$W_{crew} := 200\ lbf$ $n_{max} := 7$ $V_{max\_sl\_wo} := 400\ kn$ $\Psi_{itr\_sl} := 30\ \frac{deg}{s}$ $S_{takeoff\_50ft} := 1400\ ft$

$W_{gun} := 2000\ lbf$ $ROC_{sl} := 10000\ \frac{ft}{min}$ $V_{slp} := 375\ kn$ $S_{landing\_50ft} := 1900\ ft$

$W_{ammo} := 2000\ lbf$ $V_{stall\_sl} := 95\ kn$ $M_{cruise} := 0.5$ $AR := 6.5$

$C_{L\_max} := 2.8$

$Swet\_Sref := 2.1$

$AR_{wet} := \frac{AR}{Swet\_Sref} = 3.0952$

$KLD := 14$ $C_{fe} := .0035$

$L\_D_{max} := KLD \cdot \sqrt{AR_{wet}} = 24.6306$ $C_{D0} := C_{fe} \cdot Swet\_Sref = 0.0074$

$e_{Oswald} := \frac{4 \cdot C_{D0} \cdot L\_D_{max}^{2}}{AR \cdot \pi} = 0.8734$ $K := \frac{1}{\pi \cdot AR \cdot e_{Oswald}} = 0.0561$

State: Sea Level

$\rho_{sl} := 23.77 \cdot 10^{-4}\ \frac{slug}{ft^3}$ $a_{sl} := 661\ kn$

$V_{cruise\_sl} := M_{cruise} \cdot a_{sl} = 330.5\ kn$

$M_{max} := \frac{V_{max\_sl\_wo}}{a_{sl}} = 0.6051$

$W\_S_{stall} := \frac{1}{2} \cdot \rho_{sl} \cdot \left( V_{stall\_sl}^{2} \right) \cdot C_{L\_max} = 85.556\ psf$

$V_{corner} := \frac{g_e \cdot \sqrt{n_{max}^{2} - 1}}{\Psi_{itr\_sl}} = 252.2345\ kn$

$q_{itr\_sl} := \frac{1}{2} \cdot \rho_{sl} \cdot V_{cruise\_sl}^{2} = 369.8183\ psf$

$W\_S_{itr\_sl} := \frac{q_{itr\_sl} \cdot C_{L\_max}}{n_{max}} = 147.9273\ \frac{lbf}{ft^2}$

## Landing

$S_{Landing} := 1900\ ft$

$S_a := 450\ ft$

$W\_S_{landing} := \left(S_{Landing} - S_a\right) \cdot \frac{C_{L\_max}}{80\ \frac{ft}{psf}} = 50.75\ psf$

$S_a := 450\ ft$

$W\_S_{takeoff} := \left(S_{takeoff\_50ft} - S_a\right) \cdot \frac{C_{L\_max}}{80\ \frac{ft}{psf}} = 33$

