OVERFLOW Predictions

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OUTLINE

- SOLUTION PROCEDURE
- CONVERGENCE HISTORIES
- PRESSURE COMPARISONS
- FLOW VIZ
- DRAG POLARS
- CFD-TO-TEST CORRECTION
- DRAG-RISE
- SUMMARY

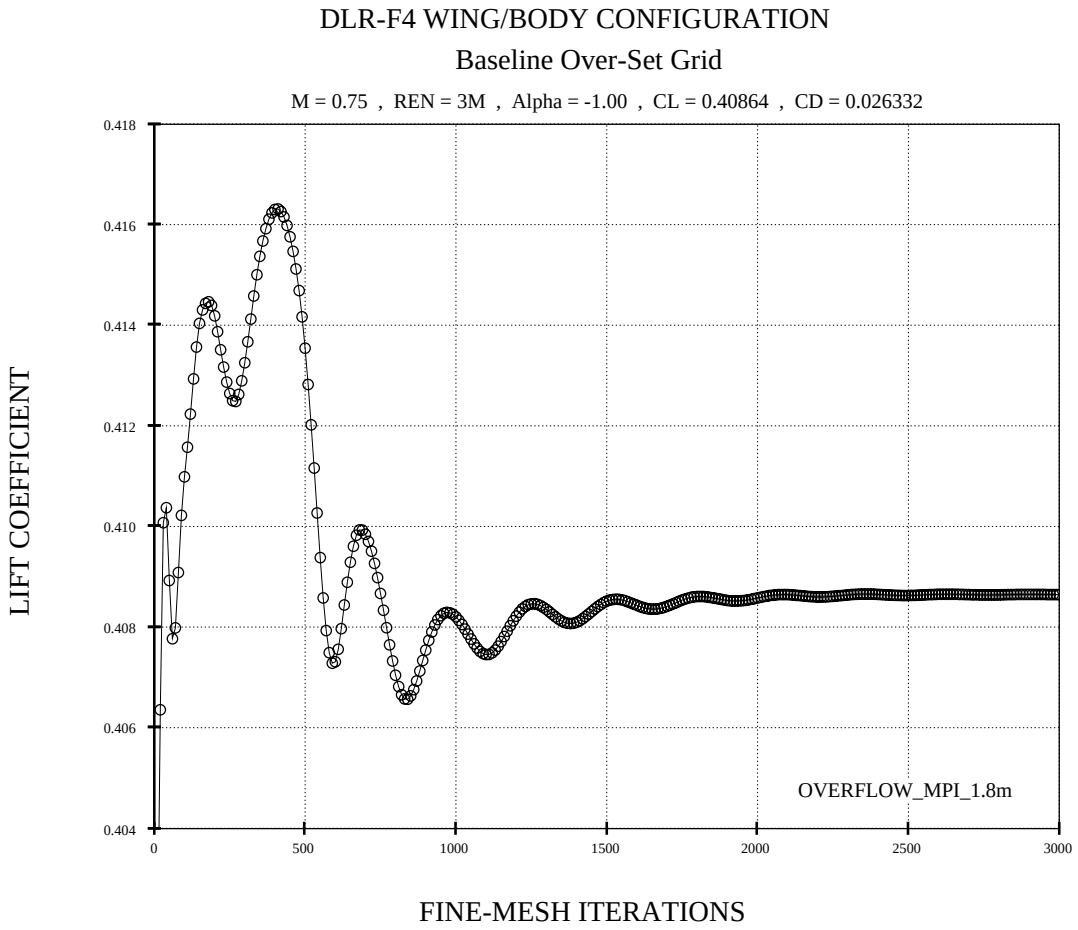
SOLUTION PROCEDURE

- **OVERFLOW: Version 1.8M**
  - Central Difference
  - Spalart-Allmaras, Fully Turbulent
  - Full Convergence (No Restarts)
    - Alpha Mode: Monitored C_L and C_D
    - Full Multigrid: 150/150/3000 Iterations
  - MPI Parallel Processing
    - Six HP-C3610s, Each w/ 2 GB RAM
    - Switched 100BaseT Ethernet
    - Nominally $\simeq$ 13 Hours per Solution

