Management of Weight and Balance Control

Title 14 of the Code of Federal Regulations (14 CFR) part 23, section 23.23 requires establishment of the ranges of weights and CGs within which an aircraft may be operated safely. The manufacturer provides this information, which is included in the approved AFM, TCDS, or aircraft specifications.

While there are no specified requirements for a pilot operating under 14 CFR part 91 to conduct weight and balance calculations prior to each flight, 14 CFR part 91, section 91.9 requires the pilot in command (PIC) to comply with the operating limits in the approved AFM. These limits include the weight and balance of the aircraft. To enable pilots to make weight and balance computations, charts and graphs are provided in the approved AFM.

Weight and balance control should be a matter of concern to all pilots. The pilot controls loading and fuel management (the two variable factors that can change both total weight and CG location) of a particular aircraft. The aircraft owner or operator should make certain that up-to-date information is available for pilot use, and should ensure that appropriate entries are made in the records when repairs or modifications have been accomplished. The removal or addition of equipment results in changes to the CG.

Weight changes must be accounted for and the proper notations made in weight and balance records. The equipment list must be updated, if appropriate. Without such information, the pilot has no foundation upon which to base the necessary calculations and decisions.

Standard parts with negligible weight or the addition of minor items of equipment such as nuts, bolts, washers, rivets, and similar standard parts of negligible weight on fixed-wing aircraft do not require a weight and balance check. The following criteria for negligible weight change is outlined in Advisory Circular (AC) 43.13-1 (as revised), Methods Techniques and Practices—Aircraft Inspection and Repair:

- One pound or less for an aircraft whose weight empty is less than 5,000 pounds
- Two pounds or less for aircraft with an empty weight of more than 5,000 pounds to 50,000 pounds
- Five pounds or less for aircraft with an empty weight of more than 50,000 pounds

Negligible CG change is any change of less than 0.05 percent Mean Aerodynamic Chord (MAC) for fixed-wing aircraft or 0.2 percent for rotary wing aircraft. MAC is the average distance from the leading edge to the trailing edge of the wing. Exceeding these limits would require a weight and balance check.

Before any flight, the pilot should determine the weight and balance condition of the aircraft. Simple and orderly procedures based on sound principles have been devised by the manufacturer for the determination of loading conditions. The pilot uses these procedures and exercises good judgment when determining weight and balance. In many modern aircraft, it is not possible to fill all seats, baggage compartments, and fuel tanks, and still remain within the approved weight and balance limits. If the maximum passenger load is carried, the pilot must often reduce the fuel load or reduce the amount of baggage.

14 CFR part 125 requires aircraft with 20 or more seats or maximum payload capacity of 6,000 pounds or more to be weighed every 36 calendar months. Multi-engine aircraft operated under 14 CFR part 135 are also required to be weighed every 36 months. Aircraft operated under 14 CFR part 135 are exempt from the 36 month requirement if operated under a weight and balance system approved in the operations specifications of the certificate holder. For additional information on approved weight and balance control programs for operations under parts 121 and 135, reference the current edition of AC 120-27, Aircraft Weight and Balance Control. AC 43.13-1, Acceptable Methods, Techniques and Practices—Aircraft Inspection and Repair also requires that the aircraft mechanic ensure that the weight and balance data in the aircraft records is current and accurate after a 100-hour or annual inspection.

Terms and Definitions

The pilot should be familiar with the appropriate terms regarding weight and balance. The following list of terms and their definitions is standardized, and knowledge of these terms aids the pilot to better understand weight and balance calculations of any aircraft. Terms defined by the General Aviation Manufacturers Association (GAMA) as industry standard are marked in the titles with GAMA.

- Arm (moment arm)—the horizontal distance in inches from the reference datum line to the CG of an item. The algebraic sign is plus (+) if measured aft of the datum and minus (–) if measured forward of the datum.
- Basic empty weight (GAMA)—the standard empty weight plus the weight of optional and special equipment that have been installed.
- Center of gravity (CG)—the point about which an aircraft would balance if it were possible to suspend it at that point. It is the mass center of the aircraft or the theoretical point at which the entire weight of the aircraft is assumed to be concentrated. It may be expressed in inches from the reference datum or in percent of MAC. The CG is a three-dimensional point with longitudinal, lateral, and vertical positioning in the aircraft.