Chapter 6

Weight and Balance Control—Large Aircraft

Weight and balance control for **large aircraft** consists of the following:

- Establishing and monitoring the **empty weight** and EWCG of the aircraft either individually, or as part of a fleet. This includes both the initial weighing and the required periodic reweighing of the aircraft.
- Maintaining a **loading schedule** that allows the aircraft to be loaded in such a way that the weight and balance remain within the approved limits. Provisions are made to track the weight and CG changes as occupants and cargo are loaded or deplaned, and as the CG is shifted by moving cargo from one bin to another. The cargo loading schedule takes into consideration the floor loading limits so the structure will not be damaged by an overweight cargo pallet.
- Providing information to the flight crew that allows them to fuel and load the aircraft to carry the maximum payload without exceeding either the maximum takeoff or **landing weights**.

This handbook contains information about the adjustment of the elevator trim for takeoff based on the **takeoff weight** and CG location, as well as information regarding the fuel dumping time needed to reduce the weight of the airplane to its allowable landing weight in an emergency situation.

Weighing Requirements

FAA-approved operating manuals describe the requirements for weighing the aircraft. These manuals may specify that each individual aircraft be weighed, or they may allow **fleet weight** to be used if the operator has several aircraft of the same model and configuration, with the same equipment installed on each.

Individual Aircraft Weight

Before an aircraft is placed into service, it should be weighed and the empty weight and CG location established. New aircraft are normally weighed at the factory and may be placed in service without reweighing, if the weight and balance records have been adjusted for alterations or modifications to the aircraft.

However, the Operation Specifications under which some large aircraft are operated mandate that the aircraft be re-weighed at specified intervals, and it is important when an aircraft is transferred from one operator to another that the regulations regarding reweighing be observed.

Large aircraft: An aircraft of more than 12,500 pounds, maximum certificated takeoff weight.

Empty weight: The weight of the airframe, engines, all permanently installed equipment, and unusable fuel. 14 CFR, Part 25 includes full oil and CAR 4B requires the oil to be drained.

Loading schedule: A method and procedure used to show that an aircraft is properly loaded and will not exceed approved weight and balance limitations during operation.

Landing weight: The takeoff weight of an aircraft less the fuel burned and/or dumped en route.

Takeoff weight: The weight of an aircraft just before lift-off. It is the ramp weight less the fuel burned during start, taxi, and ground run.

Fleet weight: The average weight of aircraft of the same model and configuration that have the same equipment installed.

Fleet Weights

To establish a fleet weight for a group of aircraft of the same model and configuration, with the same equipment installed in each, several aircraft must be weighed and an average operating weight determined. The number of aircraft weighed depends upon the size of the fleet. The FAA recommends in AC 120-27, *Aircraft Weight and Balance Control*, that these numbers range from all the aircraft in a fleet of three or less to more than six aircraft in fleets of more than nine. The aircraft chosen to be weighed are those having the highest time since last weighing.

Weighing to reestablish fleet weights is normally conducted on a 3-year basis unless changes in aircraft configuration make it necessary to reweigh and/or recalculate the CG sooner than called for by this schedule.

Weighing Procedures

Required operating practices must be followed when weighing large aircraft. Check the aircraft to be sure all the required equipment items are installed and all the fluids are properly accounted for. The aircraft must be clean, and the weighing must be done in an enclosed building.

Large aircraft are not usually raised off the floor on jacks for weighing. Rather, they are weighed on ramp-type scales similar to those in Figure 3-2 on Page 3-2. The scales must be properly calibrated, zeroed, and used in accordance with the manufacturer's instructions. Each scale should be periodically checked for accuracy as recommended in the manufacturer's calibration schedule either by the manufacturer, or by a recognized facility such as a civil department of weights and measures. If no manufacturer's schedule is available, the period between calibrations should not exceed 1 year.

For Large Aircraft

Weight and balance control consists of:

- Establishing and monitoring the empty weight and EWCG.
- Maintaining a loading schedule to keep the weight and CG within limits.
- Providing information to the flight crew that allows them to load the aircraft in such a way that the maximum payload may be safely carried.

Locating and Monitoring Weight and CG Location

It is important that the flight crew have access to the most current weight and balance records containing the empty weight and the EWCG. Without this basic information, loaded weight and balance computations cannot produce accurate results.

Determining the Empty Weight and EWCG

When the aircraft is properly prepared for weighing (*see* Page 3-2), roll it onto the scales and level it. The weights are measured at three weighing points: the two main wheel points and the nose wheel point.

The empty weight and EWCG are determined by using the following steps, and the results are recorded in the weight and balance record for use in all future weight and balance computations.

1. Determine the **moment index** of each of the main-wheel weighing points by multiplying the **net weight** (scale reading less **tare weight**), in pounds, at these points by the distance from the datum, in inches. Divide these numbers by the appropriate **reduction factor**.
2. Determine the moment index of the nose wheel weighing point by multiplying its net weight, in pounds, by its distance from the datum, in inches. Divide this by the reduction factor.
3. Determine the total weight by adding the net weight of the three weighing points and the total moment index by adding the moment indexes of each point.
4. Divide the total moment index by the total weight, and multiply this by the reduction factor. This gives the CG in inches from the datum.
5. Determine the distance of the CG behind the leading edge of the mean aerodynamic chord (LEMAC) by subtracting the distance between the datum and LEMAC from the distance between the datum and the CG.

   Distance CG to LEMAC = Datum to CG – Datum to LEMAC

6. Determine the EWCG in % MAC by using this formula:

$$\text{EWCG in \% MAC} = \frac{\text{CG in inches from LEMAC} \times 100}{\text{MAC}}$$

Moment index: The moment (weight times arm) divided by a reduction factor such as 100 or 1,000 to make the number smaller and reduce the chance of mathematical errors in computing the center of gravity.

Net weight: The scale readings taken when weighing an aircraft less the weight of any chocks or other devices used to hold the aircraft on the scales.

Tare weight: The weight of all chocks and other items used to secure an aircraft on the scales for weighing.

Reduction factor: A number, usually 100 or 1,000 by which a moment is divided to produce a smaller number that is less likely to cause mathematical errors when computing the center of gravity.

Determining the Loaded CG of the Airplane in Percent MAC

It is the responsibility of the flight crew to know that both the weight of the airplane and the location of the CG are within the allowable limits for both takeoff and landing.

The **basic operating weight (BOW)** and the **basic operating index** are entered into a loading schedule like the one in Figure 6-1 and the variables for the specific flight are entered as are appropriate to determine the loaded weight and CG.

Use the data in this example:

Basic operating weight (BOW) .... 105,500 lbs
Basic operating index (total moment/1,000) 92,837.0
MAC .... 180.9 in
LEMAC 860.5

Item		Weight	Moment/1000
BOW		105,500	92,837
PAX forward	18	3,060	1,781
PAX aft	95	16,150	16,602
Fwd cargo		1,500	1,020
Aft cargo		2,500	2,915
Fuel tank 1		10,500	10,451
Fuel tank 3		10,500	10,451
Fuel tank 2		28,000	25,589
		177,710	161,646

Figure 6-1. *Loading tables.*

Use Figure 6-2 to determine the moment indexes for the **passengers (PAX)**, cargo, and fuel.

The airplane is loaded in this way:

Passengers (nominal weight 170 pounds each)
- Forward compartment 18
- Aft compartment 95

Cargo
- Forward hold .... 1,500 lbs
- Aft hold .... 2,500 lbs

Fuel
- Tanks 1 & 3 .... 10,500 lbs each
- Tank 2 .... 28,000 lbs

Determine the location of the CG in inches aft of the datum by using this formula:

$$\text{CG in. aft of datum} = \left(\frac{\text{Total moment index}}{\text{Total weight}}\right) \times 1{,}000$$
$$= \left(\frac{161{,}646}{177{,}710}\right) \times 1{,}000$$
$$= 909.6 \text{ inches}$$

Determine the distance from the CG to the LEMAC by subtracting the distance between the datum and LEMAC from the distance between the datum and the CG:

$$\text{Distance CG to LEMAC} = \text{Datum to CG} - \text{datum to LEMAC}$$
$$= 909.6 - 860.5$$
$$= 49.1 \text{ inches}$$

The location of the CG in percent of MAC must be known in order to set the stabilizer trim for takeoff. Use this formula:

$$\text{CG \% MAC} = \left(\frac{\text{Distance CG to LEMAC}}{\text{MAC}}\right) \times 100$$
$$= \left(\frac{49.1}{180.9}\right) \times 100$$
$$= 27.1\%$$

On Board Aircraft Weighing System

Some large transport airplanes have an on board aircraft weighing system (OBAWS) that, when the aircraft is on the ground, gives the flight crew a continuous indication of the aircraft gross weight and the location of the CG in % MAC.