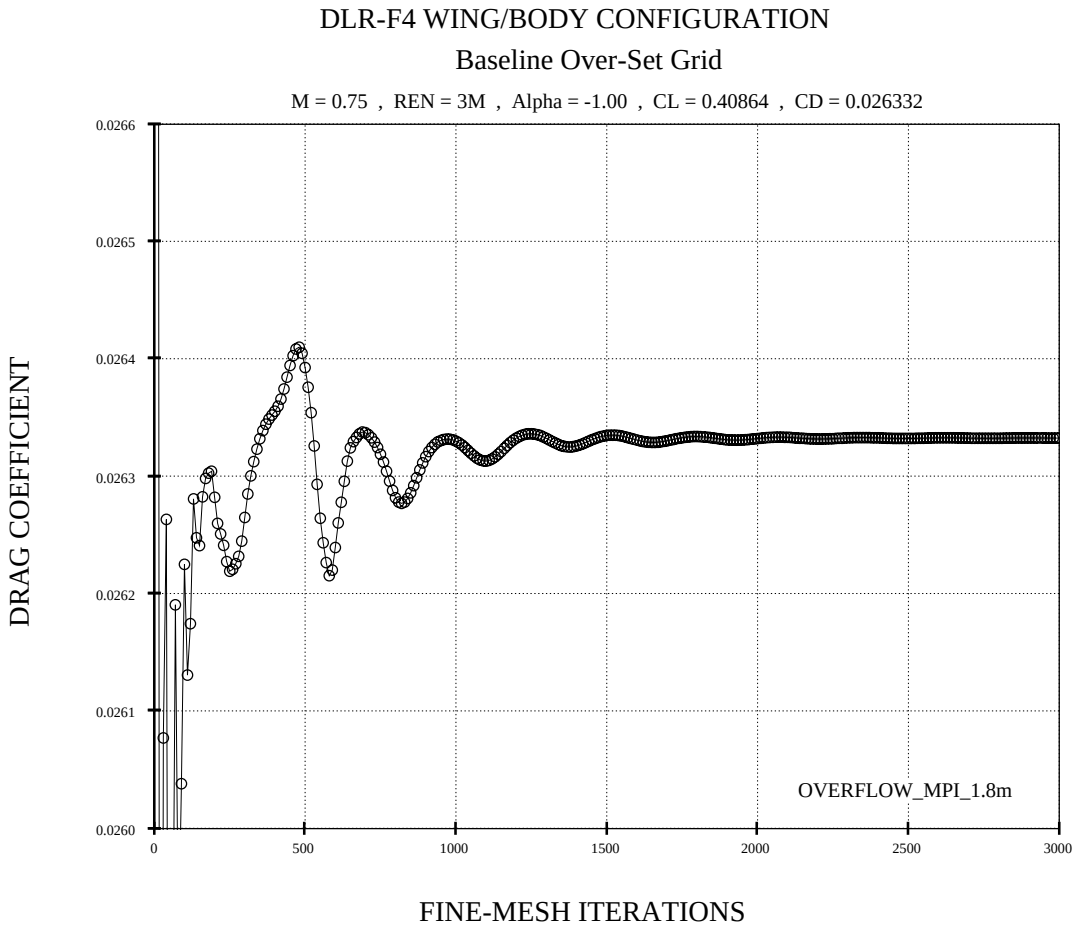
SOLUTION PROCEDURE

- **DRAG POLARS**
  - Alpha Sweeps at 10 Mach Numbers
  - Interpolate α on C_L
- **DRAG-RISE**
  - Compute $C_L = (.3, .4, .5, .6) \pm 0.001$
  - Interpolate C_D on C_L^2
  - M_{DD} at $\frac{\partial C_D}{\partial M} = 0.05$
- **TOTAL OF 53 FLOW SOLUTIONS**

CONVERGENCE HISTORIES



CONVERGENCE HISTORIES



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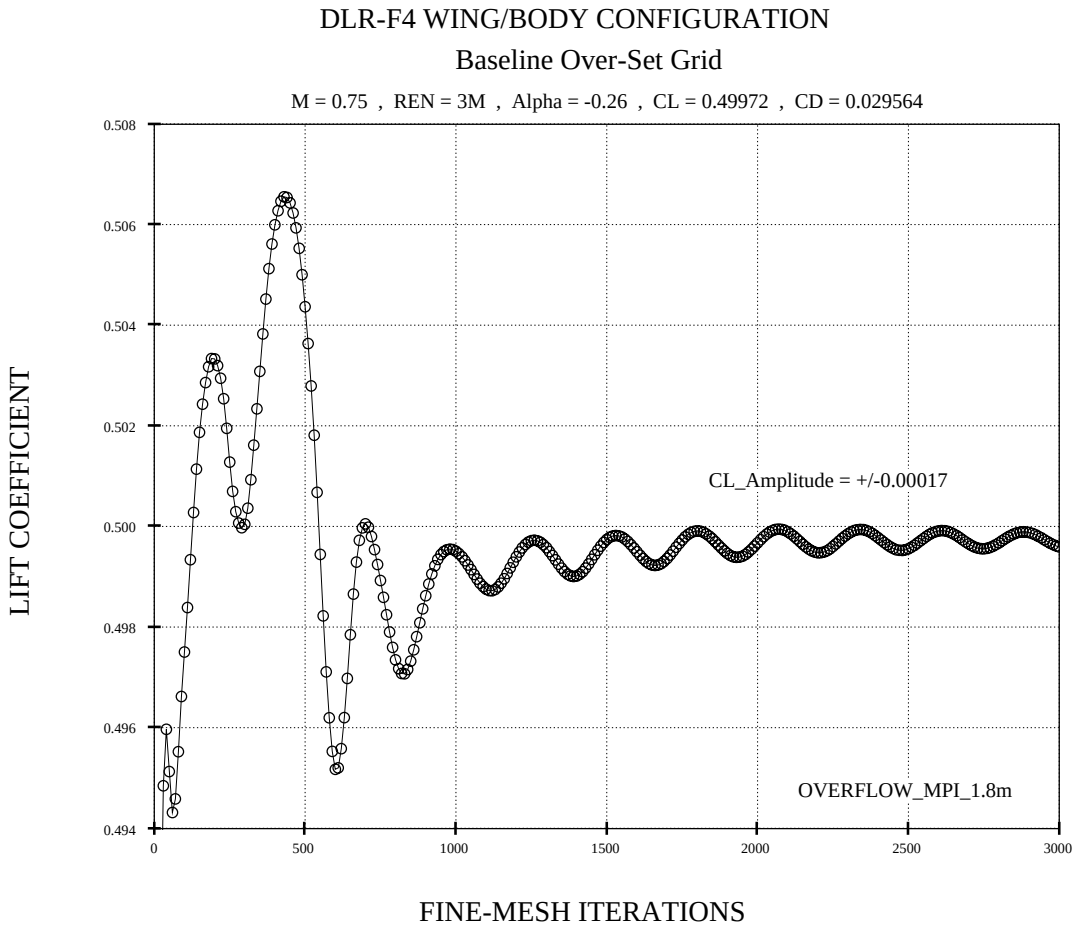