$\alpha := 0.648$

$C := 0.594$

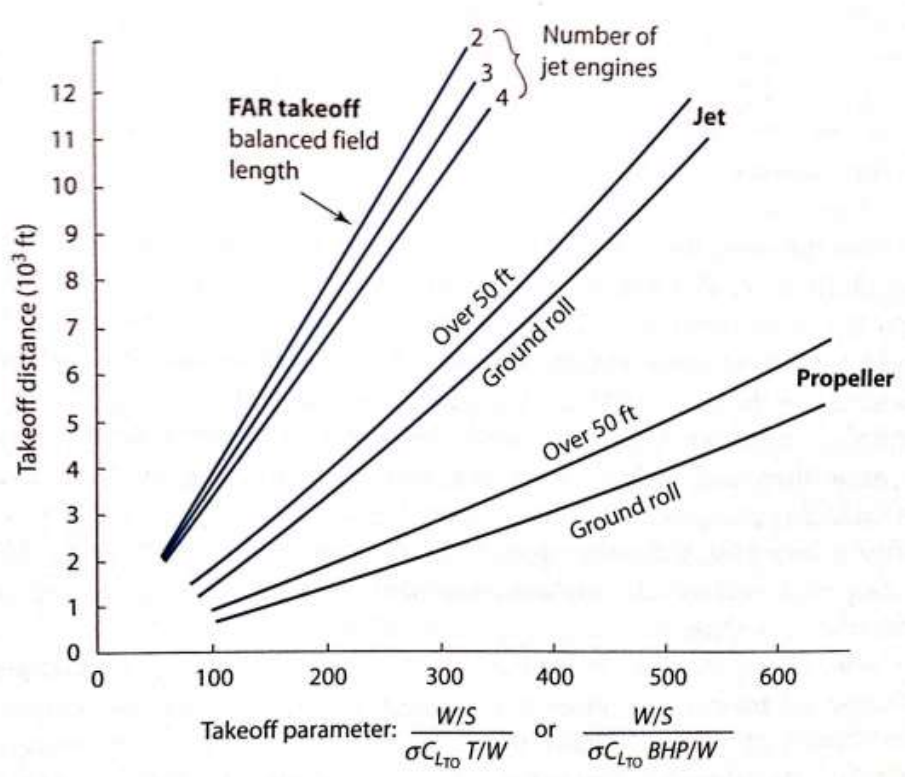
$T\_W_{max} := \alpha \cdot M_{max}^{C} = 0.4808$

$a_{30k} := 589\ kn$

$M_{slp.30k} := \frac{V_{slp}}{a_{30k}} = 0.6367$

$M_{Max} := M_{slp.30k}$

$T\_W_{max} := \alpha \cdot M_{Max}^{C} = 0.4956$




$TOP := 75\ \frac{lbf}{ft^2}$

$C_{LTO} := \frac{C_{L\_max}}{1.21}$

$$W\_S := \min\left(\left[\begin{array}{cccc} W\_S_{landing} & W\_S_{itr\_sl} & W\_S_{stall} \end{array}\right]\right) = 50.75\ \text{psf}$$

$$T\_W_{takeoff} := \frac{W\_S}{C_{LTO} \cdot TOP} = 0.2924$$

$$C_L := \frac{2 \cdot W\_S}{\rho_{sl} \cdot V_{cruise\_sl}^{\,2}} = 0.1372$$

$$C_D := C_{D0} + K \cdot C_L^{\,2} = 0.0084$$

$$L\_D := \frac{C_L}{C_D}$$

$$T\_W_{ROC} := \frac{1}{L\_D} + \frac{ROC_{sl}}{V_{cruise\_sl}} = 0.36$$

$$\rho_{35k} := 8.89 \cdot 10^{-4}\ \frac{\text{slug}}{\text{ft}^3}$$

Service Ceiling

$$a_{35} := 573\ \text{kn}$$

$$V_{cruise\_35} := M_{cruise} \cdot a_{35} = 286.5\ \text{kn}$$

$$C_{L\_35} := \frac{2 \cdot W\_S}{\rho_{35k} \cdot V_{cruise\_35}^{\,2}} = 0.4883$$

$$C_{D\_35} := C_{D0} + K \cdot C_{L\_35} = 0.0347$$

$$L\_D_{35} := \frac{C_{L\_35}}{C_{D\_35}}$$

$$T\_W_{35} := \frac{1}{L\_D_{35}} + \frac{100\ \frac{\text{ft}}{\text{min}}}{V_{cruise\_35}} = 0.0746$$

$$T\_W_{sl\_35} := T\_W_{35} \cdot \frac{\rho_{sl}}{\rho_{35k}} = 0.1994$$

$$T\_W_{ofc} := \max\left(\left[\begin{array}{cccc} T\_W_{sl\_35} & T\_W_{ROC} & T\_W_{takeoff} & T\_W_{max} \end{array}\right]\right) = 0.4956$$

$$W\_S_{ofc} := \min\left(\left[\begin{array}{ccc} W\_S_{itr\_sl} & W\_S_{landing} & W\_S_{stall} \end{array}\right]\right) = 50.75\ \text{psf}$$