The system consists of strain sensing transducers in each main wheel and nose wheel axle, a weight and balance computer, and indicators that show the gross weight, the CG location in % MAC, and an indicator of the ground attitude of the aircraft.

The **strain sensors** measure the amount each axle deflects and send this data into the computer, where signals from all of the transducers and the ground attitude sensor are integrated. The results are displayed on the indicators for the flight crew.

Basic operating weight (BOW): The empty weight of the aircraft plus the weight of the required crew, their baggage and other standard items such as meals and potable water.

Basic operating index: The moment of the airplane at its basic operating weight divided by the appropriate reduction factor.

PAX: Passengers.

Strain sensor: A device that converts a physical phenomenon into an electrical signal. Strain sensors in a wheel axle sense the amount the axle deflects and create an electrical signal proportional to the force that caused the deflection.

PASSENGER LOADING TABLE

Number of Pass.	Weight lbs	Moment/1000
Forward Compartment Centroid—582.0		
5	850	495
10	1,700	989
15	2,550	1,484
20	3,400	1,979
25	4,250	2,473
29	4,930	2,869
AFT Compartment Centroid—1028.0		
10	1,700	1,748
20	3,400	3,495
30	5,100	5,243
40	6,800	6,990
50	8,500	8,738
60	10,200	10,486
70	11,900	12,233
80	13,600	13,980
90	15,300	15,728
100	17,000	17,476
110	18,700	19,223
120	20,400	20,971
133	22,610	23,243

CARGO LOADING TABLE

	Moment/1000	
Weight lbs	Forward Hold Arm 680.0	Aft Hold Arm 1166.0
6,000		6,966
5,000	3,400	5,830
4,000	2,720	4,664
3,000	2,040	3,498
2,000	1,360	2,332
1,000	680	1,166
900	612	1,049
800	544	933
700	476	816
600	408	700
500	340	583
400	272	466
300	204	350
200	136	233
100	68	117

FUEL LOADING TABLE

TANKS 1 & 3 (EACH)			TANKS 2 (3 CELL)					
Weight lbs	Arm	Moment/1000	Weight lbs	Arm	Moment/1000	Weight lbs	Arm	Moment/1000
8,500	992.1	8,433	8,500	917.5	7,799	22,500	914.5	20,576
9,000	993.0	8,937	9,000	917.2	8,255	23,000	914.5	21,034
9,500	993.9	9,442	9,500	917.0	8,711	23,500	914.4	21,488
10,000	994.7	9,947	10,000	916.8	9,168	24,000	914.3	21,943
10,500	995.4	10,451	10,500	916.6	9,624	24,500	914.3	22,400
11,000	996.1	10,957	11,000	916.5	10,082	25,000	914.2	22,855
11,500	996.8	11,463	11,500	916.3	10,537	25,500	914.2	23,312
12,000	997.5	11,970	12,000	916.1	10,993	26,000	914.1	23,767
FULL CAPACITY			**(See note at lower left)			26,500	914.1	24,244
						27,000	914.0	24,678
**Note: Computations for Tank 2 weights for 12,500 lbs to 18,000 lbs have been purposely omitted.			18,500	915.1	16,929	27,500	913.9	25,132
			19,000	915.0	17,385	28,000	913.9	25,589
			19,500	914.9	17,841	28,500	913.8	26,043
			20,000	914.9	18,298	29,000	913.7	26,497
			20,500	914.8	18,753	29,500	913.7	26,954
			21,000	914.7	19,209	30,000	913.6	27,408
			21,500	914.6	19,664			
			22,000	914.6	20,121	FULL CAPACITY		

Figure 6-2. *Loading schedule for determining weight and CG.*

Determining the Correct Stabilizer Trim Setting

It is important before takeoff to set the stabilizer trim for the existing CG location. There are two ways the stabilizer trim setting systems may be calibrated: in % MAC, and in Units ANU (Airplane Nose Up).

Stabilizer Trim Setting in % MAC

If the stabilizer trim is calibrated in units of % MAC, determine the CG location in % MAC as has just been described, then set the stabilizer trim on the percentage figure thus determined.

Stabilizer Trim Setting in Units ANU (Airplane Nose Up)

Some aircraft give the stabilizer trim setting in Units ANU (Airplane Nose Up) that correspond with the location of the CG in % MAC. When preparing for takeoff in an aircraft equipped with this system, first determine the CG in % MAC in the way described above, then refer to the Stabilizer Trim Setting Chart on the Takeoff Performance page of the AFM. Figure 6-3 is an excerpt from such a page from the AFM of a Boeing 737.

Consider an airplane with these specifications:

CG location .... station 635.7
LEMAC .... station 625
MAC .... 134.0 in

First determine the distance from the CG to the LEMAC by using this formula:

$$\begin{aligned}\text{Distance CG to LEMAC} &= \text{Datum to CG} - \text{datum to LEMAC}\\ &= 635.7 - 625.0\\ &= 10.7 \text{ inches}\end{aligned}$$

Then determine the location of the CG in percent of MAC by using this formula:

$$\begin{aligned}\text{CG \% MAC} &= \left(\frac{\text{Distance CG to LEMAC}}{\text{MAC}}\right) \times 100\\ &= \left(\frac{10.7}{134.0}\right) \times 100\\ &= 8.0\% \text{ MAC}\end{aligned}$$

Refer to Figure 6-3. For all flap settings and a CG located at 8% MAC, the stabilizer setting is $7^3/_4$ Units ANU.

Stabilizer Trim Setting—Units Airplane Nose Up	
CG	Flaps (All)
6	8
8	7¾
10	7½
12	7
14	6¾
16	6¼
18	5¾
20	5½
22	5
24	4½
26	4
28	3½
30	3
32	2½

Figure 6-3. *Stabilizer trim setting in ANU units.*

Determining CG Changes Caused by Modifying the Cargo

Large aircraft carry so much cargo that adding, subtracting, or moving any of it from one hold to another can cause large shifts in the CG.

Effects of Loading or Offloading Cargo

Both the weight and CG of an aircraft are changed when cargo is offloaded or onloaded. This example shows the way to determine the new weight and CG after 2,500 pounds of cargo is offloaded from the forward cargo hold.

Consider these specifications:

Loaded weight .... 90,000 lbs
Loaded CG .... 22.5% MAC
Weight change .... –2,500 lbs
Fwd. cargo hold **centroid** .... station 352.1
MAC .... 141.5 in
LEMAC .... station 549.13

Centroid: The distance in inches aft of the datum of the center of a compartment or a fuel tank for weight and balance purposes.

