufacturers specified CG.



Enter these four measurements into the spreadsheet in the appropriate boxes.

The next task is to capture the weight at each wheel. You can do this with one scale, blocking the other two wheels up to make sure the plane remains level, moving the scale and blocks to each successive wheel. Alternatively, you can use three scales, making the job easier and the weights more accurate. The scale pictured here cost around \$30 on the internet. You should look for a scale that will handle 25 or more pounds. Digital is preferred.



Place the plane on the scales, wheels centered, and record weights. If you are working with a tailwheel aircraft, block up the rear scale such that the plane is weighed in a level attitude.

Record the weights in the spreadsheet as shown below. The “target CG” is the manufacturers specified measure.

Distance	From Tip	
Main to Main	15.875	inch
Nose to Main	30.75	inch
Nose Wheel to Tip	14.625	inch
Target CG	41.00	inch
Bal. Wt. Distance	3.00	inch

	From Tip	Weight	
Nose Gear	14.625	2.5	lbs
Left Main	44.33	8.9375	lbs
Right Main	44.33	9.06	lbs

Adjustments	From Tip	Weight
Item 1	3	0.2
Item 2		
Item 3		
Item 4		

Results		
Total Wt.	20.70	lbs
Computed CG	40.35	inch
Relative CG	-0.65	inch
Wt. Required	-0.36	lbs
Wt. Required	-5.70	oz

You will also note that you may enter the spot you intend to add or remove ballast to the spreadsheet. In this example, 3 inches was entered as the nose weight will be added or removed from the nose cone, approximately 3 inches aft of the tip.

The spreadsheet computes that the plane is nose heavy by .65 or about 5/8”. You can verify this as the factory specified CG is 41 inches from the tip and the computed CG is 40.35 inches from the tip. The spreadsheet has also computed that you will need to remove about .36 pounds or approximately 6 ounces from the ballast point you specified 3 inches behind the tip of the nose in the nose cone. If this number were positive and the CG were aft of the specified position, you would need to add weight at this point. Again, this ballast point is flexible, and you can enter the actual distance from the tip of the nose to the spot that you intend to use for the addition of weight.

The “adjustments” section allows you to see the impact of adding (or subtracting if you use negative weight) components to the airframe. Simply specify the distance from the tip to the balance point of the item, and its weight.

You will also note that the total weight of the aircraft is computed.

It is also recommended that when this procedure is complete, you do a rough manual check. I do this by lifting the plane off a paint stand from underneath with my fingers. Always double check all weights and measures.

