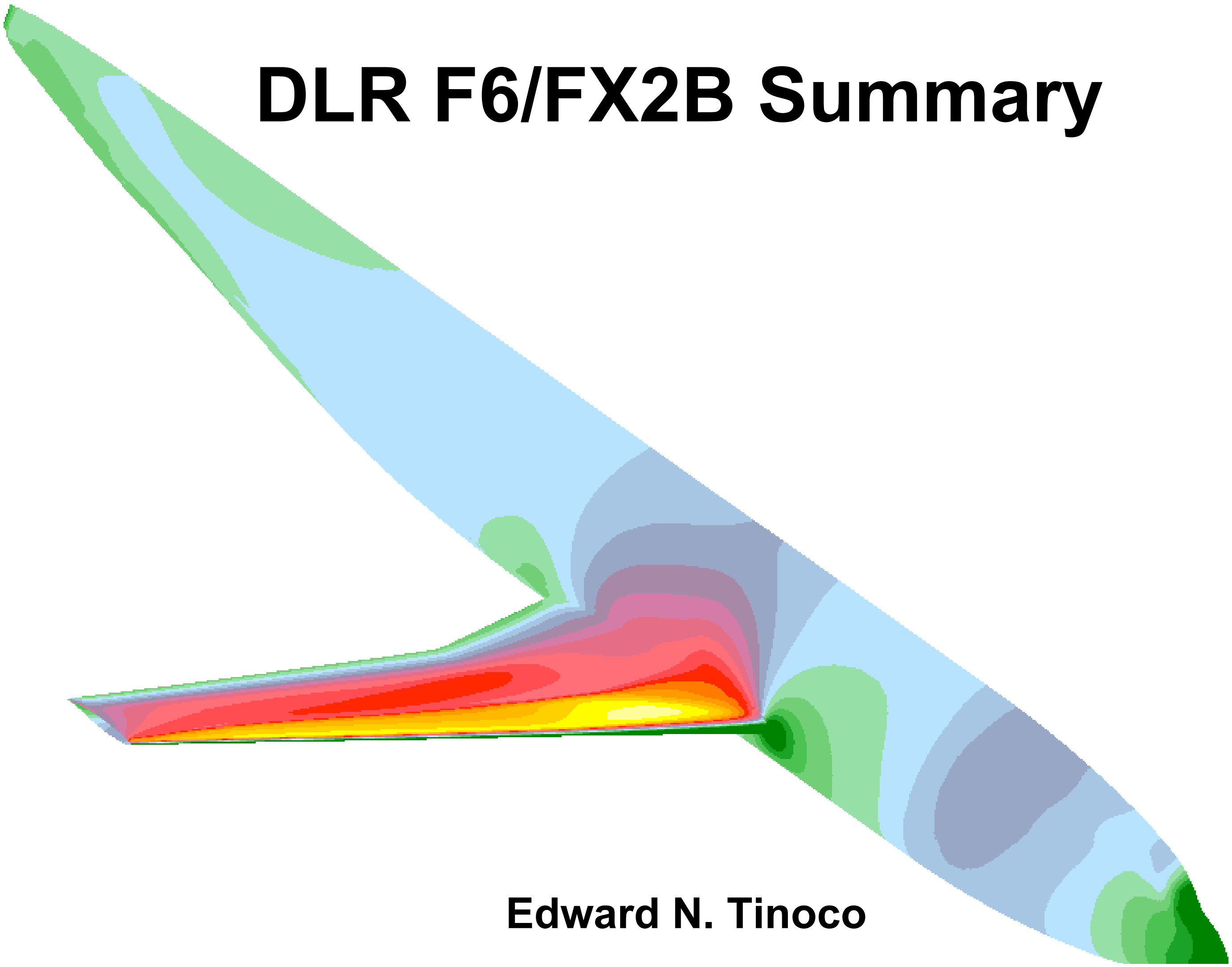
DLR F6/FX2B Summary



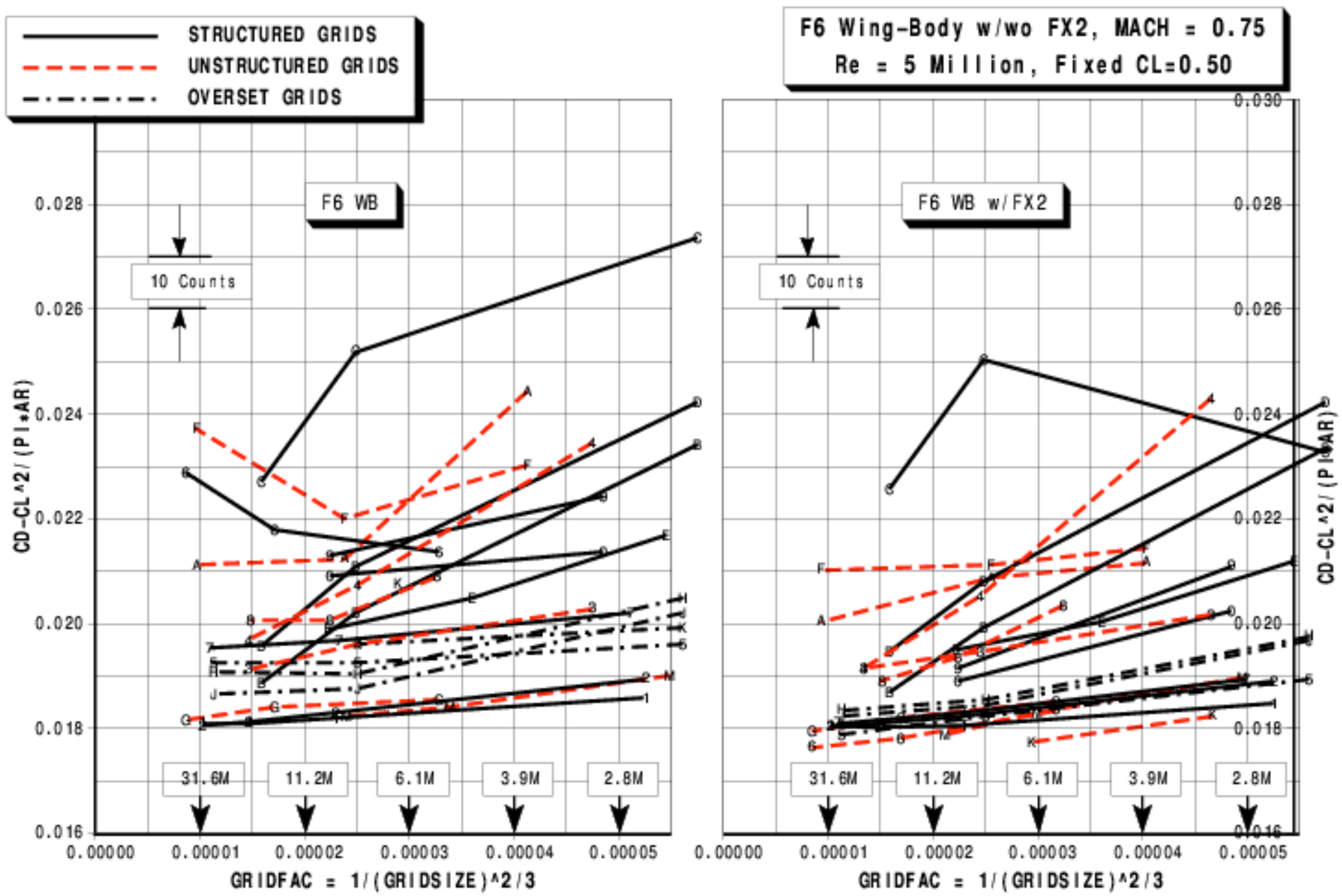
Edward N. Tinoco

Applied Aerodynamics Technical Committee

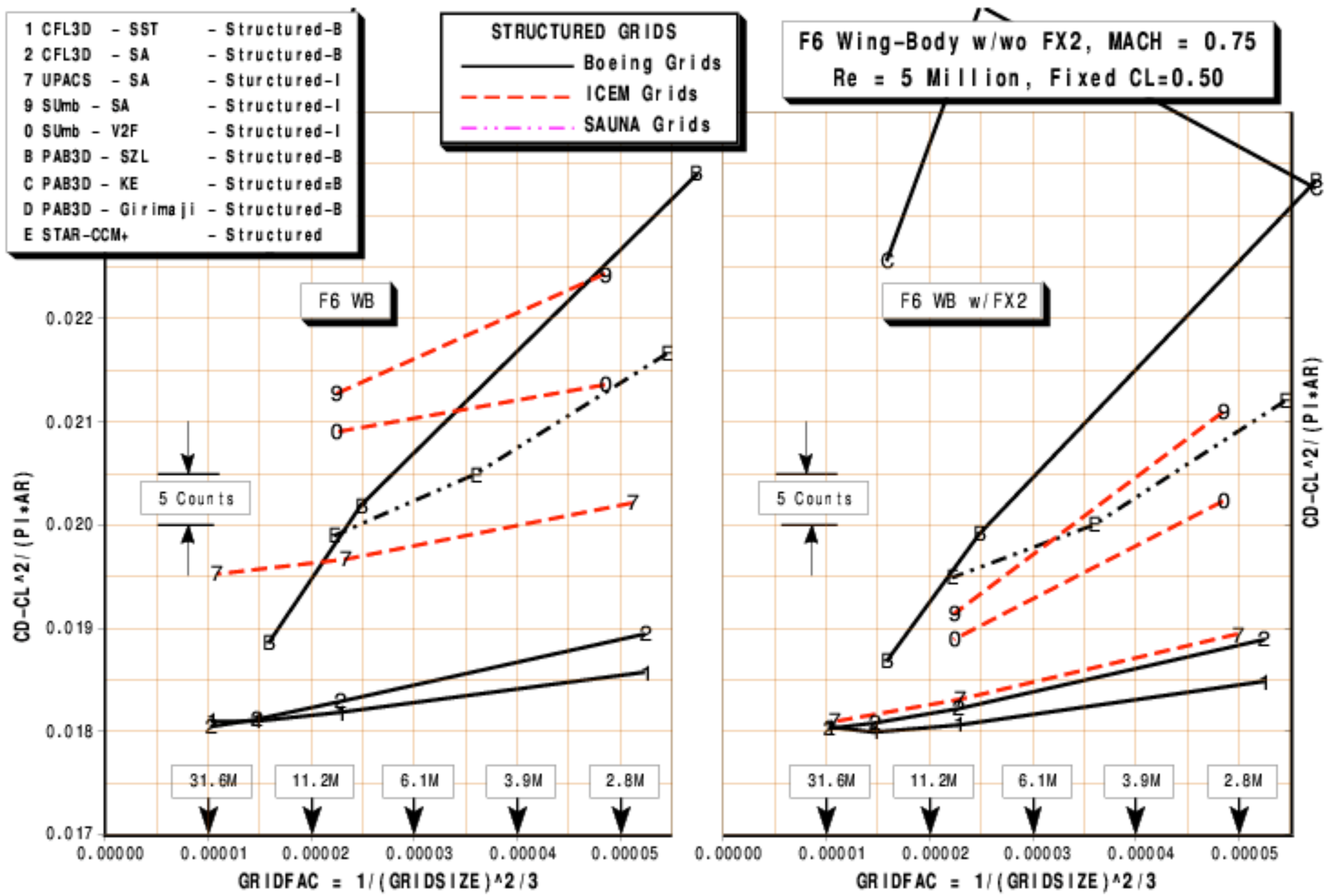
3rd CFD Drag Prediction Workshop

San Francisco, California – June 2006

Grid Convergence – All Solutions



Grid Convergence – Structured Grid Solutions



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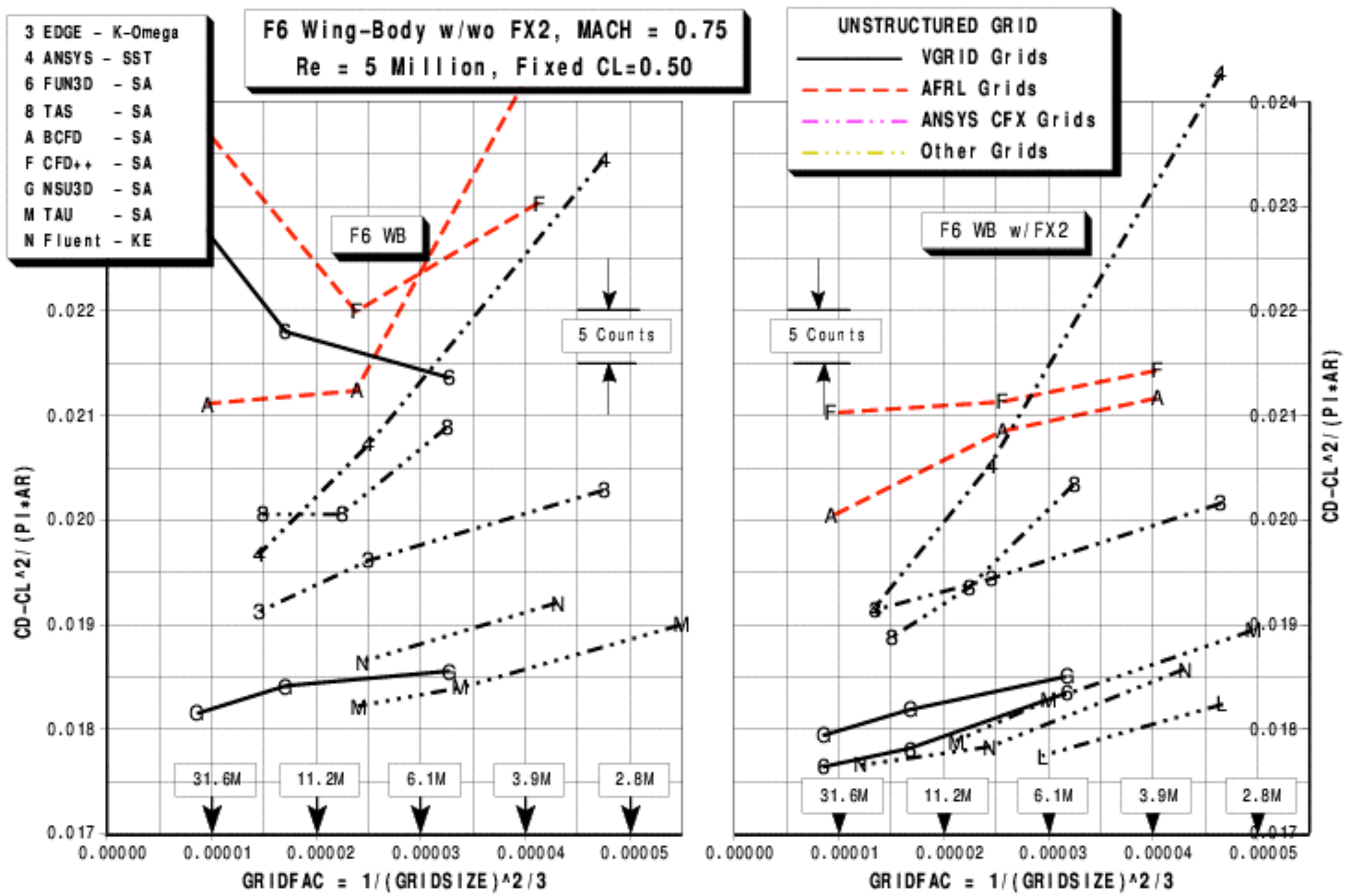