1. Determine the CG location in inches from the datum before the cargo is removed. Do this by first determining the distance of the CG aft of the LEMAC:

$$\text{CG (in. aft of LEMAC)} = \left(\frac{\text{CG in \% MAC}}{100}\right) \times \text{MAC}$$
$$= \left(\frac{22.5}{100}\right) \times 141.5$$
$$= 31.84 \text{ inches}$$

2. Determine the distance between the CG and the datum by adding the CG in inches aft of LEMAC to the distance from the datum to LEMAC:

$$\text{CG (in. from datum)} = \text{CG in. aft of LEMAC} + \text{datum to LEMAC}$$
$$= 31.84 + 549.13$$
$$= 580.97 \text{ inches}$$

3. Determine the moment/1,000 for the original weight:

$$\text{Moment/1,000} = \frac{\text{Weight} \times \text{Arm}}{1{,}000}$$
$$= \frac{90{,}000 \times 580.97}{1{,}000}$$
$$= 52{,}287.30$$

4. Determine the new weight and new CG by first determining the moment/1,000 of the removed weight.

   Multiply the amount of weight removed (–2,500 pounds) by the centroid of the forward cargo hold (352.1 inches), and then divide this by 1,000.

$$\text{Moment/1,000} = \frac{\text{Weight} \times \text{Arm}}{1{,}000}$$
$$= \frac{-2{,}500 \times 352.1}{1{,}000}$$
$$= -880.25$$

5. Subtract the removed weight and its moment/1,000 from the original weight and moment/1,000.

Item	Weight	Moment/1000
Original weight	90,000	52,287.30
Δ Weight	– 2,500	– 880.25
New weight & moment	87,500	51,407.05

6. Determine the location of the new CG by dividing the total moment/1,000 by the total weight and multiplying this by the reduction factor of 1,000.

$$\text{CG} = \left(\frac{\text{Total moment/1,000}}{\text{Total weight}}\right) \times 1{,}000$$
$$= \left(\frac{51{,}407}{87{,}500}\right) \times 1{,}000$$
$$= 587.5 \text{ inches behind the datum}$$

7. Convert the new CG location to % MAC. First, determine the distance between the CG location and LEMAC:

$$\text{CG (in. aft of LEMAC)} = \text{CG (in. from datum)} - \text{LEMAC}$$
$$= 587.5 - 549.13$$
$$= 38.37 \text{ inches}$$

8. Then, determine new CG in % MAC:

$$\text{CG \% MAC} = \left(\frac{\text{Distance CG to LEMAC}}{\text{MAC}}\right) \times 100$$
$$= \left(\frac{38.37}{141.5}\right) \times 100$$
$$= 27.1\% \text{ MAC}$$

Offloading 2,500 pounds of cargo from the forward cargo hold moves the CG from 22.5% MAC to 27.1% MAC.

Effects of Onloading Cargo

The previous example showed the way the weight and CG changed when cargo was offloaded. This example shows the way both parameters change when cargo is onloaded.

The same basic airplane is used in the example, but 3,000 pounds of cargo is onloaded in the forward cargo hold.

Weight before cargo is loaded .... 87,500 lbs
CG before cargo is loaded .... 27.1% MAC
Weight change .... + 3,000 lbs
Fwd. cargo hold centroid .... station 352.1
MAC .... 141.5 in
LEMAC .... station 549.13

CG Shift

When the CG moves aft, ?CG is positive; when it moves forward, ?CG is negative.

1. Determine the CG location in inches from the datum before the cargo is onloaded. Do this by first determining the distance of the CG aft of the LEMAC:

$$\text{CG (inches aft of LEMAC)} = \left(\frac{\text{CG in \% MAC}}{100}\right) \times \text{MAC}$$
$$= \left(\frac{27.1}{100}\right) \times 141.5$$
$$= 38.35 \text{ inches}$$

2. Determine the distance between the CG and the datum by adding the CG in inches aft of LEMAC to the distance from the datum to LEMAC:

$$\text{CG (in. from datum)} = \text{CG in. aft of LEMAC} + \text{datum to LEMAC}$$
$$= 38.35 + 549.13$$
$$= 587.48 \text{ inches}$$

3. Determine the moment/1,000 for the original weight:

$$\text{Moment/1,000} = \frac{\text{Weight} \times \text{Arm}}{1,000}$$
$$= \frac{87,500 \times 587.48}{1,000}$$
$$= 51,404.5$$

4. Determine the new weight and new CG by first determining the moment/1,000 of the added weight. Multiply the amount of weight added (3,000 pounds) by the centroid of the forward cargo hold (352.1 inches), and then divide this by 1,000.

$$\text{Moment/1,000} = \frac{\text{Weight} \times \text{Arm}}{1,000}$$
$$= \frac{3,000 \times 352.1}{1,000}$$
$$= 1,056.3$$

5. Add the onloaded cargo weight and its moment/1,000 to the original weight and moment/1,000.

	Weight	Moment/1000	CG in/datum	CG % MAC
Original weight and CG	87,500	51,404.5	587.48	27.1
Δ Weight	+ 3,000	1,056.3		
New weight and CG	90,500	52,460.8	579.68	21.59

6. Determine the location of the new CG by dividing the total moment/1,000 by the total weight and multiplying this by the reduction factor of 1,000.

$$\text{CG} = \frac{\text{Total moment/1,000}}{\text{Total weight}} \times 1,000$$
$$= \frac{52,460.8}{90,500} \times 1,000$$
$$= 579.68 \text{ inches behind the datum}$$

7. Convert the new CG location to % MAC. First, determine the distance between the CG location and LEMAC:

$$\text{CG (in. aft of LEMAC)} = \text{CG (in. from datum)} - \text{LEMAC}$$
$$= 579.68 - 549.13$$
$$= 30.55 \text{ inches}$$

8. Then, determine new CG in % MAC:

$$\text{CG \% MAC} = \left(\frac{\text{Distance CG to LEMAC}}{\text{MAC}}\right) \times 100$$
$$= \left(\frac{30.55}{141.5}\right) \times 100$$
$$= 21.59\% \text{ MAC}$$

Onloading 3,000 pounds of cargo into the forward cargo hold moves the CG forward 5.51 inches, from 27.1% MAC to 21.59% MAC.

Effects of Shifting Cargo from One Hold to Another

When cargo is shifted from one cargo hold to another, the CG changes, but the total weight of the aircraft remains the same.

As an example, use this data:

Loaded weight	90,000 lbs
Loaded CG	station 580.97 (which is 22.5% MAC)
Fwd. cargo hold centroid	station 352
Aft cargo hold centroid	station 724.9
MAC	141.5 in
LEMAC	station 549

To determine the change in CG, or ? CG, caused by shifting 2,500 pounds of cargo from the forward cargo hold to the aft cargo hold, use this formula:

$$\Delta CG = \frac{\text{Weight shifted} \times \text{Distance shifted}}{\text{Total weight}}$$

$$= \frac{2{,}500 \times (724.9 \quad 352)}{90{,}000}$$

$$= \frac{2{,}500 \times 372.9}{90{,}000}$$

$$= 10.36 \text{ inches}$$

Since the weight was shifted aft, the CG moved aft, and the CG change is positive. If the shift were forward, the CG change would be negative.

Before the cargo was shifted, the CG was located at station 580.97, which is 22.5% MAC. The CG moved aft 10.36 inches, so the new CG is:

$$\text{New CG} = \text{Old CG} \pm \Delta CG$$

$$= 580.97 + 10.36$$

$$= 591.33 \text{ inches}$$

Convert the location of the CG in inches aft of the datum to percent MAC by using this formula:

$$\Delta CG \text{ \% MAC} = \left(\frac{\Delta CG \text{ inches}}{MAC}\right) \times 100$$

$$= \left(\frac{10.36}{141.5}\right) \times 100$$

$$= 7.32\% \text{ MAC}$$

The new CG in % MAC caused by shifting the cargo is the sum of the old CG plus the change in CG:

$$\text{New CG \% MAC} = \text{Old CG} \pm \Delta CG$$

$$= 22.5\% + 7.32\%$$

$$= 29.82\% \text{ MAC}$$

Some aircraft AFMs locate the CG relative to an **index point** rather than the datum or the MAC. An index point is a location specified by the aircraft manufacturer from which arms used in weight and balance computations are measured. Arms measured from the index point are called index arms, and objects ahead of the index point have negative index arms, while those behind the index point have positive index arms.

Use the same data as in the previous example, except for these changes:

Loaded CG	index arm of 0.97, which is 22.5% MAC
Index point	fuselage station 580.0
Fwd. cargo hold centroid	–227.9 index arm
Aft cargo hold centroid	+144.9 index arm
MAC	141.5 in
LEMAC	–30.87 index arm

The weight was shifted 372.8 inches (–227.9 to +144.9 = 372.8).

