How to Use This Sheet

This sheet was used to size the 2023-24 MCR aircraft's twin boom. Key inputs, coefficients, and outputs are displayed on the "Parameters" tab. Tail sizing calculations and their respective formulas are shown on the "Tail Sizing" tab. Snorri Gudmundsson Chapter 11 was used as reference. you can find the formula derivations in this folder https://drive.google.com/drive/folders/1UWld0sJsN-1ZZWR4PXQmUiufJE09Rvyy?usp=drive_link

	Intermediate calculations
	Values given by other subteams
	Input variables determined by fuselage
	Coefficients
	Ouputs

Only alter values using **THIS TAB.** All other tabs are intermediary and are used for calculations and variable reference.

Input

Assumptions:

parameter	variable	value	units
Wing Reference Span	b_REF =	40	in
Wing Mean Geometric Chord	c_MGC =	8	in
Height of bulkhead at chord line	h_1 =	5.14	in
Width of bulkhead at chord line	w_1 =	5.14	in
Height of bulkhead at Tail end	h_2 =	1.5	in
Width of bulkhead at Tail end	w_2 =	1	in

Fixed Coefficients

parameter	variable	value	units		
Volume of vertical stabilizer	V VT =	0.04	n/a	Homebuilt	https://aerotoolbox.com/design-aircraft-tail/
Volume of horizontal stabilizer	V HT =	0.5	n/a	GA single engine	https://aerotoolbox.com/design-aircraft-tail/
Horizontal Tail Aspect Ratio	AR_HT =	3	n/a		
Vertical Tail Aspect Ratio	AR_VT =	1.5	n/a		

Output

Results

parameter	variable	value	units	
Length of tail	L T =	11.841414	in	18
Combined Span of vertical stabilizers	b VT =	8.053392	in	
Combined Span of horizontal stabilizer	b HT =	18.007931	in	
Surface area of vertical stabilizer	S VT =	43.238078	in^2	
Surface area of horizontal stabilizer	S HT =	108.095196	in^2	
Average Horizontal Tail Chord	C_avg,HT =	6.002644	in	
Average Vertical Tail Chord	C_avg,VT =	5.368928	in	

REFERENCE:	Snorri Gudmundsson - General Aviation Aircraft Design_ Applied Methods and Procedures-Butterworth-Heinemann (2021)
ASSUMPTIONS	Calculations for surface area and volume remain the same as for a single boom aircraft with the exception of tail arm length (figure 11-44 in textbook)

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below acts as reference for input/output sheet and formulas

Assumptions:			
parameter	variable	value	units
Wing Reference Span	b_REF =	40	in
Wing Mean Geometric Chord	c_MGC =	8	in
Height of bulkhead at chord line	h_1 =	5.14	in
Width of bulkhead at chord line	w_1 =	5.14	in
Height of bulkhead at Tail end	h_2 =	1.5	in
Width of bulkhead at Tail end	w_2 =	1	in

Wing reference area	S REF =	320.000000	in^2

Coefficients:		Value	Units
Volume of vertical stabilizer	V VT =	0.04	n/a
Volume of horizontal stabilizer	V HT =	0.5	n/a
Horizontal Tail Aspect Ratio	AR_HT =	3	n/a
Vertical Tail Aspect Ratio	AR_VT =	1.5	n/a

Outputs:		Value	Units
Length of tail arm	L T =	11.841414	in
Combined length of vertical stabilizers	b VT =	8.053392	in
Length of horizontal stabilizer	b HT =	18.007931	in
Combined surface area of vertical stabilizer	S VT =	43.238078	in^2
Surface area of horizontal stabilizer	S HT =	108.095196	in^2
Average Horizontal Tail Chord	C_avg,HT =	6.002644	
Average Vertical Tail Chord	C_avg,VT =	5.368928	

L

Tail

Length of tail arm — refer to figure 11-28 on textbook

$$l_t = \sqrt{\frac{S \cdot (V_{HT} \cdot C_{MGC} + V_{VT} \cdot b)}{(h_1 + w_1 + h_2 + w_2)}}$$

L_T = 11.84141429

Vertical stabilizer

Combined span of vertical stabilizers — refer to eq. 11-24 on textbook

$$b_{VT} = \sqrt{AR_{VT} \cdot S_{VT}}$$

b VT = 8.053391688

Horizontal stabilizer

Combined Span of horizontal stabilizer — refer to eq. 11-21 on textbook

$$b_{HT} = \sqrt{AR_{HT} \cdot S_{HT}}$$

b HT = 18.00793126

S

Combined surface area of vertical stabilizers — refer to eq 11-23 on textbook

$$S_{VT} = \frac{V_{VT} \cdot S_{REF} \cdot b_{REF}}{L_T}$$

S VT = 43.23807846

Surface area of horizontal stabilizer — refer to eq 11-20 on textbook

$$S_{HT} = \frac{V_{HT} \cdot S_{REF} \cdot c_{REF}}{L_T}$$

S HT = 108.0951961

C

Average chord vertical tail — refer to eq 11-25 on textbook

$$(C_{avg})_{VT} = \frac{b_{VT}}{AR_{VT}}$$

(Cavg)VT = 5.368927792

Average chord horizontal tail — refer to eq 11-22 on textbook

Average chord of HT:

$$(C_{avg})_{HT} = \frac{b_{HT}}{AR_{HT}}$$

(Cavg)HT = 6.002643755

Wing reference area	S REF =	0.000000	in^2

Coefficients:		Value	Units
			n/a
			n/a
			n/a
			n/a

Outputs:		Value	Units
Length of tail arm	L T =	11.841414	in
Combined length of vertical stabilizers	b VT =	8.053392	in
Length of horizontal stabilizer	b HT =	18.007931	in
Combined surface area of vertical stabilizer	S VT =	43.238078	in^2
Surface area of horizontal stabilizer	S HT =	108.095196	in^2
Average Horizontal Tail Chord	C_avg,HT =	6.002644	
Average Vertical Tail Chord	C_avg,VT =	5.368928	

