



Engineering, Operations & Technology
Phantom Works

Phantom

Development of a *Common Research Model* for Applied CFD Validation Studies

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The Boeing Company – Phantom Works



AIAA Applied Aerodynamics Conference
Honolulu, HI
20 August 2008

Geometry Characteristics



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Flight Sciences

- **Wing Planform & Layout**
 - Reference Quantities
 - Sweep & Thickness Distribution
 - Goal Design Point
 - $M=0.85$, $C_L=0.5$, $Ren=40M$ (Flight)
- **Fuselage**
 - Existing WT Model
 - Vertical Blade Mount
 - Accommodates Horizontal Tail
 - Has Scrubbing Flat

Wing Planform & Layout



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• Reference Quantities

- $S_{ref} = 594,720. \text{ in}^2 = 4,130 \text{ ft}^2$
- $C_{ref} = 275.80 \text{ in}$
- $\text{Span} = 2,313.50 \text{ in} = 192.8 \text{ ft}$
- $X_{ref} = 1,325.90 \text{ in}$
- $Y_{ref} = 468.75 \text{ in}$
- $Z_{ref} = 177.95 \text{ in}$
- $\lambda = 0.275$
- $\Lambda_{C/4} = 35^\circ$
- $AR = 9.0$

Wing Planform & Layout

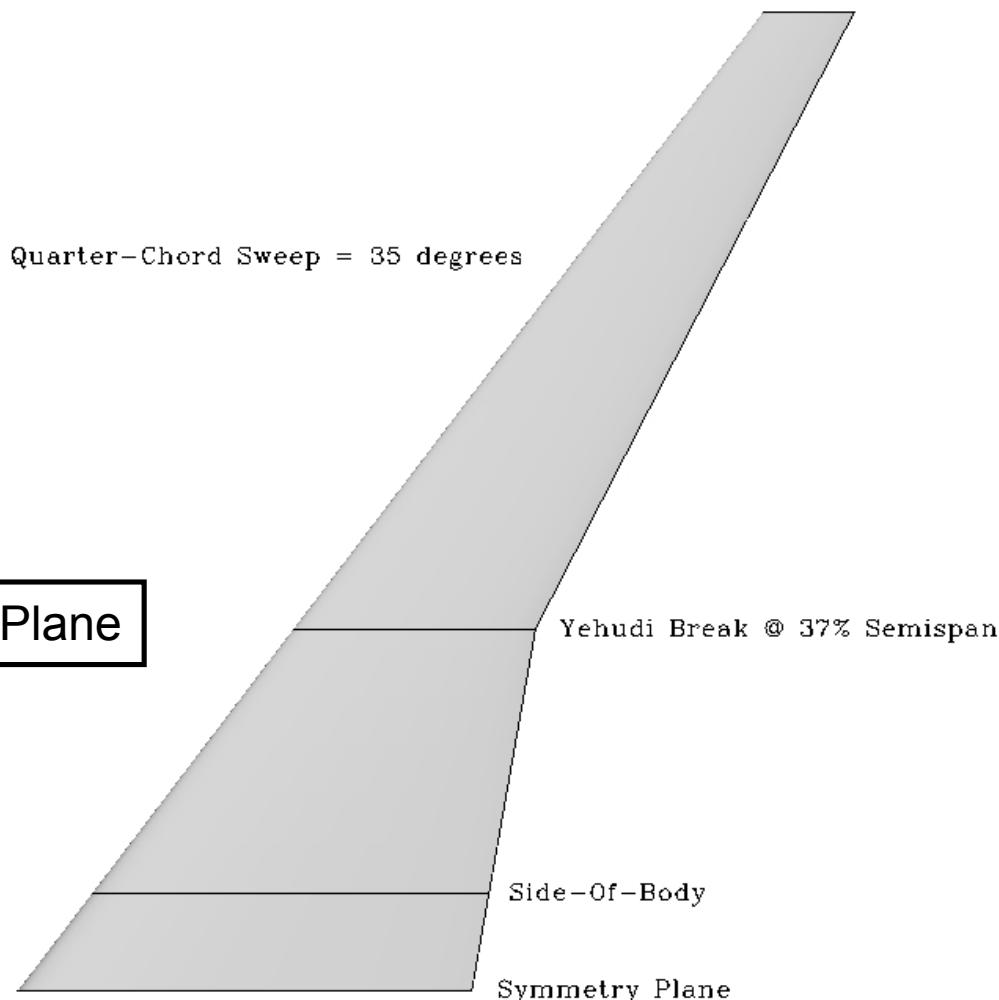


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NASA Common Model

Sref=594,720.0 , Cref=275.8 , b=2,313.5 , Xref=425.9 , AR=9.0



Wing Planform & Layout

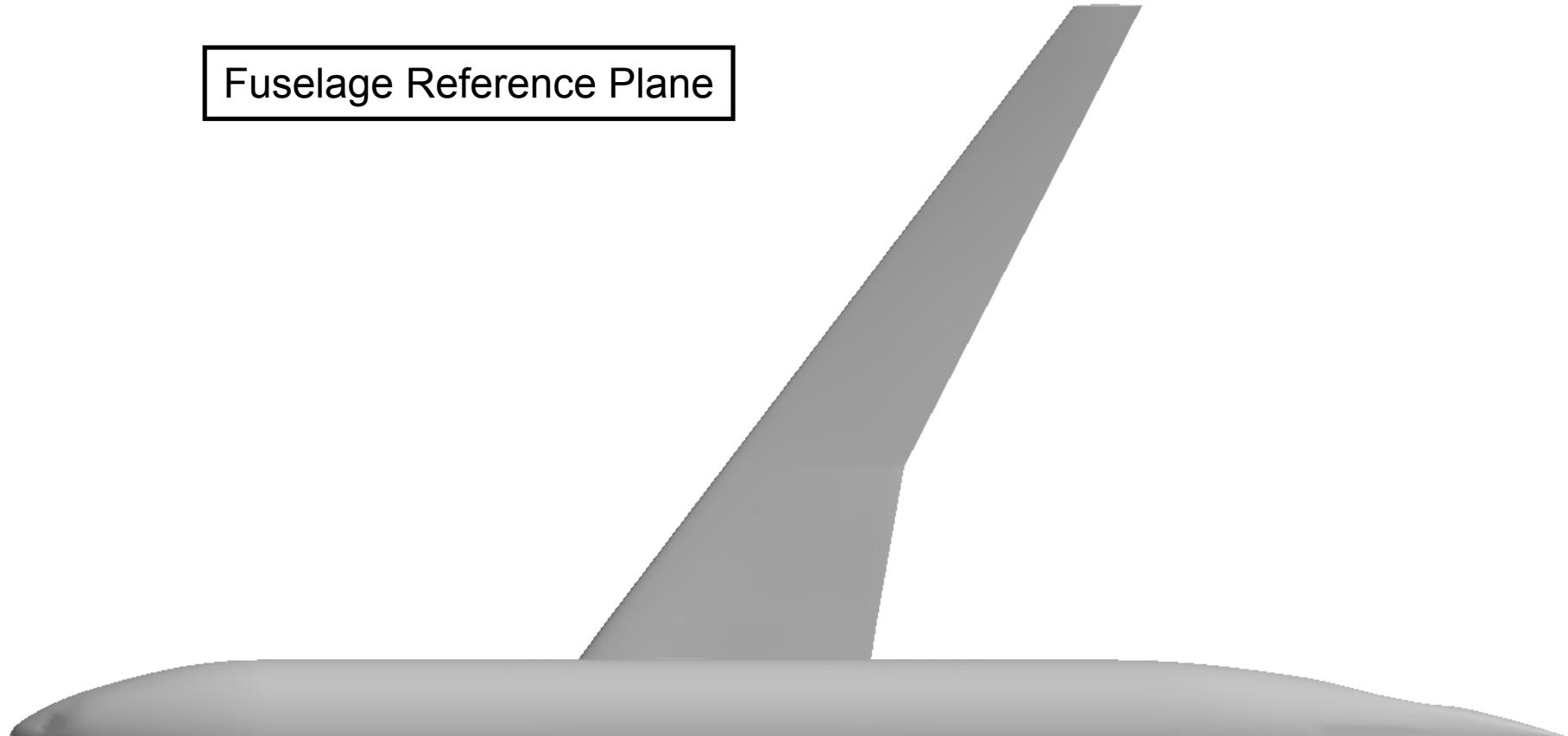


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NASA Common Research Model

Fuselage Reference Plane

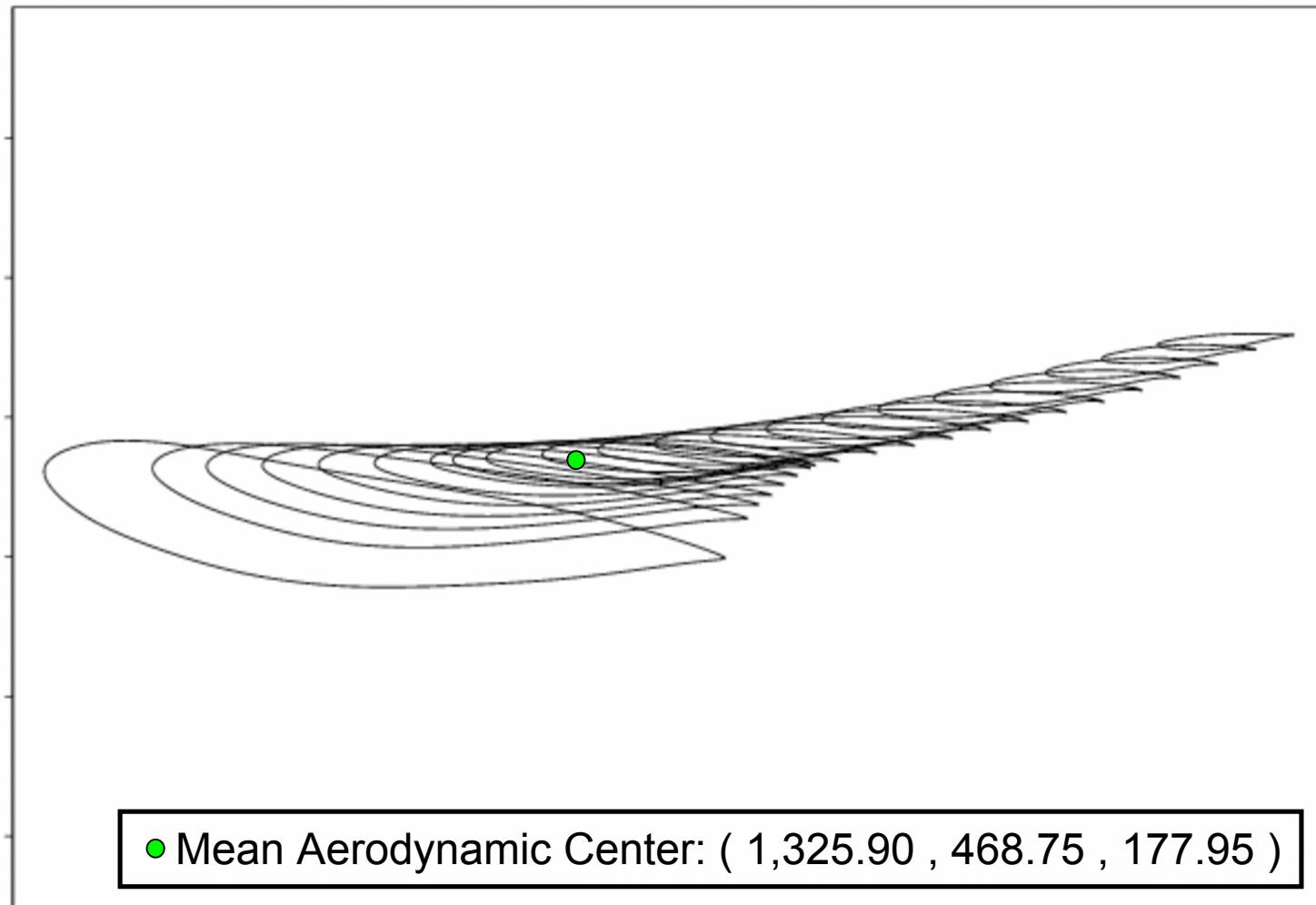


Wing Airfoil Stack



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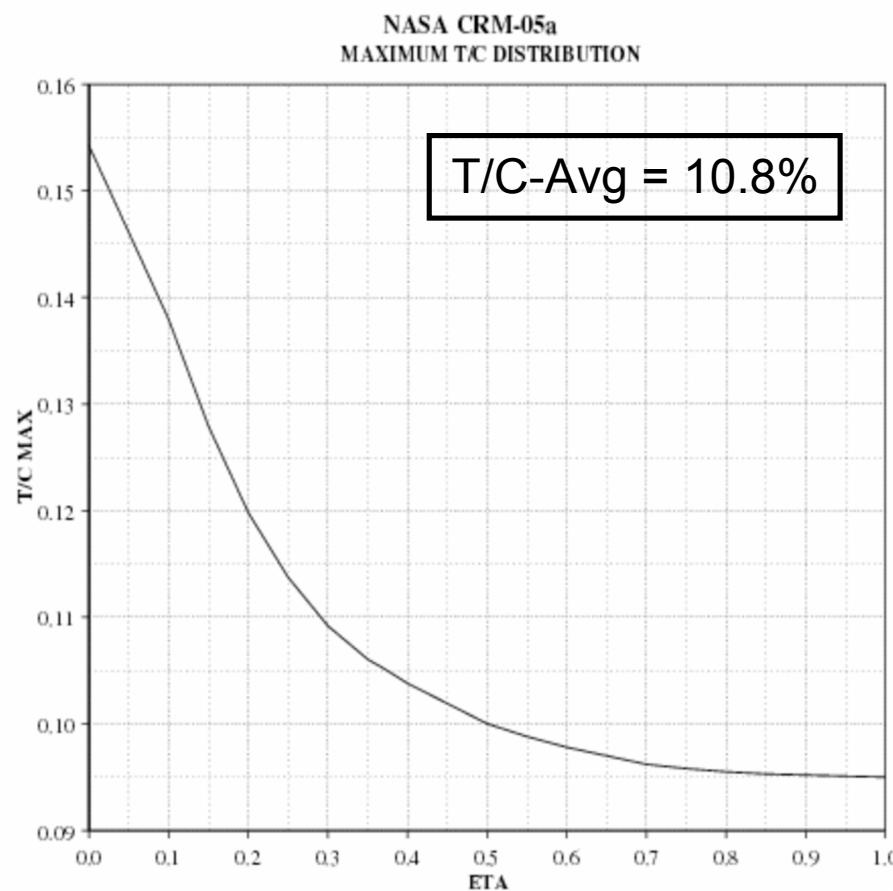
Wing Thickness

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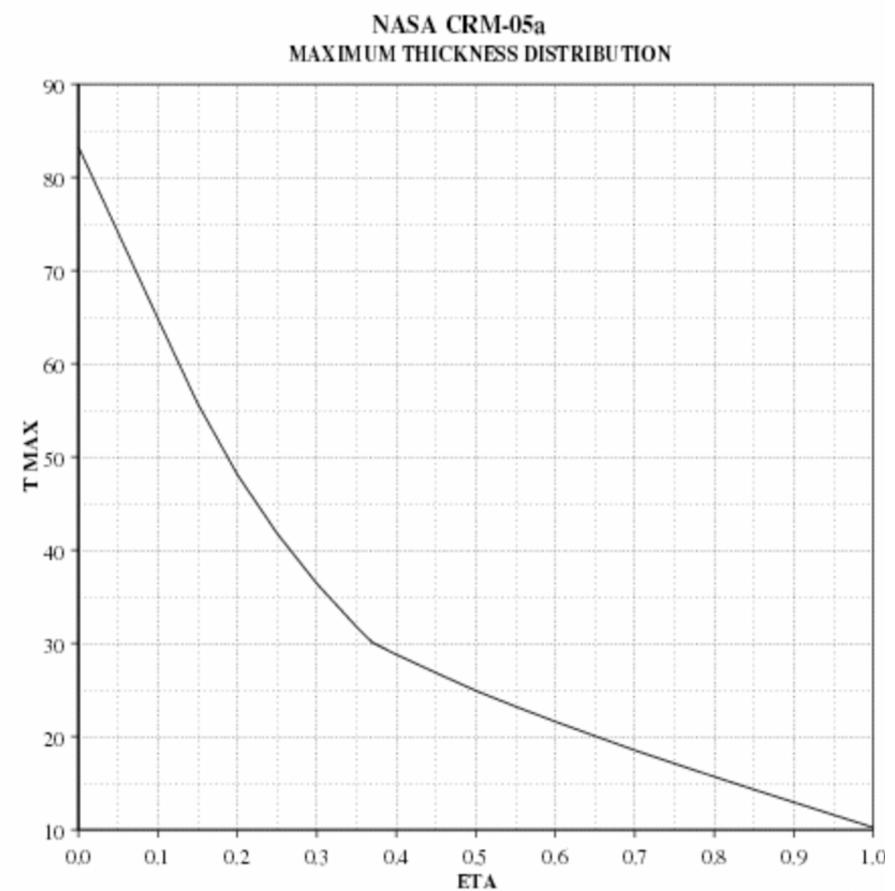