The change in CG can be calculated by using this formula:

$$\Delta CG = \frac{\text{Weight shifted} \times \text{Distance shifted}}{\text{Total weight}}$$

$$= \frac{2{,}500 \times (227.9 + 144.9)}{90{,}000}$$

$$= \frac{2{,}500 \times 372.8}{90{,}000}$$

$$= 10.36 \text{ inches}$$

Since the weight was shifted aft, the CG moved aft, and the CG change is positive. If the shift were forward, the CG change would be negative.

Index point: A location specified by the aircraft manufacturer from which arms used in weight and balance computations are measured. Arms measured from the index point are called index arms.

Before the cargo was shifted, the CG was located at 0.97 index arm, which is 22.5% MAC. The CG moved aft 10.36 inches, and the new CG is:

$$\text{New CG} = \text{Old CG} \pm \Delta\text{CG}$$
$$= 0.97 + 10.36$$
$$= 11.33 \text{ index arm}$$

The change in the CG in % MAC is determined by using this formula:

$$\text{New CG \% MAC} = \text{Old CG} \pm \Delta\text{CG}$$
$$= 22.5\% + 7.32\%$$
$$= 29.82\% \text{ MAC}$$

The new CG in % MAC is the sum of the old CG plus the change in CG:

$$\Delta\text{CG \% MAC} = \left(\frac{\Delta\text{CG inches}}{\text{MAC}}\right) \times 100$$
$$= \left(\frac{10.36}{141.5}\right) \times 100$$
$$= 7.32\% \text{ MAC}$$

Notice that the new CG is in the same location whether the distances are measured from the datum or from the index point.

Determining Cargo Pallet Loads with Regard to Floor Loading Limits

Each cargo hold has a structural floor loading limit based on the weight of the load and the area over which this weight is distributed. To determine the maximum weight of a loaded cargo pallet that can be carried in a cargo hold, divide its total weight, which includes the weight of the empty pallet and its tiedown devices, by its area in square feet. This load per square foot must be equal to or less than the floor load limit.

In this example, determine the maximum load that can be placed on this pallet without exceeding the floor load limit.

Pallet dimensions .... 36 by 48 in
Empty pallet weight .... 47 lbs
Tiedown devices .... 33 lbs
Floor load limit .... 169 pounds per square foot

Floor Load—Caution

Loaded cargo pallets must be checked to be sure they do not impose a load on the floor that is greater than the floor load limit.

The pallet has an area of 36 inches (3 feet) by 48 inches (4 feet). This is equal to 12 square feet. The floor has a load limit of 169 pounds per square foot; therefore, the total weight of the loaded pallet can be 169° 12 = 2,028 pounds.

Subtracting the weight of the pallet and the tiedown devices gives an allowable load of 1,948 pounds (2,028 – [47 + 33]).

Determine the floor load limit that is needed to carry a loaded cargo pallet having these dimensions and weights:

Pallet dimensions .... 48.5 by 33.5 in
Pallet weight .... 44 lbs
Tiedown devices .... 27 lbs
Cargo weight .... 786.5 lbs

First determine the number of square feet of pallet area:

$$\text{Area (sq. ft.)} = \frac{\text{Length (inches)} \times \text{Width (inches)}}{144}$$
$$= \frac{48.5 \times 33.5}{144}$$
$$= \frac{1{,}624.7}{144}$$
$$= 11.28 \text{ square feet}$$

Then determine the total weight of the loaded pallet:

Pallet	44.0 lbs
Tiedown devices	27.0 lbs
Cargo	786.5 lbs
	857.5 lbs

Determine the load imposed on the floor by the loaded pallet:

The floor must have a minimum load limit of 76 pounds per square foot.

$$\text{Floor Load} = \frac{\text{Loaded weight}}{\text{Pallet area}}$$
$$= \frac{857.5}{11.28}$$
$$= 76.0 \text{ pounds/square foot}$$

Determining the Maximum Amount of Payload That Can Be Carried

The primary function of a transport or cargo aircraft is to carry **payload**. This is the portion of the useful load, passengers or cargo, that produces revenue. To determine the maximum amount of payload that can be carried, follow a series of steps, considering both the maximum limits for the aircraft and the trip limits imposed by the particular trip. In each step, the trip limit must be less than the maximum limit. If it is not, the maximum limit must be used.

These are the specifications for the aircraft in this example:

Basic operating weight (BOW) .... 100,500 lbs
Maximum zero fuel weight .... 138,000 lbs
Maximum landing weight .... 142,000 lbs
Maximum takeoff weight .... 184,200 lbs
Fuel tank load .... 54,000 lbs
Est. fuel burn en route .... 40,000 lbs

1. Compute the maximum takeoff weight for this trip. This is the maximum landing weight plus the trip fuel.

Max. Limit		Trip Limit
142,000	Landing weight	142,000
	+ trip fuel	+ 40,000
184,200	Takeoff weight	182,000

2. The trip limit is the lower, so it is used to determine the zero fuel weight.

Max. Limit		Trip Limit
184,200	Takeoff weight	182,000
	– fuel load	–54,000
138,000	Zero fuel weight	128,000

3. The trip limit is again lower, so use it to compute the maximum payload for this trip.

Max. Limit		Trip Limit
138,000	Zero fuel weight	128,000
	– BOW	– 100,500
	Payload (pounds)	27,500

Under these conditions 27,500 pounds of payload may be carried.

Payload: The weight of the passengers, baggage, and cargo that produces revenue.

Maximum zero fuel weight: The maximum authorized weight of an aircraft without fuel. This is the sum of the BOW and payload.

Determining the Landing Weight

It is important to know the landing weight of the airplane in order to set up the landing parameters, and to be certain the airplane will be able to land at the intended destination.

In this example of a four-engine turboprop airplane, determine the airplane weight at the end of 4.0 hours of cruise under these conditions:

Takeoff weight .... 140,000 lbs
Pressure altitude during cruise .... 16,000 feet
Ambient temperature during cruise .... -32°C
Fuel burned during descent and landing .... 1,350 lbs

Determine the weight at the end of cruise by using the Gross Weight Table of Figure 6-4 and following these steps:

1. Use the U.S. Standard Atmosphere Table in Figure 6-5 to determine the standard temperature for 16,000. This is -16.7°C.
2. The ambient temperature is -32°C, which is a deviation from standard of 15.3°C. (-32° – -16.7° = 15.3°). It is below standard.
3. In Figure 6-4, follow the vertical line representing 140,000 pounds gross weight upward until it intersects the diagonal line for 16,000 feet pressure altitude.
4. From this intersection, draw a horizontal line to the left to the temperature deviation index (0°C deviation).
5. Draw a diagonal line parallel to the dashed lines for "Below Standard" from the intersection of the horizontal line and the Temperature Deviation Index.
6. Draw a vertical line upward from the 15.3°C Temperature Deviation From Standard.
7. Draw a horizontal line to the left from the intersection of the "Below Standard" diagonal and the 15.3°C temperature deviation vertical line. This line crosses the "Fuel Flow—100 Pounds per Hour per Engine" index at 11.35. This indicates that each of the four engines burns 1,135 (100? 11.35) pounds of fuel per hour. The total fuel burn for the 4-hour cruise is:

$$\text{Total fuel burn} = \text{Lb/hr/engine} \times \text{No. engines} \times \text{Hours flight duration}$$
$$= 1{,}135 \times 4 \times 4$$
$$= 18{,}160 \text{ pounds}$$

8. The airplane gross weight was 140,000 pounds at takeoff, and since 18,160 pounds of fuel was burned during cruise and 1,350 pounds was burned during the approach and landing phase, the landing weight is:

