



## Weighing your Seabee

**Note: The following procedure must be supervised and signed off by a qualified A&P and the final paperwork must be included in the Aircraft Records. The actual weights must be included in the Approved Flight Manual.**

For those of you rebuilding a Seabee or have made major alterations that added (or subtracted) significant weight, this procedure should help. Along with the approved FAA documents outlining the weighing procedures, this article will address the particulars of weighing a Seabee.

First some terminology:

**Datum** – Is the reference point for all weight and balance calculations. On the Seabee it's the nose or 97.5 inches forward of the wing leading edge.

**Arm** – The distance from the equipment being weighed and the Datum.

**Moment** – This is the Arm times the Weight. Units will be inch-pounds.

**CG** – Center of gravity; the point at which the moments, forward and aft, are equal. (Indicated in inches aft of the Datum)

**Tare** – The weight of anything on the scale that isn't connected to the airplane.

You will need a set of three scales that have a rating of at least 1500 pounds and a nice quiet place to take the measurements (closed hangar with all fans and air conditioning turned off). The main gear will read close to 1000 pounds and the tail wheel will be close to 500 pounds. Each scale will be under a wheel. It is also my contention that the main gear struts be extended completely (pump the struts up to maximum extension) as this is the "normal" in-flight configuration. Your weighing building (hangar) should be rather high, as the tail is just over 12 feet when the Seabee is in the level flight attitude.

You may have noticed two rather large lugs on the lower left-hand doorframe. These lugs are flat on the top so that a carpenter's level can be held there during the leveling process. There are no lugs on the right side. The lateral leveling is done using the joint seams just under the front seat. The lateral leveling will most likely not be required if the struts are extended fully and the main gear scales are at the same elevation.

The certified empty weight is just that, empty. This means that everything that is not attached to the airframe (exceptions noted below) must not be included in the empty weight. All fuel must be drained (oil full) and all the "pockets" emptied of their contents. In our Seabees, required equipment should be included in the empty weight; i.e., life vests, signaling device, fire extinguisher, boat hook, Throwable cushion, CAA (FAA) Approved Flight Manual, Anchor and line, etc. This is the weight we are going to calculate. Additional equipment added later will be calculated when you do the normal Weight and Balance for your flight. To quote the FAA 8083, chapter 4:

*“The empty weight of an aircraft includes all operating equipment that has a fixed location and is actually installed in the aircraft. It includes the weight of the airframe, powerplant, required equipment, optional or special equipment, fixed ballast, hydraulic fluid, and residual fuel and oil. Residual fuel and oil are the fluids that will not normally drain out because they are trapped in the fuel lines, oil lines, and tanks. They must be included in the aircraft’s empty weight. For most aircraft certified after 1978, the full capacity of the engine oil system is also included in the empty weight. Information regarding residual fluids in aircraft systems that must be included in the empty weight, and whether or not full oil is included, will be indicated in the Aircraft Specifications or Type Certificate Data Sheet.”*

Notice the “fixed Ballast” entry above. Most Seabees have ballast that is bolted to the floor at the 4.5 station in the nose. This could be 50 pounds plus or minus a few pounds or not at all. This ballast was installed by Republic during construction and is referred to in many of the Republic Service Bulletins. Some Seabees have this ballast removed for various reasons and perhaps you purchased a Seabee that doesn’t have it.



**Republic-installed lead weights at Sta. 4.5**

Adding temporary ballast (lead weights), when required makes up this ballast shortcoming. This is especially important when flying alone as the CG will most likely be outside the aft CG limit in most cases. It is even more critical with a Lycoming conversion.

The FAA says, Temporary ballast should be placarded:

**“BALLAST, XX LB. REMOVAL REQUIRES  
WEIGHT AND BALANCE CHECK.”**

We are fortunate in a way in that the “CG envelope” is a perfect square. The forward CG limit is 111.5 and the aft limit is 118.3 regardless of loading and weight. Ballast may be needed to get the CG inside the envelope upon normal loading. Our calculations are made much easier in that the Datum is on the nose so all the moments will be positive; they simply have to be added together to get the total moment.



Another peculiar aspect of our Seabees is that the gear retracts aft. This shifts the CG aft slightly upon retraction. There could be times when the CG is perfectly fine with the gear down but once it comes up you could exceed the aft CG limit. More on this later. If you have an original weight and balance in your CAA Approved Flight Manual, you will notice a small moment correction listed for the landing gear retracted (2,820 inch-pounds).

