



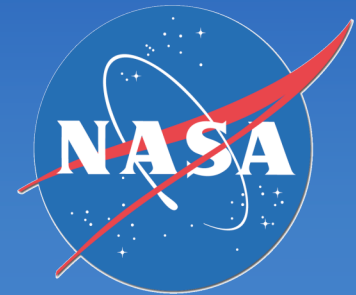
Phantom

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

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The Boeing Company – Phantom Works

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NASA Langley Research Center

AIAA Applied Aerodynamics Conference
Honolulu, HI
20 August 2008



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

Wing Planform & Layout



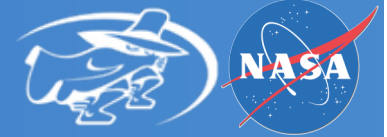
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• Reference Quantities

- **Sref = 594,720. in² = 4,130 ft²**
- **Cref = 275.80 in**
- **Span = 2,313.50 in = 192.8 ft**
- **Xref = 1,325.90 in**
- **Yref = 468.75 in**
- **Zref = 177.95 in**
- **$\lambda = 0.275$**
- **$\Lambda_{C/4} = 35^\circ$**
- **AR = 9.0**

Wing Planform & Layout



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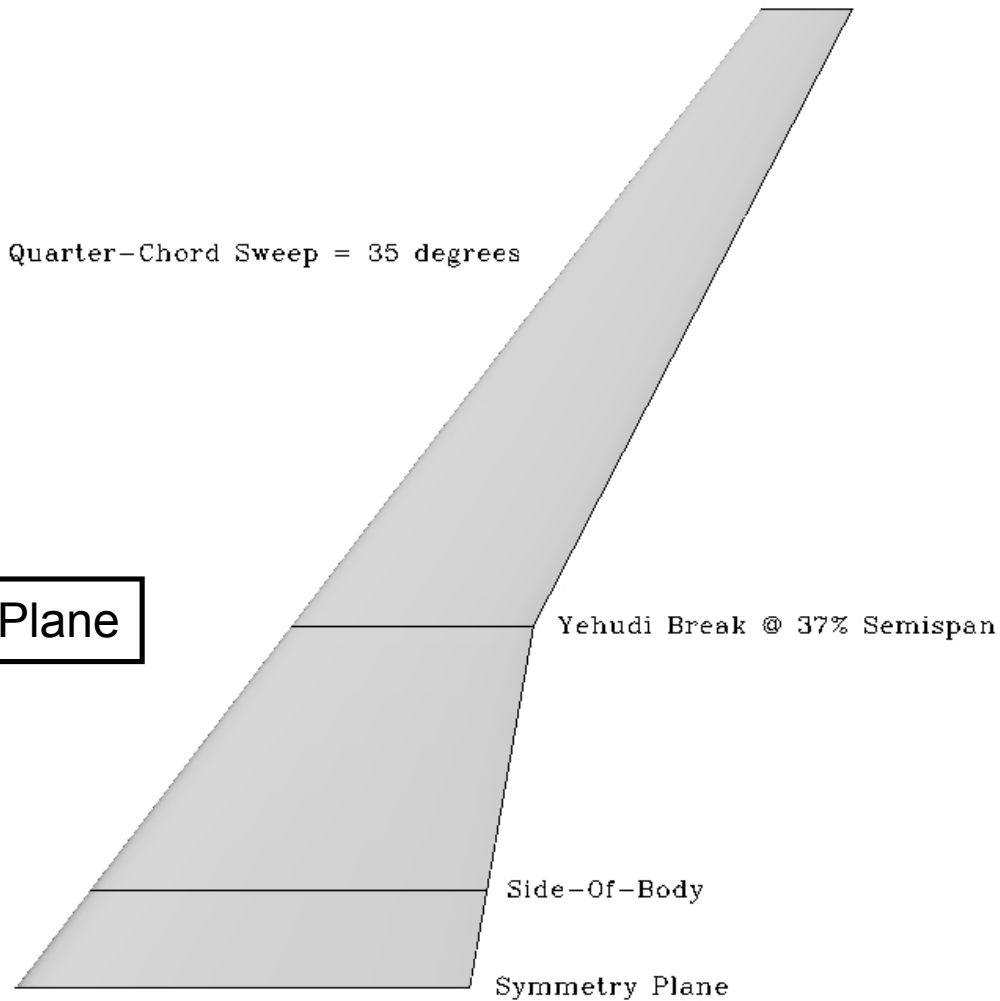
Flight Sciences