   140,000 – (18,160 + 1,350) = 120,490 pounds

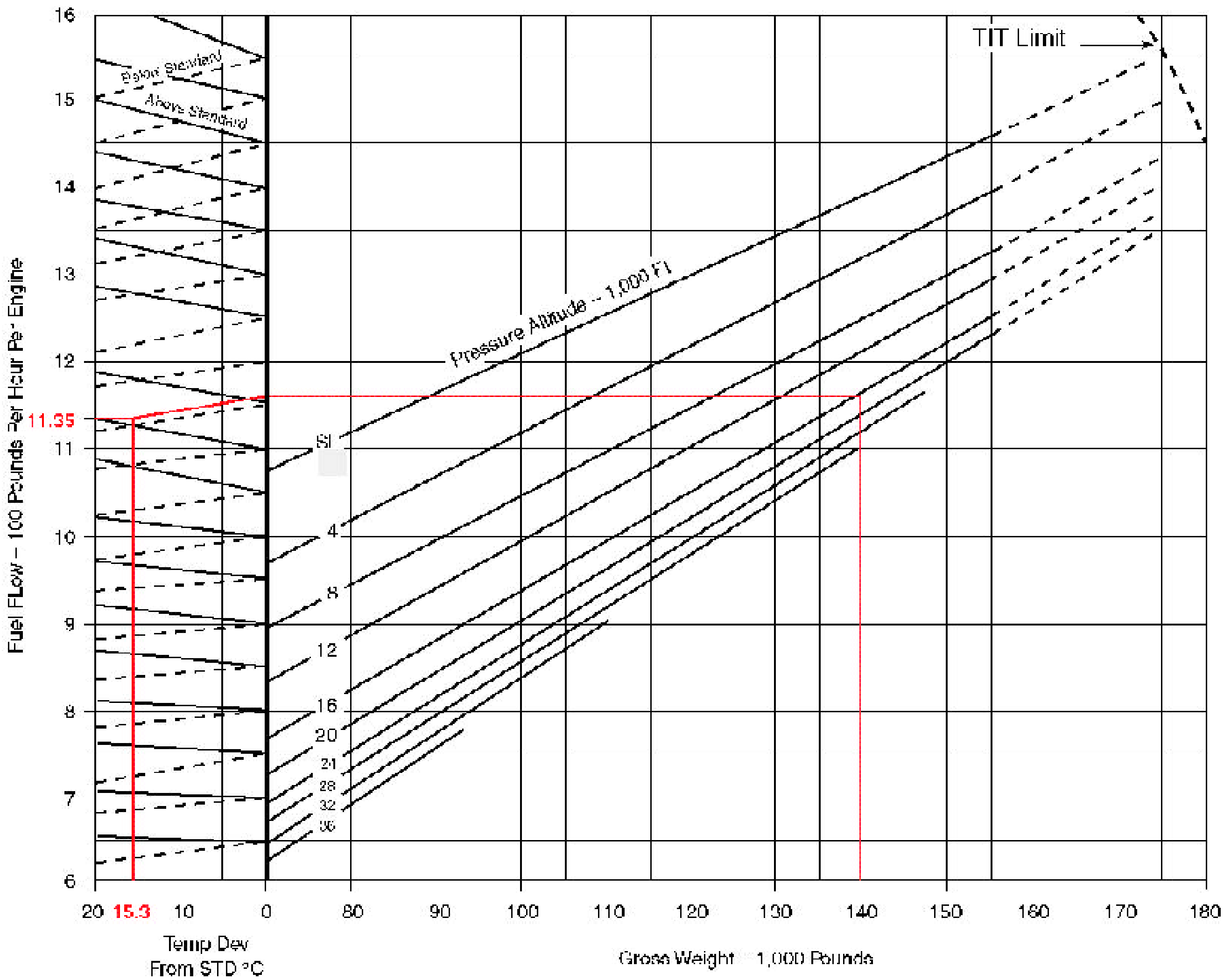


Figure 6-4. *Gross weight table.*

TABLE OF U.S. STANDARD ATMOSPHERE

Feet	inHg	mmHg	PSI	°C	°F
0	29.92	760.0	14.70	15.0	59.0
2,000	27.82	706.7	13.66	11.0	51.9
4,000	25.84	656.3	12.69	7.1	44.7
6,000	23.98	609.1	11.78	3.1	37.6
8,000	22.23	564.6	10.92	-0.8	30.5
10,000	20.58	522.7	10.11	-4.8	23.3
12,000	19.03	483.4	9.35	-8.8	16.2
14,000	17.58	446.5	8.63	-12.7	9.1
16,000	16.22	412.0	7.96	-16.7	1.9
18,000	14.95	379.7	7.34	-20.7	-5.2
20,000	13.76	349.5	6.75	-24.6	-12.3
22,000	12.65	321.3	6.21	-28.6	-19.5
24,000	11.61	294.9	5.70	-32.5	-26.6
26,000	10.64	270.3	5.22	-36.5	-33.7
28,000	9.74	237.4	4.78	-40.5	-40.9
30,000	8.90	226.1	4.37	-44.4	-48.0
32,000	8.12	206.3	3.98	-48.4	-55.1
34,000	7.40	188.0	3.63	-52.4	-62.3
36,000	6.73	171.0	3.30	-56.3	-69.4
38,000	6.12	155.5	2.99	-56.5	-69.7
40,000	5.56	141.2	2.72	-56.5	-69.7
42,000	5.05	128.3	2.47	-56.5	-69.7
44,000	4.59	116.6	2.24	-56.5	-69.7
46,000	4.17	105.9	2.04	-56.5	-69.7
48,000	3.79	96.3	1.85	-56.5	-69.7
50,000	3.44	87.4	1.68	-56.5	-69.7
55,000	2.71	68.6	1.32	TEMPERATURE REMAINS CONSTANT	
60,000	2.14	54.4	1.04		

inHg – Inches of Mercury °C – Centigrade

mmHg = Millimeter of Mercury °F = Fahrenheit

PSI = Pounds per square inch

Figure 6-5. *Standard atmosphere table.*

Determining the Minutes of Fuel Dump Time

Most large aircraft are approved for a greater weight for takeoff than for landing, and to make it possible for them to return to landing soon after takeoff, a **fuel jettison system** is sometimes installed.

It is important in an emergency situation that the flight crew be able to dump enough fuel to lower the weight to its allowed landing weight. This is done by timing the dumping process.

In this example, the aircraft has three engines operating and these specifications apply:

Cruise weight .... 171,000 lbs
Maximum landing weight .... 142,500 lbs
Time from start of dump to landing .... 19 minutes
Average fuel flow
 during dumping and descent .... 3,170 lb/hr/eng
Fuel dump rate .... 2,300 pounds per minute

Follow these steps to determine the number of minutes of fuel dump time:

1. Determine the amount the weight of the aircraft must be reduced to reach the maximum allowable landing weight:

171,000	lbs cruise weight
– 142,500	lbs maximum landing weight
28,500	lbs required reduction

2. Determine the amount of fuel burned from the beginning of the dump to touchdown:

$$\text{Fuel flow} = \frac{3{,}170\ \text{lb/hr/engine}}{60}$$
$$= 52.83\ \text{lb/min engine}$$

For all three engines, this is 52.83° 3 = 158.5 lbs/min.

The three engines will burn 158.5° 19 = 3,011.5 pounds of fuel between the beginning of dumping and touchdown.

Fuel jettison system: A fuel subsystem that allows the dumping of fuel in an emergency to lower the weight of an aircraft to the maximum landing weight. This system must allow enough fuel to be jettisoned that the aircraft can still meet the climb requirements in 14 CFR Part 25.

3. Determine the amount of fuel needed to dump by subtracting the amount of fuel burned during the dumping from the required weight reduction:

28,500.0	lbs required weight reduction
–3,011.5	lbs fuel burned after start of dumping
25,488.5	lbs fuel to be dumped

4. Determine the time needed to dump this amount of fuel by dividing the number of pounds of fuel to dump by the dump rate:

$$\frac{25{,}488.5 \text{ lbs}}{2{,}300 \text{ lb/min}} = 11.08 \text{ minutes}$$

Weight and Balance of Commuter Category Airplanes

The Beech 1900 is a typical commuter category airplane that can be configured to carry passengers or cargo. Figure 6-6 shows the loading data of this type of airplane in the passenger configuration, and Figure 6-14 on Page 6-18 shows the cargo configuration.

Jet Fuel Weight Affected by Temperature

The colder the fuel, the more dense and therefore the more pounds of fuel per gallon.