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Non-Dimensional



Absolute (inches)



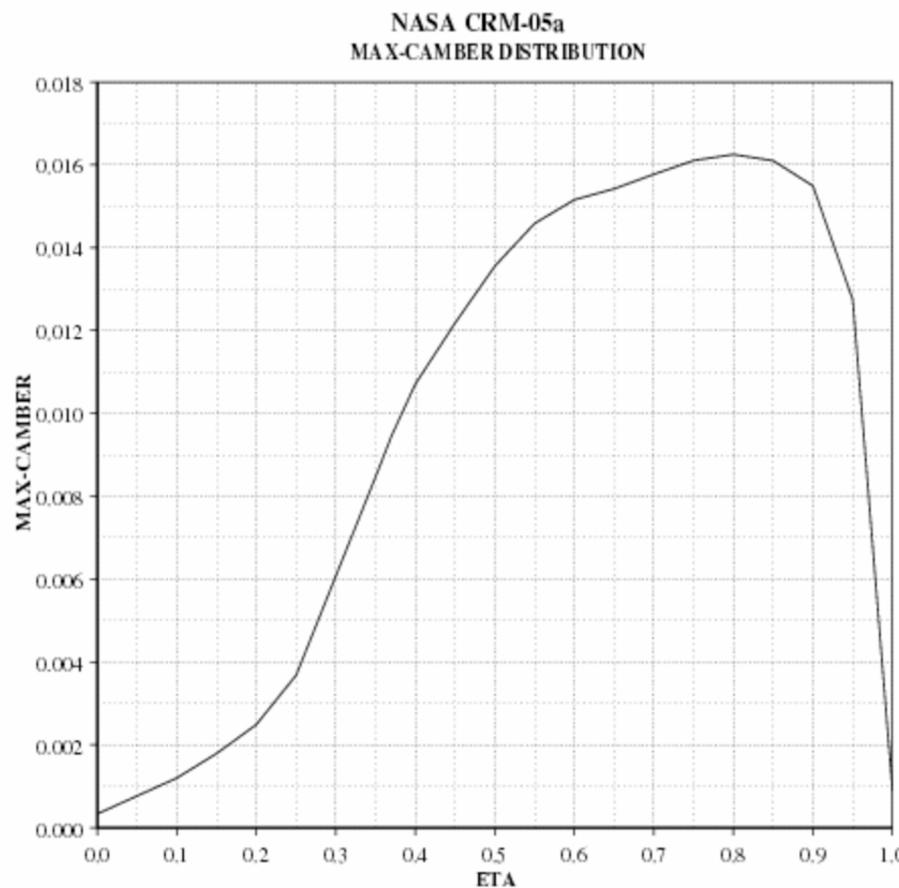
Wing Camber & Twist



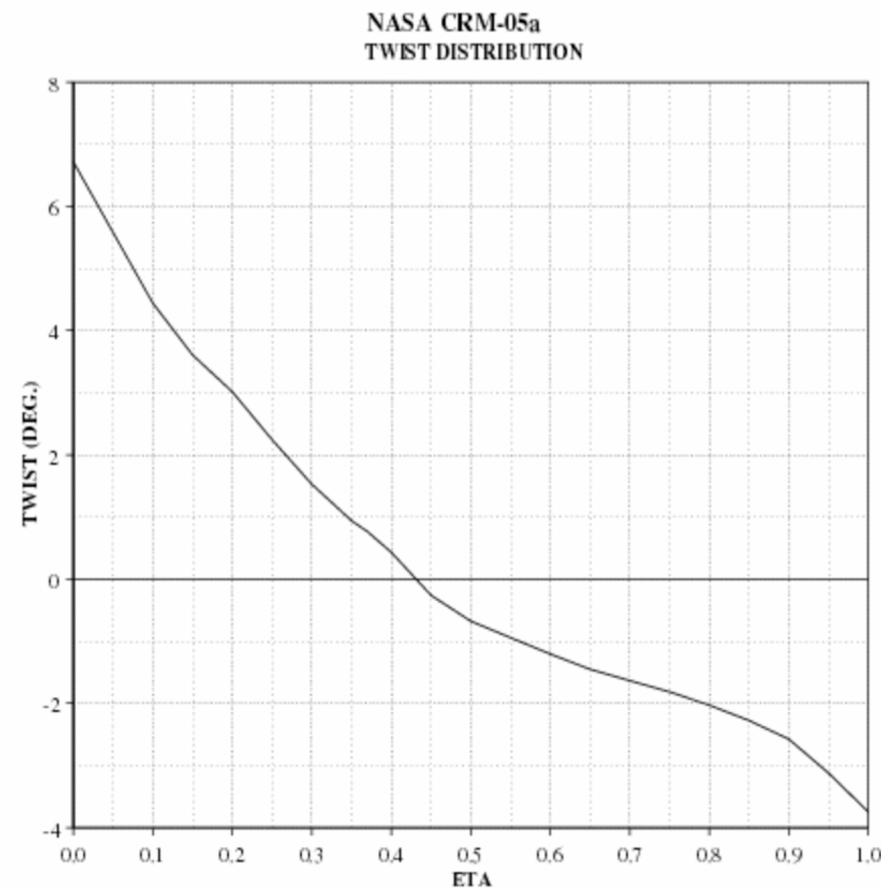
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Max-Camber



Twist (deg)