Another consideration during the preflight weight and balance calculations is the lack of "arms" for various positions on the Seabee. For example, the position forward of the back seats. If you load anything on the floor in the back, the CAA (FAA) Approved Flight Manual does not address this "arm". The same goes for the floor forward of the front seats. (See chart below)

	Normal Category					
	Most Forward C.G.			Most Aft C.G.		
	Weight	Arm	Moment	Weight	Arm	Moment
Weight Empty	2360.5	126.41	298,380	2360.5	126.41	298,380
Ballast	0.0	0.0	0	112.0	4.5	504
Pilot	170.0	62.0	10,540	170.0	62.0	10,540
Passenger-Front	170.0	62.0	10,540			
Passenger-Rear (2)	340.0	96.0	32,640			
Oil	15.0	149.0	2,235	22.5	149.0	3352.5
Fuel = Min. 25 Gal.	150.0	116.0	17,400	150.0	116.0	17,400
Wheels Up Difference						2,820
Total	3205.5	115.97	371,735	2815.0	118.29	332,997

Weight and Balance chart from CAA (FAA) Approved Flight Manual

You will notice in the chart above that there is no entry for the anchor compartment or the floor areas in front of the seats. These could affect your CG location. All is not lost however as these arms should be indicated on the Aircraft Equipment List. This list should be part of the CAA (FAA) Certified Flight Manual; usually towards the back of the document. This list is required to be in the airplane at all times and is usually part of the Approved Flight Manual.

### **Weighing**

The scales should be directly under the main wheels and the tail wheel jacked up so the carpenter's level indicates "0" with the level on the leveling studs up front. The tail wheel jack, or support system, should be completely on the tail wheel scale. Most scales have a "0" (tare weight) function that allows the scale to be zeroed out with the support system in place. Otherwise you will need to subtract the weight of the support system from the final tail wheel weight. The "0" function of the scale eliminates one of the steps required to get the actual tail wheel weight. Less math is a good thing. Now let's weigh this thing!



Below is a checklist of things to do before weighing:

- Get all required papers ready to calculate the Weight and Balance. (See form below)
- Make sure all panels and access plates are installed.
- Neutralize all controls. (see page 5 for description)
- Flaps should be retracted.
- Take everything out of the airplane that is not attached or required.
- Vacuum and clean out the airplane of any dirt, grease and oil.
- Leave the engine oil quantity full (usually 12 quarts).
- Drain the fuel tank or fill it completely.  
**Note:** If you fill the fuel tank, you must subtract the fuel load and moment from the Weight and Balance calculations.
- Hydraulic reservoir must be filled.
- Extend the oleo struts to full extension.
- Close and latch the doors, cowling and any other compartment doors.
- Place the main gear on the scales.
- Place the tail wheel on a scale. Make sure it is secure and will not fall!
- Chock the wheels and release the brakes. Weight of the chocks must be subtracted from the scale reading.



# Aircraft Weight and Balance Report

## Results of Aircraft Weighing

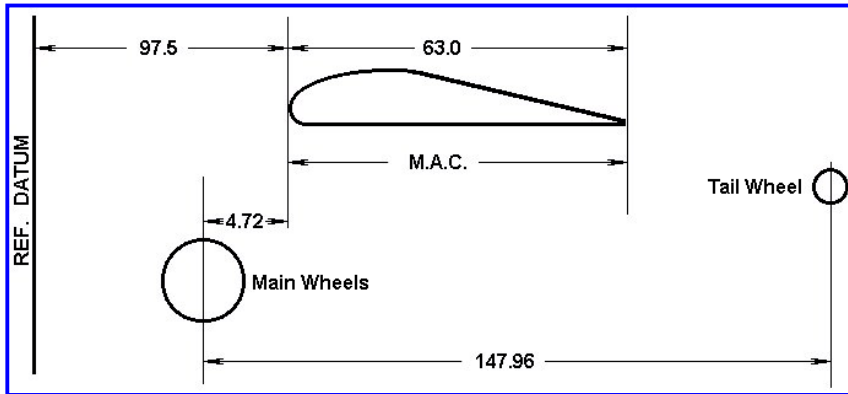
Make: **Republic Aviation Corp.**

Model: **RC-3 Seabee**

Serial Number \_\_\_\_\_

Reg. Number: \_\_\_\_\_

Datum Location: **97.5** inches forward of wing leading edge (see illustration)