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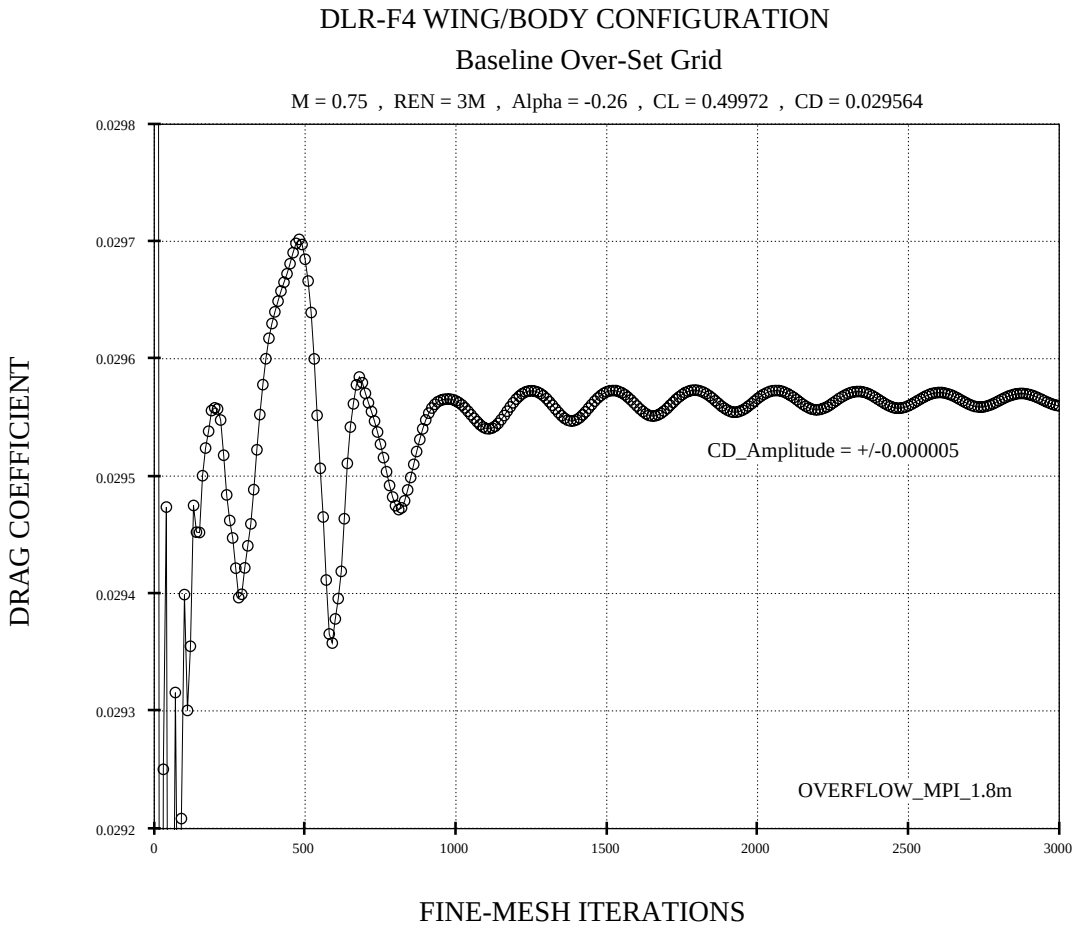