NASA Common Model

$S_{ref}=594,720.0$, $C_{ref}=275.8$, $b=2,313.5$, $X_{ref}=425.9$, $AR=9.0$

Quarter-Chord Sweep = 35 degrees

Wing Reference Plane



Wing Planform & Layout

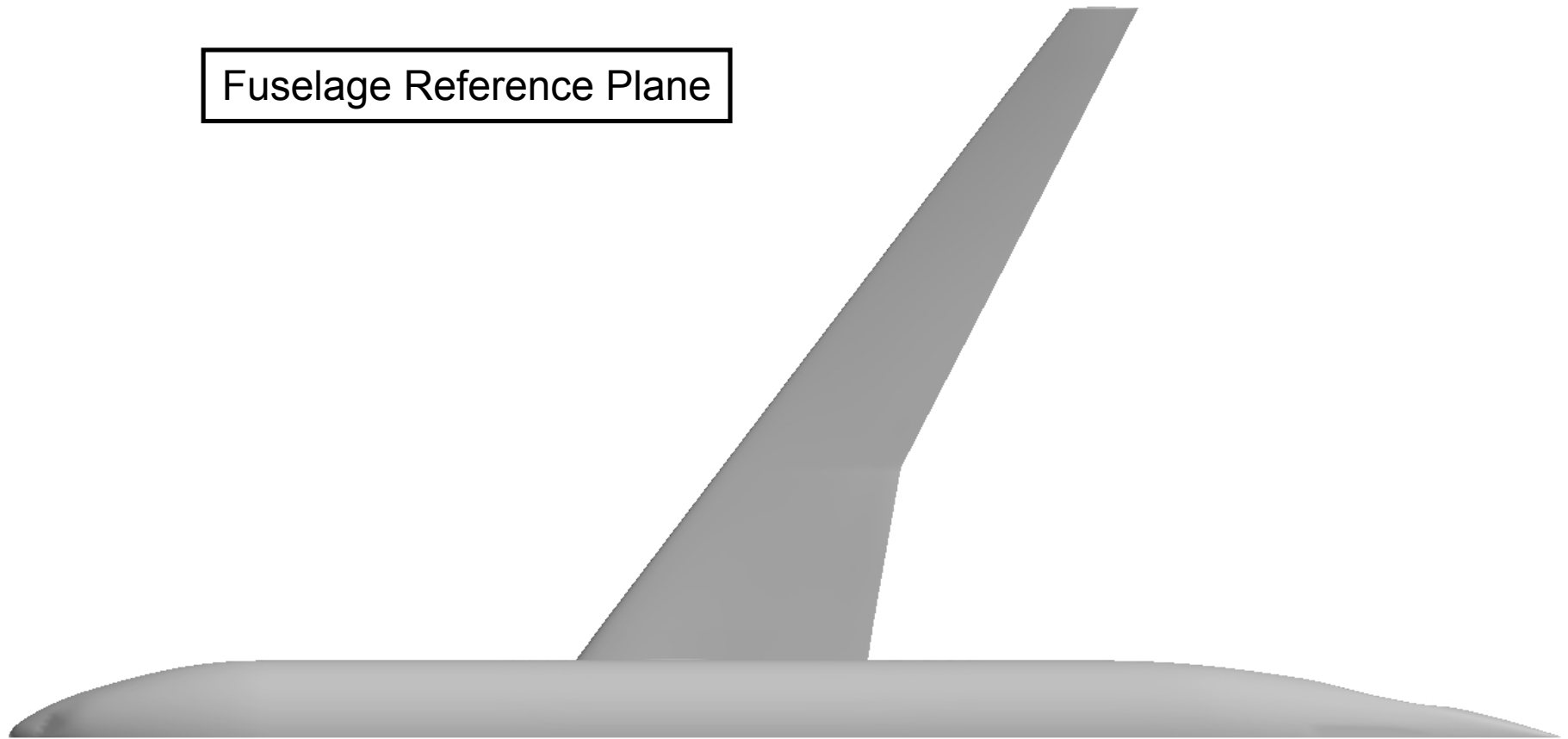


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NASA Common Research Model

Fuselage Reference Plane

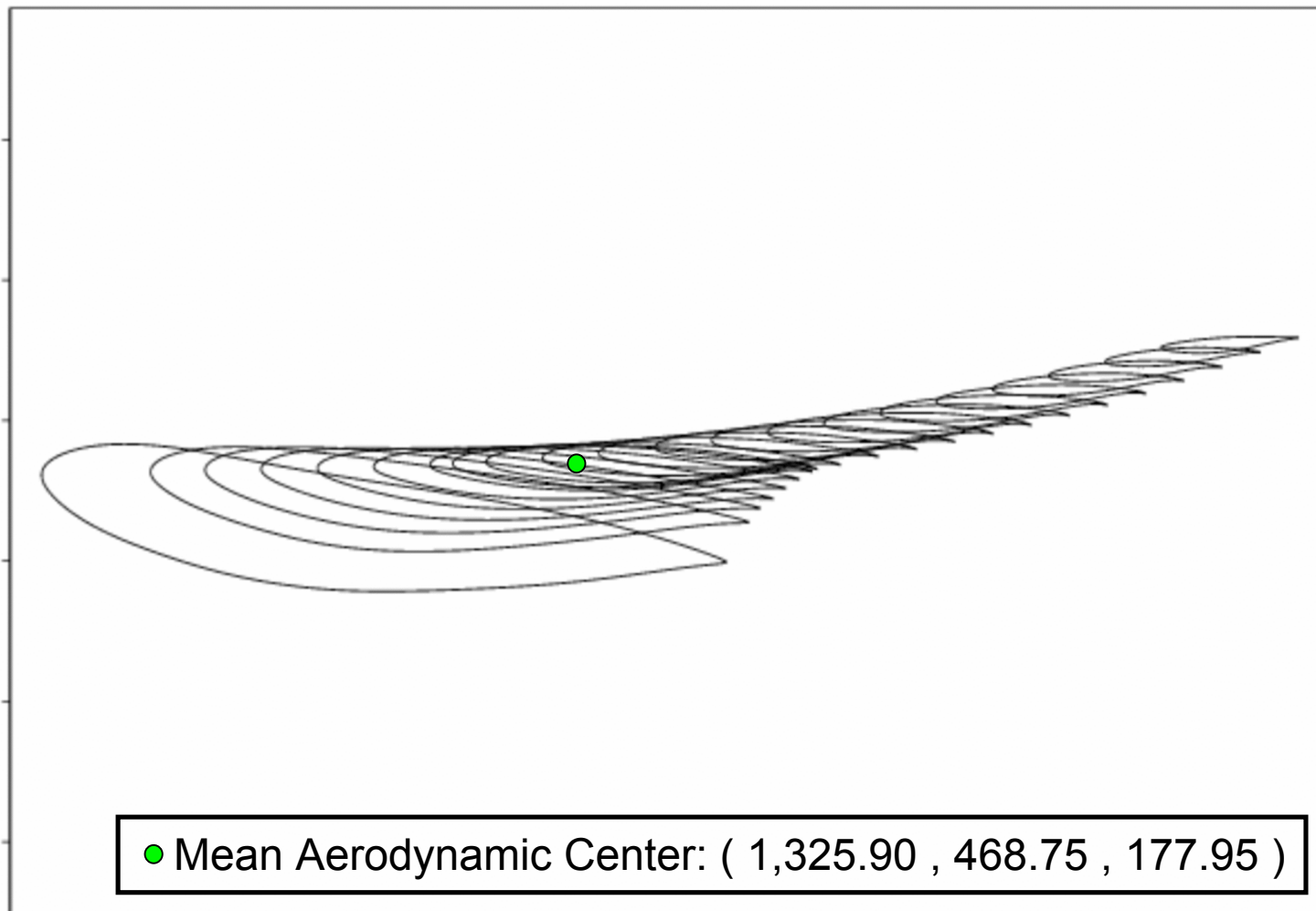


Wing Airfoil Stack

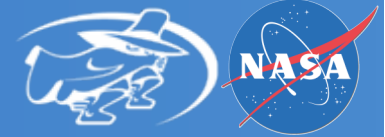


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Wing Thickness



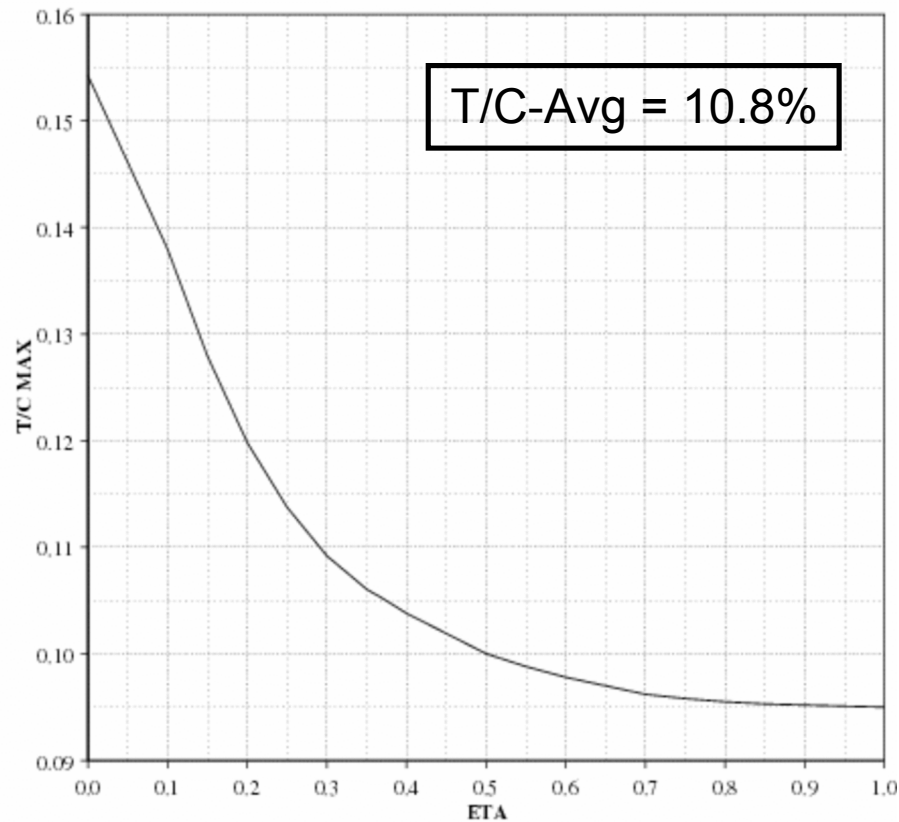
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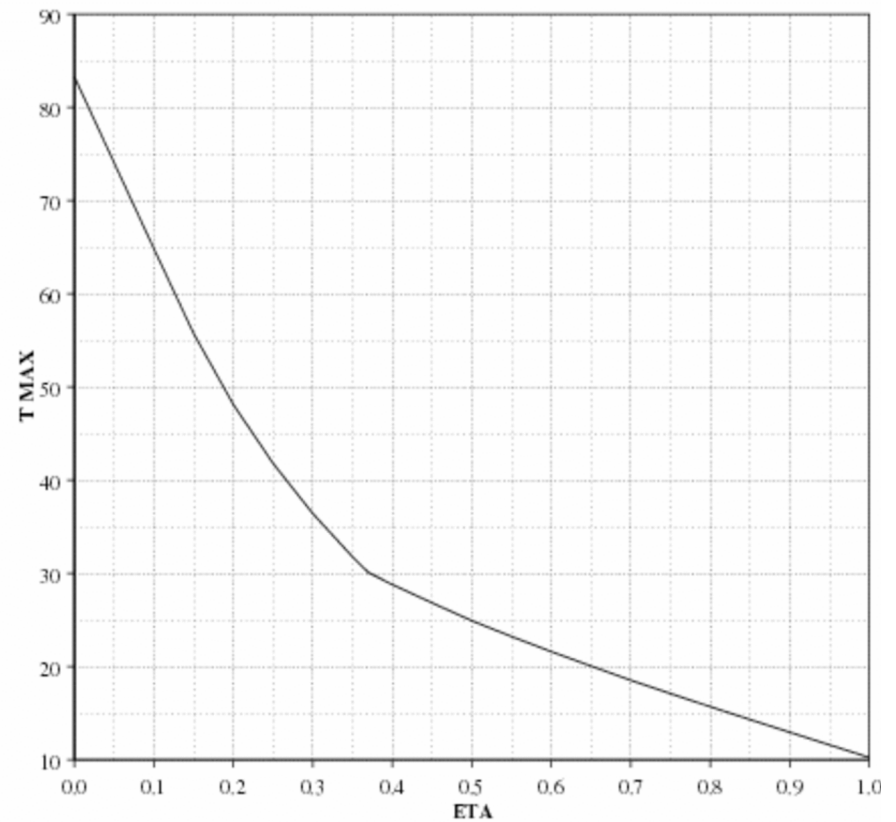
Non-Dimensional