Grid Convergence – Unstructured Grid Solutions



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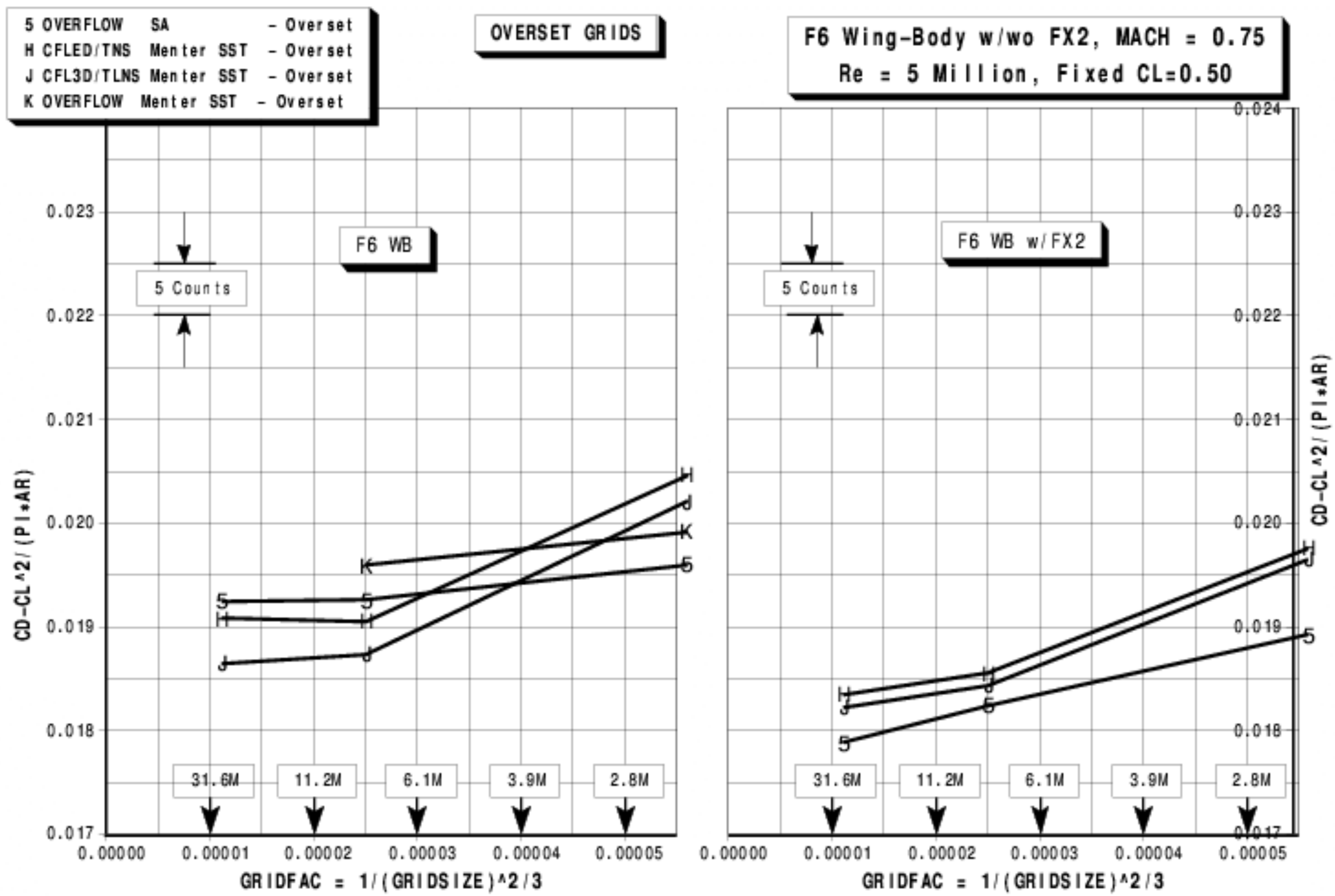
Grid Convergence – Overset Grid Solutions



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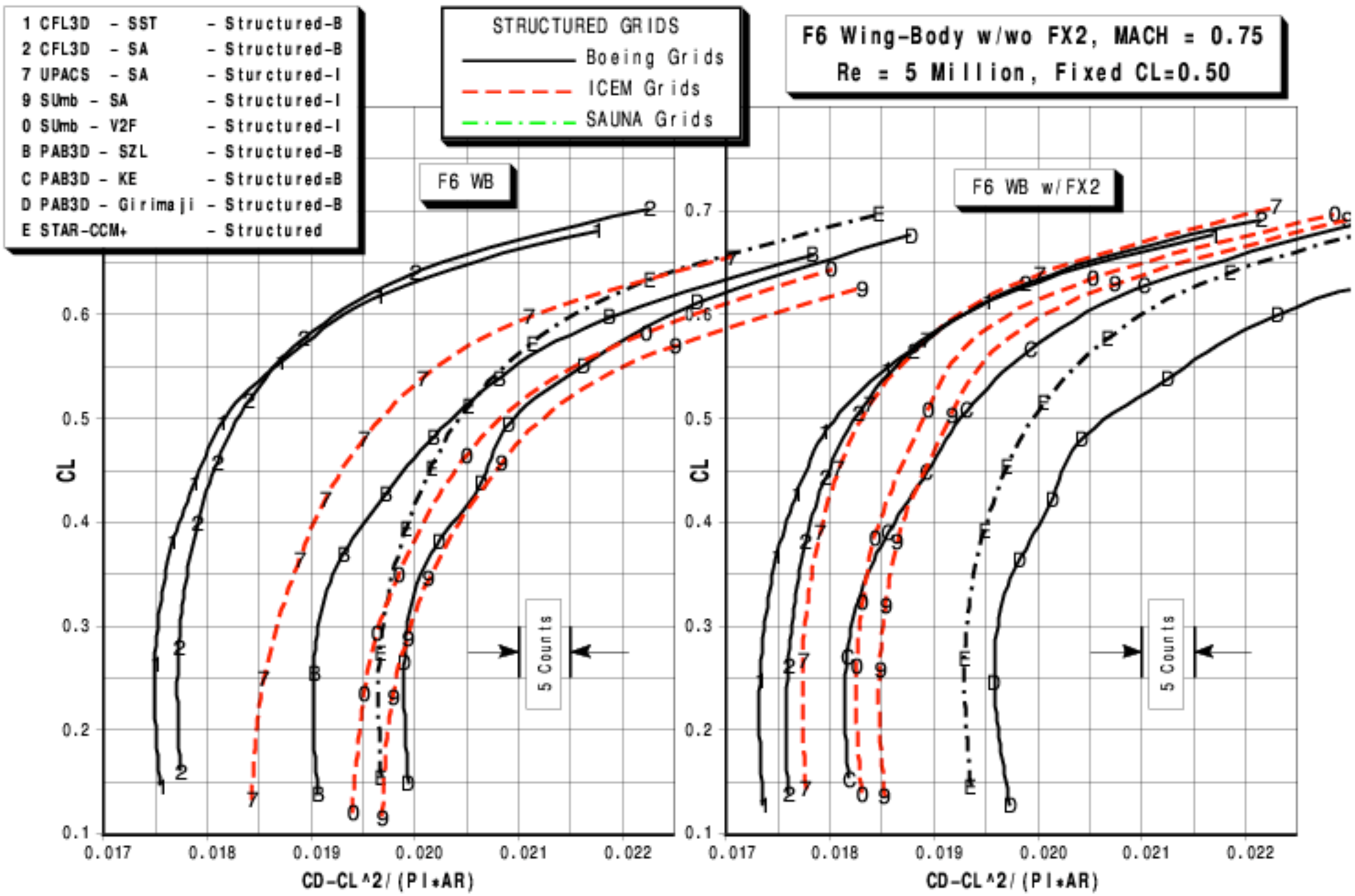
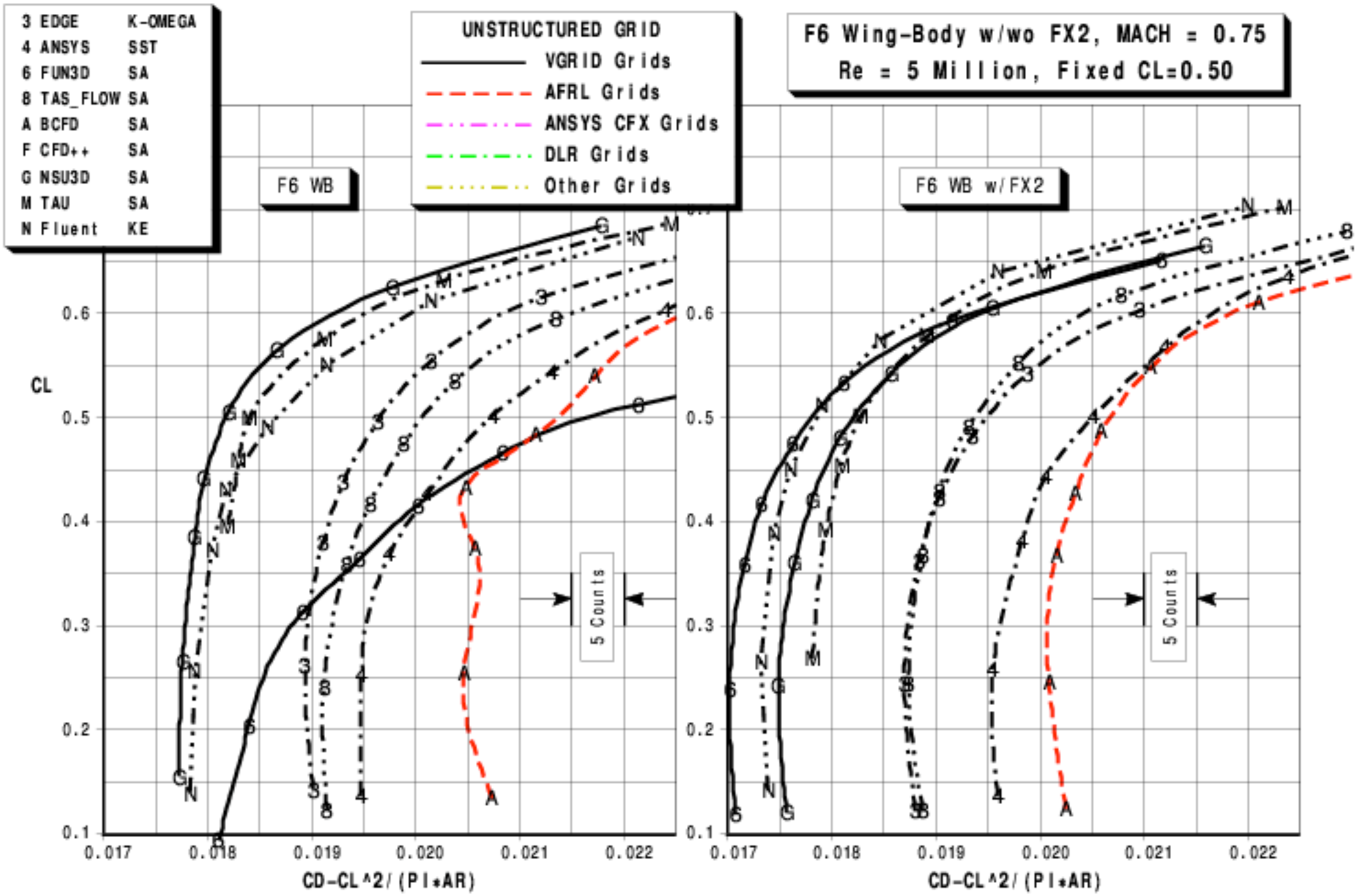
"Drag" Polars – Structured Grid Solutions