$W_{guess} := 39900\ lbf$

$T_{sl} := T\_W_{ofc} \cdot W_{guess} = 19773.0648\ lbf$

$S_{ref} := \frac{W_{guess}}{W\_S_{ofc}} = 786.2069\ ft^2$

Mission:

1. Warmup and Takeoff:

$W_1 := W_{guess} - (10\ min \cdot 10\ \% + 1\ min \cdot 100\ \%) \cdot T_{sl} \cdot 0.75\ \frac{lbf}{lbf\ hr} = 39405.6734\ lbf$

2. Climb

$C_{L\_wg} := \frac{2 \cdot W_1}{\rho_{sl} \cdot V_{cruise\_sl}^2 \cdot S_{ref}} = 0.1355$

$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^2 = 0.0084$

$RC_{sl} := V_{cruise\_sl} \cdot \left( T\_W_{ofc} - \frac{C_{D\_wg}}{C_{L\_wg}} \right) = 143.3495\ kn$

$D_{sl} := \frac{W_1}{\frac{C_{L\_wg}}{C_{D\_wg}}} = 10837.9556\ N$

$\rho_{30k} := 10.97 \cdot 10^{-4}\ \frac{slug}{ft^3}$

$a_{30k} := 589\ kn$

$V_{30k} := M_{cruise} \cdot a_{30k} = 294.5\ kn$

$C_{L\_wg} := \frac{2 \cdot W_1}{\rho_{30k} \cdot V_{30k}^2 \cdot S_{ref}} = 0.3699$

$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^2 = 0.015$

$RC_{30k} := V_{30k} \cdot \left( T\_W_{ofc} \cdot \frac{\rho_{30k}}{\rho_{sl}} - \frac{C_{D\_wg}}{C_{L\_wg}} \right) = 55.3947\ kn$

$a := \frac{RC_{30k} - RC_{sl}}{30000\ ft} = -0.0049\ Hz$

$t_{climb30k} := \frac{1}{a} \cdot \ln\left( \frac{RC_{30k}}{RC_{sl}} \right) = 192.1448\ s$

$D_{30k} := \frac{W_1}{\frac{C_{L\_wg}}{C_{D\_wg}}} = 7118.1692\ N$

$R_{climb30k} := \frac{t_{climb30k}}{2} \cdot \left( V_{cruise\_sl} \cdot \left( \cos\left( \operatorname{asin}\left( \frac{RC_{sl}}{V_{cruise\_sl}} \right) \right) \right) + V_{30k} \cdot \left( \cos\left( \left( \operatorname{asin}\left( \frac{RC_{30k}}{V_{30k}} \right) \right) \right) \right) \right) = 15.6661$

$$W_2 := W_1 - \left(0.6 \frac{\text{lbf}}{\text{lbf hr}}\right) \cdot \left(\frac{D_{sl} + D_{30k}}{2}\right) \cdot t_{climb30k} = 39341.0375 \text{ lbf}$$

3. Cruise Out: $R_{CruiseOut} := 400 \text{ nmi}$

$$C_{L\_wg} := \frac{2 \cdot W_2}{\rho_{30k} \cdot V_{30k}^2 \cdot S_{ref}} = 0.3692$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^2 = 0.015$$

$$W_3 := W_2 \cdot \mathbf{e}^{-\left(\frac{\left(R_{CruiseOut} - R_{climb30k}\right) \cdot 0.48 \frac{\text{lbf}}{\text{lbf hr}}}{V_{30k} \cdot \frac{C_{L\_wg}}{C_{D\_wg}}}\right)} = 38352.9227 \text{ lbf}$$