Absolute (inches)

NASA CRM-05a
MAXIMUM T/C DISTRIBUTION



NASA CRM-05a
MAXIMUM THICKNESS DISTRIBUTION



Wing Camber & Twist

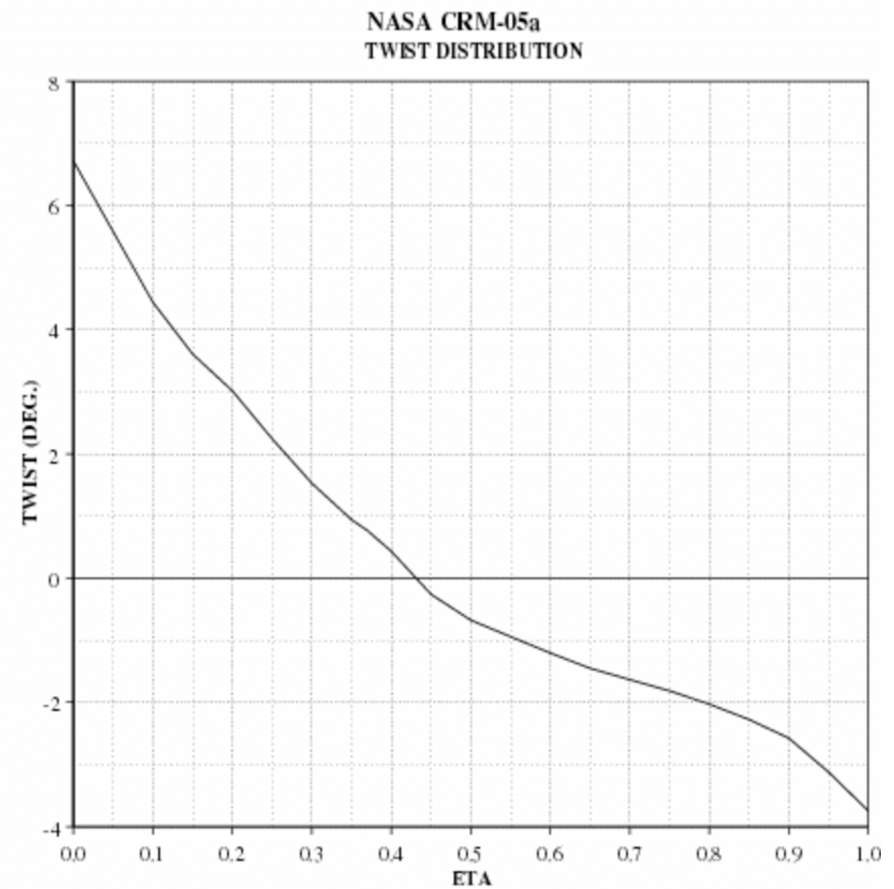
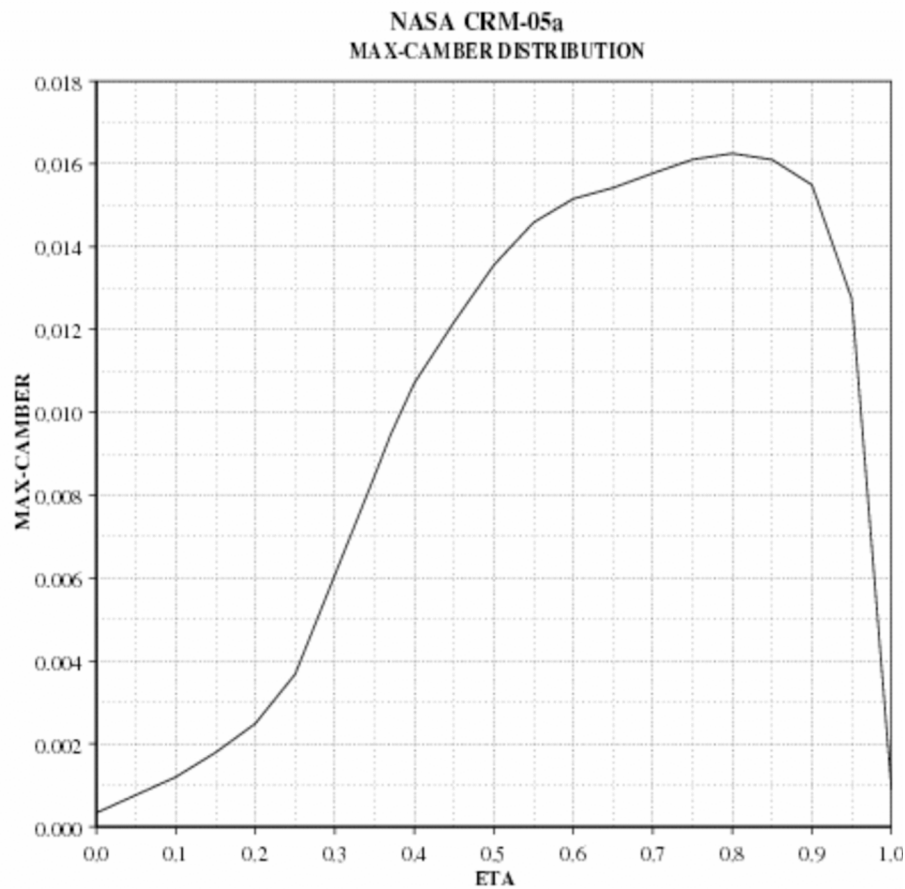


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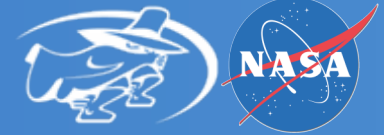
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Max-Camber

Twist (deg)



