CHAPTER 08

LEVELING AND WEIGHING
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Section 08-00 General

This chapter includes the information necessary to properly level the aircraft for any of the various maintenance, overhaul or major repairs which may be necessary during the life of the aircraft.

The information in this chapter comes from Liberty Aerospace, Inc. document number 135A-995-254 (currently revision A). Use the most current revision of this document as the definitive source for information when weighing and leveling the airplane and calculating the center of gravity.

It also includes those units or components that are specifically dedicated to record, store or compute weight and balance data.

The chapter includes the practices necessary to prepare the aircraft for weighing, leveling, and calculating the center of gravity. The information from this chapter needs to match the information in the Airplane Flight Manual for each airplane.

Section 00-01 Weight and Balance and the Calculation for the Center of Gravity

The result of the weight and balance calculation is a critical piece of information and needs to be very accurate for the safe operation of the airplane. The result of the weight and balance calculation is the location of the center of gravity of the airplane, or the point at which an aircraft would balance if it were possible to suspend it at that point.

The procedures that are in Section 08-10 - Weighing and Balancing Procedures on page 7 of this chapter will provide the data that goes into the following tables.

Certain information is needed to find the center of gravity (CG or CoG) of the airplane. This is the total weight of the airplane and the moment (in in-lbs). The airplane needs weighing on three scales (adding the weights) and calculating the individual moments.

The example shown here uses data from an actual XL-2 airplane. Use this information with the data derived from the procedures to calculate the CG of a specific serial number airplane.

Table 08-1 shows the weights taken from the three scales used to weigh the airplane. This data is from the Airplane Weighing procedure on page 12 of this chapter. From these weights, it is required to subtract any items used to level the airplane (such as shims, chocks, etc.). This will give you the empty weight at each point and the total of these gives you the total empty weight of the airplane.
### Data Point (lbs)

<table>
<thead>
<tr>
<th>Location of Weight</th>
<th>Scale Reading</th>
<th>Weight of non-airplane items</th>
<th>Net Weight (Wn, Wp, Ws)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nose Wheel (N)</td>
<td>305</td>
<td>15</td>
<td>290</td>
</tr>
<tr>
<td>Port Main Wheel (P)</td>
<td>457</td>
<td>22</td>
<td>435</td>
</tr>
<tr>
<td>Starboard Main Wheel (S)</td>
<td>455</td>
<td>18</td>
<td>437</td>
</tr>
<tr>
<td>Total Weight (Wn)</td>
<td></td>
<td></td>
<td>1162</td>
</tr>
</tbody>
</table>

### Table 08-1 Table Showing the Calculations for the Empty Weight of the Airplane

Table 08-2 shows the weight data from Table 08-1, the station point for a given weight, and the calculation of the moment. The moment is the weight (lbs) times the station number (in). The station points are from the Moment Arm Determination procedure on page 10 of this chapter.

The data entered into the table is calculated based on the reference station data point of 48.1. Therefore, the station number (Moment Arm) for the nose wheel (9.935 inches forward of station 48.1) is 38.2 inches (Station Reference – Distance forward of the Reference). The station for the port and starboard main wheels is aft of station 48.1, therefore, the station number (47.973 inches aft of station 48.1) is 96.1 (Station Reference + Distance aft of the Reference).

<table>
<thead>
<tr>
<th>Data Point</th>
<th>Weight (lbs) (Wn, Wp, Ws)</th>
<th>Station (in)</th>
<th>Moment (in-lbs) (Mn, Mp, Ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nose Wheel (N)</td>
<td>290</td>
<td>38.2</td>
<td>11078.0</td>
</tr>
<tr>
<td>Port Main Wheel (P)</td>
<td>435</td>
<td>96.1</td>
<td>41803.5</td>
</tr>
<tr>
<td>Starboard Main Wheel (S)</td>
<td>437</td>
<td>96.1</td>
<td>41995.7</td>
</tr>
<tr>
<td>Total Weight (Wn)</td>
<td>1162</td>
<td></td>
<td>94877.2</td>
</tr>
</tbody>
</table>