4.1. Conduct Sea Level Penetration for 50NM at 375 kts.

$$M_{slp.30k} := \frac{V_{slp}}{a_{30k}} = 0.6367 \qquad M_{slp.sl} := \frac{V_{slp}}{a_{sl}} = 0.5673$$

$$M_{Max} := M_{slp.30k}$$

$$T\_W_{max} := \alpha \cdot M_{Max}^C = 0.4956$$

$$C_{L\_wg} := \frac{2 \cdot W_3}{\rho_{30k} \cdot V_{slp}^2 \cdot S_{ref}}$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^2 = 0.0101$$

$$SR_{30k} := V_{slp} \cdot \left(T\_W_{ofc} \cdot \frac{\rho_{30k}}{\rho_{sl}} - \frac{C_{D\_wg}}{C_{L\_wg}}\right) = 68.6823 \text{ kn}$$

$$C_{L\_wg} := \frac{2 \cdot W_3}{\rho_{sl} \cdot V_{slp}^2 \cdot S_{ref}} = 0.1025$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^2 = 0.0079$$

$$D_{30k} := \frac{W_1}{\frac{C_{L\_wg}}{C_{D\_wg}}} = 3053.151\ \text{lbf}$$

$$SR_{sl} := V_{slp} \cdot \left( T\_W_{ofc} - \frac{C_{D\_wg}}{C_{L\_wg}} \right) = 156.7821\ \text{kn}$$

$$a := \frac{SR_{sl} - SR_{30k}}{30000\ \text{ft}} = 0.005\ \text{Hz}$$

$$t_{slp} := \frac{1}{a} \cdot \ln\left( \frac{SR_{sl}}{SR_{30k}} \right) = 166.5212\ \text{s}$$

$$R_{slp} := \frac{t_{slp}}{2} \cdot \left( V_{slp} \cdot \left( \cos\left( \left( \operatorname{asin}\left( \frac{SR_{30k}}{V_{slp}} \right) \right) \right) \right) + V_{slp} \cdot \left( \cos\left( \operatorname{asin}\left( \frac{SR_{sl}}{V_{slp}} \right) \right) \right) \right) = 16.4049\ \text{nmi}$$

$$W_4 := W_3 \cdot \mathbf{e}^{-\left( \frac{(50\ \text{nmi}) \cdot 0.38\ \frac{\text{lbf}}{\text{lbf hr}}}{V_{slp} \cdot \frac{C_{L\_wg}}{C_{D\_wg}}} \right)} = 38202.6575\ \text{lbf}$$

### 4.2. Combat:

$$W_4 := W_4 - (15\ \text{min}) \cdot T_{sl}\ 1\ \frac{\text{lbf}}{\text{lbf hr}} = 33259.3913\ \text{lbf}$$

### 5. Fire All:

$$W_5 := W_4 - W_{ammo} = 31259.3913\ \text{lbf}$$

### 6. Climb back again 35

$$V_{35k} := M_{cruise} \cdot a_{35} = 286.5\ \text{kn}$$

$$C_{L\_wg} := \frac{2 \cdot W_5}{\rho_{sl} \cdot V_{cruise\_sl}^{\ 2} \cdot S_{ref}} = 0.1075$$

$$D_{sl} := \frac{W_5}{\frac{C_{L\_wg}}{C_{D\_wg}}} = 10267.2658\ \text{N}$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^{\ 2} = 0.008$$

$$RC_{sl} := V_{cruise\_sl} \cdot \left( T\_W_{ofc} - \frac{C_{D\_wg}}{C_{L\_wg}} \right) = 139.1977\ \text{kn}$$

$$\boxed{C_{L\_wg} := \frac{2 \cdot W_5}{\rho_{35k} \cdot V_{35k}^{\ 2} \cdot S_{ref}} = 0.3825}$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^{\ 2} = 0.0156$$

$$RC_{35k} := V_{35k} \cdot \left( T\_W_{ofc} \cdot \frac{\rho_{35k}}{\rho_{sl}} - \frac{C_{D\_wg}}{C_{L\_wg}} \right) = 41.451 \text{ kn}$$

$$a := \frac{RC_{35k} - RC_{sl}}{35000 \text{ ft}} = -0.0047 \text{ Hz}$$

$$t_{climb35k} := \frac{1}{a} \cdot \ln\left( \frac{RC_{35k}}{RC_{sl}} \right) = 256.9948 \text{ s}$$