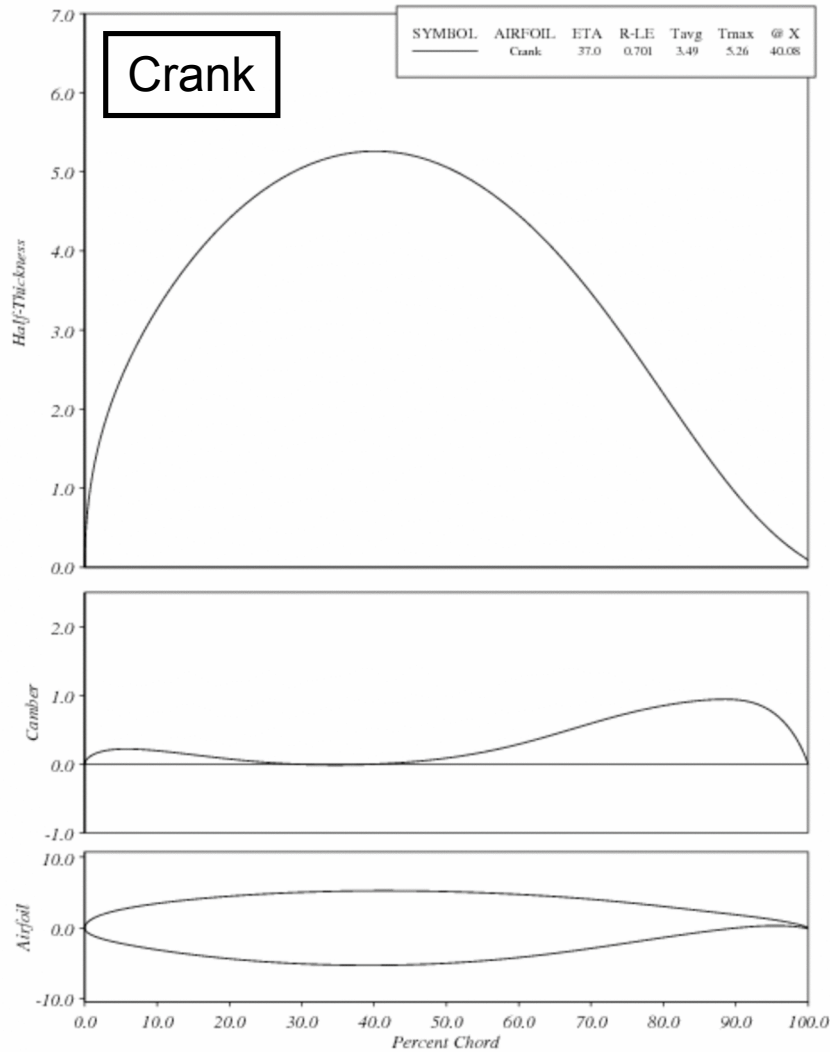
Airfoil Characteristics



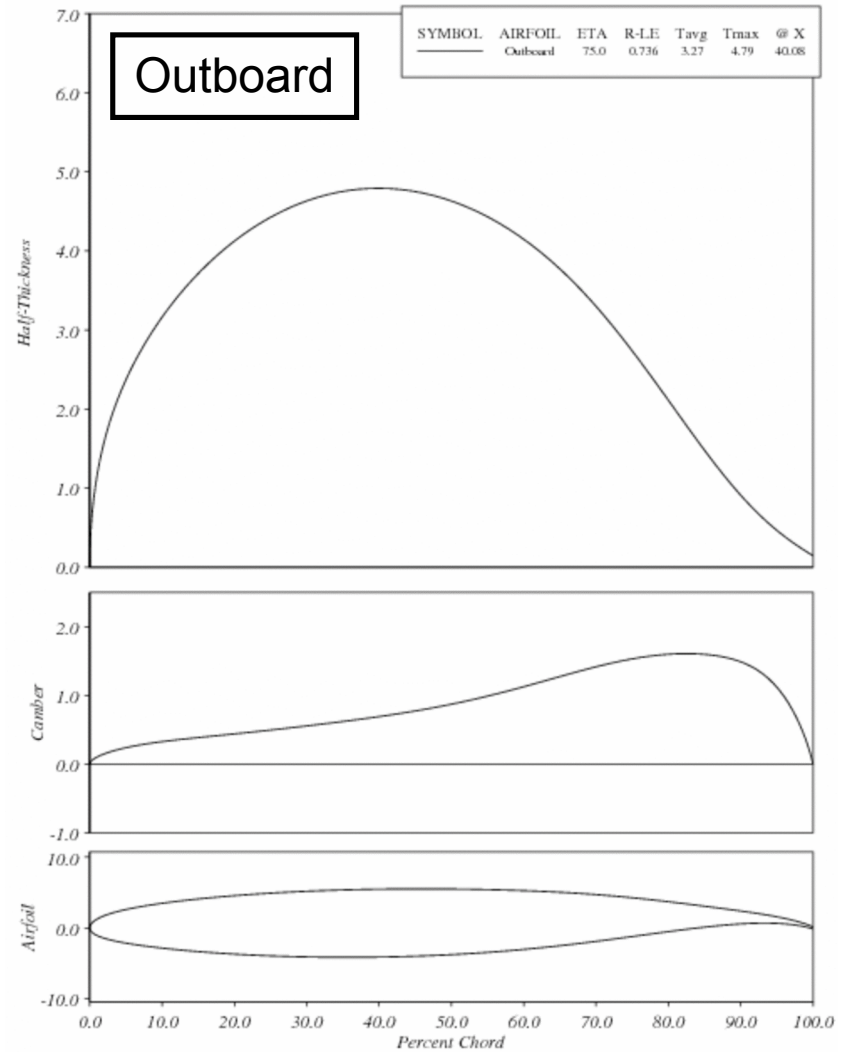
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NASA CRM Wing
Airfoil Geometry -- Camber & Thickness Distributions



NASA CRM Wing
Airfoil Geometry -- Camber & Thickness Distributions



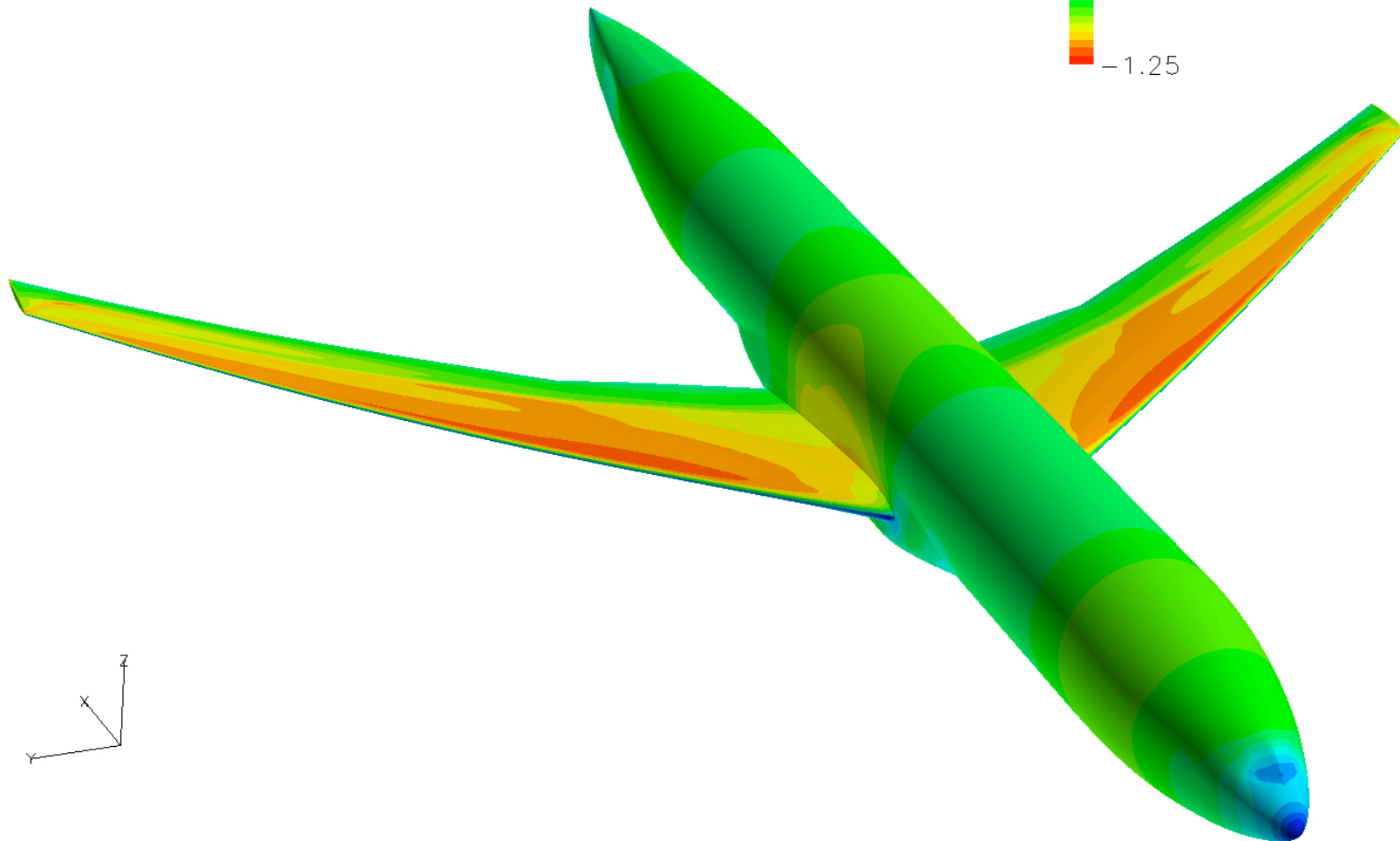
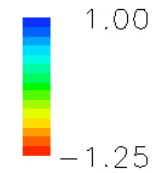
Surface Isobars



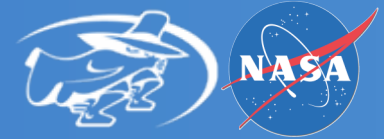
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NASA Common Research Model
M=0.85 , CL=0.508 , Ren=40M



