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WEIGHT AND BALANCE

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SECTION 6  
WEIGHT AND BALANCE

## 6.1 GENERAL

In order to achieve the performance and flying characteristics which are designed into the airplane, it must be flown with the weight and center of gravity (C.G.) position within the approved operating range (envelope). Although the airplane offers a tremendous flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks and maximum baggage. With the flexibility comes responsibility. The pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff.

Misloading carries consequences for any aircraft. An overloaded airplane will not take off, climb or cruise as well as a properly loaded one. The heavier the airplane is loaded, the less climb performance it will have.

Center of gravity is a determining factor in flight characteristics. If the C.G. is too far forward in any airplane, it may be difficult to rotate for takeoff or landing. If the C.G. is too far aft, the airplane may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins; and spin recovery becomes more difficult as the center of gravity moves aft of the approved limit.

A properly loaded airplane, however, will perform as intended. Before the airplane is delivered, it is weighed, and a basic empty weight and C.G. location is computed (basic empty weight consists of the standard empty weight of the airplane plus the optional equipment). Using the basic empty weight and C.G. location, the pilot can easily determine the weight and C.G. position for the loaded airplane by computing the total weight and moment and then determining whether they are within the approved envelope.

**6.1 GENERAL (continued)**

The basic empty weight and C.G. location are recorded in the Weight and Balance Data Form (Figure 6-5) and the Weight and Balance Record (Figure 6-7). The current values should always be used. Whenever new equipment is added or any modification work is done, the mechanic responsible for the work is required to compute a new basic empty weight and C.G. position and to write these in the Aircraft Logbook and the Weight and Balance Record. The owner should make sure that it is done.

A weight and balance calculation is necessary in determining how much fuel or baggage can be boarded so as to keep within allowable limits. Check calculations prior to adding fuel to ensure against improper loading.

The following pages are forms used in weighing an airplane in production and in computing basic empty weight, C.G. position, and useful load. Note that the useful load includes usable fuel, baggage, cargo and passengers. Following this is the method for computing takeoff weight and C.G.

**6.3 AIRPLANE WEIGHING PROCEDURE**

At the time of licensing, Piper provides each airplane with the basic empty weight and center of gravity location. This data is supplied by Figure 6-5.

The removal or addition of equipment or airplane modifications can affect the basic empty weight and center of gravity. The following is a weighing procedure to determine this basic empty weight and center of gravity location:

**(a) Preparation**

- (1) Be certain that all items checked in the airplane equipment list are installed in the proper location in the airplane.
- (2) Remove excessive dirt, grease, moisture, foreign items such as rags and tools from the airplane before weighing.
- (3) Defuel airplane. Then open all fuel drains until all remaining fuel is drained. Operate engine on each tank until all undrainable fuel is used and engine stops. Then add the unusable fuel (5.0 gallons total, 2.5 gallons each wing).

## 6.3 AIRPLANE WEIGHING PROCEDURE (continued)

*CAUTION*

Whenever the fuel system is completely drained and fuel is replenished it will be necessary to run the engines for a minimum of 3 minutes at 1000 rpm on each tank to insure no air exists in the fuel supply lines.

- (4) Fill with oil to full capacity.
- (5) Place pilot and copilot seats in fourth (4th) notch, aft of forward position. Put flaps in the fully retracted position and all control surfaces in the neutral position. Tow bar should be in the proper location and all entrance and baggage doors closed.
- (6) Weigh the airplane inside a closed building to prevent errors in scale readings due to wind.

## (b) Leveling

- (1) With airplane on scales, block main gear oleo pistons in the fully extended position.
- (2) Level airplane (refer to Figure 6-3) deflating nose wheel tire, to center bubble on level.

## (c) Weighing - Airplane Basic Empty Weight

- (1) With the airplane level and brakes released, record the weight shown on each scale. Deduct the tare, if any, from each reading.