$$D_{35k} := \frac{W_5}{\frac{C_{L\_wg}}{C_{D\_wg}}} = 5653.9021 \text{ N}$$

$$R_{climb35k} := \frac{t_{climb35k}}{2} \cdot \left( V_{cruise\_sl} \cdot \left( \cos\left( \left( \left( \text{asin}\left( \frac{RC_{sl}}{V_{cruise\_sl}} \right) \right) \right) \right) + V_{35k} \cdot \left( \cos\left( \text{asin}\left( \frac{RC_{35k}}{V_{35k}} \right) \right) \right) \right) = 20.818$$

$$W_6 := W_5 - \left( 0.6 \frac{\text{lbf}}{\text{lbf hr}} \right) \cdot \left( \frac{D_{sl} + D_{35k}}{2} \right) \cdot t_{climb35k} = 31182.7379 \text{ lbf}$$

7. Cruise back

$$\boxed{C_{L\_wg} := \frac{2 \cdot W_6}{\rho_{35k} \cdot V_{35k}^{\,2} \cdot S_{ref}} = 0.3816}$$

$$C_{D\_wg} := C_{D0} + K \cdot C_{L\_wg}^{\,2} = 0.0155$$

$$W_7 := W_6 \cdot \mathbf{e}^{-\left( \frac{\left( R_{CruiseOut} - R_{climb35k} \right) \cdot 0.4 \frac{\text{lbf}}{\text{lbf hr}}}{V_{35k} \cdot \frac{C_{L\_wg}}{C_{D\_wg}}} \right)} = 30518.7558 \text{ lbf}$$

8. Loiter $\boxed{E := 30 \text{ min}}$

$$W_8 := W_7 \cdot \mathbf{e}^{\left( -\frac{E \cdot 0.25 \frac{\text{lbf}}{\text{lbf hr}}}{L\_D_{max}} \right)} = 30364.2658 \text{ lbf}$$

Empty Weight:

$$K_{vs} := 1.00$$

$$W_{empty} := W_8 - W_{gun} - W_{crew} = 28164.2658 \text{ lbf}$$

$$W_{Empty} := 95 \text{ \%} \cdot W_{empty} = 26756.0525 \text{ lbf}$$

$$W_e := W_{guess} \cdot \left( -.02 + 2.16 \cdot \left( \frac{W_{guess}}{lbf} \right)^{-.1} \cdot AR^{.2} \cdot T\_W_{ofc}^{.04} \cdot \left( \frac{W\_S_{ofc}}{psf} \right)^{-.1} \cdot M_{Max}^{.08} \right) \cdot K_{vs} = 26711.69$$

$$\%ERROR := \left| \frac{W_{Empty} - W_e}{W_e} \right| \cdot 100 = 0.1661$$

$$W_0 := W_{guess} = 39900\ lbf$$

$$W_{fuel} := W_0 - W_{Empty} = 13143.9475\ lbf$$

$$\frac{W_{fuel}}{W_0} = 0.3294$$

- Geometry sizing of the fuselage (starting point):

| Length = $aW_0^c$ (ft or {m}) | a | c |
|---|---|---|
| Sailplane—unpowered | 0.86 {0.383} | 0.48 |
| Sailplane—powered | 0.71 {0.316} | 0.48 |
| Homebuilt—metal/wood | 3.68 {1.35} | 0.23 |
| Homebuilt—composite | 3.50 {1.28} | 0.23 |
| General aviation—single engine | 4.37 {1.6} | 0.23 |
| General aviation—twin engine | 0.86 {0.366} | 0.42 |
| Agricultural aircraft | 4.04 {1.48} | 0.23 |
| Twin turboprop | 0.37 {0.169} | 0.51 |
| Flying boat | 1.05 {0.439} | 0.40 |
| Jet trainer | 0.79 {0.333} | 0.41 |
| Jet fighter | 0.93 {0.389} | 0.39 |
| Military cargo/bomber | 0.23 {0.104} | 0.50 |
| Jet transport | 0.67 {0.287} | 0.43 |

$$L_f := \left( 0.93\ ft \cdot \left( \frac{W_{guess}}{lbf} \right)^{0.39} \right) = 57.9245\ ft$$

$$W_{Eng} := 3700\ lbf$$

$$ENGINE := GE\_CF34\_10E$$

$W_{Bod} := 0.44 \cdot \left( W_{Empty} - W_{Eng} \right) = 10144.6631 \text{ lbf}$