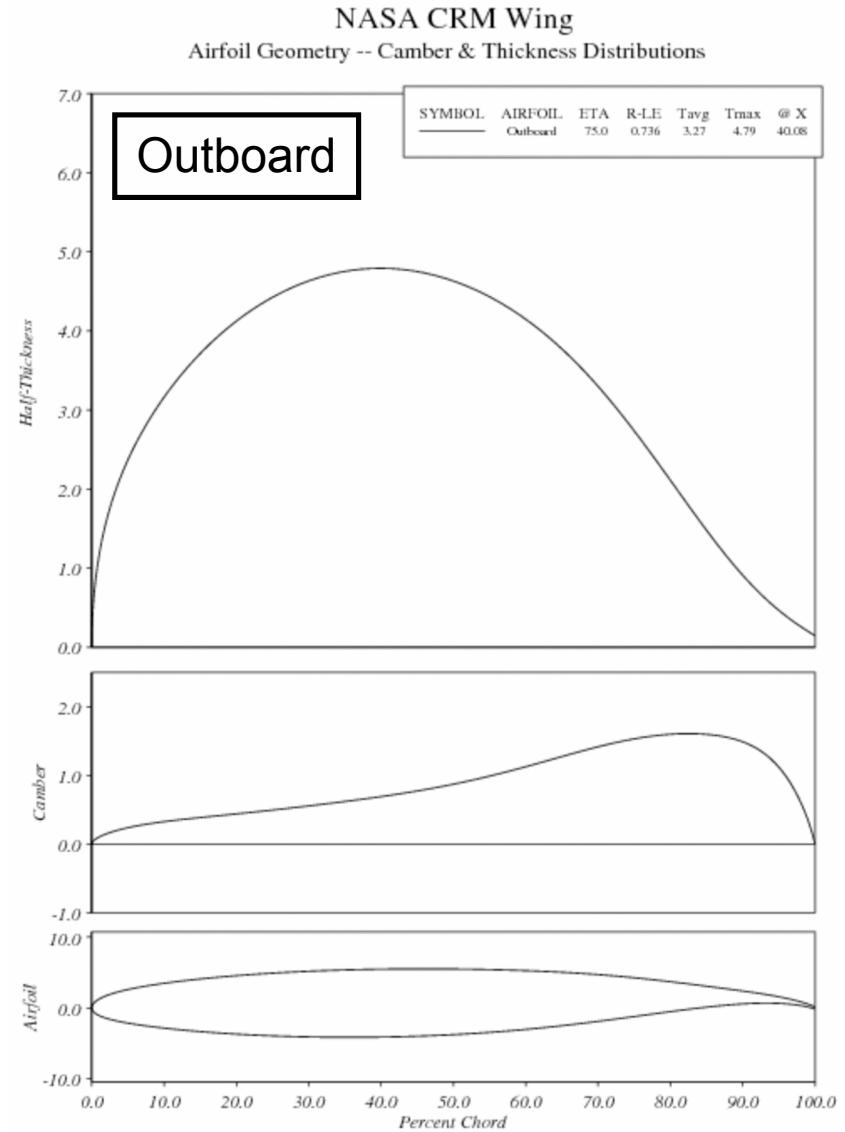
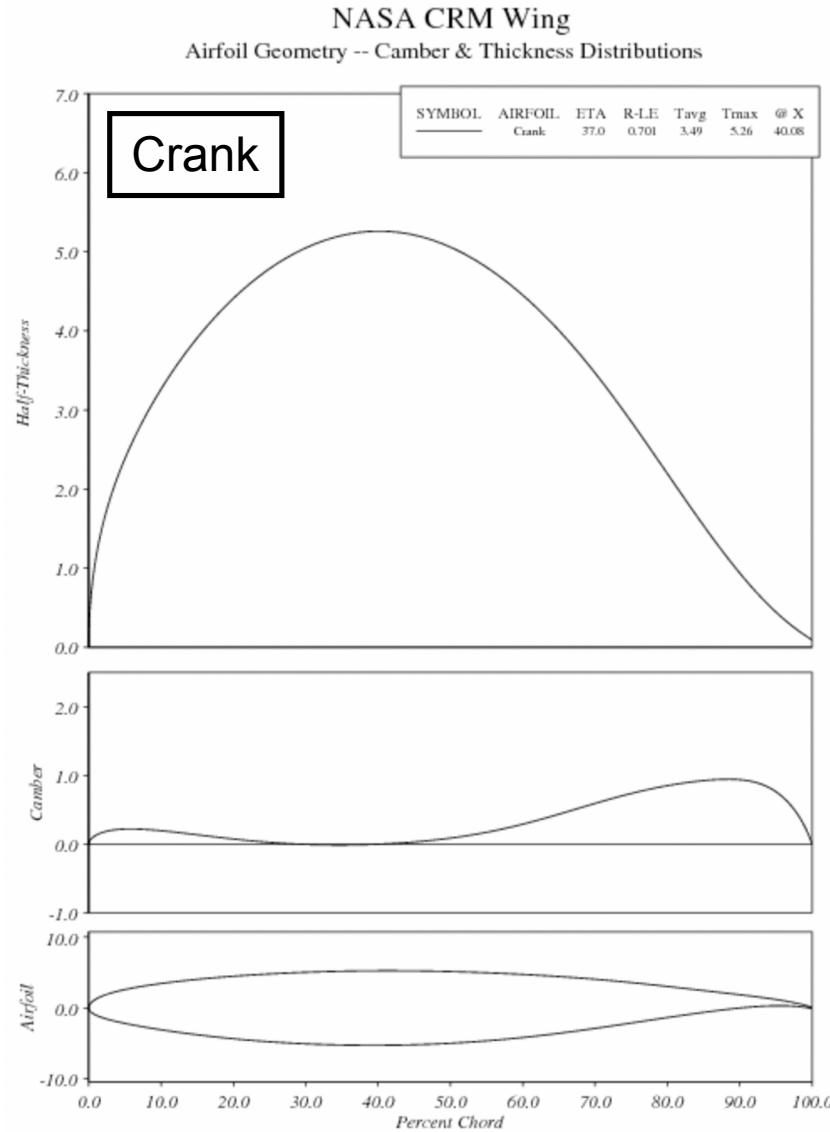


Airfoil Characteristics



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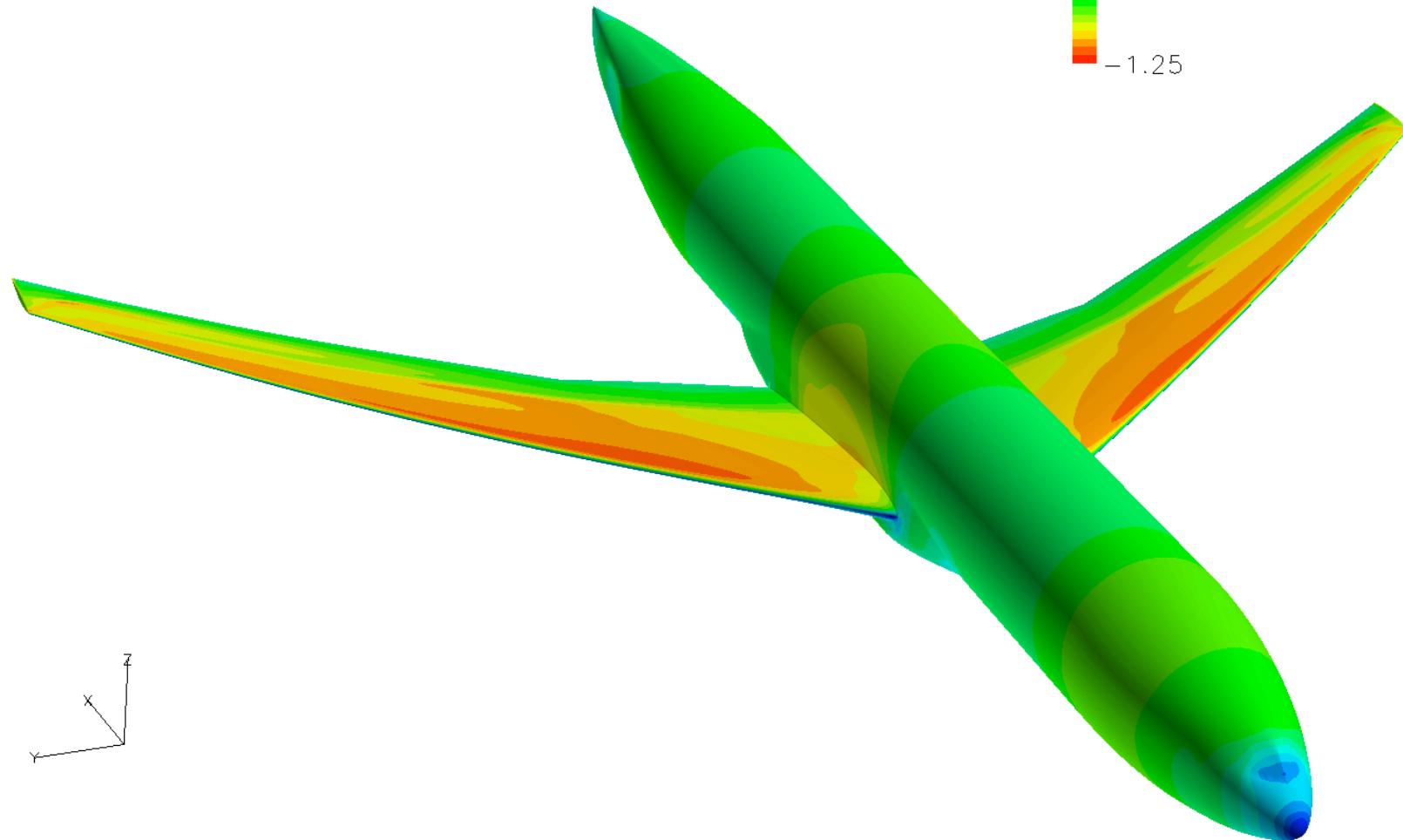
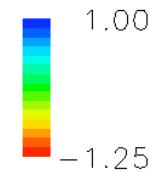
Surface Isobars



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NASA Common Research Model
 $M=0.85$, $CL=0.508$, $Re=40M$