6.3 AIRPLANE WEIGHING PROCEDURE (continued)

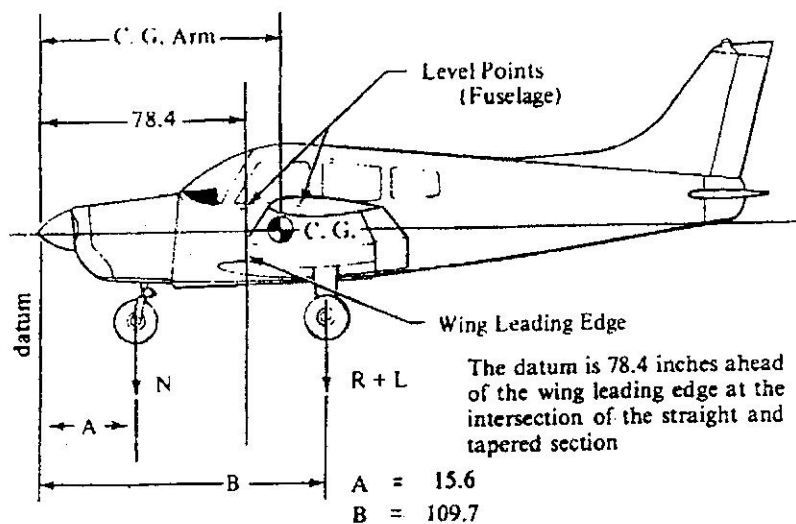
Scale Position and Symbol	Scale Reading	Tare	Net Weight
Nose Wheel (N)			
Right Main Wheel (R)			
Left Main Wheel (L)			
Basic Empty Weight, as Weighed (T)			

WEIGHING FORM

Figure 6-1

(d) Basic Empty Weight Center of Gravity

- (1) The following geometry applies to the PA-28R-201 airplane when it is level. Refer to Leveling paragraph 6.3 (b).



LEVELING DIAGRAM

Figure 6-3

**6.3 AIRPLANE WEIGHING PROCEDURE (continued)**

- (2) The basic empty weight center of gravity (as weighed including optional equipment, full oil and unusable fuel) can be determined by the following formula:

$$\text{C.G. Arm} = \frac{N(A) + (R + L)(B)}{T} \text{ inches}$$

Where:  $T = N + R + L$

**6.5 WEIGHT AND BALANCE DATA AND RECORD**

The Basic Empty Weight, Center of Gravity Location and Useful Load listed in Figure 6-5 are for the airplane as licensed at the factory. These figures apply only to the specific airplane serial number and registration number shown.

The basic empty weight of the airplane as licensed at the factory has been entered in the Weight and Balance Record (Figure 6-7). This form is provided to present the current status of the airplane basic empty weight and a complete history of previous modifications. Any change to the permanently installed equipment or modification which affects weight or moment must be entered in the Weight and Balance Record.

**SECTION 6**  
**WEIGHT AND BALANCE**

**PA-28R-201, ARROW**

**6.5 WEIGHT AND BALANCE DATA AND RECORD (continued)**

**MODEL PA-28R-201 ARROW**

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

Registration Number \_\_\_\_\_

Date \_\_\_\_\_

**AIRPLANE BASIC EMPTY WEIGHT**

Item	Weight x (Lbs)	C.G. Arm (Inches Aft of Datum)	= Moment (In-Lbs)
Actual			
Standard Empty Weight* Computed			
Optional Equipment			
Basic Empty Weight			

\*The standard empty weight includes full oil capacity and 5.0 gallons of unusable fuel.

**AIRPLANE USEFUL LOAD — NORMAL CATEGORY OPERATION**

(Gross Weight) - (Basic Empty Weight) = Useful Load

(2750 lbs) - (                      lbs) =                      lbs

THIS BASIC EMPTY WEIGHT, C.G., AND USEFUL LOAD ARE FOR THE AIRPLANE AS LICENSED AT THE FACTORY. REFER TO APPROPRIATE AIRCRAFT RECORD WHEN ALTERATIONS HAVE BEEN MADE.