$W_{Wing} := 0.34 \cdot \left( W_{Empty} - W_{Eng} \right) = 7839.0579 \text{ lbf}$

$W_{Tail} := 0.12 \cdot \left( W_{Empty} - W_{Eng} \right) = 2766.7263 \text{ lbf}$

$W_{LG} := 0.1 \cdot \left( W_{Empty} - W_{Eng} \right) = 2305.6053 \text{ lbf}$

$$ScaleFactor := \frac{W_0}{\left( W_{Bod} + W_{Wing} + W_{Tail} + W_{Eng} + W_{LG} + W_{fuel} \right)} = 1$$

$c_{nasa\_sc2} := 6 \text{ m} = 19.685 \text{ ft}$

$wing\_cg_{nasa\_sc2} := 0.40 \cdot c_{nasa\_sc2} = 7.874 \text{ ft}$

$X_{Gun} := 11 \text{ \%} \cdot L_f = 6.3717 \text{ ft}$

$X_{Crew} := 13.8 \text{ \%} \cdot L_f = 7.9936 \text{ ft}$

$X_{Amm0} := 20.8 \text{ \%} \cdot L_f = 12.0483 \text{ ft}$

$X_{Bod} := 39 \text{ \%} \cdot L_f = 22.5906 \text{ ft}$

$X_{Wing} := 55.9 \text{ \%} \cdot L_f = 32.3798 \text{ ft}$

$X_{Tail} := 89.9 \text{ \%} \cdot L_f = 52.0741 \text{ ft}$

$X_{Eng} := 87 \text{ \%} \cdot L_f = 50.3943 \text{ ft}$

$X_{Fuel} := 34.1 \text{ \%} \cdot L_f = 19.7523 \text{ ft}$

$X_{LG1} := 20 \text{ \%} \cdot L_f = 11.5849 \text{ ft}$

$X_{LG2} := 65 \text{ \%} \cdot L_f = 37.6509 \text{ ft}$

$$x_{cg\_wo} := \frac{\left( W_{crew} \right) \cdot \left( X_{Crew} \right) + W_{ammo} \cdot \left( X_{Amm0} \right) + W_{Bod} \cdot \left( X_{Bod} \right) + W_{Wing} \cdot \left( X_{Wing} \right) + W_{Tail} \cdot \left( X_{Tail} \right) + W_{Eng} \cdot \left( X_{Eng} \right) -}{W_0 + W_{crew} + W_{gun} + W_{ammo}}$$

$x_{cg\_wo} = 26.7204 \text{ ft}$

$\frac{x_{cg\_wo}}{L_f} = 46.1298 \text{ \%}$

$x_{cg\_wo} - X_{Wing} = -5.6594 \text{ ft}$

$Z_{Crew} := 5.87 \text{ ft}$

$Z_{Gun} := 1.58 \text{ ft}$

$Z_{Ammo} := 2.57 \text{ ft}$

$Z_{Bod} := 2.8 \text{ ft}$

$Z_{LG} := 1.22 \text{ ft}$

$Z_{Fuel} := 2.90 \text{ ft}$

$Z_{Wing} := 2.30 \text{ ft}$

$Z_{Eng} := 7.43 \text{ ft}$

$Z_{HT} := 3.49 \text{ ft}$

$Z_{VT} := 5.87 \text{ ft}$

$$z_{cg\_wo} := \frac{\left(W_{crew}\right)\cdot\left(Z_{Crew}\right) + W_{ammo}\cdot\left(Z_{Ammo}\right) + W_{Bod}\cdot\left(Z_{Bod}\right) + W_{Wing}\cdot\left(Z_{Wing}\right) + \frac{W_{Tail}}{2}\cdot\left(Z_{HT}\right) + W_{Eng}\cdot\left(Z_{Eng}\right) +}{W_0 + W_{crew} + W_{gun} + W_{ammo}}$$