“Drag” Polars – Unstructured Grid Solutions



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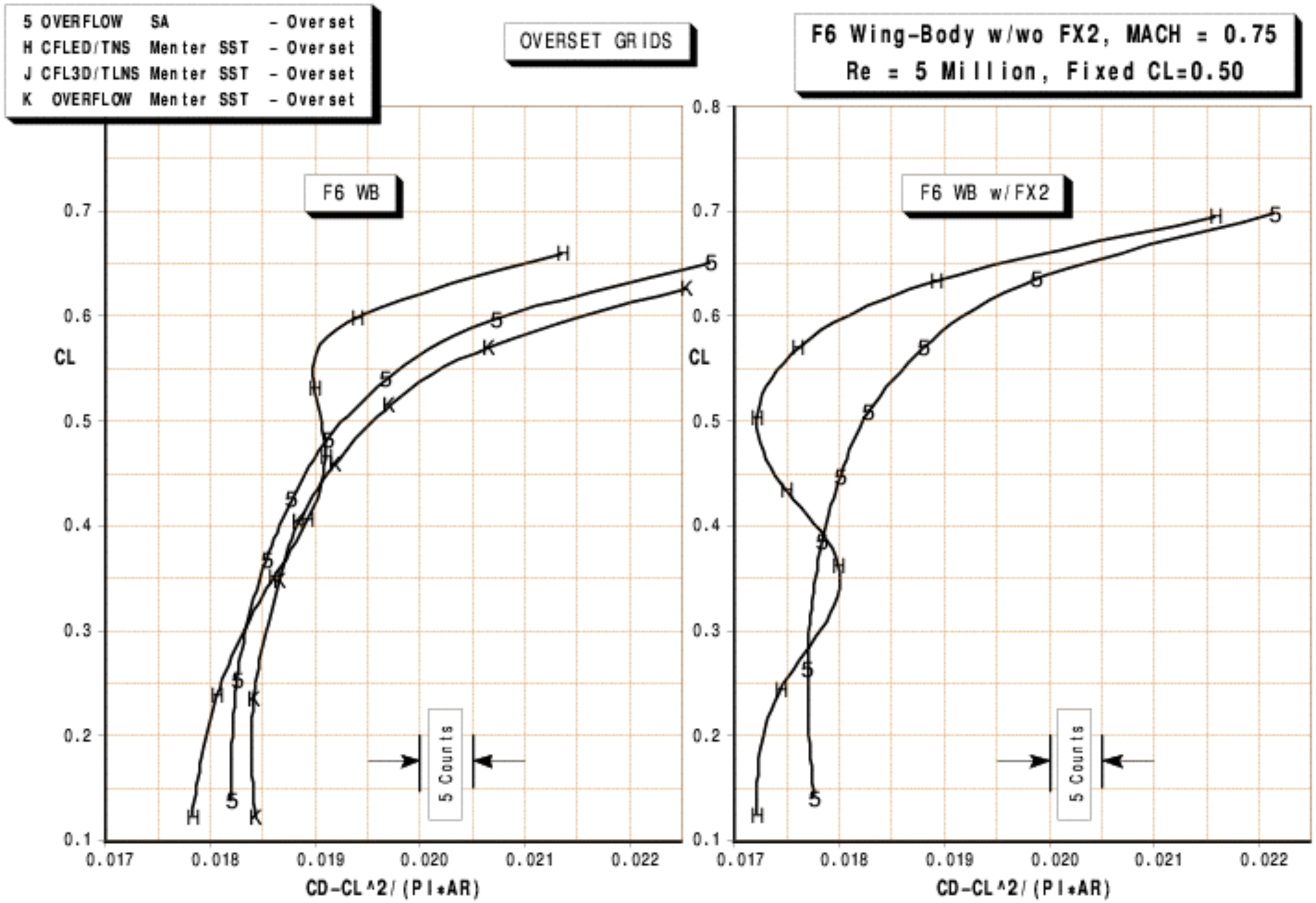
"Drag" Polars – Overset Grid Solutions



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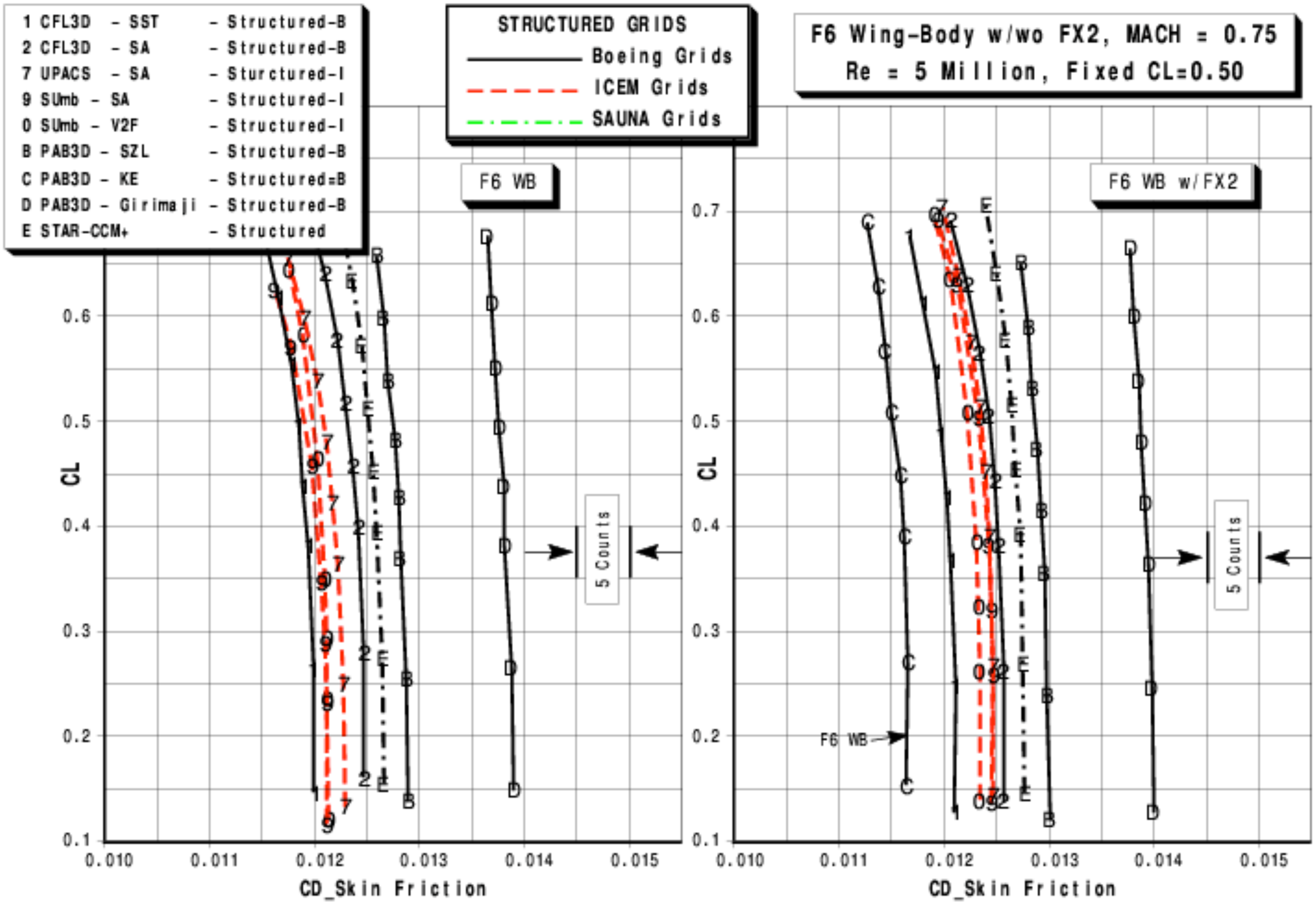
Skin Friction – Structured Grid Solutions