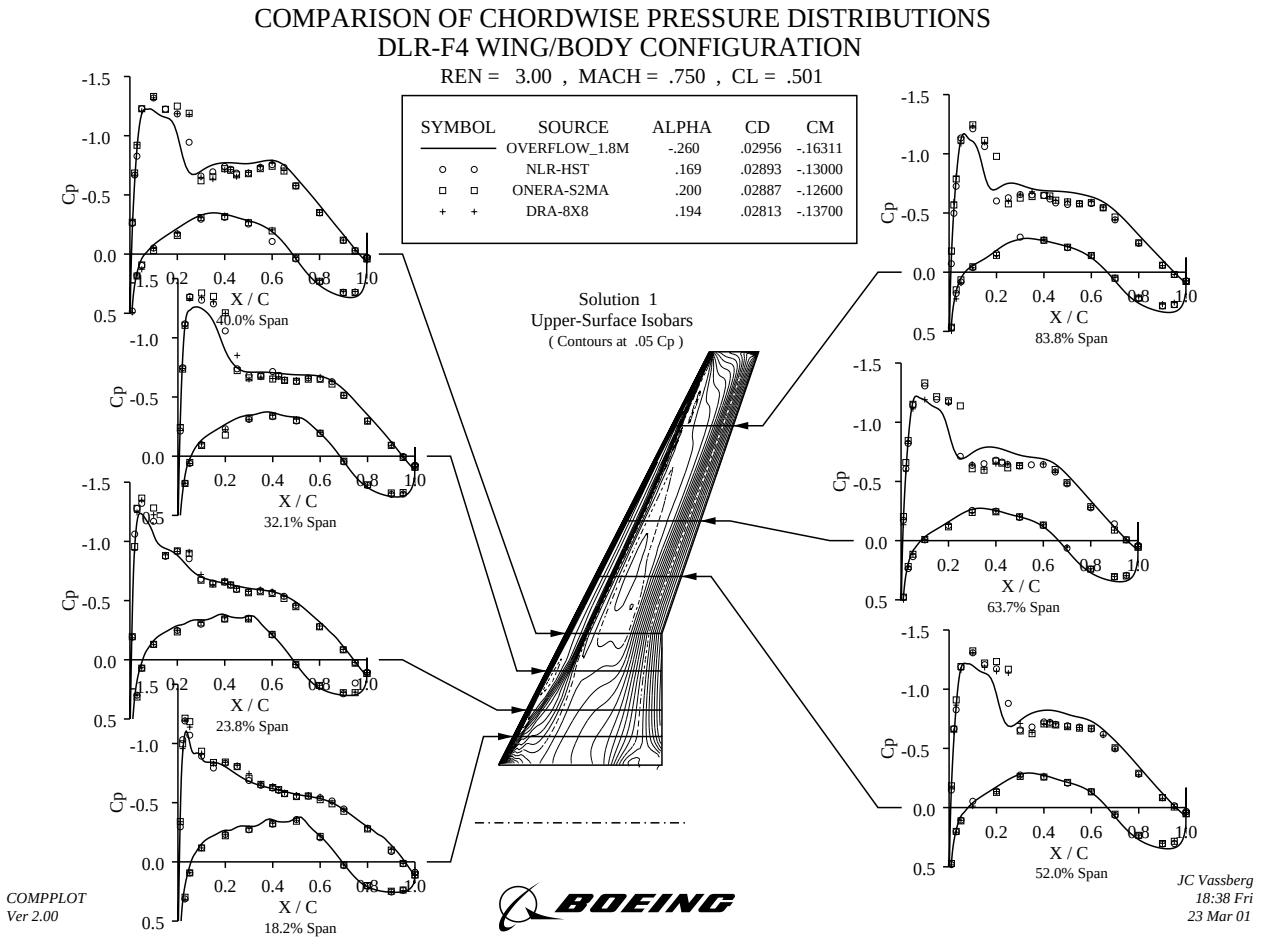
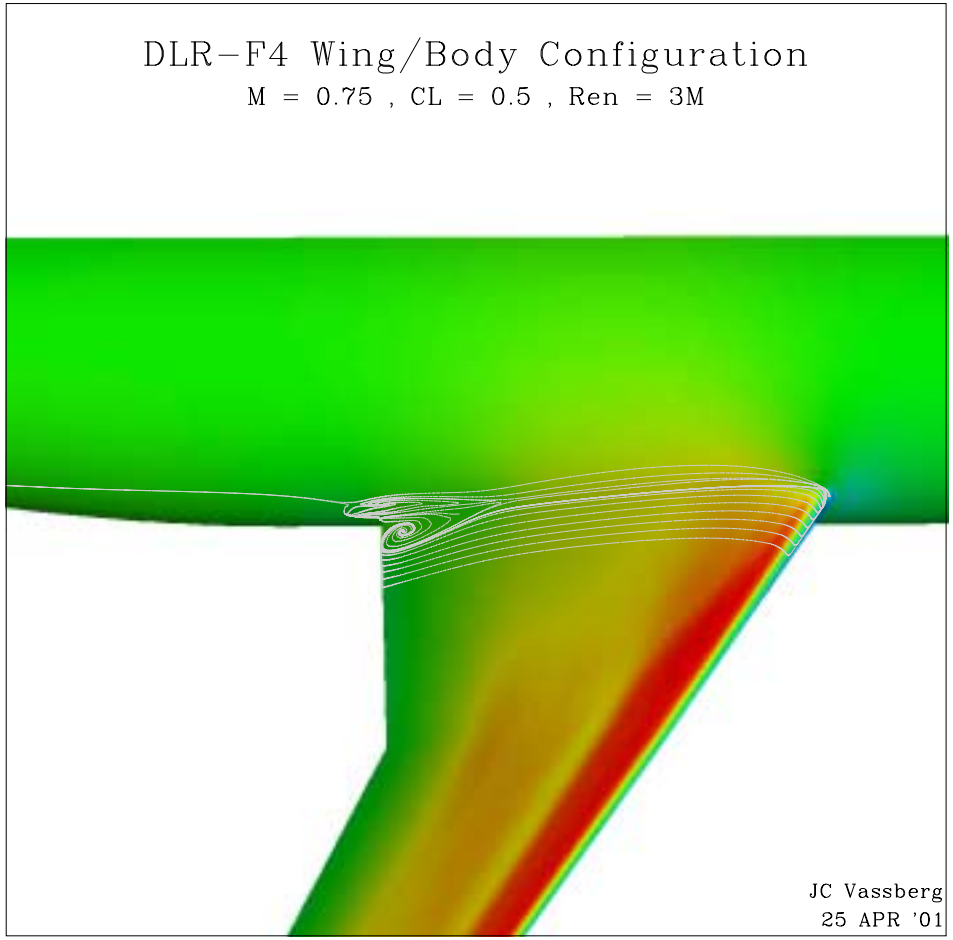