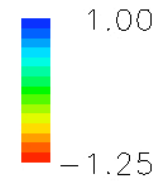
Surface Isobars



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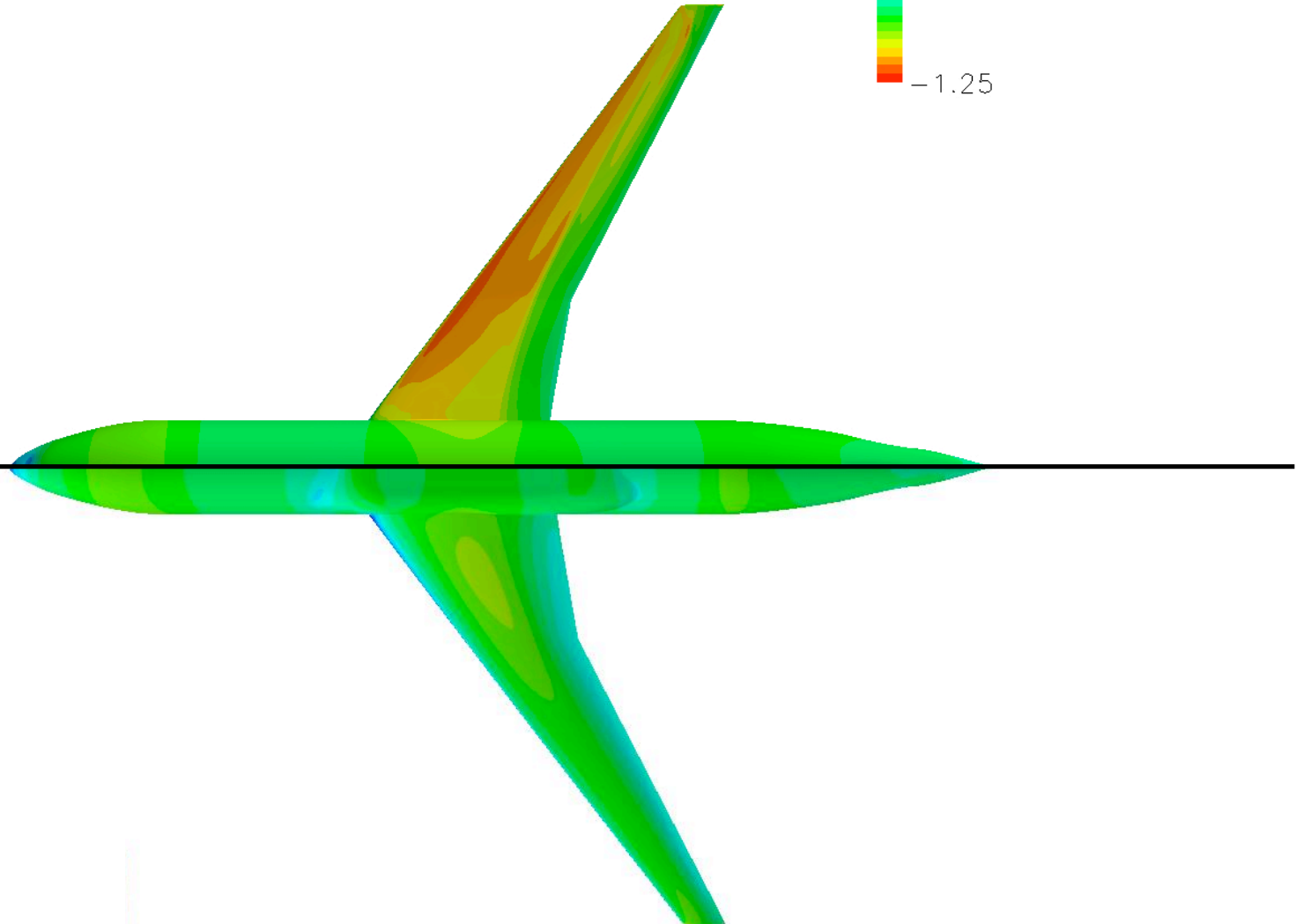
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NASA Common Research Model
M=0.85 , CL=0.508 , Ren=40M