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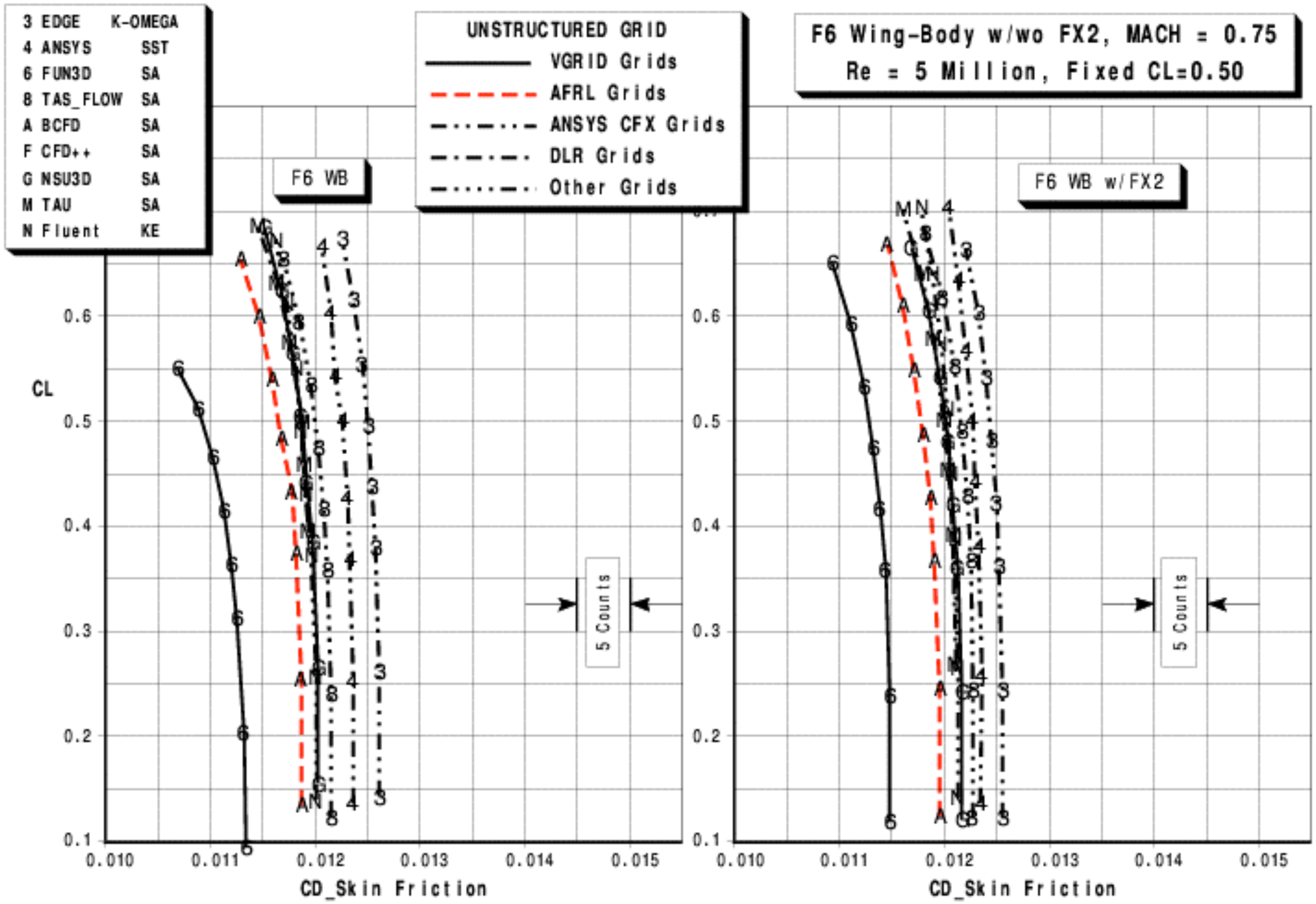
Skin Friction – Unstructured Grid Solutions



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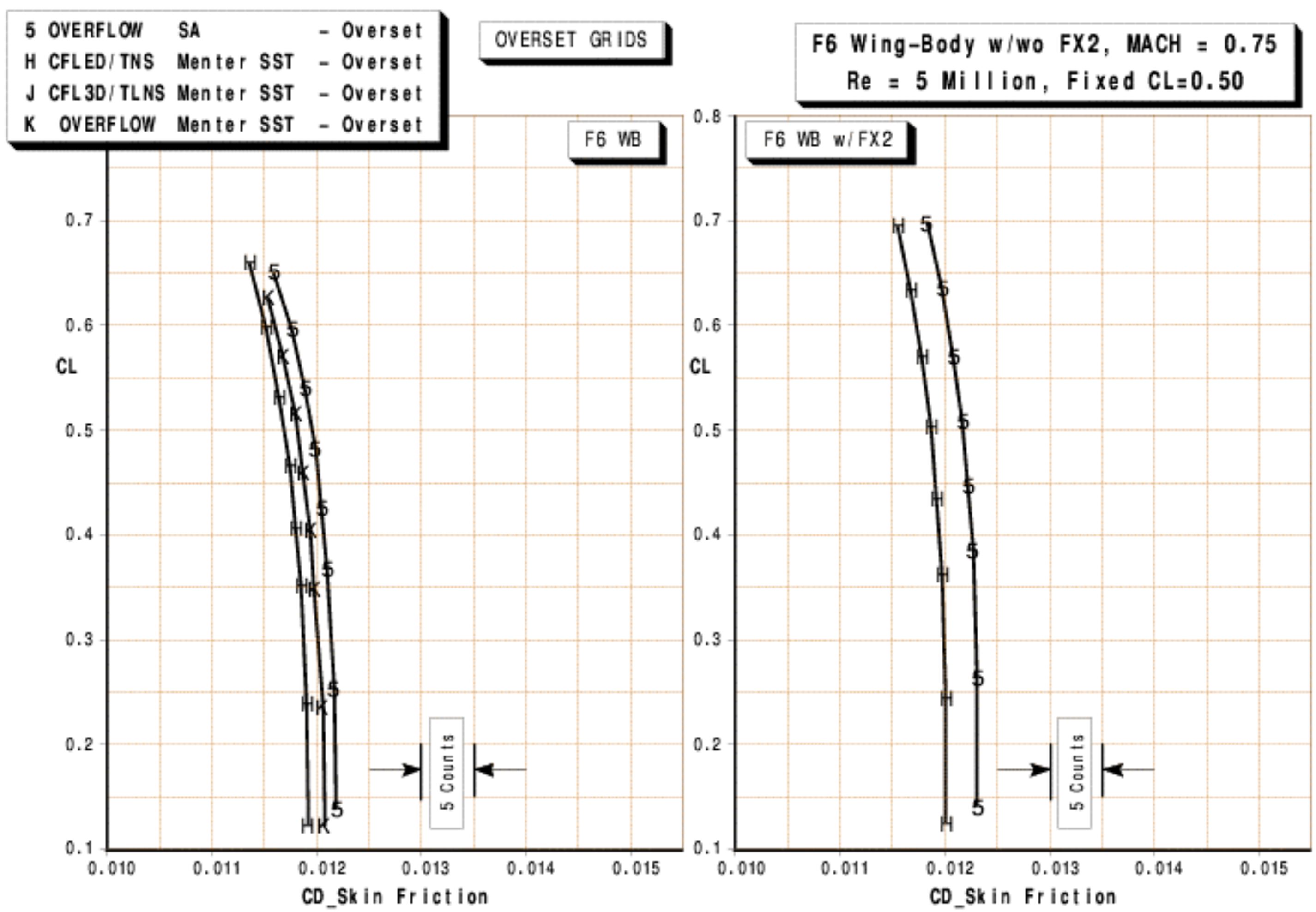
Skin Friction – Overset Grid Solutions