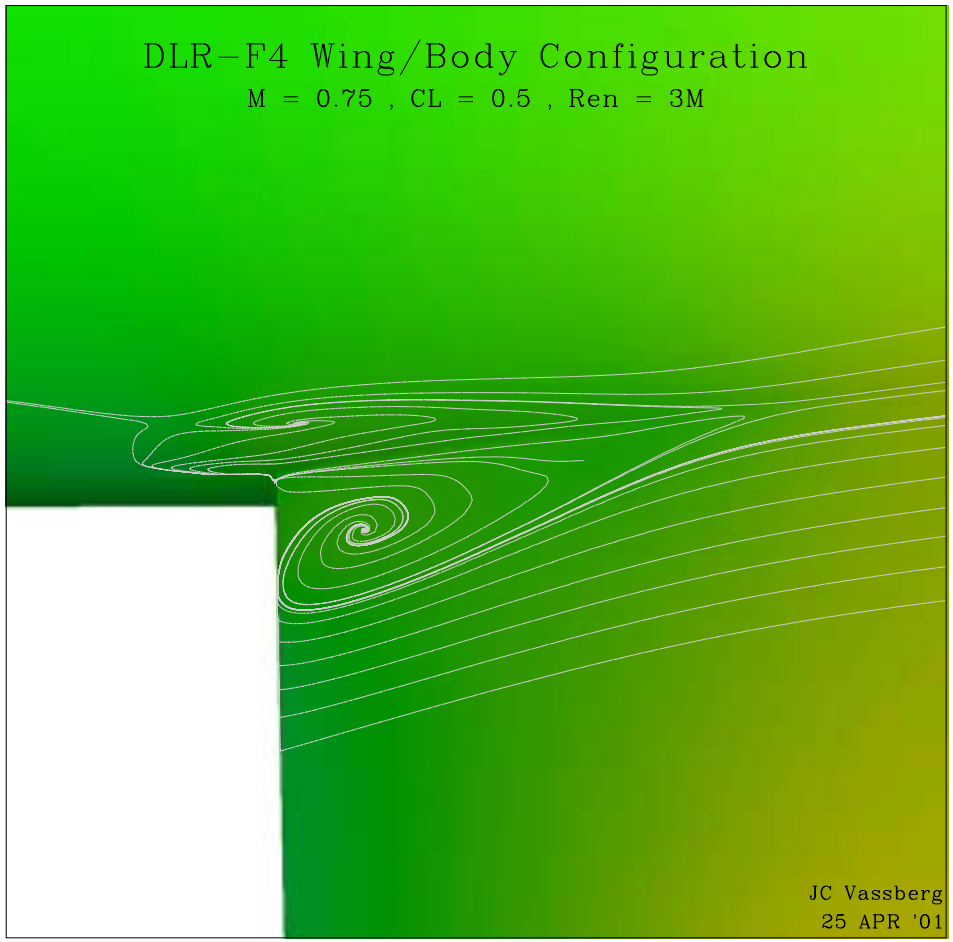
PRESSURE COMPARISONS



FLOW VIZ


DLR−F4 Wing/Body Configuration
M = 0.75 , CL = 0.5 , Ren = 3M
JC Vassberg
25 APR '01