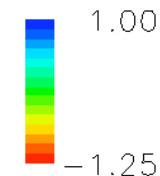
Surface Isobars



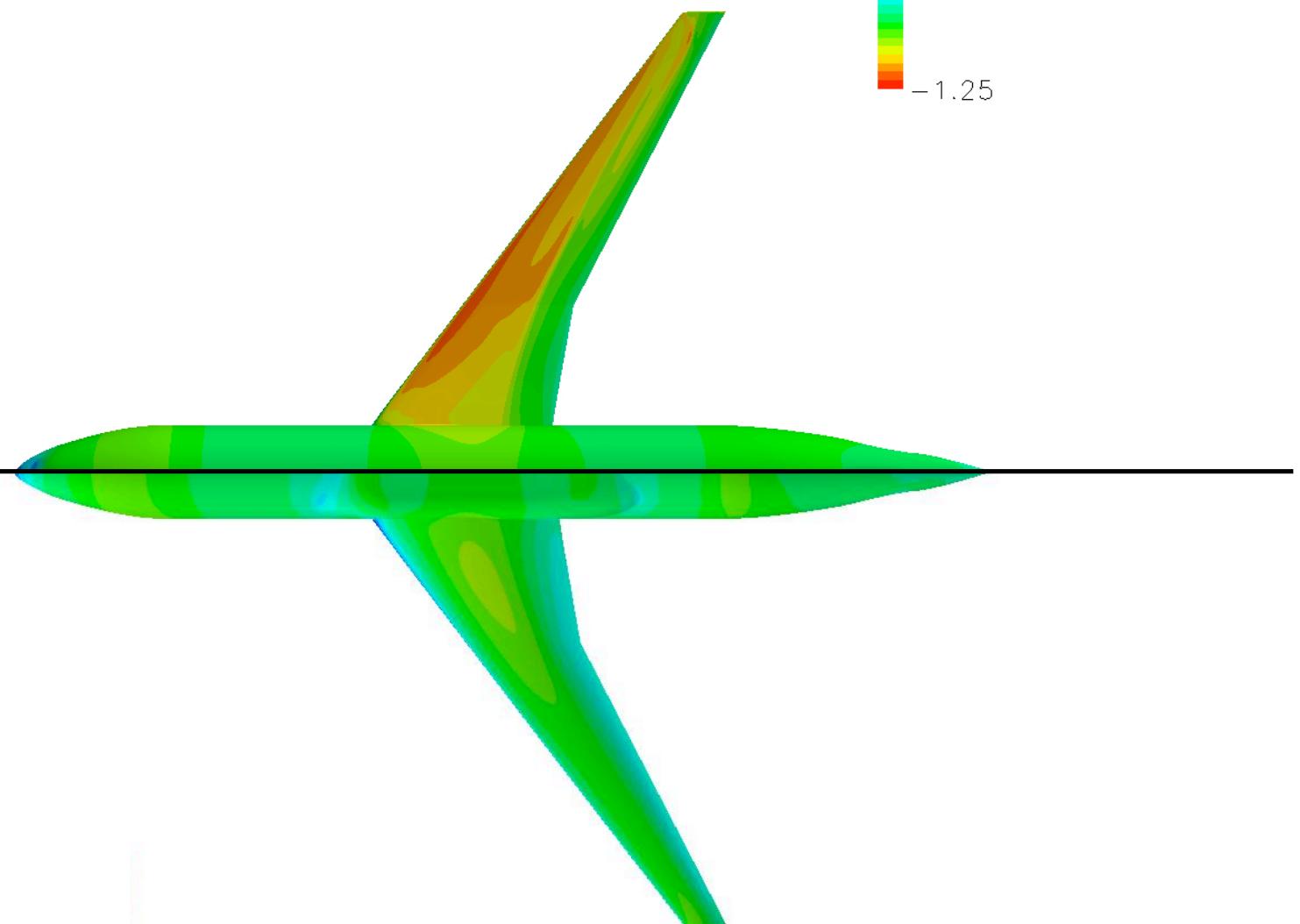
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NASA Common Research Model
 $M=0.85$, $CL=0.508$, $Re=40M$