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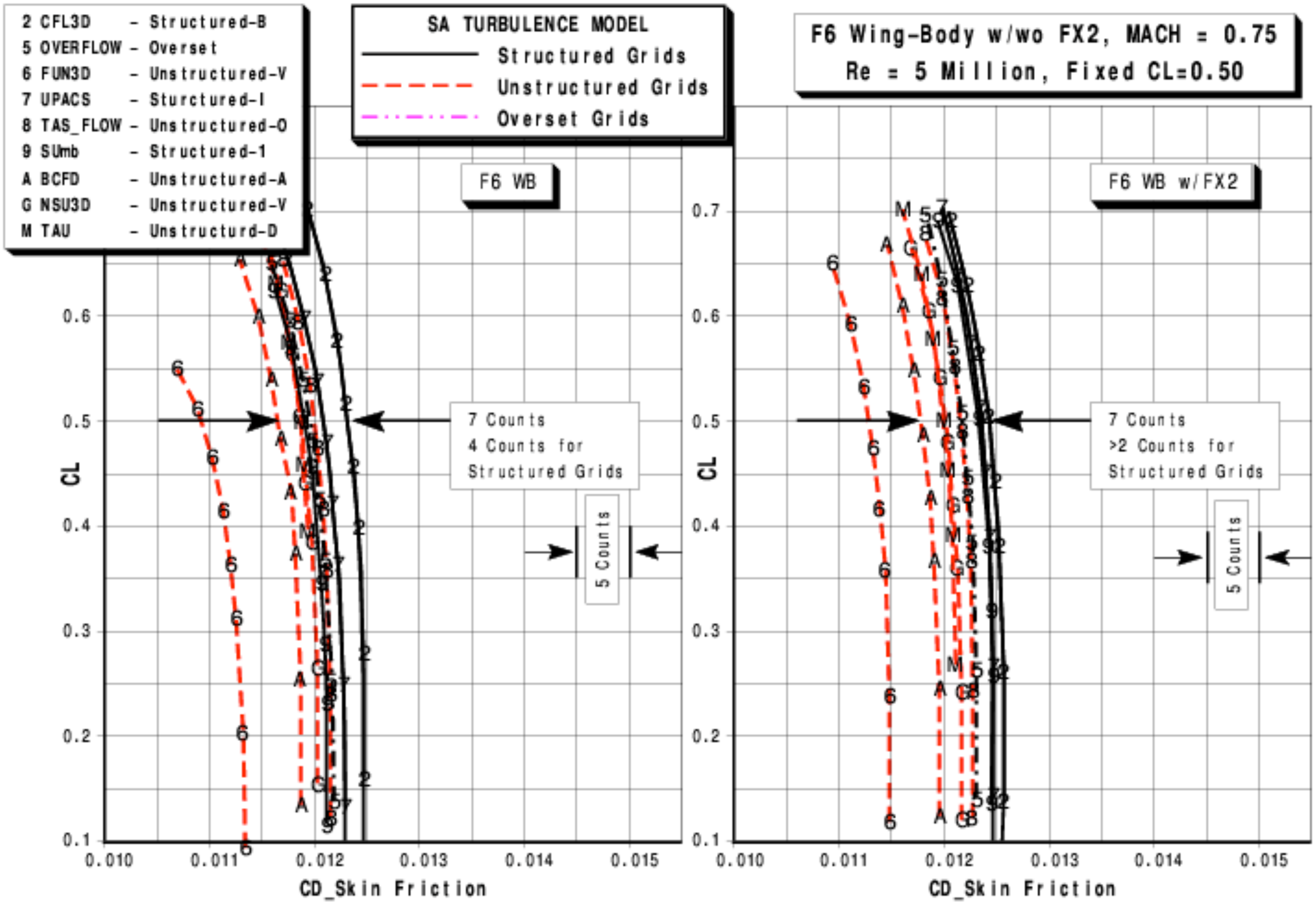
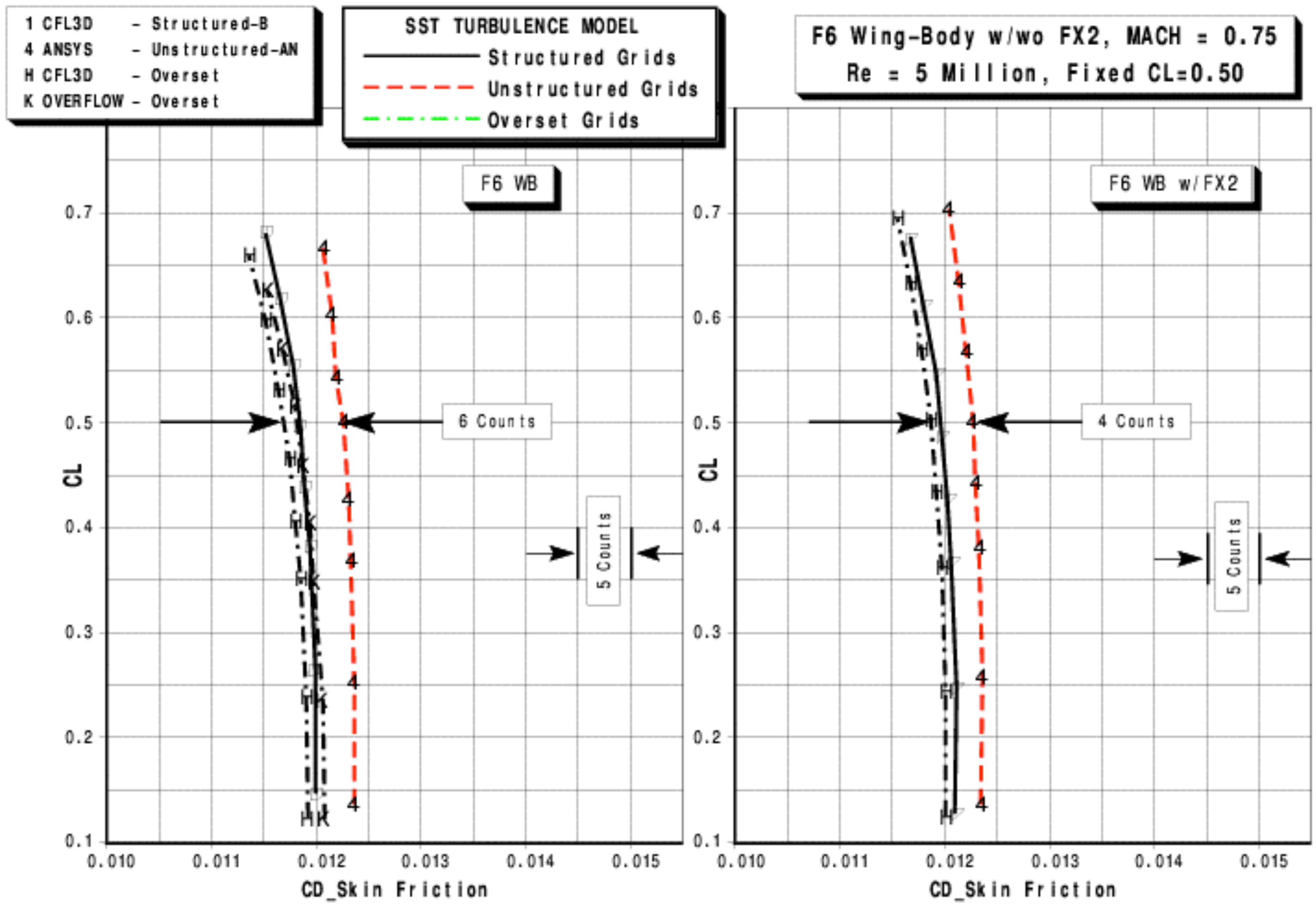
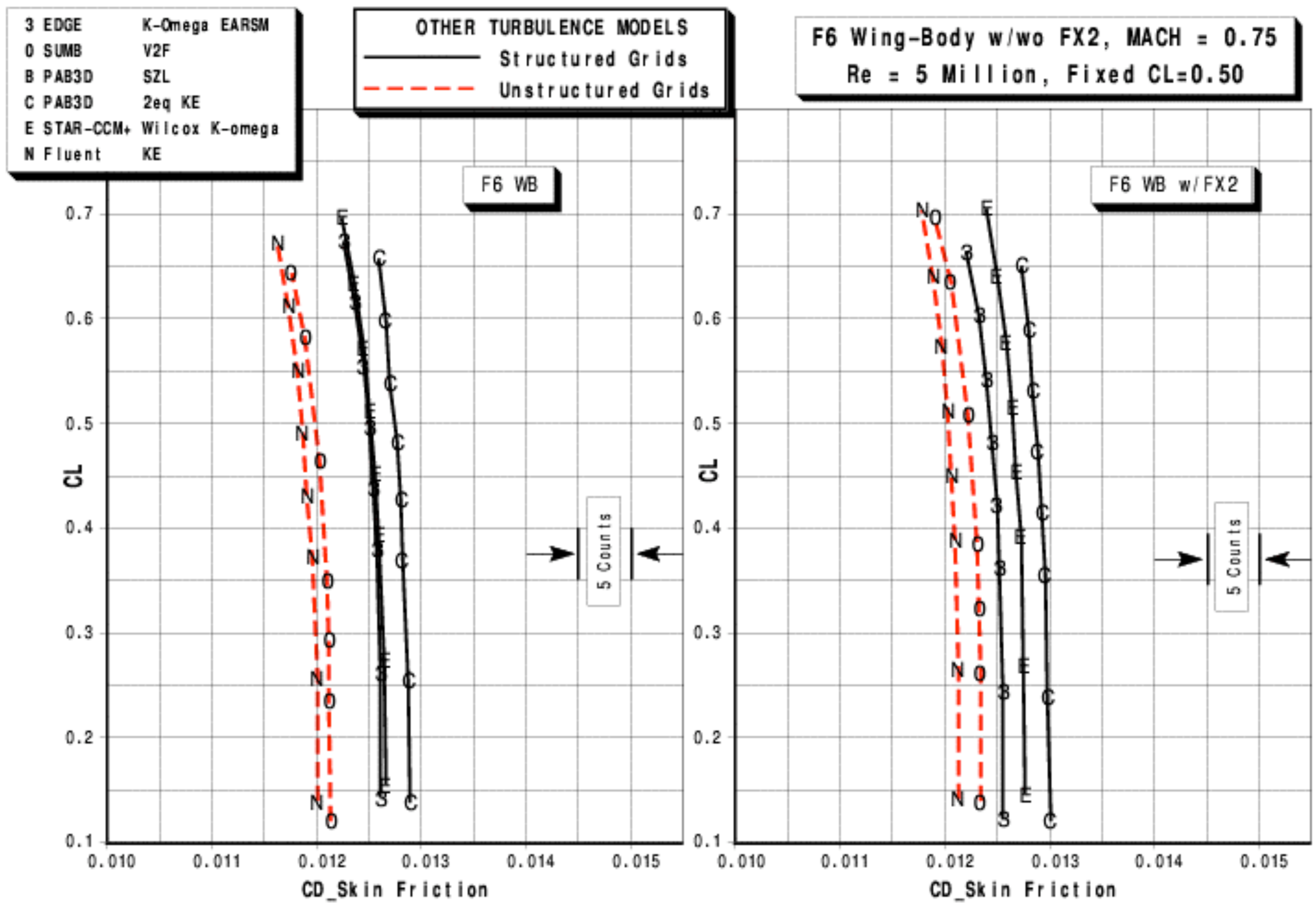
Skin Friction – SA Turbulence Model Solutions



Skin Friction – SST Turbulence Model Solutions



Skin Friction – Other Turbulence Model Solutions



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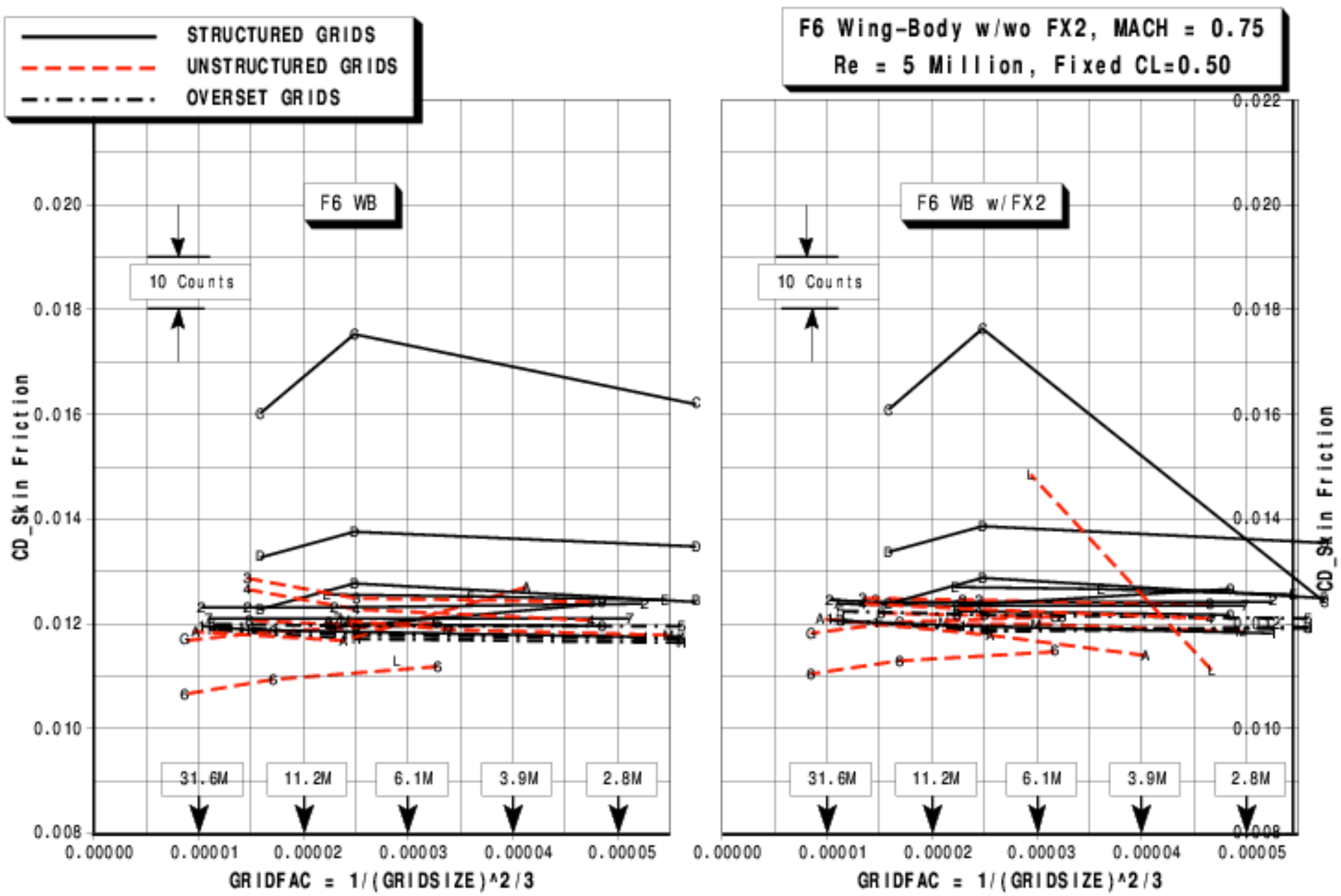
Skin Friction – Grid Type