$z_{cg\_wo} = 3.0491\ \text{ft}$

$$MAC_1 = \bar{c}_1 = \frac{2}{3} c_{R_1} \frac{\left(1 + \lambda_1 + \lambda_1^2\right)}{(1 + \lambda_1)}, \quad MAC_2 = \bar{c}_2 = \frac{2}{3} c_{R_2} \frac{\left(1 + \lambda_2 + \lambda_2^2\right)}{(1 + \lambda_2)}$$

$$MAC = \bar{c} = \frac{(\bar{c}_1 \cdot S_1) + (\bar{c}_2 \cdot S_2)}{S}$$

$b_1 := 24\ \text{ft}$ $b_2 := 22\ \text{ft}$

$b := b_1 + b_2 = 46\ \text{ft}$

$c_{T1} := 18\ \text{ft}$ $c_{T2} := 16\ \text{ft}$ $c_T := c_{T2}$

$c_{R1} := c_{T1}$ $c_{R2} := c_{R1} = 18\ \text{ft}$

$\Lambda_{LE1} := 0\ \text{deg}$

$\lambda_1 := \frac{c_{T1}}{c_{R1}} = 1$ $\lambda_2 := \frac{c_{T2}}{c_{R2}} = 0.8889$

$\Lambda_{LE2} := \text{atan}\left(\frac{2\ \text{ft}}{16\ \text{ft}}\right) = 7.125\ \text{deg}$ $\lambda_{ht} := 1$

$S_1 := \frac{b_1}{2} \cdot c_{R1} \cdot \left(1 + \lambda_1\right) = 432\ \text{ft}^2$

$S_2 := \frac{b_2}{2} \cdot c_{R2} \cdot \left(1 + \lambda_2\right) = 374\ \text{ft}^2$

$S := S_1 + S_2 = 806\ \text{ft}^2$ $S_{ref} = 786.2069\ \text{ft}^2$

$S > S_{ref} = 1$

$AR_{act} := \frac{b^2}{S} = 2.6253$

$\lambda := \text{solve}\left(\frac{2 \cdot S}{b \cdot c_T} - \left(\frac{1}{\lambda} + 1\right), \lambda, 0.01, 1.0\right) = 0.8402$

$c_R := \frac{c_T}{\lambda} = 19.0435\ \text{ft}$

$\Lambda_{LE} := \text{atan}\left(\frac{\tan\left(\Lambda_{LE1}\right)\cdot S_1 + \tan\left(\Lambda_{LE2}\right)\cdot S_2}{S}\right) = 3.3196\ \text{deg}$

$c_{bar.1} := \frac{2}{3} \cdot c_{R1} \cdot \left(\frac{1 + \lambda_1 + \lambda_1^2}{1 + \lambda_1}\right) = 18\ \text{ft}$

$c_{bar.2} := \frac{2}{3} \cdot c_{R2} \cdot \left(\frac{1 + \lambda_2 + \lambda_2^2}{1 + \lambda_2}\right) = 17.0196\ \text{ft}$

$c_{bar} := \frac{2}{3} \cdot c_R \cdot \left(\frac{1 + \lambda + \lambda^2}{1 + \lambda}\right) = 17.5658\ \text{ft}$

$c_{bar.0} := \frac{c_{bar.1} \cdot S_1 + c_{bar.2} \cdot S_2}{S} = 17.5451\ \text{ft}$

$y_{mac} := \frac{b}{6} \cdot \left(\frac{1 + 2 \cdot \lambda}{1 + \lambda}\right) = 11.1671\ \text{ft}$