Upper Surface



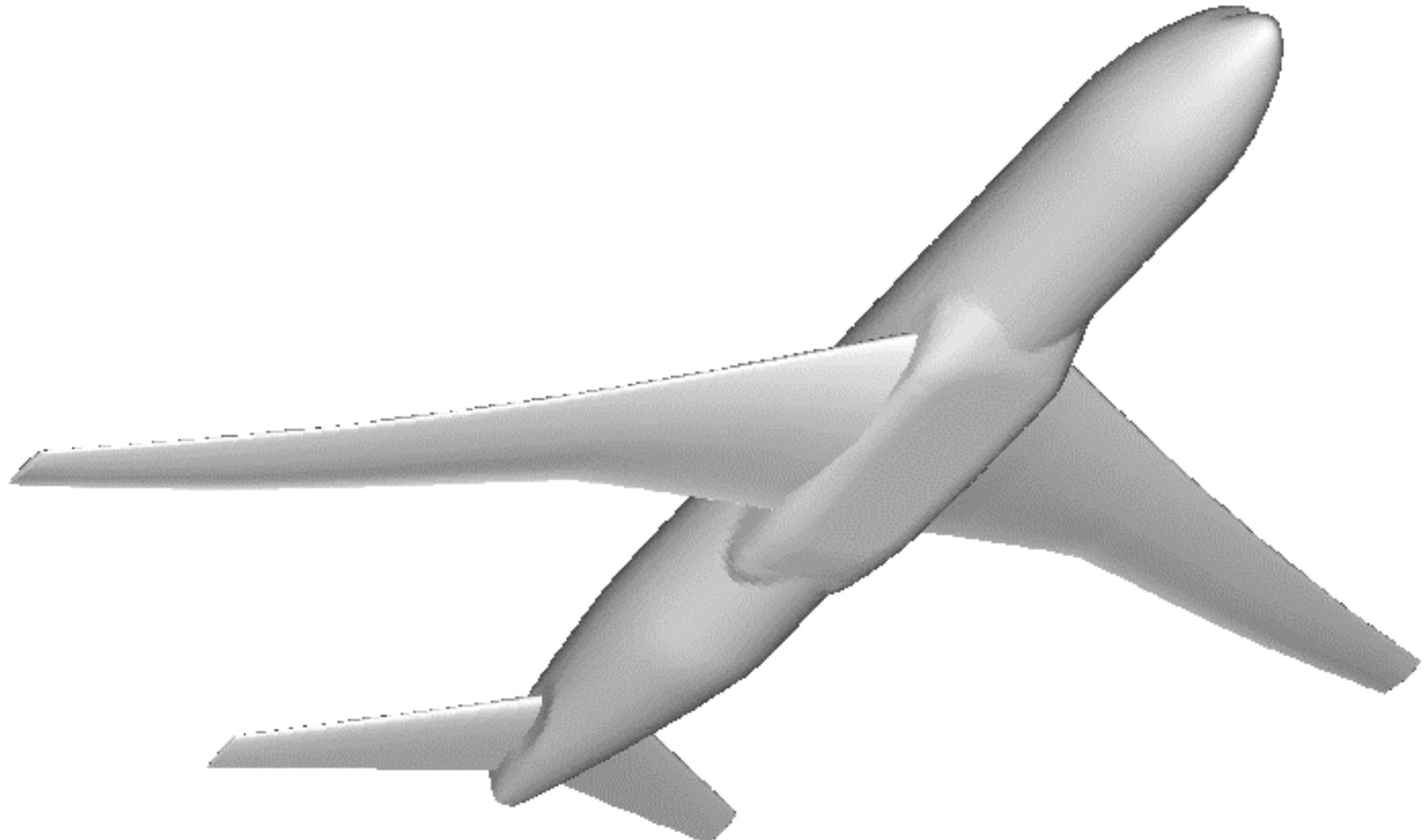
Lower Surface

WBH Configuration



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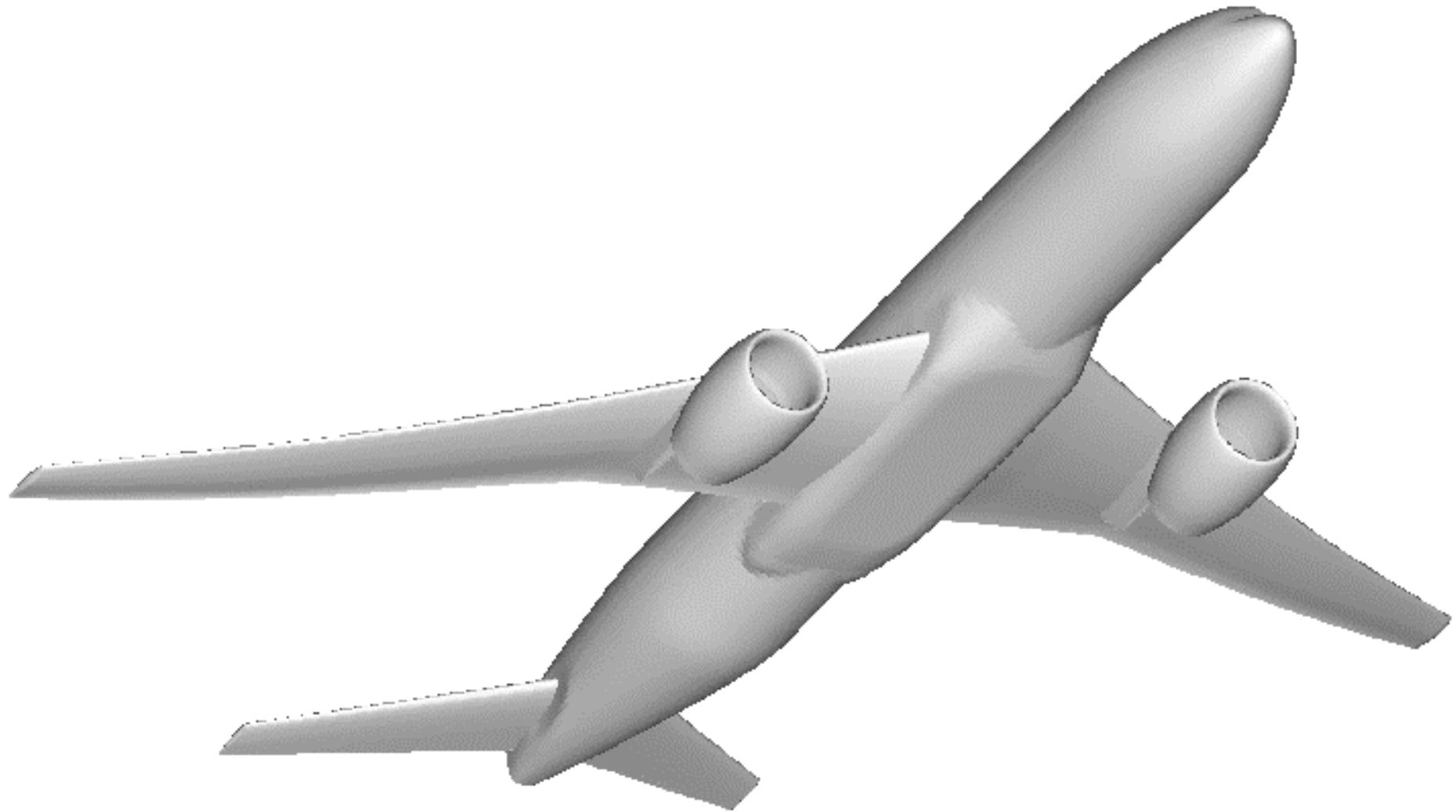


WBNPH Configuration



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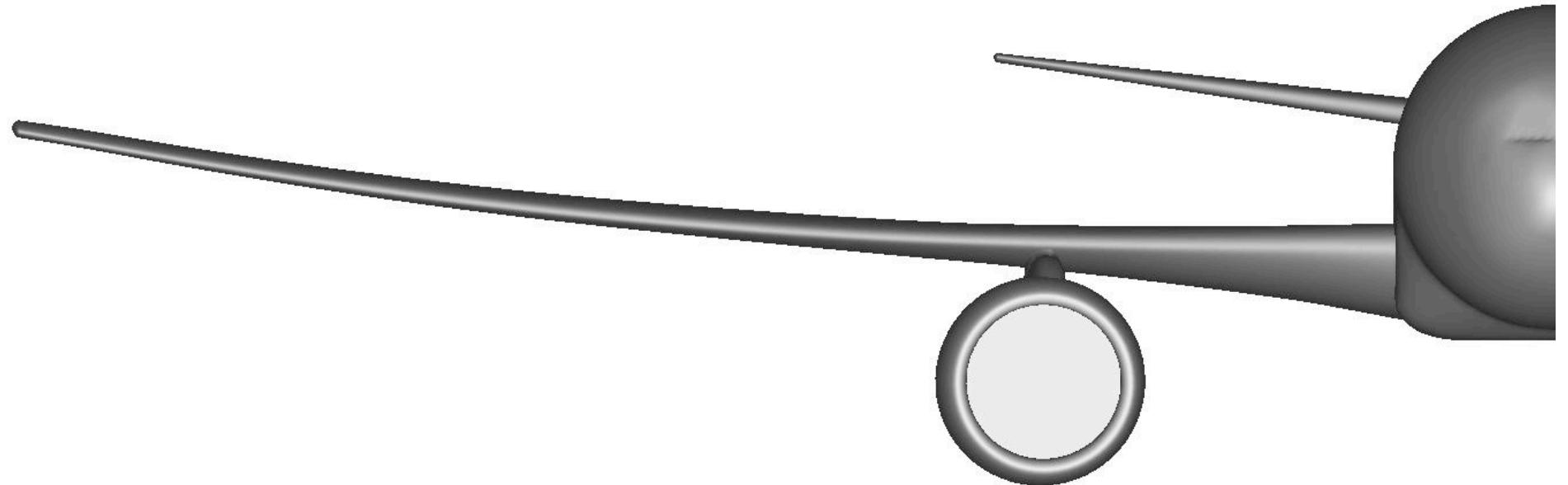


WBNPH Configuration



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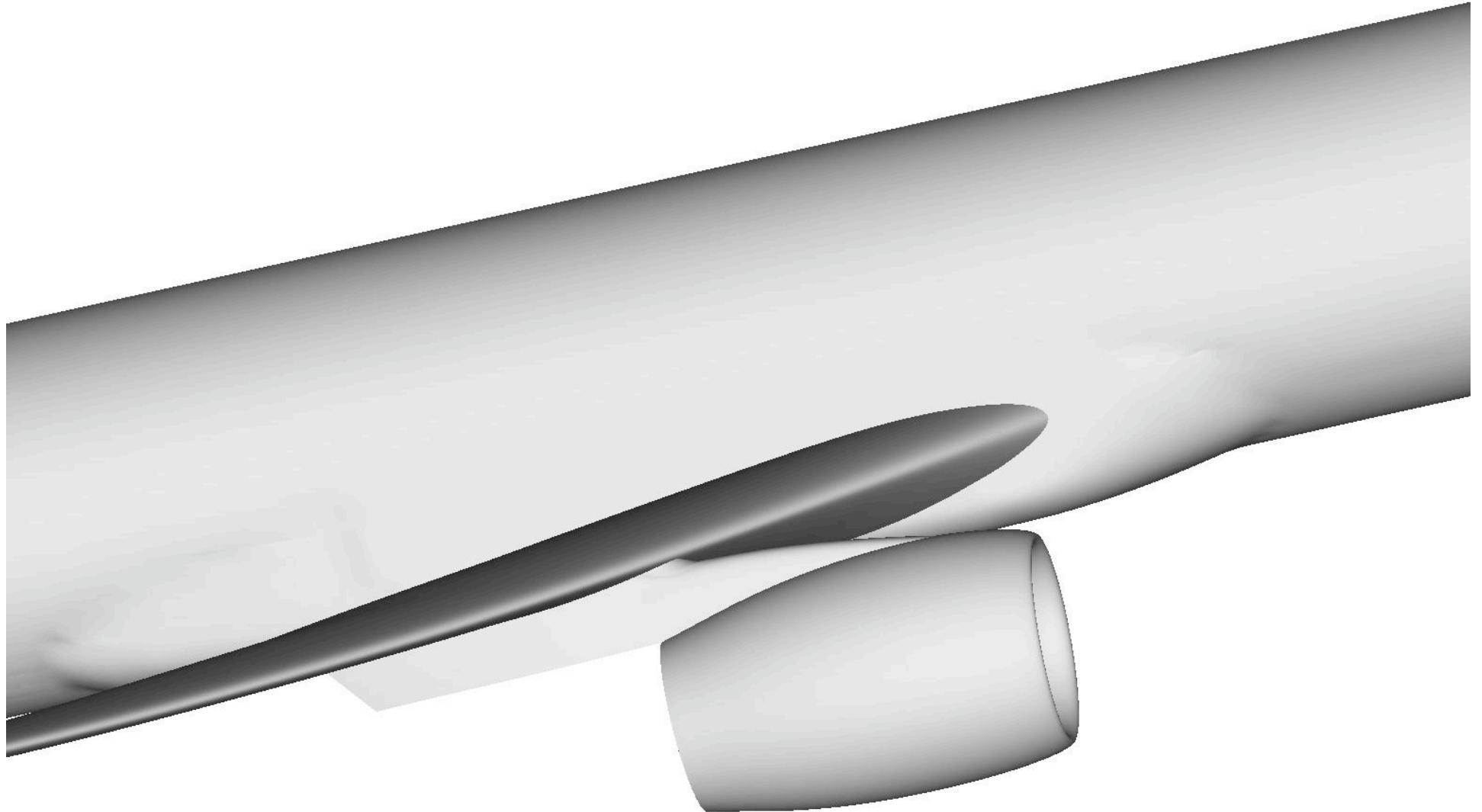