Leveling means: Leveling studs on left fuselage side below pilot's seat

Scale Arms: Tail wheel: 240.74 Left Main: 92.78 Right Main: 92.78

Scale Weights: Tail wheel: \_\_\_\_\_ Left Main: \_\_\_\_\_ Right Main: \_\_\_\_\_

Tare Weights: Tail wheel: \_\_\_\_\_ Left Main: \_\_\_\_\_ Right Main: \_\_\_\_\_

## Weight and Balance Calculation

Item	Scale (lb)	Tare Wt. (lb)	Net Wt. (lb)	Arm (inches)	Moment (in-lbs)
Tail Wheel				240.74	
Left Main				92.78	
Right Main				92.78	
Subtotal					
Fuel				116.0	
Oil	-	-			
Misc.					
<b>Total</b>					

Aircraft Current Empty Weight: \_\_\_\_\_

Aircraft Current Empty Weight CG: \_\_\_\_\_

Aircraft Maximum Weight: **3250 lbs.** (3150 lbs. for Franklin powered Seabee)

Aircraft Useful Load: \_\_\_\_\_

Computed By: \_\_\_\_\_ (print name)

\_\_\_\_\_ (signature)

Certificate Number: \_\_\_\_\_ (A&P, Repair Station, etc.)

Date: \_\_\_\_\_

Sample Form

The form above is a sample form that may be used in your calculations. Your mechanic may have a slightly different form but will include all the same entries. This form should be included in the Aircraft Records and remain there until you add or subtract something from your Seabee. There is no requirement to notify the FAA of the new weights. As a side note, FAA AC 43.13 says:

**“Negligible Weight Change** is any change of one pound or less for aircraft whose weight empty is less than 5,000 pounds.”

and/or

“C. G. change is any change of less than 0.05% MAC for fixed wing aircraft.” (Weight may change however)

**NOTE:** Each engine type has different Oil CG Arms. Check the Type Certificate for your engine type for the Arm of the Oil Quantity entry and enter it on the Weight and Balance form.

So nuts, bolts, washers and other various hardware do not have to have the weight and balance information changed to reflect these additions. Also anything you add or subtract later that weighs a pound or less need not revise the current weight and balance. This does not eliminate the requirement to calculate a preflight weight and balance simply because all the things you take with you, individually, weigh less than a pound, put all together it may be significant. The CG change of .05% is about .03” on our Seabees which can barely be measured so this may not apply to us ever.

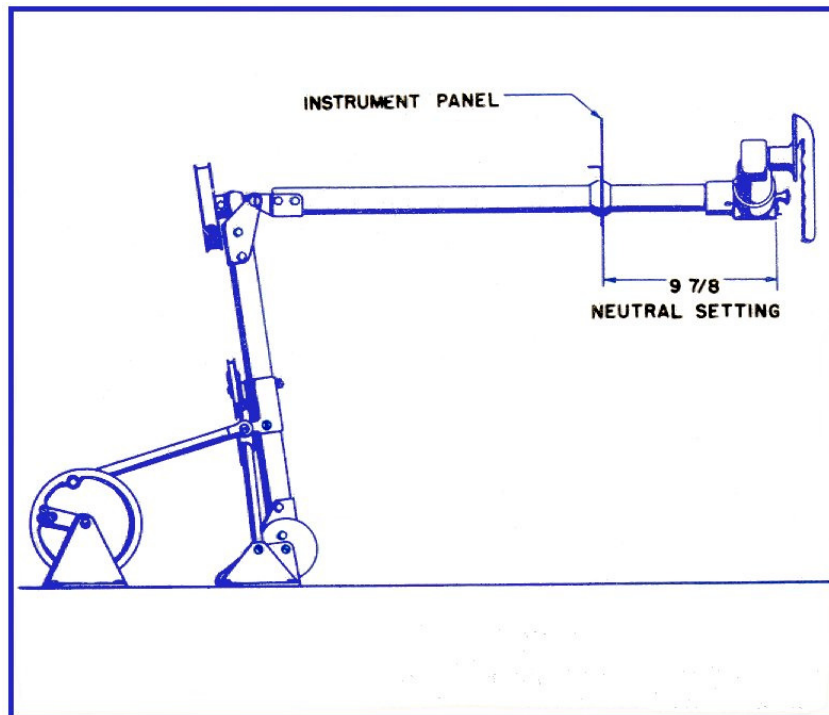
To neutralize the controls, the control wheel should be centered, the rudder pedals centered and the elevator can be centered using a PVC “Neutral Elevator Tool”. It weighs nothing so it doesn't have to be subtracted from the scale readings you get. Make sure it is the correct length so the elevator is neutral.