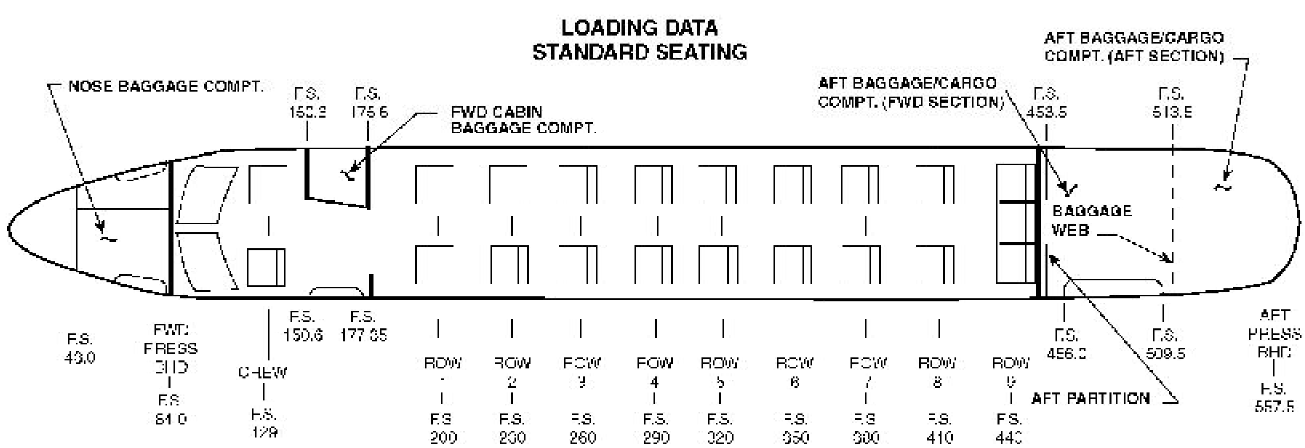
Determining the Loaded Weight and CG

As this airplane is prepared for flight, a manifest like the one in Figure 6-7 is prepared.

1. The crew weight and the weight of each passenger is entered into the manifest, and the moment/100 for each occupant is determined by multiplying the weight by the arm and dividing by 100. This data is available in the AFM and is shown in the Weight and Moments—Occupants table in Figure 6-8 on Page 6-14.
2. The weight of the baggage in each compartment that is used is entered with its moment/100. This is determined in the Weights and Moments—Baggage table in Figure 6-9 on Page 6-14.
3. Determine the weight of the fuel. Jet A fuel has a nominal specific gravity at +15°C of 0.812 and weighs 6.8 pounds per gallon, but at +25°C, according to the chart in Figure 6-10 on Page 6-15, it weighs 6.75 lbs/gal.

   Using Figure 6-11 on Page 6-16, determine the weights and moment/100 for 390 gallons of Jet A fuel by interpolating between those for 6.7 lbs/gal and 6.8 lbs/gal. The 390 gallons of fuel at this temperature weighs 2,633 pounds, and its moment index is 7,866 lb-in/100.

(Continued on Page 6-17)



BAGGAGE/CARGO LOCATION	CAPACITY—POUNDS	CENTROID (FUSELAGE STATION)
NOSE BAGGAGE COMPARTMENT	150	65.5
FORWARD CABIN BAGGAGE COMPARTMENT (INCLUDES UP TO 100 POUNDS WHICH MAY BE SUSPENDED FROM CLOTHES ROD)	250	163.3
AFT BAGGAGE/CARGO COMPARTMENT – FWD SECTION	880	483.5
AFT SECTION	630	533.0

NOTE:

1. For compartment loadings which result in only partial utilization of total compartment volume, load items must be distributed or secured in a manner to preclude shifting under normally anticipated operating conditions.

Figure 6-6. *Loading data for passenger configuration.*

Item	Weight	Arm	Moment/100	CG
Airplane basic EW	9,226		25,823	
Crew	340	129	439	
Passengers				
Row 1	300	200	600	
Row 2	250	230	575	
Row 3	190	260	494	
Row 4	170	290	493	
Row 5	190	320	608	
Row 6	340	350	1,190	
Row 7	190	380	722	
Row 8		410		
Row 9		440		
Baggage				
Nose		65.5		
Fwd Cabin	100	163.6	164	
Aft (Fwd Section)	200	483.5	967	
Aft (Aft Section)	600	533.0	3,198	
Fuel Jet A @ +25°C				
Gallons 390	2,633		7,866	
	14,729		43,139	292.9

Figure 6-7. *Determining the loaded weight and CG of a Beech 1900 in the passenger configuration.*

USEFUL LOAD WEIGHTS AND MOMENTS
OCCUPANTS

	CREW		CABIN SEATS							
WEIGHT	F.S. 129	F.S. 200	F.S. 230	F.S. 260	F.S. 290	F.S. 320	F.S. 350	F.S. 380	F.S. 410	F.S. 440
	MOMENT/100									
80	103	160	184	208	232	256	280	304	328	352
90	116	180	207	234	261	288	315	342	369	396
100	129	200	230	260	290	320	350	380	410	440
110	142	220	253	286	319	352	385	418	451	484
120	155	240	276	312	348	384	420	456	492	528
130	168	260	299	338	377	416	455	494	533	572
140	181	280	322	364	406	448	490	532	574	616
150	194	300	345	390	435	480	525	570	615	660
160	206	320	368	416	464	512	560	608	656	704
170	219	340	391	442	493	544	595	646	697	748
180	232	360	414	468	522	576	630	684	738	792
190	245	380	437	494	551	608	665	722	779	836
200	258	400	460	520	680	640	700	760	820	880
210	271	420	483	546	609	672	735	798	861	924
220	284	440	506	572	638	704	770	836	902	968
230	297	460	529	598	667	736	805	874	943	1012
240	310	480	552	624	696	768	840	912	984	1056
250	323	500	575	650	725	800	875	950	1025	1100

Note: Weights reflected in above table represent weight per seat.

Figure 6-8. *Weights and moments—occupants.*

USEFUL LOAD WEIGHTS AND MOMENTS
BAGGAGE

WEIGHT	NOSE BAGGAGE COMPARTMENT F.S. 65.5	FORWARD CABIN BAGGAGE COMPARTMENT F.S. 163.6	AFT BAGGAGE/ CARGO COMPARTMENT (FORWARD SECTION) F.S. 483.5	AFT BAGGAGE/ CARGO COMPARTMENT (AFT SECTION) F.S. 533.0
	MOMENT/100			
10	7	16	48	53
20	13	33	97	107
30	20	49	145	160
40	26	65	193	213
50	33	82	242	266
60	39	98	290	320
70	46	115	338	373
80	52	131	387	426
90	59	147	435	480
100	66	164	484	533
150	98	245	725	800
200		327	967	1066
250		409	1209	1332
300			1450	1599
350			1692	1866
400			1934	2132
450			2176	2399
500			2418	2665
550			2659	2932
600			2901	3198
630			3046	3358
650			3143	
700			3384	
750			3626	
800			3868	
850			4110	
880			4255	

Figure 6-9. *Weights and moments—baggage.*

DENSITY VARIATION OF AVIATION FUEL

BASED ON AVERAGE SPECIFIC GRAVITY

FUEL	AVERAGE SPECIFIC GRAVITY AT 15°C (59°F)
AVIATION KEROSENE JET A AND JET A1	.812
JET B (JP-4)	.705
AV GAS GRADE 100/130	.703

NOTE: The Fuel Quantity Indicator is calibrated for correct indication when using Aviation Kerosene Jet A and Jet A1. When using other fuels, multiply the indicated fuel quantity in pounds by .99 for Jet B (JP-4) or by .98 for Aviation Gasoline (100/130) to obtain actual fuel quantity in pounds.