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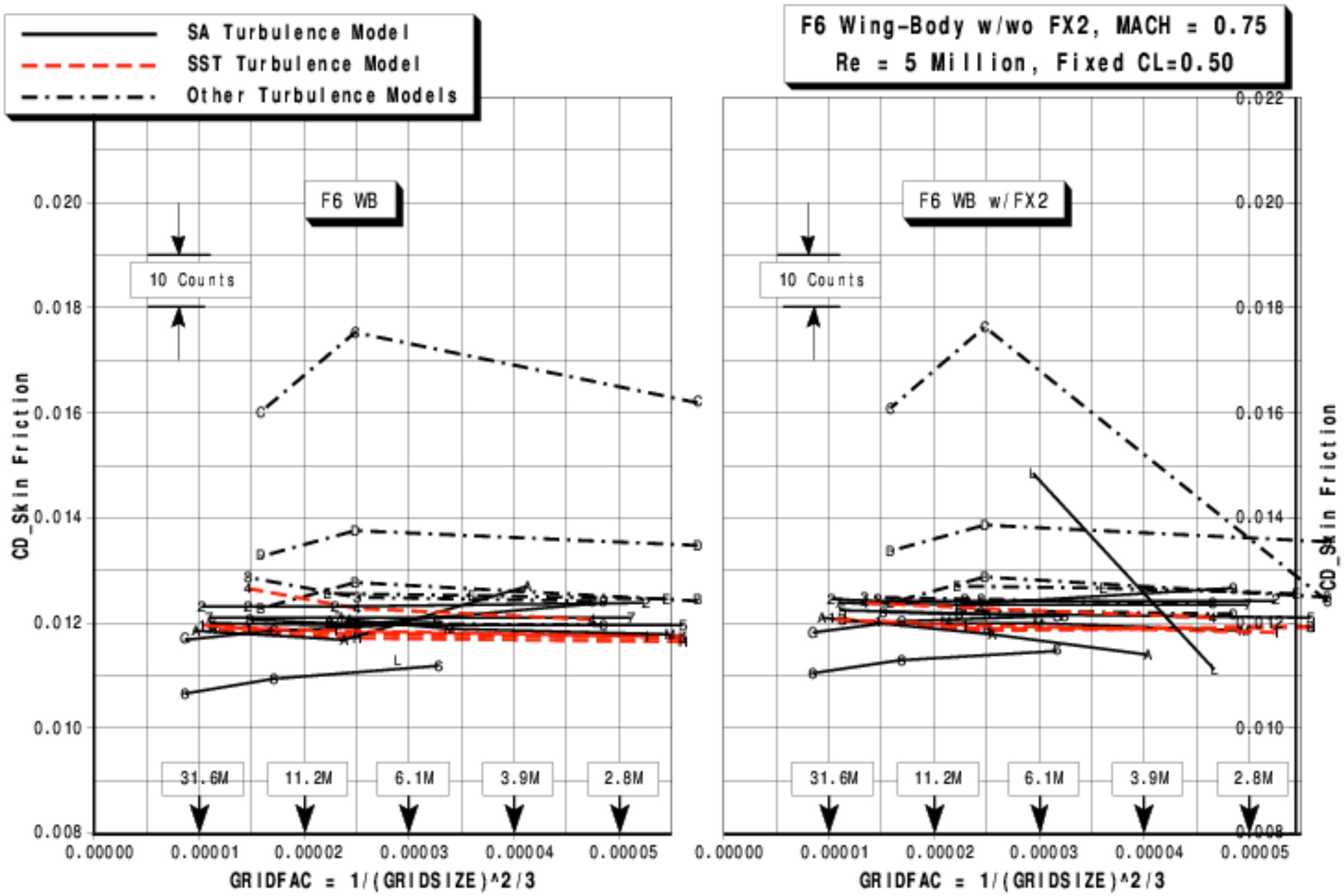
Skin Friction – Turbulence Model



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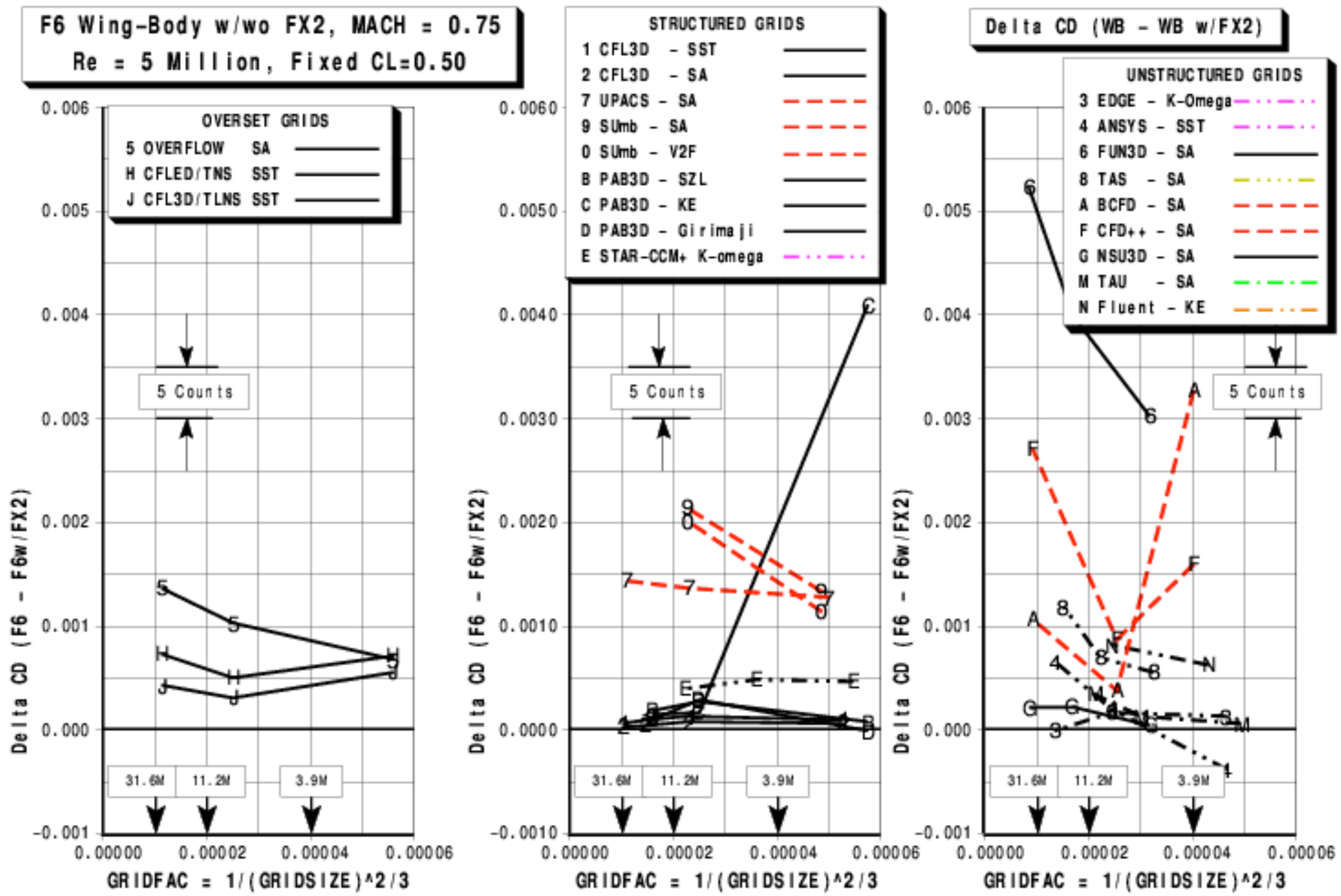
Drag Increment – Grid Type



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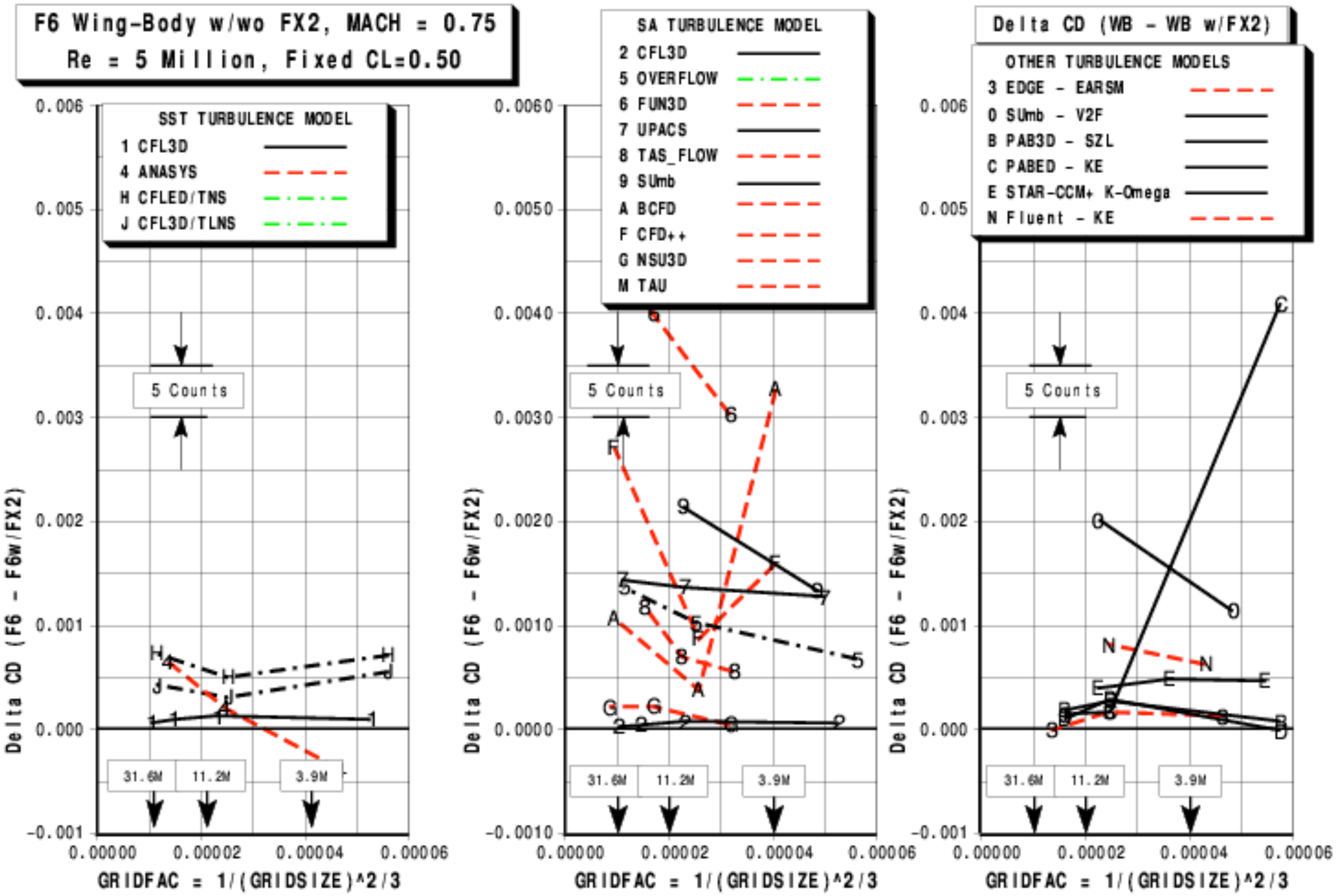
Drag Increment – Turbulence Models