**WEIGHT AND BALANCE DATA FORM**

Figure 6-5

## 6.5 WEIGHT AND BALANCE DATA AND RECORD (continued)

PA-28R-201	Serial Number	Registration Number	Page Number
Date	Description of Article or Modification	Weight Change	Running Basic Empty Weight
Item No.	Added (+) Removed (-)	Wt. (Lb.)	Moment 100
		Arm (In.)	Wt. (Lb.)
		Moment 100	Moment 100
	As Licensed		

### WEIGHT AND BALANCE RECORD

Figure 6-7

## SECTION 6

PA-28R-201. ARROW

### 6.5 WEIGHT AND BALANCE DATA AND RECORD (continued)

[illegible]**WEIGHT AND BALANCE RECORD (cont)**

Figure 6-7 (cont)

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**6.7 WEIGHT AND BALANCE DETERMINATION FOR FLIGHT**

- Add the weight of all items to be loaded to the basic empty weight.
- Use the Loading Graph (Figure 6-13) to determine the moment of all items to be carried in the airplane.
- Add the moment of all items to be loaded to the basic empty weight moment.
- Divide the total moment by the total weight to determine the C.G. location.
- By using the figures of item (a) and item (d) (above), locate a point on the C.G. range and weight graph (Figure 6-15). If the point falls within the C.G. envelope, the loading meets the weight and balance requirements.

	Weight (Lbs)	Arm Aft Datum (Inches)	Moment (In-Lbs)
Basic Empty Weight	1890	84.8	160272
Pilot and Front Passenger	340.0	80.5	27370
Passengers (Rear Seats)	170.0	118.1	20077
Fuel (72 Gallons Maximum)	294	95.0	27930
Baggage (200 Lbs. Maximum)	64	142.8	9139
Ramp Weight (2758 Lbs. Maximum)	2758	88.76	244788
Fuel Allowance For Engine Start, Taxi, and Run-Up	-8	95.0	-760
Moment due to Retraction of Landing Gear			819
Takeoff Weight (2750 Lbs. Maximum)	2750	89.04	244847

The center of gravity (C.G.) of this sample loading problem is at 89.04 inches aft of the datum line. Locate this point (89.04) on the C.G. range and weight graph. Since this point falls within the weight - C.G. envelope, this loading meets the weight and balance requirements.

IT IS THE RESPONSIBILITY OF THE PILOT AND AIRCRAFT OWNER TO ENSURE THAT THE AIRPLANE IS LOADED PROPERLY.

**SAMPLE LOADING PROBLEM (NORMAL CATEGORY)**

Figure 6-9

**SECTION 6**  
**WEIGHT AND BALANCE**

**PA-28R-201, ARROW**

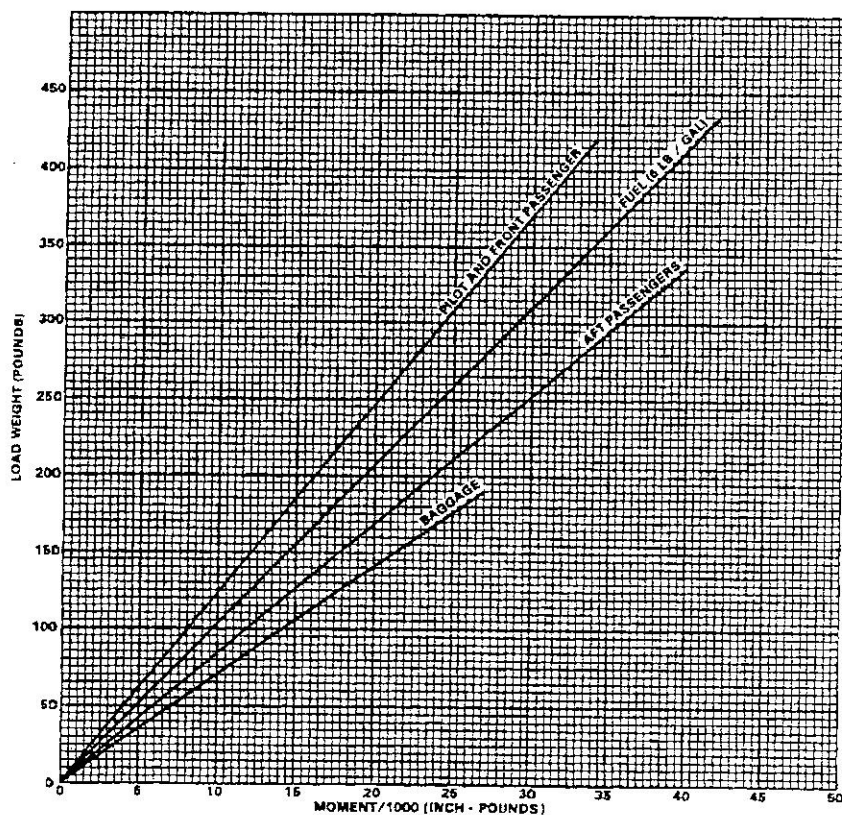
**6.7 WEIGHT AND BALANCE DETERMINATION FOR FLIGHT**  
**(continued)**