### Table 08-2 Table Showing the Calculations for the Empty Weight of the Airplane

The calculation of the center of gravity or CG is the division of the Total Moment (Me) by the total Weight (We). In this case, the CG is located at Station 81.6 or 33.5 inches aft of the Station Reference (Station 48.1).
Section 08-10 Weighing and Balancing Procedures

The following procedures are given to determine the aircraft’s weight and balance. Weighing and balancing of the airplane is done in four procedures, Empty Weight and Preparation, Leveling, Determining the Moment Arm, and Weighing.

Section 10-01 Equipment Required

The following is a list of required equipment to perform the procedures in this chapter.

- Aircraft Scales
- Level – Spirit type 4 to 5 feet long
- Levels - Digital Torpedo type
- Aileron yoke blocks – P/N 135A-02-511 (requires two blocks)
- Plumb bob with string
- Measuring Tape
- Metal yard stick
- Carpenter’s combination square

**NOTE**

The Aileron yoke blocks, P/N 135A-02-511, are available from Liberty Aerospace, Inc. Customer Service only.
EMPTY WEIGHT AND PREPARATION

The aircraft must be brought to its “empty” status to obtain the aircraft empty weight. This is accomplished as follows:

1. Verify equipment installation is in accordance with aircraft equipment records.
2. Run engine to ‘wet’ fuel system.
3. Open fuel tank sump drain fitting and fuel gascolator drain valve to flush system of all fuel. Close drains and add 1.5 gallons of 100 LL Avgas to represent unusable fuel.
4. Service engine oil to maximum mark on the dip stick.
5. Service the hydraulic brake fluid to top of clamp holding brake reservoir.
6. Inflate tires (3) to recommended operating pressures (50 -0/+2 psi) and align nose wheel with aircraft centerline.
7. Place all control surfaces in neutral position, with flaps fully retracted (0°).
9. Check the fire extinguisher is current and full and mounted in its carrier.
10. Check for the safety hammer and micro-fine cleaning cloth are in their proper place and secure.
11. Place all seat belts and shoulder straps within seat base.
12. Check that all interior cushions and carpets are installed. Check foot wells, seats, baggage bay, carpets and cushions are clean, and in good condition.
13. Install and secure all cowls (3) (upper engine cowl, lower engine cowl, and belly panel) and all access panels (8).
14. Rotate propeller until it is parallel to horizontal and close doors.

This completes the Empty Weight and Preparation procedure.
LEVELING

Perform this procedure to level the airplane in preparation for weighing the airplane.

1. Perform Longitudinal Leveling procedure (on Page 14) or Alternate Method of Longitudinal Leveling (on Page 15) procedure of this chapter.

2. Perform Lateral Leveling procedure (Page 16) of this chapter.
MOMENT ARM DETERMINATION

To calculate the center of gravity (CG) location with respect to the reference datum, one must calculate each wheel moment with respect to the reference datum. To calculate the moment, the weight and the arm is needed. The weights are provided by the scales; the arms are determined as follows;

1. Check the nose wheel that it is aligned with aircraft centerline.
2. Level the airplane per the Leveling procedure on page 9 of this chapter.
3. Drop a plumb bob from both port and starboard lower engine frame pickups. Draw reference line between these points on floor. This trace marks station 48.1 (STA 48.1). Use this reference to measure wheel locations.

4. Measure distance between each side of nose wheel axle and STA 48.1.
5. Average the measurements from step 4. Enter the number in to the cell for the nose wheel station in a table similar to Table 08-2

\[
\frac{\text{Measurement 1} + \text{Measurement 2}}{2} = \text{Average}
\]

Figure 08-1 Plumb Bob Dropped at Reference Location (STA 48.1)

Measure from each side of nose wheel axle and average the measurements.
6. Mark floor at inside face of each main gear leg to represent port and starboard main wheels axle.