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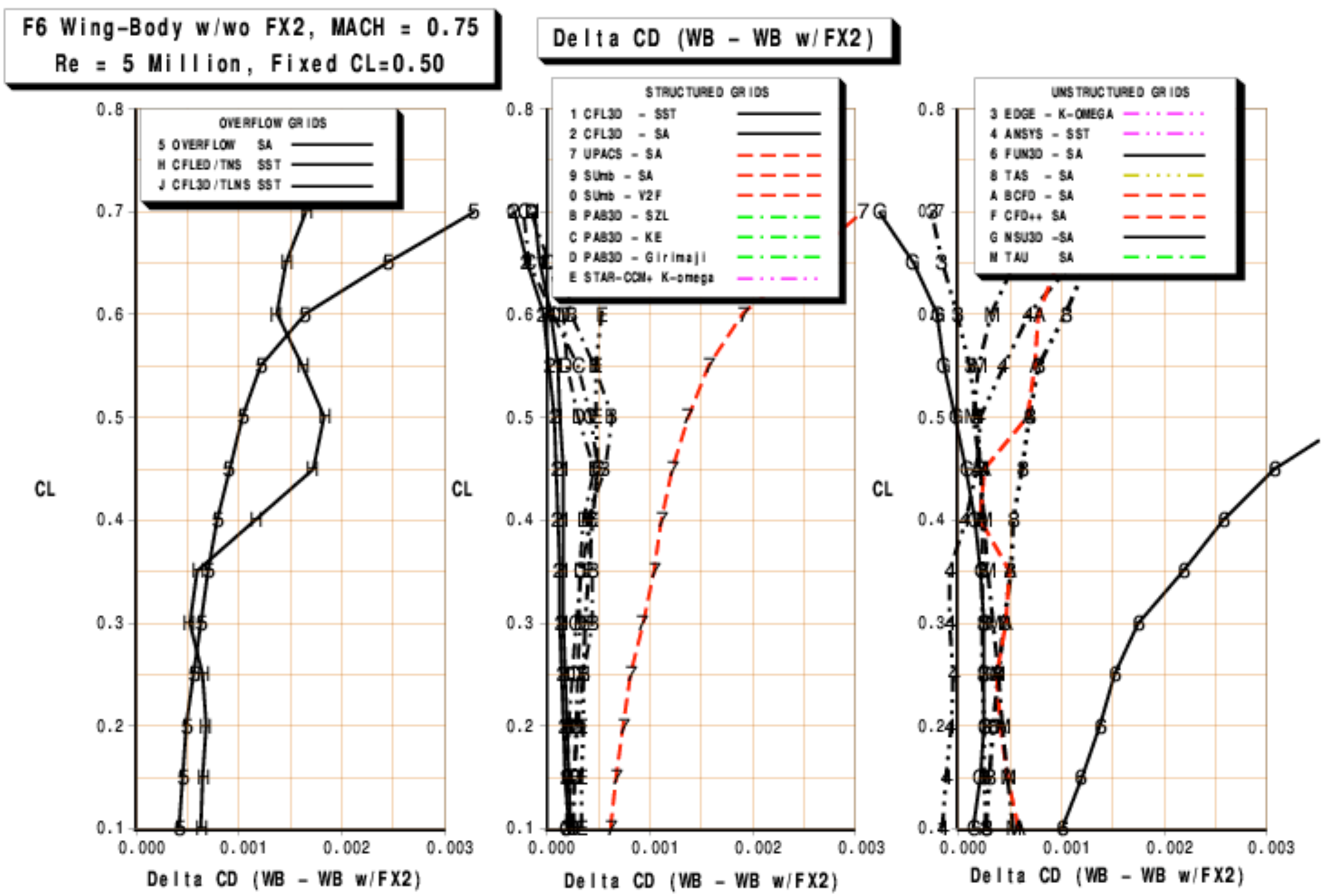
F6 Wing-Body w/wo FX2, MACH = 0.75
Re = 5 Million, Fixed CL=0.50
Delta CD (WB - WB w/FX2)
OVERFLOW GRIDS
5 OVERFLOW SA
H CFLED/TNS SST
J CFL3D/TLNS SST
STRUCTURED GRIDS
1 CFL3D - SST
2 CFL3D - SA
7 UPACS - SA
9 SUmb - SA
0 SUmb - V2F
B PAB3D - SZL
C PAB3D - KE
D PAB3D - Girimaji
E STAR-CCM+ K-omega
UNSTRUCTURED GRIDS
3 EDGE - K-OMEGA
4 ANSYS - SST
6 FUN3D - SA
8 TAS - SA
A BCFD - SA
F CFD++ SA
G NSU3D -SA
M TAU SA
CL
Delta CD (WB - WB w/FX2)

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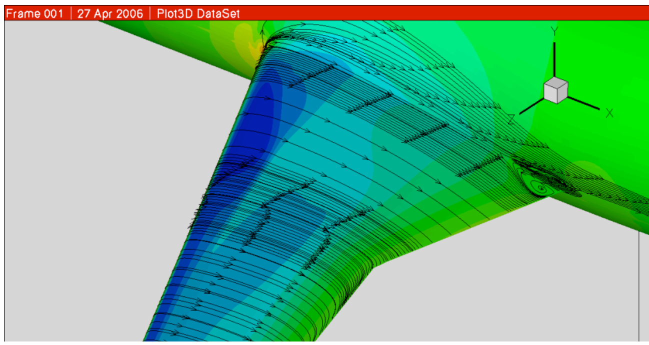
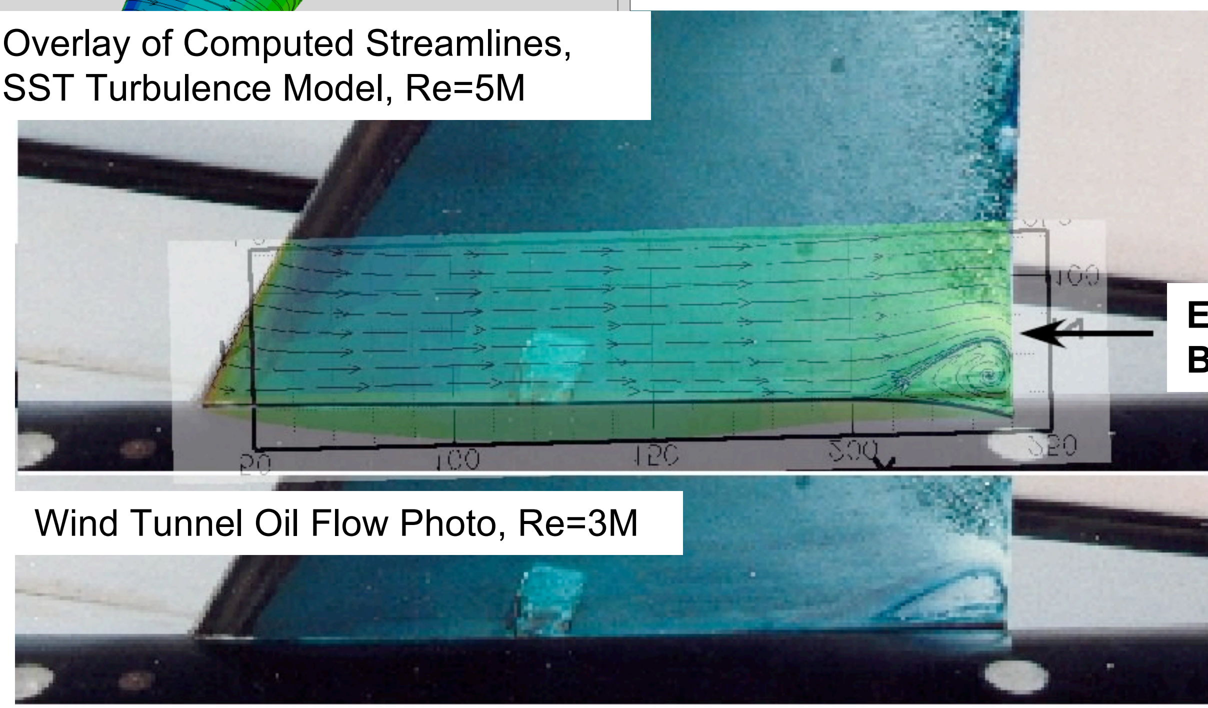
F6 WB Separation Bubble on Wing



Overlay of Computed Streamlines, SST Turbulence Model, Re=5M



Edge of Separation Bubble on Wing

Wind Tunnel Oil Flow Photo, Re=3M

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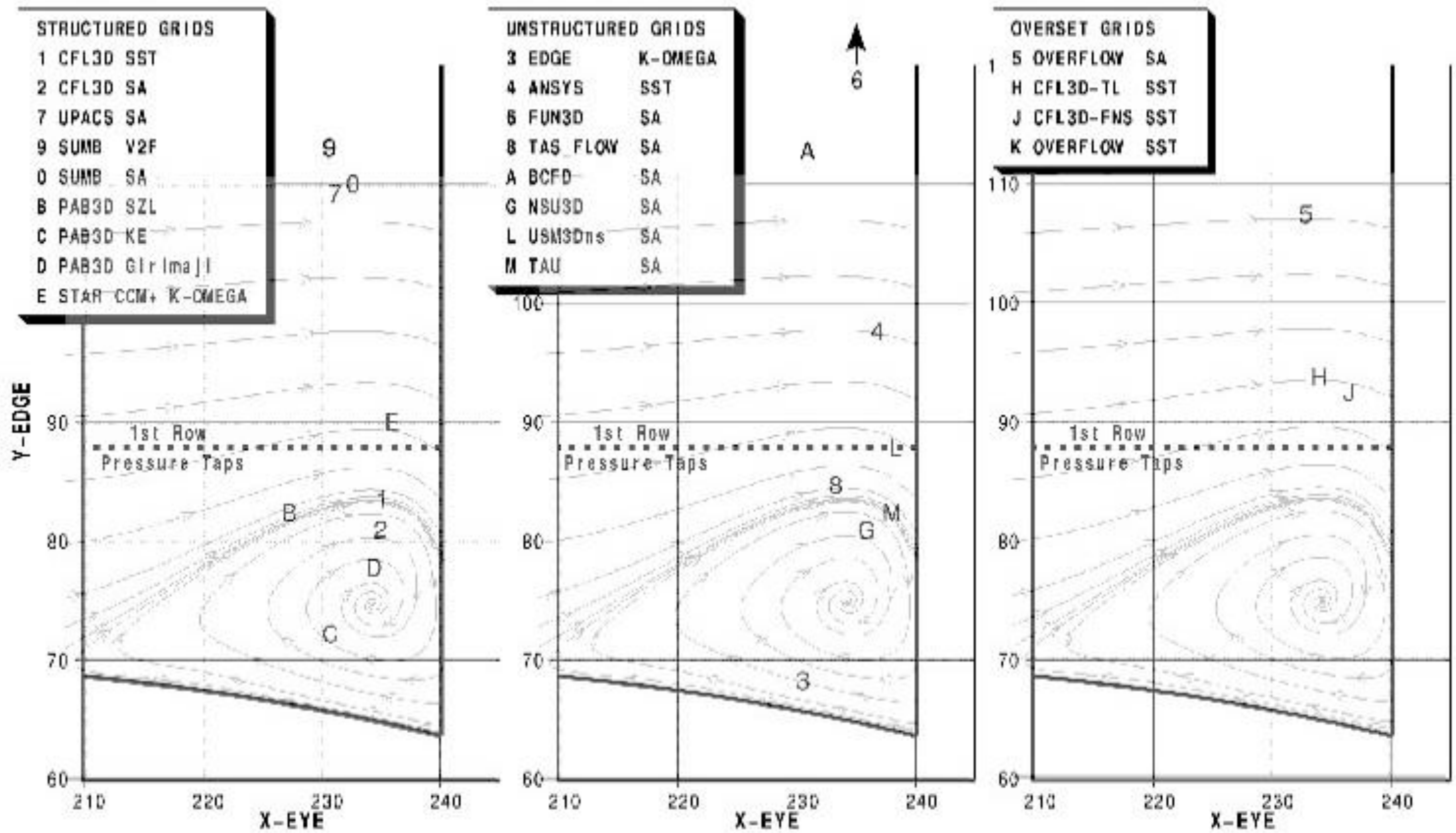
Separation Bubble Size – Grid Type