Upper Surface

Lower Surface

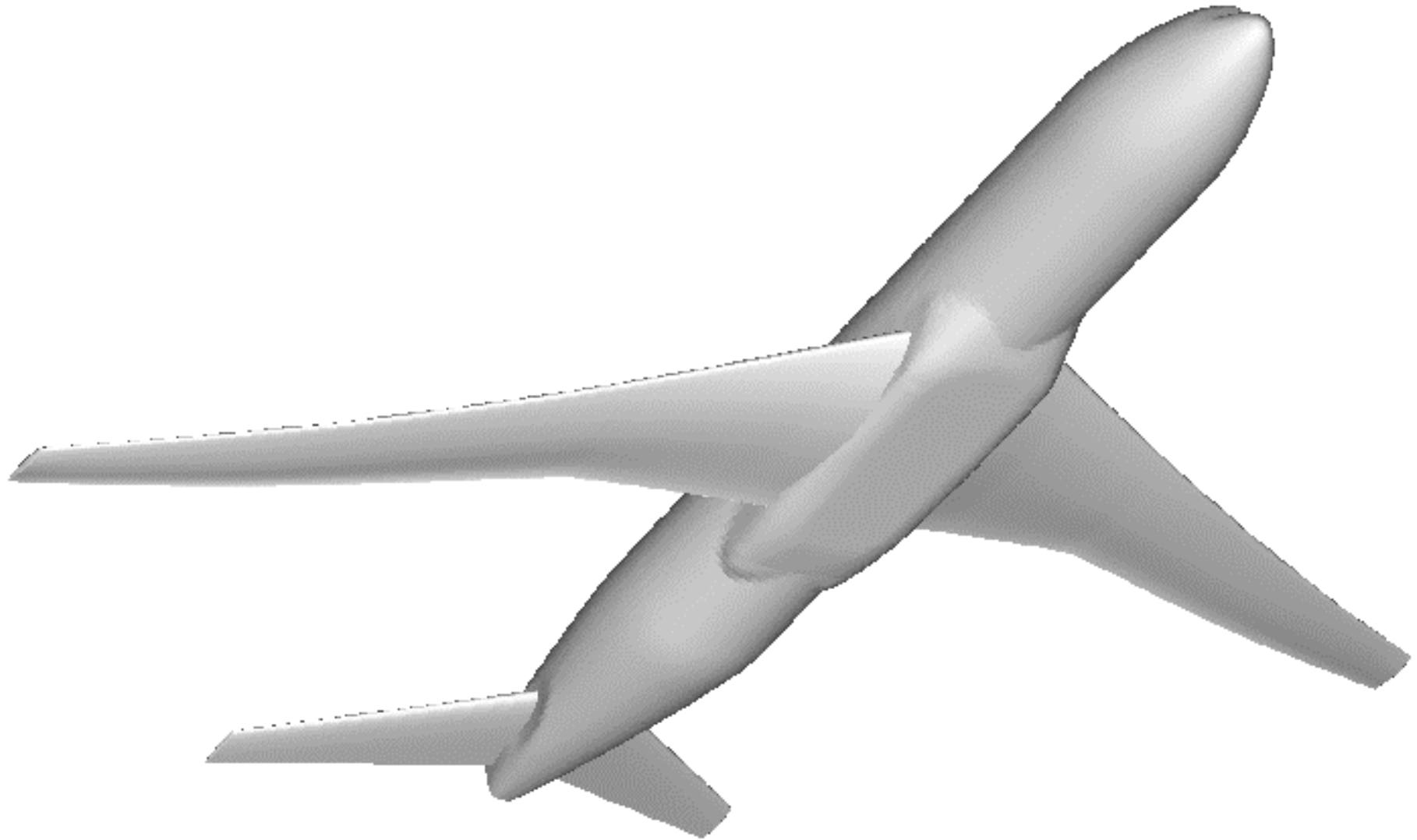


WBH Configuration



The Boeing Company - Phantom Works

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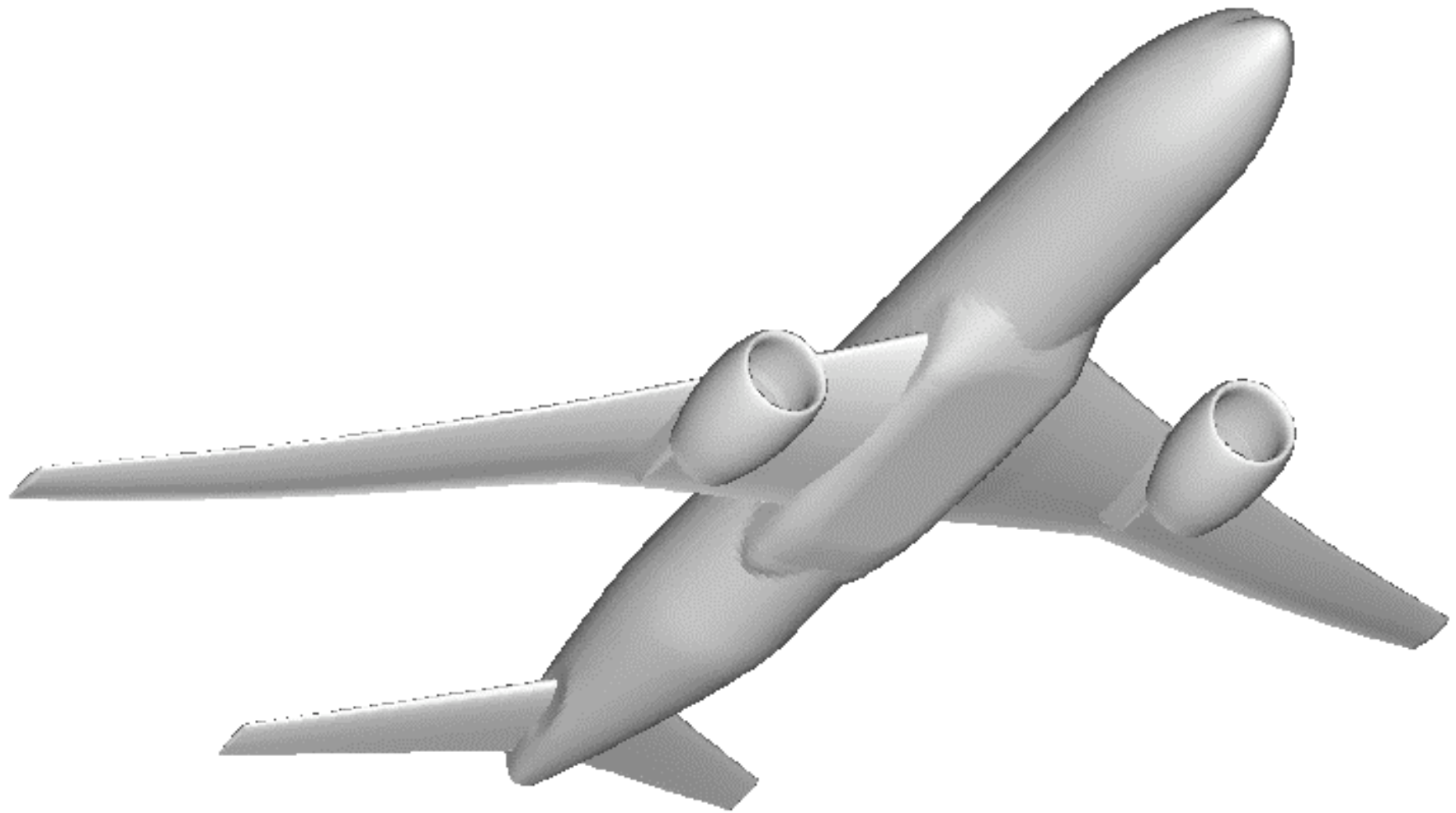


WBNPH Configuration



The Boeing Company - Phantom Works

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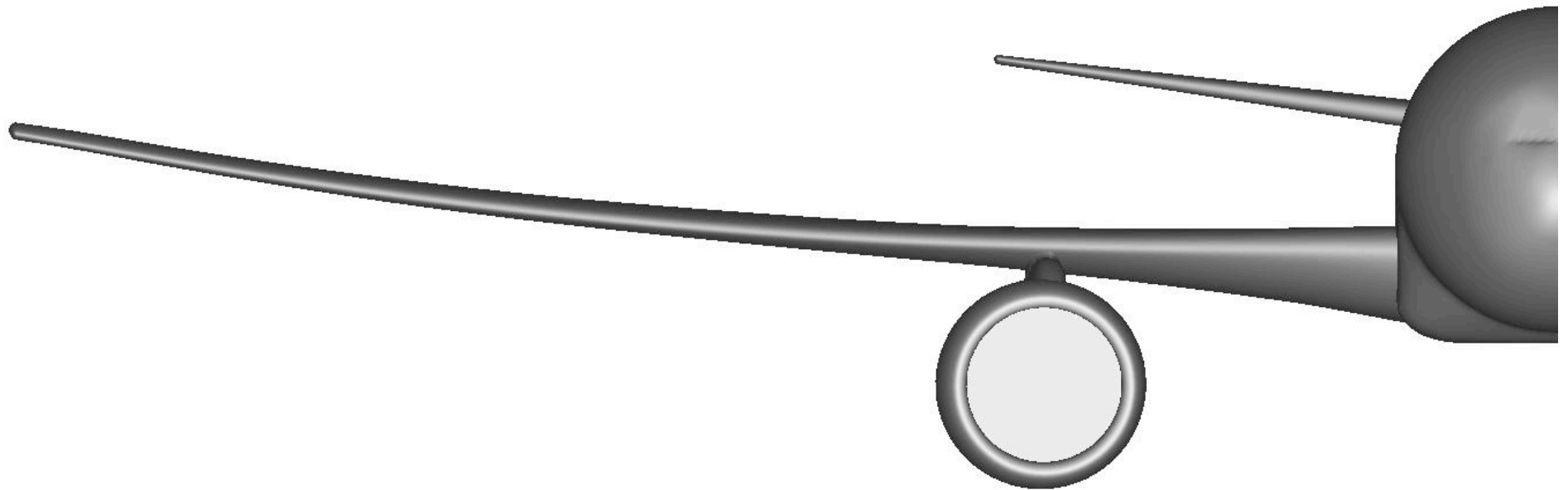


WBNPH Configuration



The Boeing Company - Phantom Works

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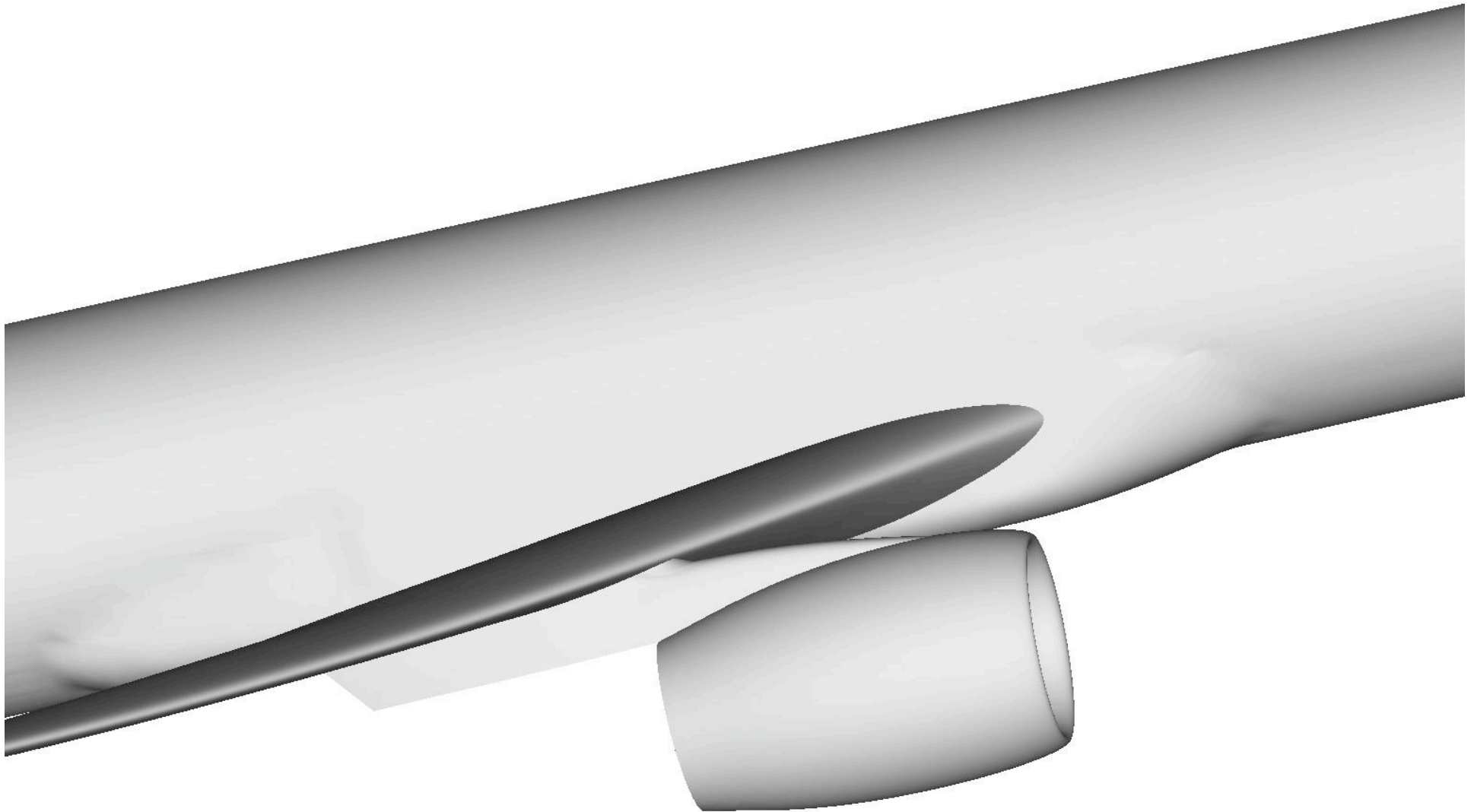