PVC Neutral Elevator Tool; cut to length that keeps elevator neutral



Your elevator should be neutral according to the illustration below. If it is not, your elevator cables may need adjusting. Consult with you're A&P mechanic for elevator cable adjustments if necessary.



**Elevator Control Wheel Setting  
(from the Seabee Owner's Manual)**

After all of the above is complete, you can now take the readings from the scales and fill in the Weight and Balance form. It is now just a matter of multiplying the **Weights** by the associated **Arms** to get the **Moments** of each wheel. The **Empty Weight CG** can then be calculated by dividing the total Empty Weight Moment by the Total Empty Weight. This will give you the **CG** in inches aft of the Datum (nose). It should definitely be aft of the Aft CG limit if all your calculations are correct. These numbers are then used for all preflight calculations for Weight and Balance.

Commercial operators must weigh their airplanes every two or three years by regulation. We don't need to do that but you might consider it if it has been a few decades since the last weighing of your Seabee. After all the additions and subtractions of various radios, engines and such, your Seabee probably doesn't weigh what you think it does. I'm getting ready to do an engine change that is a little heavier than the engine installed now so a new weighing will be required. I will be very curious to see how accurate the previous equipment/accessory changes have been over the years. But make sure you get the assistance of a qualified mechanic and preferably someone who has done a Seabee before. Good luck and may the gravity gods be with you!



While we are talking about weight and balance, you will notice two columns on the chart on page 3 labeled "Most Forward CG" and "Most Aft CG". These are FAA requirements for the CAA (FAA) Certified Flight Manual. They need proof that the Seabee CG range will be within limits in the extreme weight conditions.

There are a few ways you can figure out your CG before you fly: You could make a blank weight and balance sheet like the one on page 3, use a calculator and crunch the numbers. You can use an app on your phone or iPad like Foreflight that allows you to enter the weights and the CG is automatically figured out for you. (Provided you entered the correct weights and arms to begin with) or you could just download the spreadsheet that member Bruce Hinds figured out for you. It is an Excel spreadsheet that has all the formulas already in there. All you have to do is enter the weights for any given station and the math is done for you. You must, however, enter YOUR Seabee empty weight and Moment in the Empty Weight/Moment boxes. These numbers should never change unless you add or subtract something significant (more than a pound) to your Seabee. The spreadsheet is available on the Seabee Club website right under this document.

Below is a snapshot of the spreadsheet. Notice that Bruce has gone to the trouble of refining the Republic form to include the area in front of the seats and the anchor compartment. Notice the Gear Up moment figure (2820 in-lbs) is there as well along with the associated CG. There is also an entry for stuff you put under the seats. This spreadsheet makes it as easy as it gets. Thanks to Bruce for his excellent work.

Seabee Weight & Balance Worksheet for "Our Bee"				
	QT / GAL	Weight	Arm	Moment
Empty Weight		<b>2442.14</b>	<b>124.89</b>	<b>304998</b>
Pilot -		225	62	13950
Copilot		135	62	8370
Pass - Rear		0	96	0
Baggage Area		45	116	5220
Floor btwn F&R seats		0	70	0
Bow bilge		8	25	200
Anchor Locker		20	40	800
Under Front Seat Storage		25	62	1550
" Rear "		3	96	288
Oil quarts	10	18.75	136	2550
Fuel us-gallons	30	180	116	20880
		GW	CG	
Gear Down CG		<b>3101.89</b>	<b>115.6733</b>	<b>358806</b>
Gear Up CG shift				2820
Gear Up CG			<b>116.5825</b>	<b>361626</b>
CG Limits		Forward <b>111.5</b> / Aft <b>118.3</b>		
Max Gross Wt		<b>3250</b>		
<b>To compute W&amp;B, just fill in these boxes for your flight!</b>				
<i>Italic red numbers are automatically calculated!</i>				
SET UP-Enter your data from FAA approved W&B in <b>BOLD</b> cells; Empty Weight/Arm/Moment, Oil Arm & Max Gross WT				