FLOW VIZ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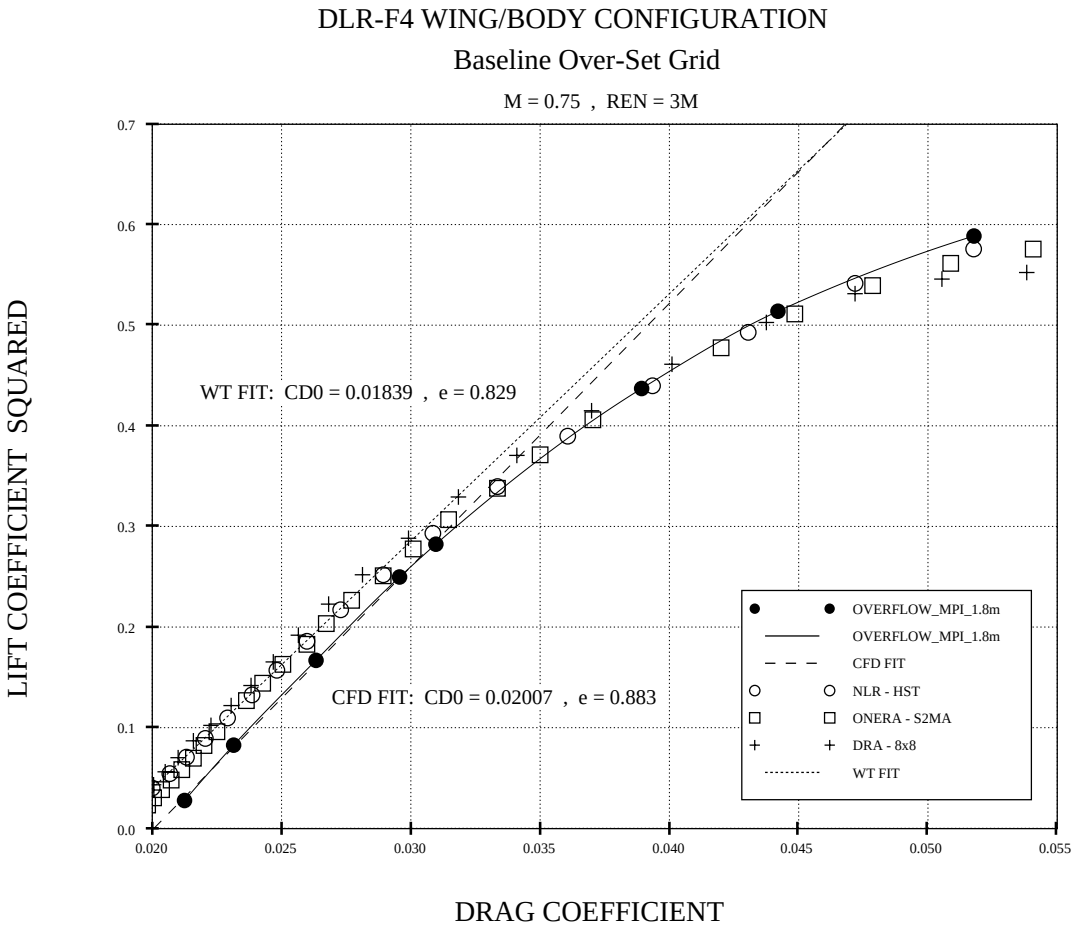
DRAG POLARS


DLR-F4 WING/BODY CONFIGURATION
Baseline Over-Set Grid
M = 0.75 , REN = 3M
LIFT COEFFICIENT SQUARED
DRAG COEFFICIENT
WT FIT: CD0 = 0.01839 , e = 0.829
CFD FIT: CD0 = 0.02007 , e = 0.883
OVERFLOW_MPI_1.8m
OVERFLOW_MPI_1.8m
CFD FIT
NLR - HST
ONERA - S2MA
DRA - 8x8
WT FIT
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.020
0.025
0.030
0.035
0.040
0.045
0.050
0.055