7. Measure distance between port and starboard main wheels axle and mark representing STA 48.1. Enter the number in to the cell for the port and starboard main wheel station in a table similar to Table 08-2.

Figure 08-3 Measurement of Distance Between STA 48.1 and Main Gear Axles

This completes the Moment Arm Determination procedure.
AIRPLANE WEIGHING

Perform this procedure to weigh the airplane.

NOTE

Perform the weighing of the airplane indoors, in a location free from air currents.

1. Bring airplane to empty condition per Empty Weight and Preparation procedure on page 8 of this chapter.
2. Level aircraft on scales see Section 08-20 - Leveling on page 13 of this chapter.
3. Roll aircraft off scales.
4. Zero all scales. After all scales read zero, roll aircraft back onto scales. Check that wheels are centered on scales and apply parking brake.
5. Align nose wheel tire with aircraft centerline and verify aircraft is level.
6. Enter the weights indicated by all scales in to the cells of Table 08-1 for the Nose Weight, Port Wheel Weight, and the Starboard Wheel Weight.
7. Roll aircraft off scales.
8. Weigh the shims, wheel chocks or other items used to weigh the airplane but are not part of the airplane and were associated with the scale. Enter these weights in to the appropriate cells of Table 08-1.
9. Subtract this weights entered in to Table 08-1 from step 8 from the numbers entered in step 6.
10. Transfer these numbers from Table 08-1 in to the appropriate cells in Table 08-2

This completes the Airplane Weighing procedure.
Section 08-20 Leveling

Leveling of the aircraft for the weight and balance determination must be conducted on aircraft scales.

The port and starboard doorsills are to be used as a longitudinal support for the spirit level or digital protractor.
LONGITUDINAL LEVELING

1. Place spirit level or digital protractor on top of port or starboard doorsill.

2. Shim under tires to achieve longitudinal level.

3. Repeat on opposite side of aircraft to confirm level has been achieved.

This completes the Longitudinal Leveling procedure.

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Figure 08-4 Port Doorsill

- Place spirit level or digital protractor on top of port or starboard doorsill.

Figure 08-5 Doorsills Used in Longitudinal Leveling

- Shim under tires to achieve longitudinal level.
- Repeat on opposite side of aircraft to confirm level has been achieved.

This completes the Longitudinal Leveling procedure.
ALTERNATE METHOD OF LONGITUDINAL LEVELING

This alternate method of longitudinal leveling is presented as a matter of being possibly more convenient than the previous method. Both methods are equally acceptable.

1. Place spirit level lengthwise along aircraft centerline on flat area between two seat backs.
2. Shim under tires to achieve longitudinal level.

Figure 08-6 Alternate Method of Longitudinal Leveling
LATERAL LEVELING

Perform this procedure to do the lateral leveling of the airplane.

**NOTE**

*To determine that level is placed correctly, place the level such that equal distance exists between forward end of doorsill and end of level.*

1. Refer to Figure 08-7. Place a 4-ft length (minimum) beam level at approximately center of the door opening 19 to 20 inches from forward edge of door.

**NOTE**

*Remove a portion of the door seal from the lower edge of the door opening*

*Place the beam level perpendicular to the aircraft’s centerline.*

*Liberty Aerospace, Inc. recommends the use of aileron yoke blocks, P/N 135A-02-511, placed on the doorsill to support the beam level. The doorsill is a better surface for checking the lateral level of the airplane*

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**Figure 08-7 Aircraft Laterally Leveled (Aileron Yoke Blocks Are Not Shown)**

2. Shim under main gear tires to achieve lateral level.

3. After leveling is achieved, remove level. Do not disturb balance.

4. Roll aircraft off scales and shims.

5. If aircraft is to be weighed, weigh shims so their weight may be subtracted from the overall weight obtained.

This completes the Lateral Leveling procedure.