WBNPH Configuration



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Horizontal Tail



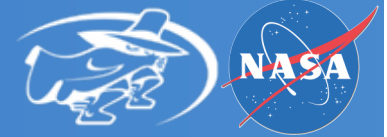
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- **Reference Quantities**

- **Sref = 144,000. in² = 1,000 ft²**
- **Cref = 185.00 in**
- **Span = 840.00 in = 70 ft**
- **Xref = 2,375.60 in**
- **Yref = 176.30 in**
- **Zref = 275.00 in**
- **$\lambda = 0.35$**
- **$\Lambda_{C/4} = 37^\circ$**
- **AR = 4.9**

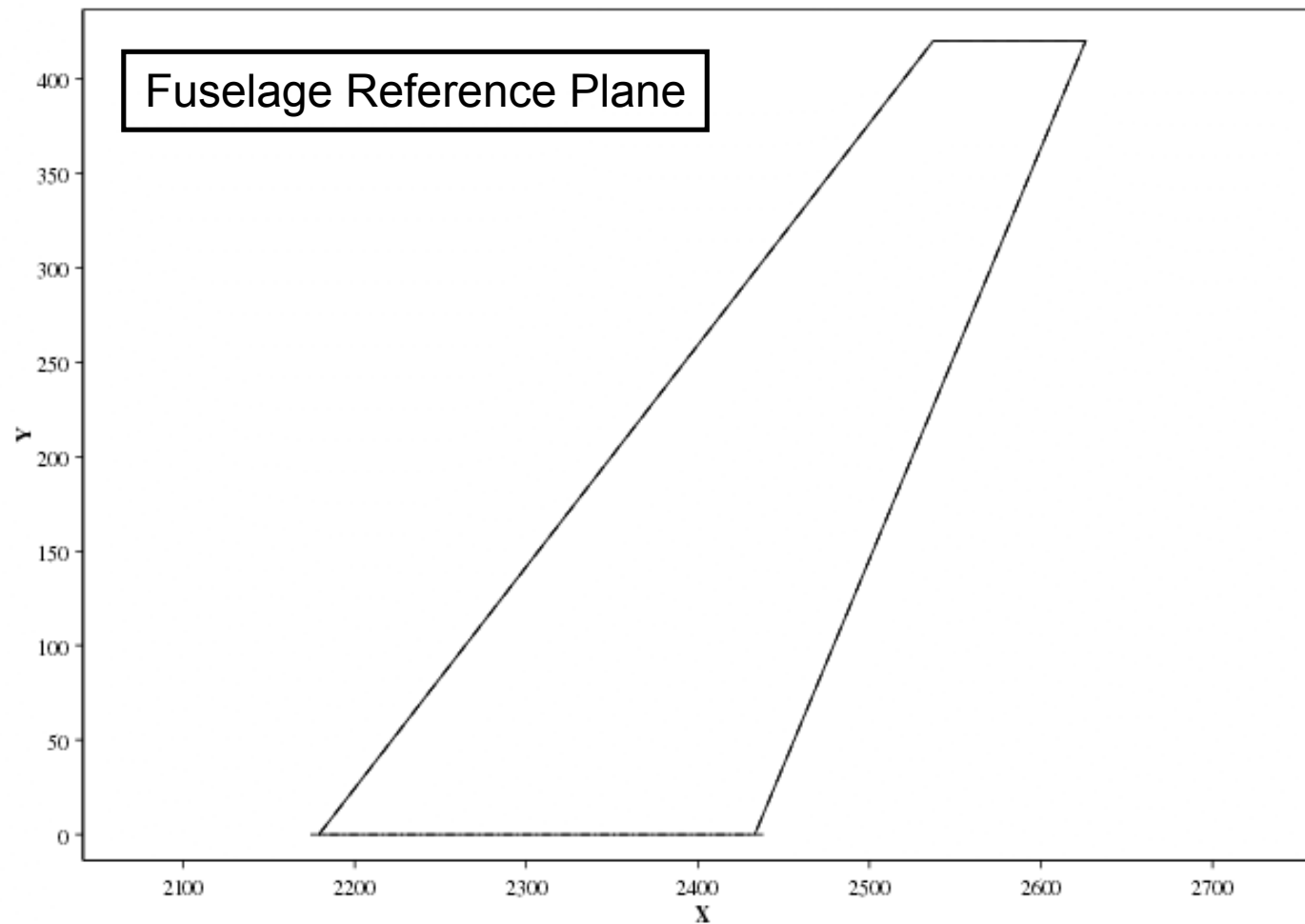
Horizontal Tail Planform



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NASA CRM Tail
PLANFORM PLOT



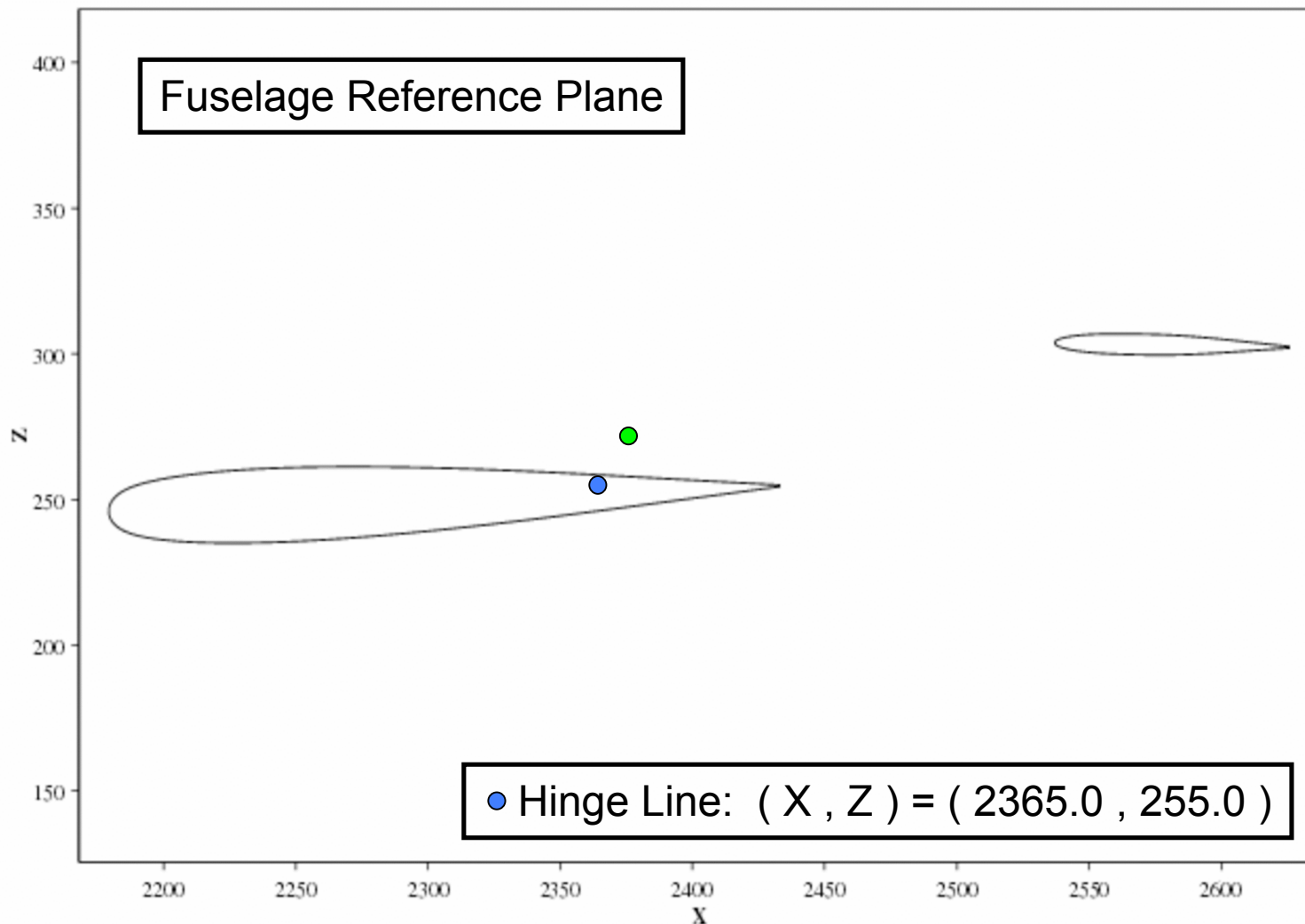
Horizontal Tail Airfoil Stack



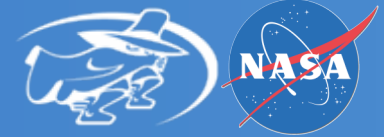
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NASA CRM Tail
