

Initial Sizing

Weight of Crew = 180 lbs = 81.6466 kgs

Weight of passengers and baggage = 1000 lbs = 453.5924 kgs

Empty weight fraction is calculated as:

$$W_e/W_0 = A W_0^C K_{vs}$$

Where A = 2.36, C = -0.18 for a GA single engine aircraft

The maximum take-off weight is calculated as:

$$W_0 = \frac{W_{crew} + W_{payload}}{1 - (W_f/W_0) - (W_e/W_0)}$$

Calculation of fuel weight fraction:

- 1) From historical data, the following fuel weight fractions are considered for the given phases:

Phase	W_i/W_{i-1}
Warmup and take-off	0.97
Climb	0.985
Landing	0.995

- 2) Calculation of cruise weight fraction:

Required target cruise range = 300 nmi = 555.6km = 1822834.646 ft

$(L/D)_{\max} = 17.237$

Cruise velocity (maximum) = 250 knots = 128.611 m/s = 421.952 ft/s

Specific fuel consumption, C = 0.7

From the Breguet Range Equation,

$$\frac{W_i}{W_{i-1}} = \exp \frac{-RC}{V (L/D)}$$

Which gives the cruise weight fraction as 0.952436

3) Calculation of loiter weight fraction:

The loiter weight fraction is calculated using the Breguet Endurance equation,

$$\frac{W_i}{W_{i-1}} = \exp\left(\frac{-EC}{L/D}\right)$$

Where,

Loiter time, E = 45 min = 2700s

C = 0.6

L/D = 17.237 x 0.866

This gives loiter weight fraction as 0.970304

4) Calculation of total fuel fraction including reserve:

Mission fuel fraction, at the end of landing:

$$\frac{W_5}{W_0} = 0.87 = 0.985 \times 0.952436 \times 0.970304 \times 0.995 \times 0.97$$

Total fuel fraction:

$$\frac{W_f}{W_0} = 1.06 \left(1 - \frac{W_5}{W_0}\right)$$

Which gives $W_f / W_0 = 0.128719$

Calculation of MTOW:

The MTOW is calculated iteratively using the following equation:

$$W_0 = \frac{W_{crew} + W_{payload}}{1 - \left(W_f / W_0\right) - \left(W_e / W_0\right)}$$

Initial W_0 guess = 4000 lbs

W₀ guess (lbs)	W_e/W₀	W₀ calculated (lbs)
4000	0.530324	3460.8409
3460	0.54435	3609.324
3600	0.540477	3567.0669
3500	0.543225	3596.946863
3580	0.54102	3572.928
3570	0.541292	3575.876

3575	0.541156	3574.4036
3574	0.541183	3574.696

MTOW chosen from the result of the iteration is 3575 lbs = 1621.5928 kgs

Therefore,

Fuel weight fraction, $W_f/W_0 = 0.128719$ leads to a fuel weight of 460.170425 lbs = 208.7298 kgs.

Corresponding empty weight fraction, W_e/W_0 of 0.541156 leads to an empty weight of 1934.6327 lbs = 877.53469 kgs