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**AUS OPERATIONS, FLIGHT PLANNING AND  
PERFORMANCE**

**CHAPTER 8  
ECHO WEIGHT AND BALANCE LOAD SHEET**

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## ECHO - THE WEIGHT AND BALANCE SHEET

Before flying, a weight and balance sheet must be prepared.

### Example

Prepare a Load and Trim Sheet for the Echo Mark IV to ensure that the aircraft is safe for flight. An ECHO Mk IV aircraft has a Basic Empty Weight of 1980kg and a Basic Empty Index of 490 IU.

The aircraft is loaded on the ramp as follows:

<b>Row 1</b>	Pilot + 1 pax.
<b>Row 2</b>	2 pax.
<b>Row 3</b>	20kg luggage
<b>FWD Compartment</b>	20kg cargo.
<b>Left wing compartment</b>	20kg spare.
<b>AFT compartment</b>	90kg cargo.
<b>Main Tanks</b>	Full
<b>Aux Tanks</b>	23 US Gal each.
<b>Est. FBO</b>	60 US Gal.

### WEIGHT CALCULATION

The weight calculation for fuel management is as follows:

Main tanks full with 50 US gallons usable each	100 US gallons
Less start and taxi	3 US gallons
Usable fuel in the mains at take off 97 galls @ 2.687 kg / US gallon = 260.64 kg	97 gallons <b>260.64 kg</b>
Auxiliary tanks with 23 gallons each	46 US gallons
Less unusable fuel	- 6 US gallons
Usable fuel at take off in auxiliary tanks 40 US gallons @ 2.687 kg / US gallon = 107.48 kg	40 US gallons <b>107.48 kg</b>
Weight of FOB at take off	368.12 kg
Weight of fuel in mains at landing	368.12 - (60 x 2.687) kg <b>206.9 kg</b>

## PROCEDURE

- Prepare the load sheet showing the weights placed into the various stations. The manual lists the arms needed to calculate the moments.

Location	Maximum Permissible Load	Loading Arm (mm aft of datum)
Seating:		
Row 1 (Seats 1 & 2)	Pilot & 1 pass.	2290
Row 2 (Seats 3 & 4)	2 pass.	3300
Row 3 (Seats 5 & 6)	2 pass.	4300
Cargo & Baggage Compartments:		
Forward compartment	55 Kg	500
Left wing compartment	55 Kg	3550
Right wing compartment	55 Kg	3550
rear compartment	155 Kg	5000
Floor loading intensity (all compartments)	450 Kg/m <sup>2</sup>	
Fuel:		
Left main tank	50 gal	1780
Right main tank	50 gal	1780
left auxiliary tank	40 gal	2800
Right auxiliary tank	40 gal	2800

- Add all weights without any fuel to find the ZERO FUEL WEIGHT (ZFW) and add all moments to find the ZFW MOMENT.
- Divide the ZFW MOMENT by the ZFW to get the ZFW C of G in mm aft of the datum.
- Add the fuel on board at take-off, extract the arms of the tanks from the manual and find the moments for the fuel.
- Add the weight of the fuel on board to the ZFW and obtain the TAKE-OFF WEIGHT. Add the fuel moments to the ZFW moment to obtain the take-off moment.
- Divide the take off moment by the take off weight to get the take off C of G position in mm aft of the datum.
- Subtract from the take-off weight the fuel burn off from the various tanks to get the LANDING WEIGHT. Subtract the moments the FBO gives us from the take off moment to get the landing moment. Identify the C of G position in mm aft of the datum for landing by dividing the landing moment by the landing weight.

## THE LOAD AND TRIM SHEET

ITEM	WEIGHT (kg)	ARM (mm)	INDEX UNITS
Basic	1,980		490.0
Row 1	154	2,290	35.3
Row 2	154	3,300	50.8
Row 3	20	4,300	8.6
FWD	20	500	1.0
AFT	90	5,000	45.0
WING	20	3,550	7.1
<b>ZFW</b>	<b>2,438</b>	<b>C of G = 2,616.02</b>	<b>637.8</b>
Main	261.00	1,780	46.5
Aux	107.60	2,550.54	30.1
<b>Take-off</b>	<b>2,806.60</b>	<b>C of G = 2,545.32</b>	<b>714.4</b>
<b>FBO</b>	-	-	-
Aux	-107.60	2800	-30.1
Main	-53.8	1780	-9.6
<b>Landing</b>	<b>2,645.20</b>	<b>C of G = 2,550.46</b>	<b>674.7</b>

### Now check

- The C of G is within the C of G limits at the ZFW.
- Check that the C of G is within limits at take off weight.
- Calculate the C of G FWD limit at the take off weight 2,806.66kg.

$$\begin{aligned}
 \text{FWD Limit} &= 2,400 + (2,806.66 - 2,360) \times .271 \\
 &= 2,400 + 121.04 \\
 &= 2521.04 \text{ mm}
 \end{aligned}$$

#### Note:

The C of G at take off is close to but within the FWD limit.

The take off C of G is further AFT than the FWD limit 2521.03mm. Therefore take off is permissible.

The landing C of G is between the ZFW C of G and the take off C of G position.

The C of G position is acceptable for ZFW, take off weight and landing weight.

### Accident report - December 25<sup>th</sup> 2003

At 1459 local time, a Boeing 727-200 operated by Union des Transports Africains (UTA) took off in Visual Meteorological Conditions from Cotonou (Benin) Airport. Shortly after becoming airborne, it struck a 2.45m high concrete building before descending onto a beach and coming to rest in the sea. Approximately five crew members and 136 passengers were killed. 5 other crew members, 18 passengers and a technician who was working inside the building received serious injuries. The aircraft was totally destroyed.

The captain had more than 11,000 flying hours, including 5,000 flying hours in command on the B-727-200 .

Following the accident, investigators calculated the aircraft's takeoff weight and found it to be greater by several tons than the maximum acceptable *under the conditions of the day of the accident*.

Performance calculations indicated that the aircraft's C of G was at 14% MAC, a forward balance that *would have made rotation on takeoff very slow and difficult*. UTA was unable to produce (for investigators) any documentation relating to weight and balance calculations for the doomed flight.

Article from of Flight Safety Foundation – 'Accident Prevention' publication – October 2005.