WBNPH Configuration



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Horizontal Tail



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- **Reference Quantities**

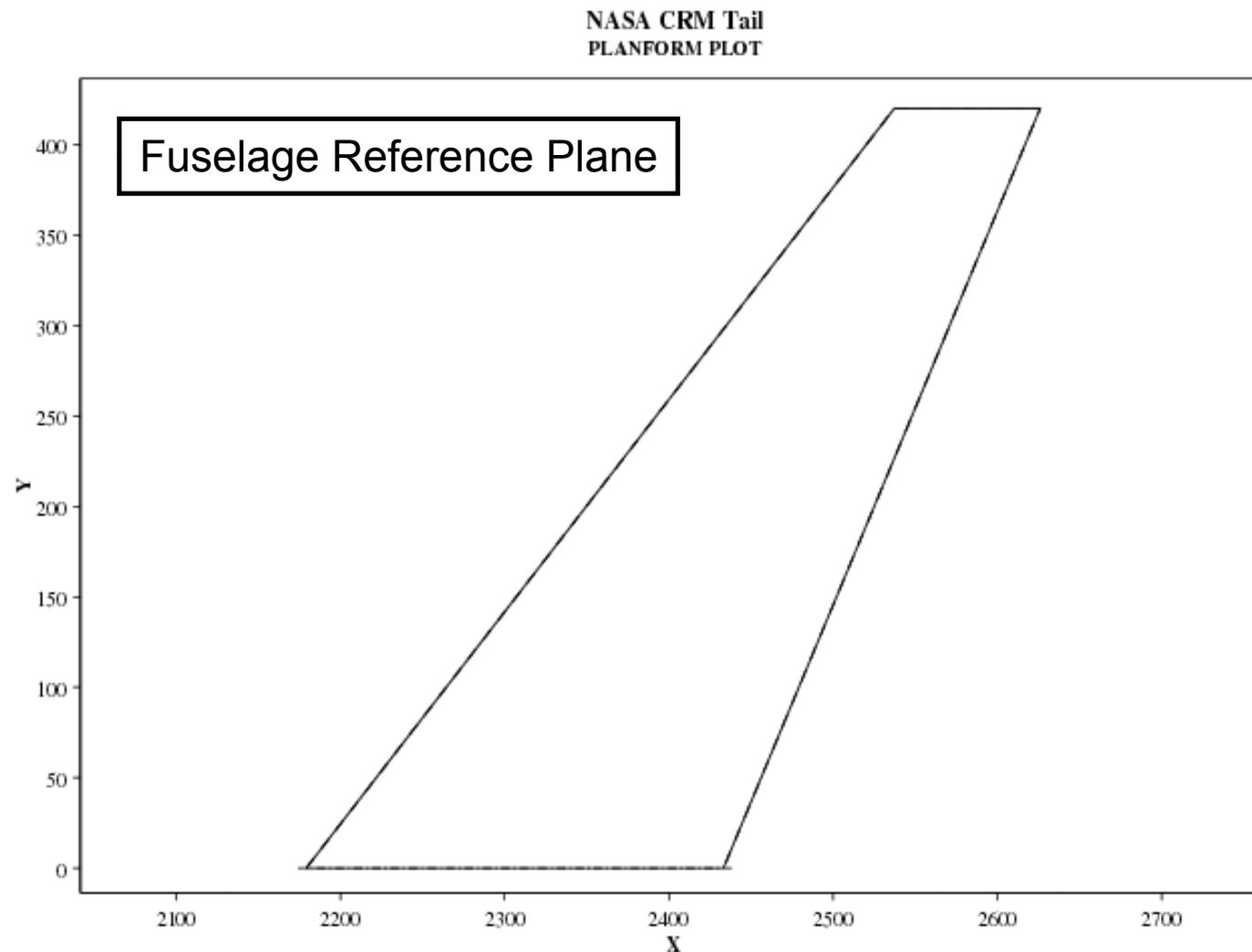
- $S_{ref} = 144,000. \text{ in}^2 = 1,000 \text{ ft}^2$
- $C_{ref} = 185.00 \text{ in}$
- $\text{Span} = 840.00 \text{ in} = 70 \text{ ft}$
- $X_{ref} = 2,375.60 \text{ in}$
- $Y_{ref} = 176.30 \text{ in}$
- $Z_{ref} = 275.00 \text{ in}$
- $\lambda = 0.35$
- $\Lambda_{C/4} = 37^\circ$
- $AR = 4.9$

Horizontal Tail Planform



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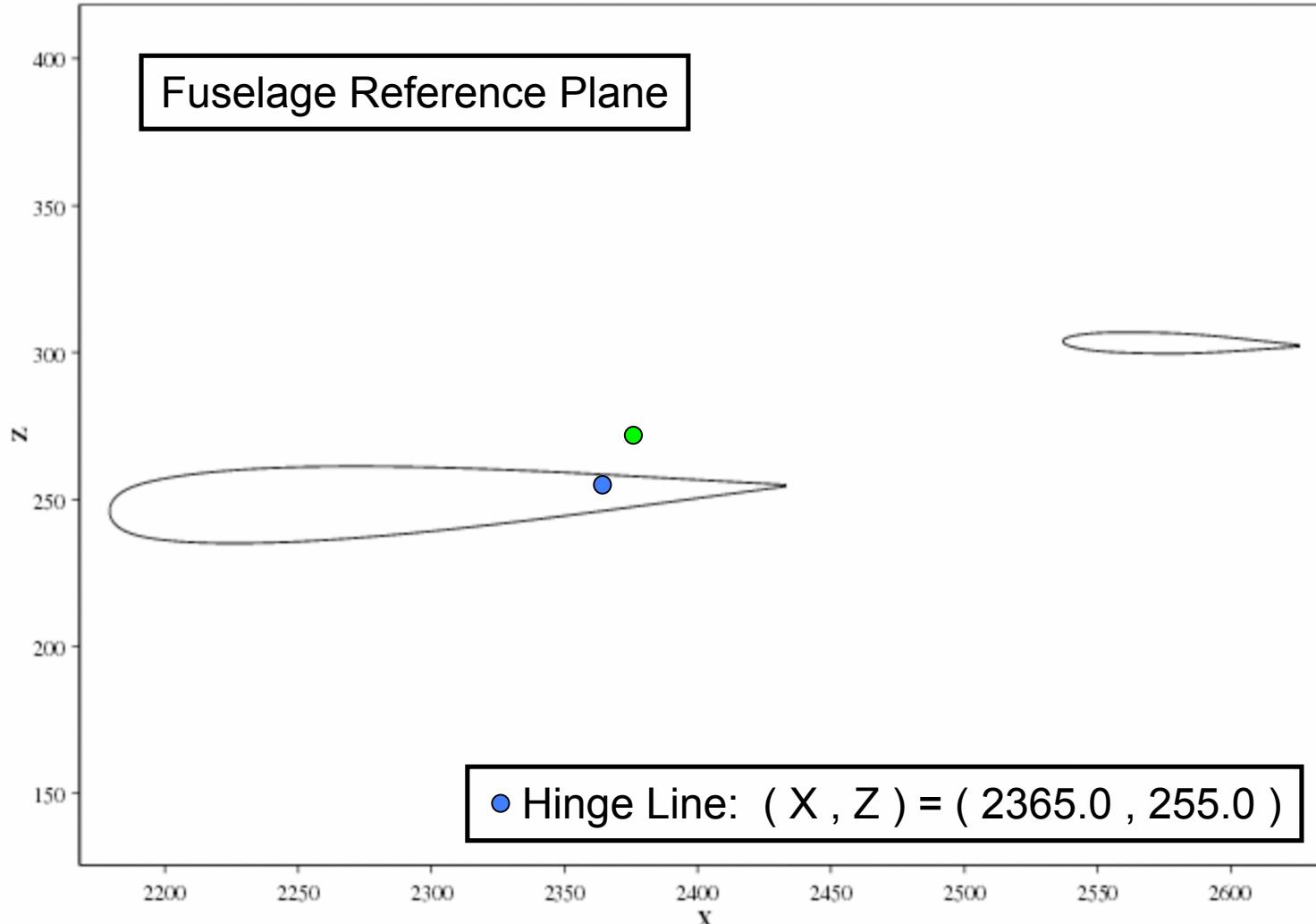
Horizontal Tail Airfoil Stack