$x_{mac} := y_{mac} \cdot \tan\left(\Lambda_{LE}\right) = 0.6477\ ft$

$l_H := X_{Tail} - x_{cg\_wo} = 25.3537\ ft$

$C_{RH} := 8\ ft$

$C_{TH} := C_{RH} = 8\ ft$

$$S_H := \frac{0.3 \cdot S_{ref} \cdot \left(y_{mac}\right)}{l_H} = 103.8859\ ft^2$$

$$b_H := \frac{S_H}{C_{RH}} = 12.9857\ ft$$

$$c_{bar\_ht} := \frac{2}{3} \cdot C_{RH} \cdot \left(\frac{1 + \lambda_{ht} + \lambda_{ht}^2}{1 + \lambda_{ht}}\right) = 8\ ft$$

$$y_{mac\_ht} := \frac{b_H}{6} \cdot \left(\frac{1 + 2 \cdot \lambda_{ht}}{1 + \lambda_{ht}}\right) = 3.2464\ ft$$

$x_{mac\_ht} := y_{mac} \cdot \tan\left(\Lambda_{LE}\right) = 0.6477\ ft$

$$V_H := \frac{S_H \cdot l_H}{S_{ref} \cdot \left(\frac{c_{T1} + c_{T2}}{2}\right)} = 0.1971$$

$$Z_{ac} := \frac{Z_{Wing} \cdot S + Z_{HT} \cdot S_H}{S + S_H} = 2.4359\ ft$$

$l_v := X_{Tail} - x_{cg\_wo} = 25.3537\ ft$

$S_V := 0.15 \cdot S_H = 15.5829\ ft^2$

$$V_v := \frac{S_V \cdot l_v}{S_{ref} \cdot b} = 0.0109$$

$x_{ac} := x_{mac} + .25 \cdot c_{bar} = 5.0392\ ft$

$x_{nose2\_LE} := 47\ \% \cdot L_f = 27.2245\ ft$

$x\_ac := x_{ac} + x_{nose2\_LE} = 32.2637\ ft$

$\frac{x\_ac}{L_f} = 55.6995\ \%$ $\frac{x_{cg\_wo}}{L_f} = 46.1298\ \%$

$x_{cg\_wo} - x\_ac = -5.5432\ ft$

$$static\_margen_{withAmmo} := \left|\frac{x_{cg\_wo} - x\_ac}{c_{bar}}\right| = 31.557\ \%$$

$$x\_cg_{noammo} := \frac{\left(W_{crew}\right) \cdot \left(X_{Crew}\right) + W_{Bod} \cdot \left(X_{Bod}\right) + W_{Wing} \cdot \left(X_{Wing}\right) + W_{Tail} \cdot \left(X_{Tail}\right) + W_{Eng} \cdot \left(X_{Eng}\right) + W_{fuel} \cdot \left(X_{Fu}\right.}{W_0 + W_{crew} + W_{gun}}$$

$x\_cg_{noammo} - x\_ac = -4.8462\ ft$

$$static\_margen_{withOutAmmo} := \left| \frac{x\_cg_{noammo} - x\_ac}{c_{bar}} \right| = 27.589\ \%$$

$$x\_cg_{NoAmo\_NoFuel} := \frac{\left(W_{crew}\right)\cdot\left(X_{Crew}\right) + W_{Bod}\cdot\left(X_{Bod}\right) + W_{Wing}\cdot\left(X_{Wing}\right) + W_{Tail}\cdot\left(X_{Tail}\right) + W_{Eng}\cdot\left(X_{Eng}\right) + \left(\frac{1}{3}\cdot W\right.}{W_0 + W_{crew} + W_{gun} - W_{fuel}}$$

$$x\_cg_{NoAmo\_NoFuel} - x\_ac = -1.3668\ ft$$

$$static\_margen_{withOutAmmoNoFuel} := \left| \frac{x\_cg_{NoAmo\_NoFuel} - x\_ac}{c_{bar}} \right| = 7.781\ \%$$