AIRFOIL SECTION CUTS



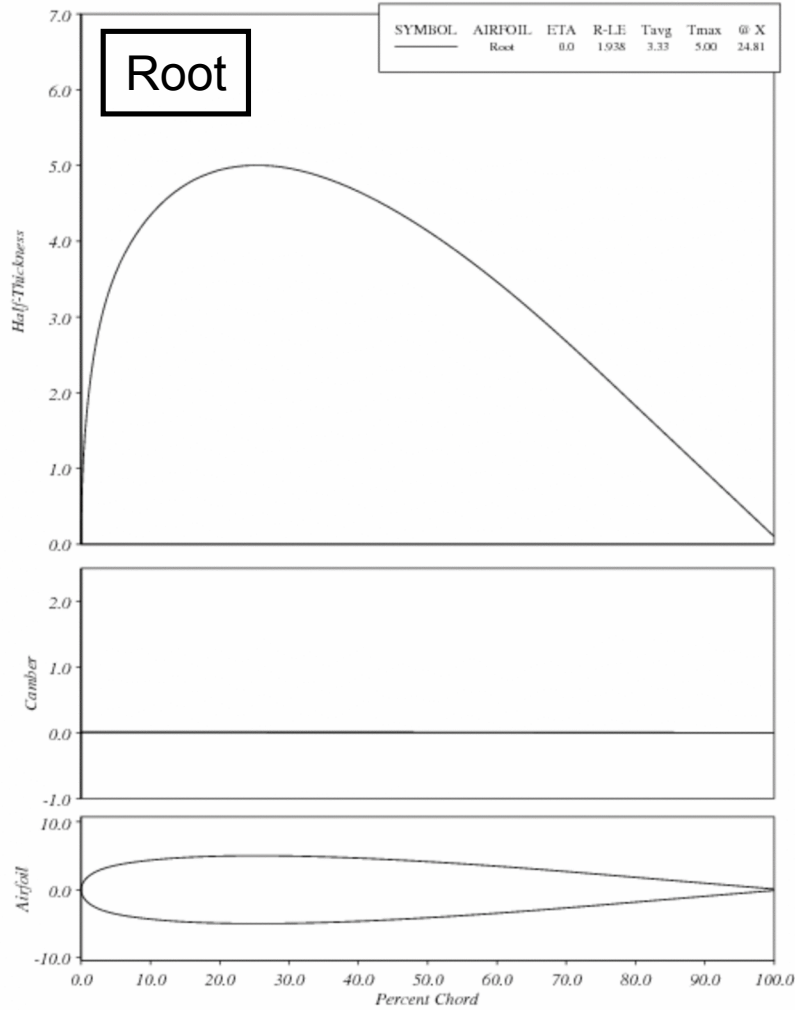
Tail Airfoil Characteristics



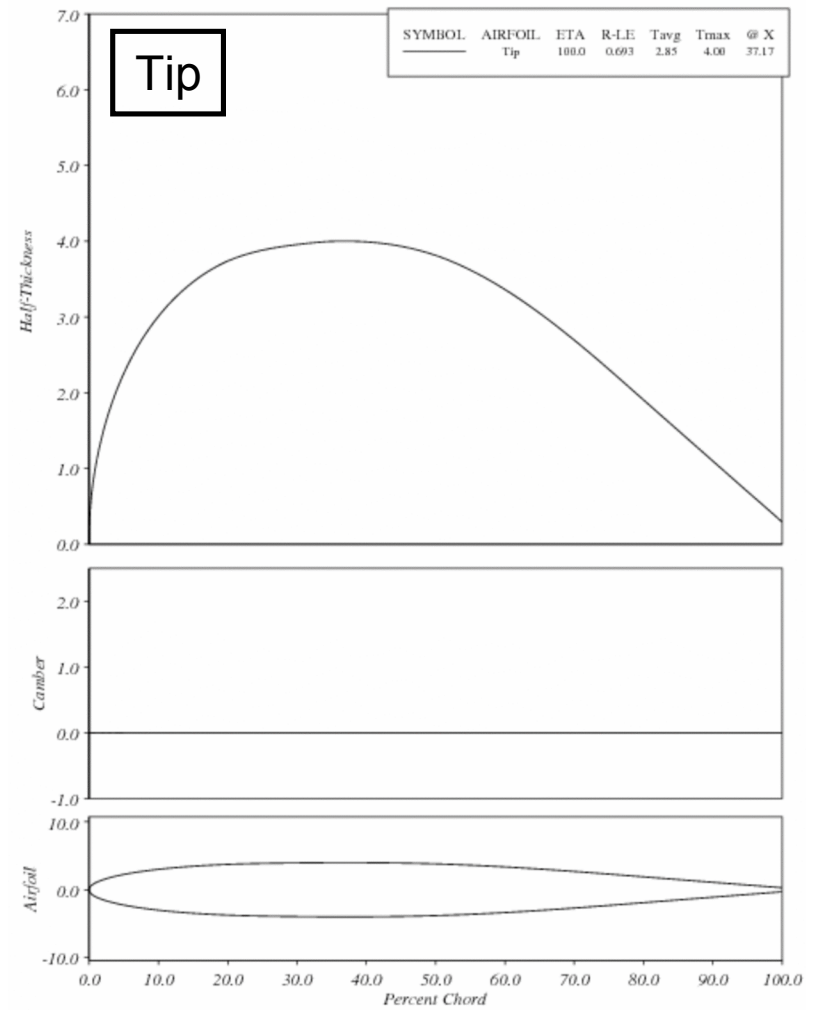
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NASA CRM Tail Root Section
Airfoil Geometry -- Camber & Thickness Distributions



NASA CRM Tail Tip Section
Airfoil Geometry -- Camber & Thickness Distributions



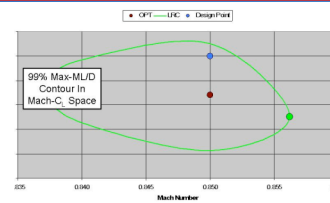
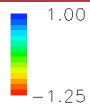
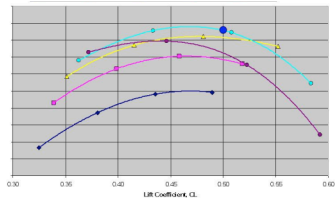
Questions?



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NASA Common Research Model
M=0.85, CL=0.508, Ren=40M



Key	Rn _c (10 ⁶)	T _t (°F)	P _t (psia)	Q (psf)	Q/E (10 ⁻⁵)
● (Yellow)	5.0	100	29.2	1,325	0.349
● (Green)	19.8	-250	28.9	1,310	0.349
● (Cyan)	19.8	-182	43.7	1,986	0.507
● (Blue)	30.0	-250	43.9	1,986	0.503