CFD-TO-TEST CORRECTIONS

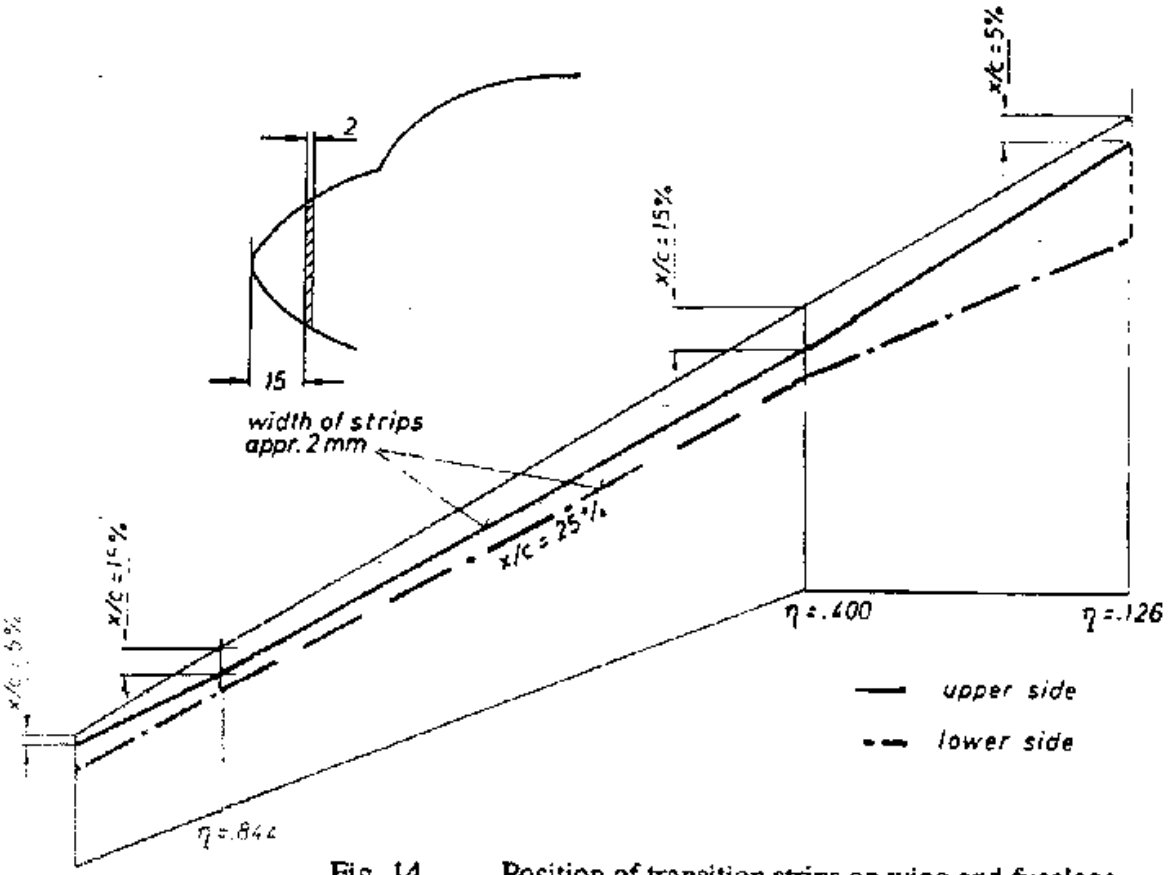
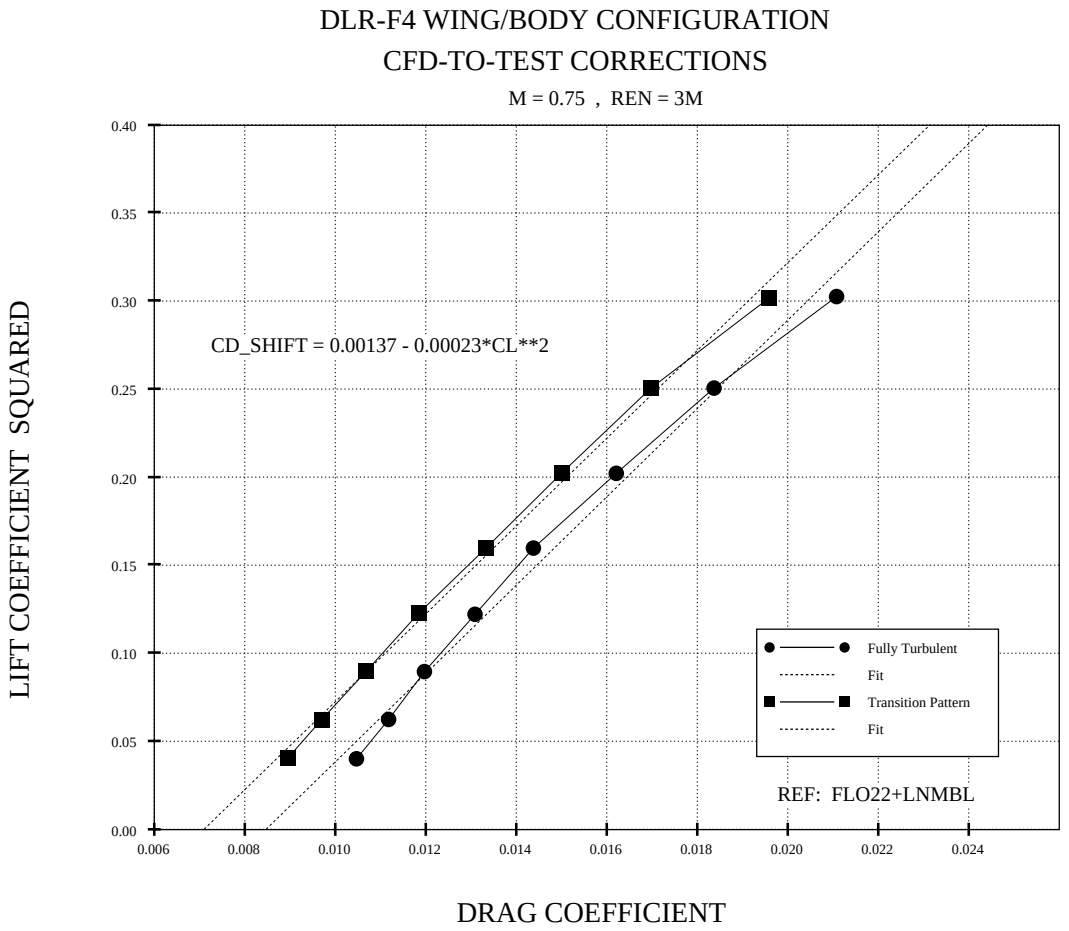