How to Use This Sheet

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	Intermediate calculations
	Values given by other subteams
	Input variables determined by fuselage
	Coefficients
	Ouputs

Only alter values using **THIS TAB.** All other tabs are intermediary and are used for calculations and variable reference.

Input

Output

Assumptions:

parameter	variable	value	units
Wing Reference Span	b_REF =	40	in
Wing Mean Geometric Chord	c_MGC =	8	in
Radius of Tail Boom Thickness at Wing Quarter Chord	R_1 =	2.5	in
Radius of Tail Boom Thickness at Tail Quarter Chord	R_2 =	0.5	in

Fixed Coefficients

parameter	variable	value	units		
Volume of vertical stabilizer	V VT =	0.04	n/a	Homebuilt	https://aerotoolbox.com/design-aircraft-tail/
Volume of horizontal stabilizer	V HT =	0.5	n/a	GA single engine	https://aerotoolbox.com/design-aircraft-tail/
Horizontal Tail Aspect Ratio	AR_HT =	3	n/a		
Vertical Tail Aspect Ratio	AR_VT =	1.5	n/a		

Results

parameter	variable	value	units
Length of tail	L T =	19.500621	in
Combined Span of vertical stabilizers	b VT =	6.275616	in
Combined Span of horizontal stabilizer	b HT =	14.032705	in
Surface area of vertical stabilizer	S VT =	26.255574	in^2
Surface area of horizontal stabilizer	S HT =	65.638936	in^2
Average Horizontal Tail Chord	C_avg,HT =	4.677568	in
Average Vertical Tail Chord	C_avg,VT =	4.183744	in

REFERENCE:	Snorri Gudmundsson - General Aviation Aircraft Design_ Applied Methods and Procedures-Butterworth-Heinemann (2021)
ASSUMPTIONS	Calculations for surface area and volume remain the same as for a single boom aircraft with the exception of tail arm length (figure 11-44 in textbook)

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Parameters:		Value	Units
Wing Reference Span	b_REF =	40.000000	in
Wing Mean Geometric Chord	c_MGC =	8.000000	in
Radius of Tail Boom Thickness at Wing Quarter Chord	R_1 =	2.500000	in
Radius of Tail Boom Thickness at Tail Quarter Chord	R_2 =	0.500000	in
Wing reference area	S REF =	320.000000	in^2

Coefficients:		Value	Units
Volume of vertical stabilizer	V VT =	0.04	n/a
Volume of horizontal stabilizer	V HT =	0.5	n/a
Horizontal Tail Aspect Ratio	AR_HT =	3	n/a
Vertical Tail Aspect Ratio	AR_VT =	1.5	n/a

Outputs:		Value	Units
Length of tail arm	L T =	19.500621	in
Combined length of vertical stabilizers	b VT =	6.275616	in
Length of horizontal stabilizer	b HT =	14.032705	in
Combined surface area of vertical stabilizer	S VT =	26.255574	in^2
Surface area of horizontal stabilizer	S HT =	65.638936	in^2
Average Horizontal Tail Chord	C_avg,HT =	4.677568	
Average Vertical Tail Chord	C_avg,VT =	4.183744	

L

Tail		Vertical stabilizer		Horizontal stabilizer	
Length of tail arm	refer to figure 11-28 on textbook	Combined span of vertical stabilizers	refer to eq. 11-24 on textbook	Combined Span of horizontal stabilizer	refer to eq. 11-21 on textbook
$l_T = \sqrt{\frac{2 \cdot S(V_{HT} \cdot c_{MGC} + V_{VT} \cdot b)}{\pi(R_1 + R_2)}}$		$b_{VT} = \sqrt{AR_{VT} \cdot S_{VT}}$		$b_{HT} = \sqrt{AR_{HT} \cdot S_{HT}}$	
L_T =	19.50062078	b VT =	6.275616434	b HT =	14.03270495

S

Combined surface area of vertical stabilizers	refer to eq 11-23 on textbook	Surface area of horizontal stabilizer	refer to eq 11-20 on textbook
$S_{VT} = \frac{V_{VT} \cdot S_{REF} \cdot b_{REF}}{L_T}$		$S_{HT} = \frac{V_{HT} \cdot S_{REF} \cdot c_{REF}}{L_T}$	
S VT =	26.25557442	S HT =	65.63893604

C

Average chord vertical tail	refer to eq 11-25 on textbook	Average chord horizontal tail	refer to eq 11-22 on textbook
$(C_{avg})_{VT} = \frac{b_{VT}}{AR_{VT}}$		Average chord of HT: $(C_{avg})_{HT} = \frac{b_{HT}}{AR_{HT}}$	
(Cavg)VT	4.183744289	(Cavg)HT	4.677568316