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NASA CRM Tail
AIRFOIL SECTION CUTS

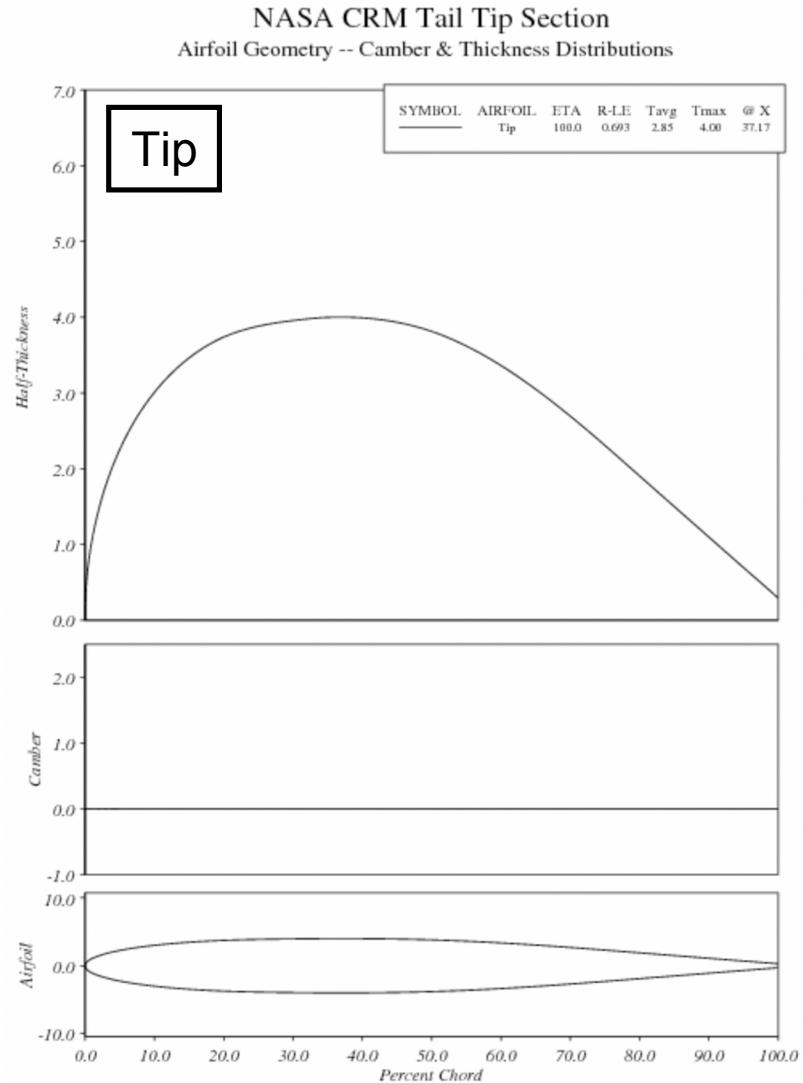
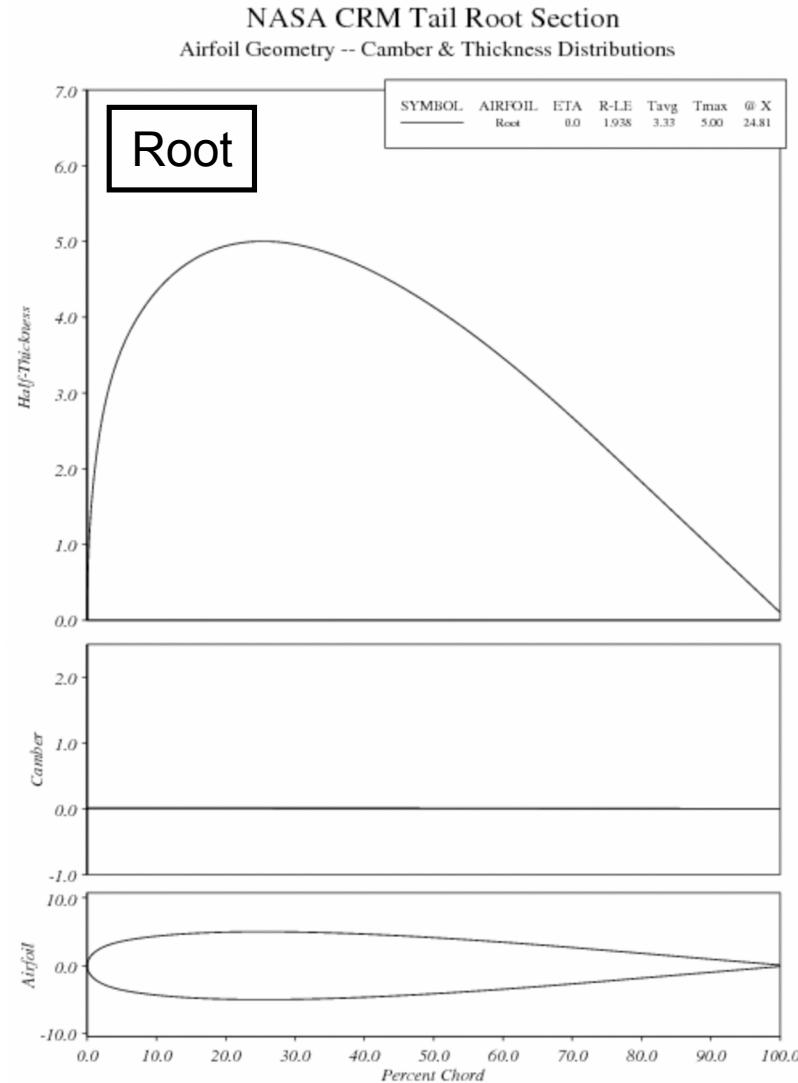


Tail Airfoil Characteristics



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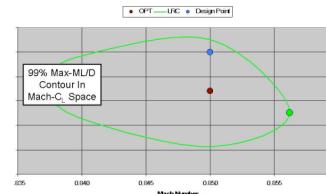
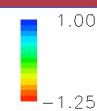
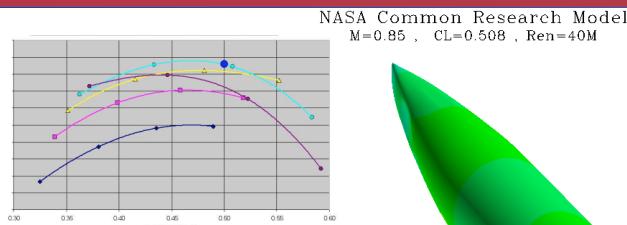


Questions?



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Key	Rn _c (10 ⁶)	T _t (°F)	P _t (psia)	Q (psf)	Q/E (10 ⁻⁶)
●	5.0	100	29.2	1,325	0.349
●	19.8	-250	28.9	1,310	0.349
●	19.8	-182	43.7	1,986	0.507
●	30.0	-250	43.9	1,986	0.503