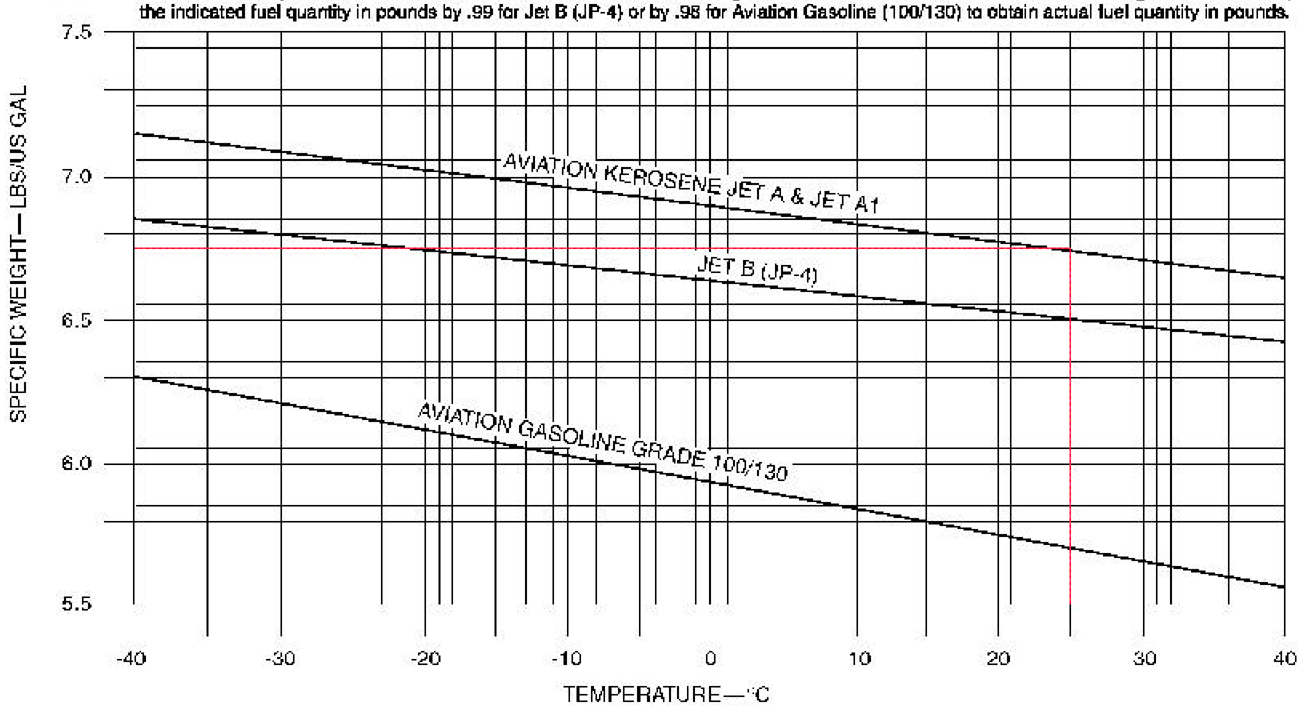


Figure 6-10. *Density variation of aviation fuel.*

USEFUL LOAD WEIGHTS AND MOMENTS
USABLE FUEL

	6.5 LB/GAL		6.6 LB/GAL		6.7 LB/GAL		6.8 LB/GAL	
GALLONS	WEIGHT	MOMENT / 100	WEIGHT	MOMENT / 100	WEIGHT	MOMENT / 100	WEIGHT	MOMENT / 100
10	65	197	66	200	67	203	68	206
20	130	394	132	401	134	407	136	413
30	195	592	198	601	201	610	204	619
40	260	789	264	802	268	814	272	826
50	325	987	330	1002	335	1018	340	1033
60	390	1185	396	1203	402	1222	408	1240
70	455	1383	462	1404	469	1426	476	1447
80	520	1581	528	1605	536	1630	544	1654
90	585	1779	594	1806	603	1834	612	1861
100	650	1977	660	2007	670	2038	680	2068
110	715	2175	726	2208	737	2242	748	2275
120	700	2372	792	2409	804	2445	816	2482
130	845	2589	858	2808	871	2648	884	2687
140	910	2765	924	2808	938	2850	952	2893
150	975	2962	990	3007	1005	3053	1020	3099
160	1040	3157	1056	3205	1072	3254	1086	3303
170	1105	3351	1122	3403	1139	3454	1156	3506
180	1170	3545	1188	3600	1206	3654	1224	3709
190	1295	9799	1254	9797	1279	3854	1292	3912
200	1300	3932	1320	3992	1340	4053	1360	4113
210	1365	4124	1386	4187	1407	4250	1428	4314
220	1430	4315	1452	4382	1474	4448	1496	4514
230	1495	4507	1518	4576	1541	4646	1564	4715
240	1560	4698	1584	4770	1608	4843	1632	4915
250	1625	4889	1650	4964	1675	5040	1700	5115
260	1690	5080	1716	5158	1742	5236	1768	5315
270	1755	5271	1782	5352	1808	5433	1836	5514
280	1820	5462	1848	5548	1876	5630	1904	5714
290	1885	5851	1914	5738	1943	5825	1972	5912
300	1950	5842	1980	5932	2010	6022	2040	6112
310	2015	6032	2046	6125	2077	6218	2108	6311
320	2080	6225	2112	6321	2144	6416	2176	6512
330	2145	6417	2178	6518	2211	6615	2244	6713
340	2210	6610	2244	6711	2278	6813	2312	6915
350	2275	6802	2310	6907	2346	7011	2380	7116
360	2340	6995	2376	7103	2412	7210	2448	7318
370	2405	7186	2442	7299	2479	7409	2516	7520
380	2470	7381	2508	7495	2546	7609	2584	7722
390	2535	7575	2574	7691	2613	7808	2652	7924
400	2600	7768	2640	7888	2680	8007	2720	8127
410	2665	7962	2706	8085	2747	8207	2788	8330
420	2730	8156	2772	8282	2814	8407	2856	8532
425	2763	8253	2805	8388	2848	8513	2800	8640

Figure 6-11. *Weights and moments—usable fuel.*

WEIGHT AND BALANCE DIAGRAM

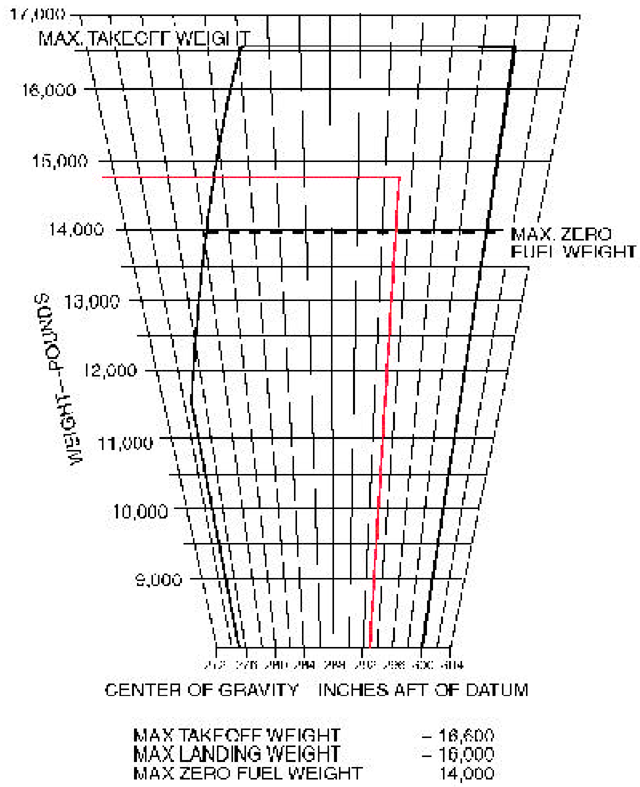


Figure 6-12. *Weight and balance diagram.*

Item	Weight	Arm	Moment/100	CG
Row 1 Row 2	(-) 300 (-) 250	200 230	(-) 600 (-) 575	
Row 8	(+) 300	410	(+) 1,230	
Row 9	(+) 250	440	(+) 1,100	
Original conditions	14,729		43,139	
Changes	0		(+) 1,155	
New conditions	14,729		44,294	300.7

Figure 6-13. *Change in CG caused by shifting passenger seats.*

4. Add all of the weights and all of the moment indexes. Divide the total moment index by the total weight, and multiply this by the reduction factor of 100. The total weight is 14,729 pounds, the total moment index is 43,139 lb-in/100. The CG is located at fuselage station 292.9.
5. Check to determine that the CG is within limits for this weight. Refer to the Weight and Balance Diagram in Figure 6-12 on Page 6-16. Draw a horizontal line across the envelope at 14,729 pounds of weight and a vertical line from the CG of 292.9 inches aft of datum. These lines cross inside the envelope verifying the CG is within limits for this weight.