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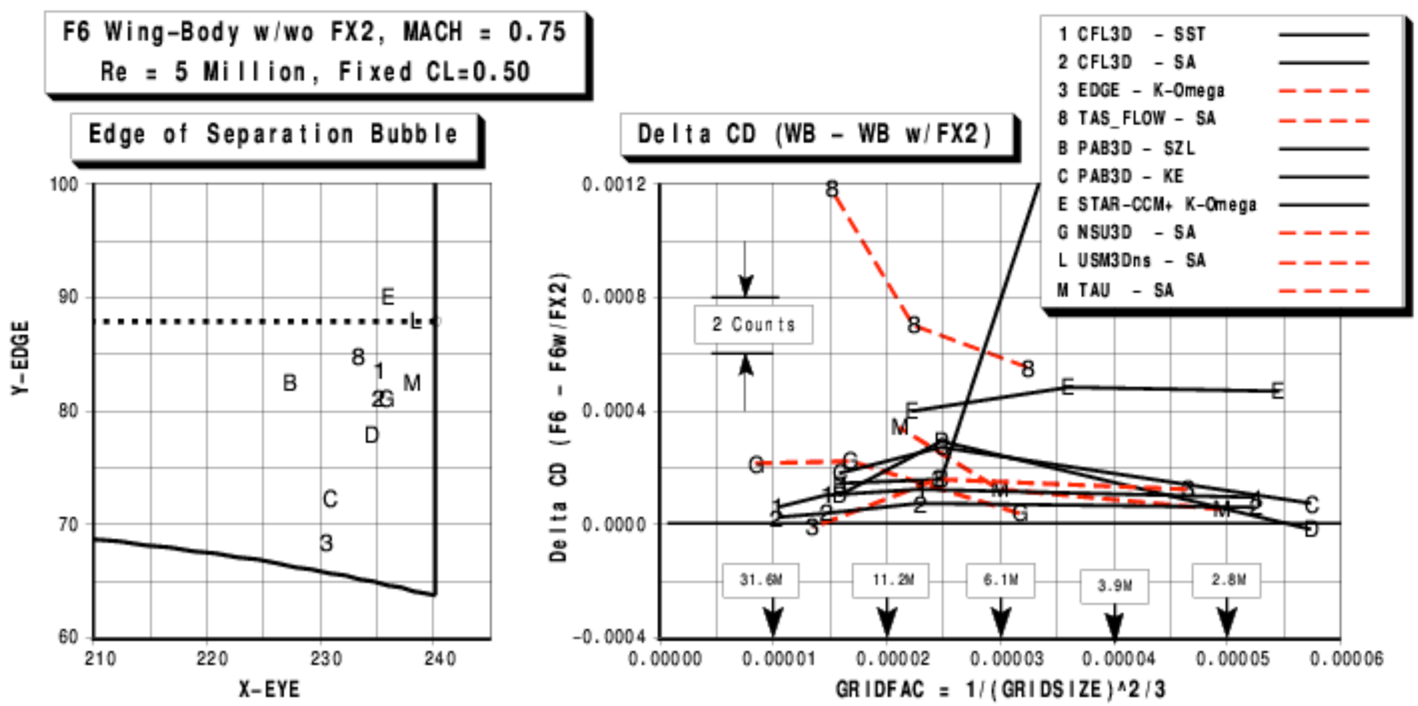
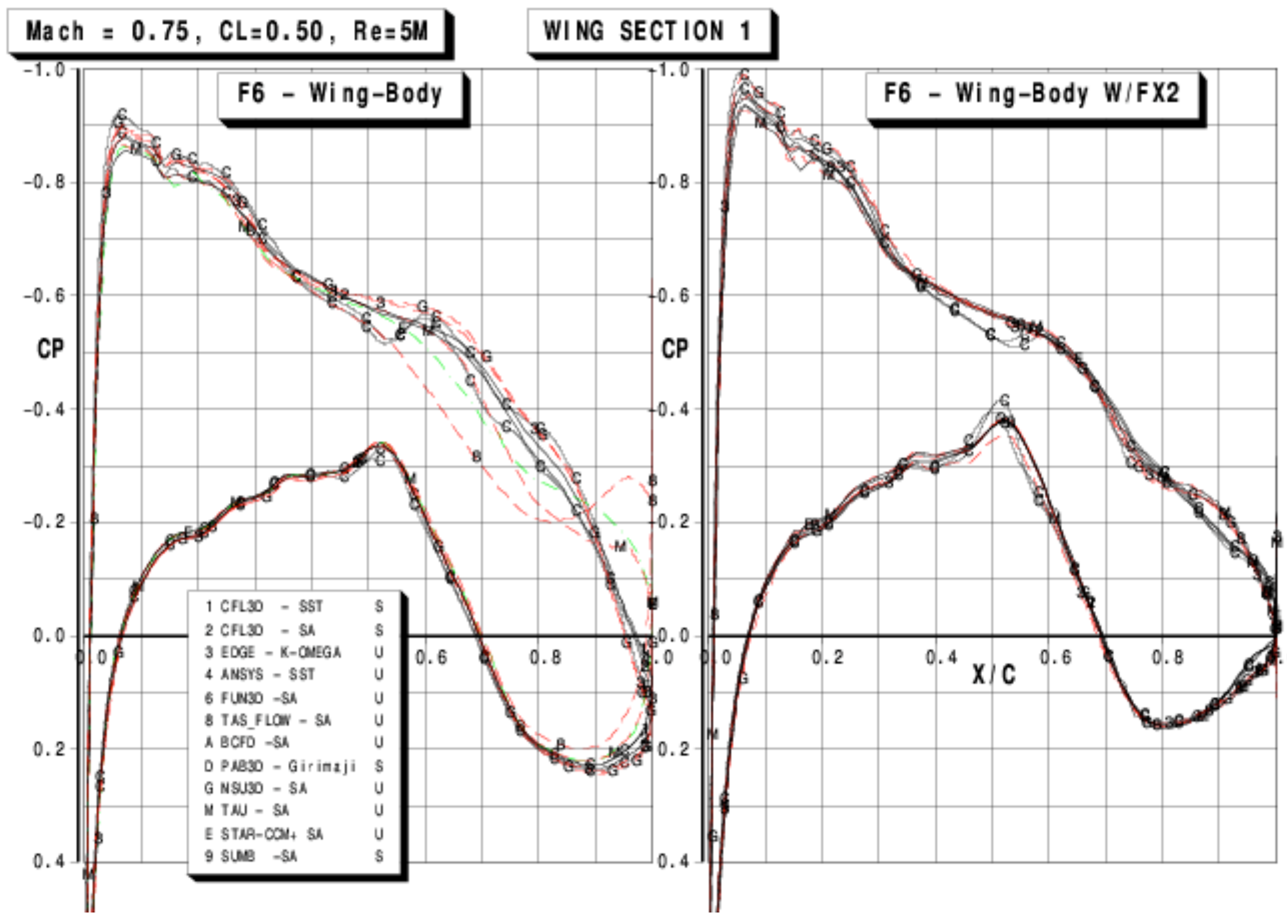
Drag Increment – Filtered by Bubble Size



Pressure Distributions – Wing Section 1



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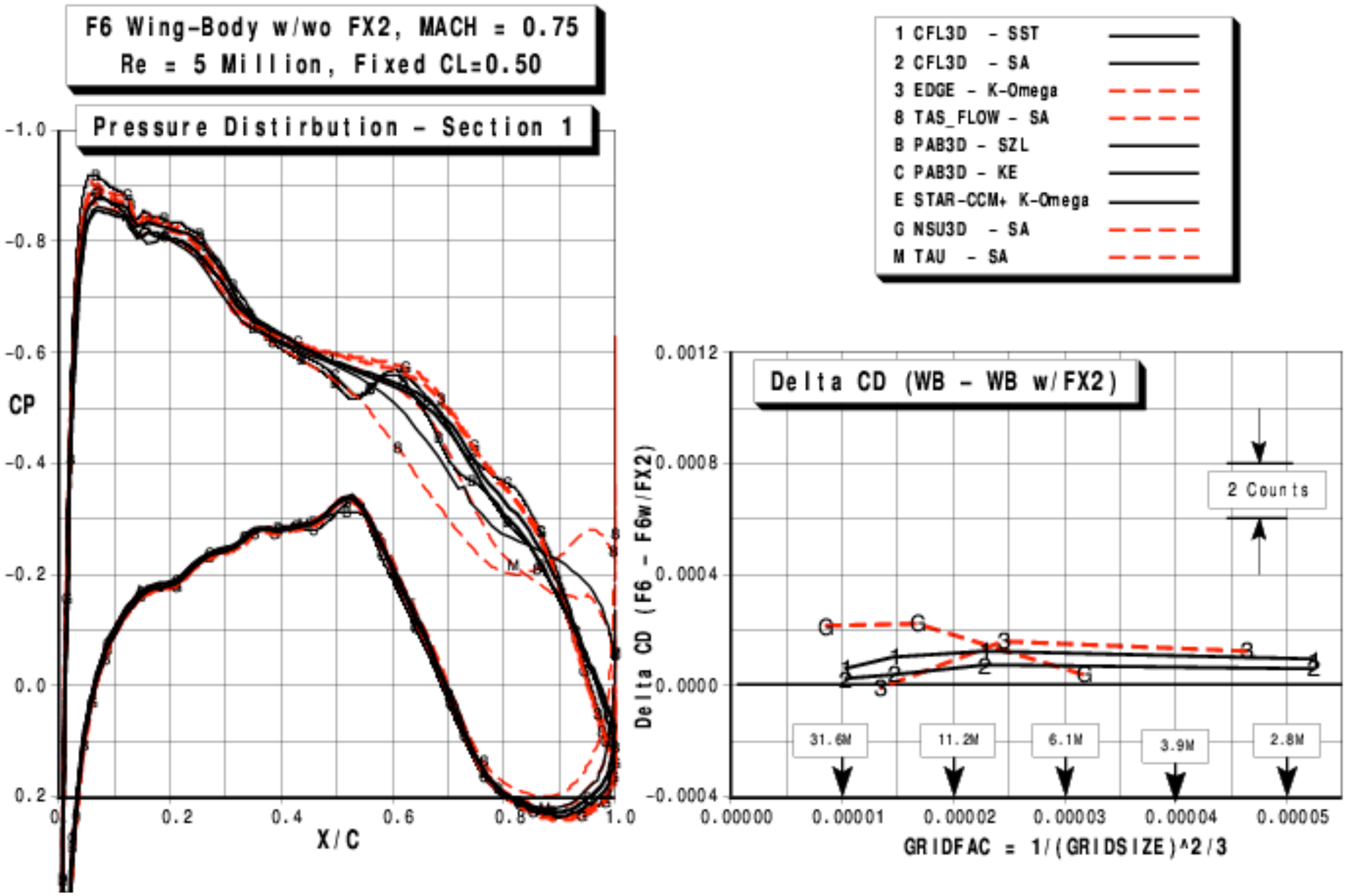
Drag Increment
Filtered by Bubble Size and Pressure Distribution



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OBSERVATIONS

- Disappointing!!
- Inboard separation bubble continues to be a major source of difficulty
- No major trends based on grid type or turbulence model
- Grid convergence characteristics suggest difficulty in generating consistent sets of grids
- Some sets had obvious problems with convergence, matching CL
- Good news
    - Just about all solution sets showed the fairing to reduce drag
    - Skin friction predictions well behaved, relatively tight groupings

BACKUP / EXTRA