	Weight (Lbs)	Arm Aft Datum (Inches)	Moment (In-Lbs)
Basic Empty Weight			
Pilot and Front Passenger		80.5	
Passengers (Rear Seats)		118.1	
Fuel (72 Gallons Maximum)		95.0	
Baggage (200 Lbs. Maximum)		142.8	
Ramp Weight (2758 Lbs. Maximum)			
Fuel Allowance For Engine Start, Taxi, and Run-Up	-8	95.0	-760
Moment due to Retraction of Landing Gear			819
Takeoff Weight (2750 Lbs. Maximum)			

Totals must be within approved weight and C.G. limits. It is the responsibility of the airplane owner and the pilot to insure that the airplane is loaded properly. The Basic Empty Weight C.G. is noted on the Weight and Balance Data Form (Figure 6-5). If the airplane has been altered, refer to the Weight and Balance Record for this information.

**WEIGHT AND BALANCE LOADING FORM**

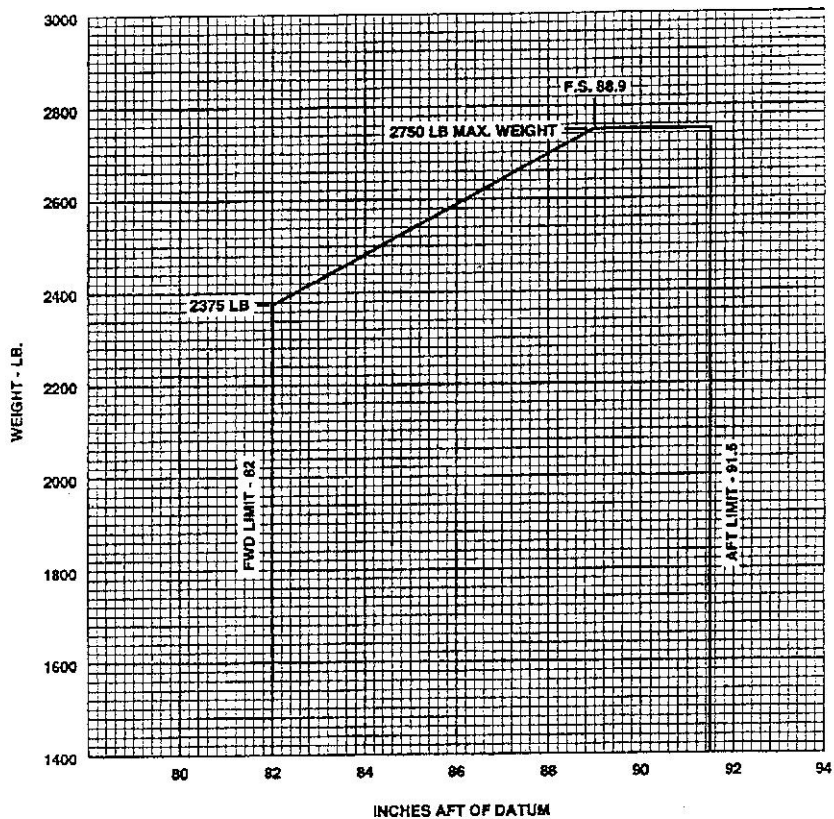
Figure 6-11

6.7 WEIGHT AND BALANCE DETERMINATION FOR FLIGHT  
(continued)

LOADING GRAPH

Figure 6-13

6.7 WEIGHT AND BALANCE DETERMINATION FOR FLIGHT  
(continued)



C. G RANGE AND WEIGHT  
Figure 6-15