



Photo by James Williams

You Can't Take All That!!

What Aircraft Weight & Balance Means to You

BY SUSAN PARSON

One of the joys of traveling in a general aviation (GA) airplane is that you don't have to limit your liquids and gels, or remove your shoes, or go through airport security scanners. Why, you can take anything you like! So you pack accordingly, only to discover that your personal pilot is far more ferocious than the stone-faced screeners at Big Airplane Airport. As soon as you appear with your bags and bundles, your pilot freezes — scowls — and states (or shouts):

YOU CAN'T TAKE ALL THAT IN THIS AIRPLANE!!

Your offer to take care of fitting it all in, just like you do for family auto trips, doesn't do much to soothe the pilot. On the contrary, he or she gets even more agitated because *YOU DON'T UNDERSTAND HOW IT WORKS!*

For reasons we're about to discuss, most pilots will always prefer to perform (or closely supervise)

the loading of baggage and passengers. Still, knowing something about the basics of aircraft weight and balance could reduce some of the tension that can arise on such occasions.

A-Weigh We Go

The description of GA aircraft as "light airplanes" is apt, because "light" is the name of the game. The lighter the airplane is, the faster and higher it can fly with a given type of engine and propeller. Also, keeping the aircraft on the lighter side enables the pilot to carry more fuel, more passengers, and/or more cargo.

Notice that I said "and/or" — not just "and." GA flying involves tradeoffs. The fact that a light GA airplane has four seats doesn't mean that the pilot can always carry four passengers, especially if those passengers have baggage. Nor can the pilot just top off the tanks and launch. Here's why.

In order to stay aloft, the airplane's wings must be able to generate enough lift to equal the weight of the airplane and everything it carries: e.g., people, packages, and petroleum. When an airplane is made, its manufacturer determines its maximum gross weight. You can think of this number as the manufacturer's guarantee that the airplane is capable of generating sufficient lift to carry that amount of weight. It's up to the pilot to decide how to use that set "weight allowance" on any given flight. In most cases, it is simply not possible to load a light GA aircraft with full fuel, full seats, and passenger bags without grossly exceeding the manufacturer's established value for maximum gross weight.

So the pilot has to make choices, which means that passengers may be "volun-told" to pack very lightly. Or, if all passenger seats will be occupied, it could mean launching with less than a full fuel load — which might require one or more fuel stops en route to the destination.

Hanging in the Balance

You have dutifully (albeit reluctantly) agreed that you can't take all THAT, and limited your luggage accordingly. So now you wonder why the pilot starts rearranging the items you've already stowed in the baggage compartment, and why he or she is making passenger seat assignments.

That's where the "balance" part of "weight and balance" comes in. To be stable in all phases of flight, an airplane's weight must be balanced around a point within a fairly narrow range of values established when the airplane is manufactured and flight-tested. The idea is to avoid loading the airplane in a way that makes it either nose-heavy or tail-heavy.

To achieve this goal, the pilot uses the manufacturer's paper charts and graphs or, more likely nowadays, apps containing that data, to make a weight and balance calculation. The weight part of the equation is fairly obvious: the pilot starts with the airplane's published empty weight, and totals the weights for passengers, bags, and fuel to calculate the total weight.

As long as the total weight is below the airplane's published maximum gross weight, the pilot can proceed to the next step of calculating the airplane's "center of gravity," or CG. This process involves multiplying each component of the weight (e.g., pilot and front seat passenger) by the published "station" value



for that specific load-carrying position. The product of this calculation is called the "moment." Once the pilot has calculated all the moments, the next step is to add them together, and then divide total moments by total weight. The resulting number is the CG — the airplane's balance point. The final step is for the pilot to check the charts and ensure that the CG is within the acceptable range. If so, good to go. If not, the pilot will need to rearrange the load by moving passengers or bags until the CG is acceptable.

Once weight and balance is calculated and within acceptable limits, away you go! ✈️

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