Determining the Changes in CG When Passengers are Shifted

Consider the airplane above for which the loaded weight and CG have just been determined, and determine the change in CG when the passengers in rows 1 and 2 are moved to rows 8 and 9. Figure 6-13 shows the changes from the conditions shown in Figure 6-7. There is no weight change, but the moment index has been increased by 1,155 pound-inches/100 to 44,294. The new CG is at fuselage station 300.7.

$$CG = \left(\frac{43{,}139 + 1{,}155}{14{,}729}\right) \times 100$$
$$= 300.7$$

This type of problem is usually solved by using these two formulas (below). The total amount of weight shifted is 550 pounds (300 + 250) and both rows of passengers have moved aft by 210 inches (410 – 200 and 440 – 230).

$$\Delta CG = \frac{\text{Weight shifted} \times \text{Distance shifted}}{\text{Total weight}}$$
$$= \frac{550 \times 210}{14{,}729}$$
$$= 7.8 \text{ inches}$$

$$CG = \text{Original CG} + \Delta CG$$
$$= 292.9 + 7.8$$
$$= 300.7 \text{ inches aft of datum}$$

The CG has been shifted aft 7.8 inches and the new CG is at station 300.7.

Determining Changes in Weight and CG When the Airplane is Operated in its Cargo Configuration

Consider the airplane configuration shown in Figure 6-14.

The airplane is loaded as recorded in the table in Figure 6-15. The basic operating weight (BOW) includes the pilots and their baggage so there is no separate item for them.

The arm of each cargo section is the centroid of that section, as is shown in Figure 6-14.

The fuel, at the standard temperature of 15°C weighs 6.8 pounds per gallon. Refer to the Weights and Moments—Usable Fuel in Figure 6-11 on Page 6-16 to determine the weight and moment index of 370 gallons of Jet A fuel.

The CG under these loading conditions is located at station 296.2.

Determining the CG Shift When Cargo is Moved From One Section to Another

When cargo is shifted from one section to another, use this formula:

$$\Delta CG = \frac{\text{Weight shifted} \times \text{Distance shifted}}{\text{Total weight}}$$

If the cargo is moved forward, the ? CG is subtracted from the original CG. If it is shifted aft, add the ? CG to the original.

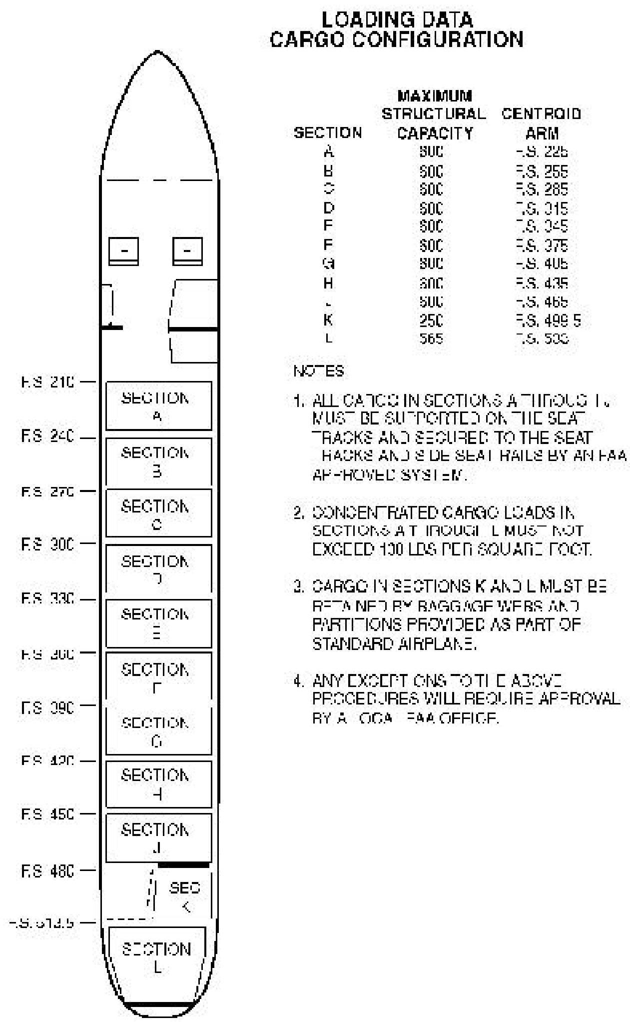


Figure 6-14. *Loading data for cargo configuration.*

Item	Weight	Arm	Moment/100	CG
BOW	9,005		25,934	
Cargo Section A	300	225	675	
Cargo Section B	400	255	1,020	
Cargo Section C	450	285	1,283	
Cargo Section D	600	315	1,890	
Cargo Section E	600	345	2,070	
Cargo Section F	600	375	2,250	
Cargo Section G	200	405	810	
Cargo Section H		435		
Cargo Section J		465		
Cargo Section K		499.5		
Cargo Section L		533		
Fuel Jet A @ +15°C				
Gallons 370	2,516		7,520	
	14,671		43,452	296.2

Figure 6-15. *Flight manifest of a Beech 1900 in the cargo configuration.*

Determining the CG Shift When Cargo is Added or Removed

When cargo is added or removed, add or subtract the weight and moment index of the affected cargo to the original loading chart. Determine the new CG by dividing the new moment index by the new total weight, and multiply this by the reduction factor.

$$CG = \frac{\text{Total moment index}}{\text{Total weight}} \times \text{Reduction factor}$$

Determining Which Limits are Exceeded

When preparing an aircraft for flight, you must consider all parameters and check to determine that no limit has been exceeded.

Consider the parameters below, and determine which limit, if any, has been exceeded.

- The airplane in this example has a basic empty weight of 9,005 pounds and a moment index of 25,934 pound-inches/100.
- The crew weight is 340 pounds, and its moment/100 is 439.
- The passengers and baggage have a weight of 3,950 pounds and a moment/100 of 13,221.
- The fuel is computed at 6.8 lbs/gal:
  The ramp load is 340 gallons, or 2,312 pounds.
  Fuel used for start and taxi is 20 gallons, or 136 pounds.
  Fuel remaining at landing is 100 gallons, or 680 pounds.
- Maximum takeoff weight is 16,600 pounds.
- Maximum zero fuel weight is 14,000 pounds.
- Maximum landing weight is 16,000 pounds.

Take these steps to determine which limit, if any, is exceeded:

1. Determine the zero fuel weight, which is the weight of the aircraft with all of the useful load except the fuel on board.

Item	Weight	Moment/100	CG
Basic empty weight	9,005	25,934	
Crew	340	439	
PAX & Baggage	3,950	13,221	
Zero fuel weight	13,295	39,594	

The zero fuel weight of 13,295 pounds is less than the maximum of 14,000 pounds, so this parameter is acceptable.

2. Determine the takeoff weight and CG. The takeoff weight is the zero fuel weight plus the ramp load of fuel, less the fuel used for start and taxi. The takeoff CG is the (moment/100 ÷ weight)°?100.

Item	Weight	Moment/100	CG
Zero fuel weight	13,295	39,594	
Takeoff fuel 320 gal Ramp load – fuel			
for start & taxi 340 – 20 = 320 gal	2,176	6,512	
Takeoff weight	15,471	46,106	298.0

The takeoff weight of 15,471 pounds is below the maximum takeoff weight of 16,600 pounds, and a check of Figure 6-12 on Page 6-16 shows that the CG at station 298.0 is also within limits.

3. Determine the landing weight and CG. This is the zero fuel weight plus the weight of fuel at landing.

Item	Weight	Moment/100	CG
Zero fuel weight	13,295	39,594	
Fuel at landing 100 gal	680	1,977	
Landing weight	13,975	41,571	297.5

The landing weight of 13,975 pounds is less than the maximum landing weight, of 14,000 pounds. According to Figure 6-12, the landing CG at station 297.5 is also within limits.