Fig. 14 Position of transition strips on wing and fuselage

CFD-TO-TEST CORRECTIONS



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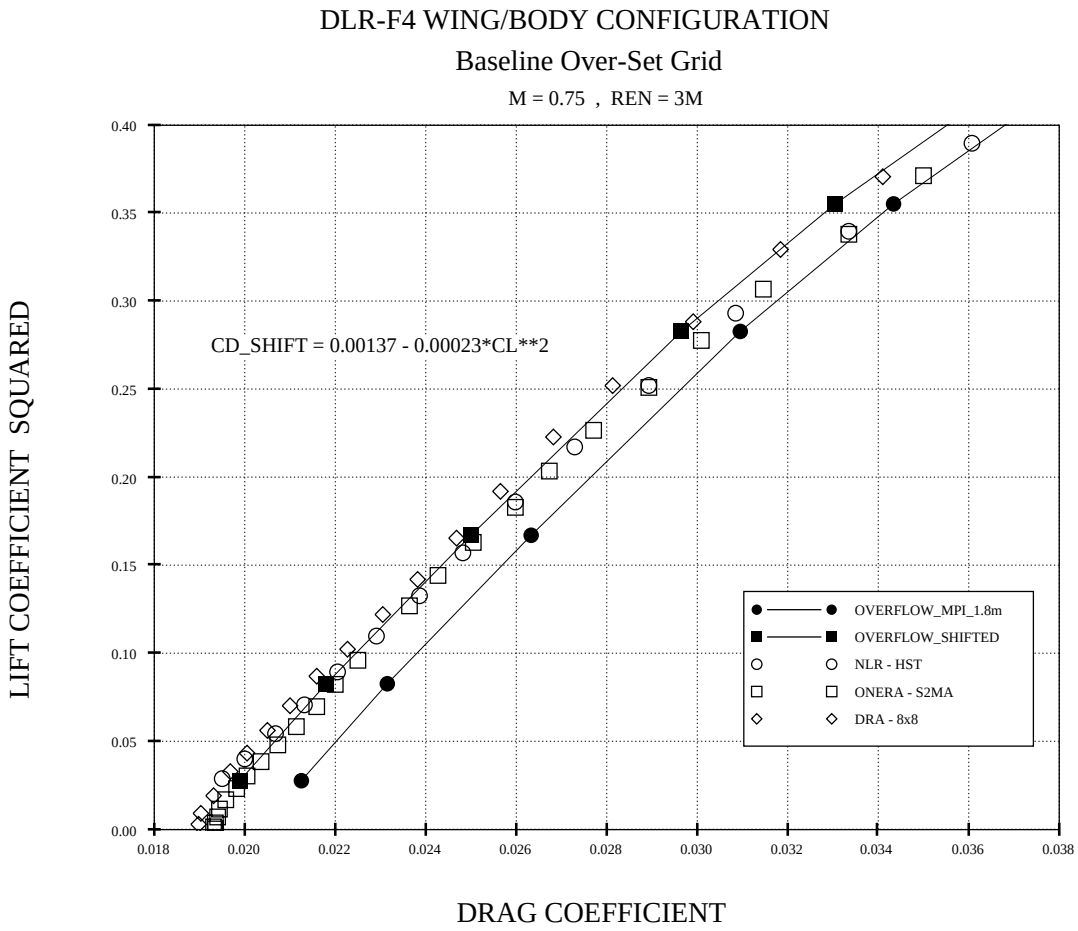
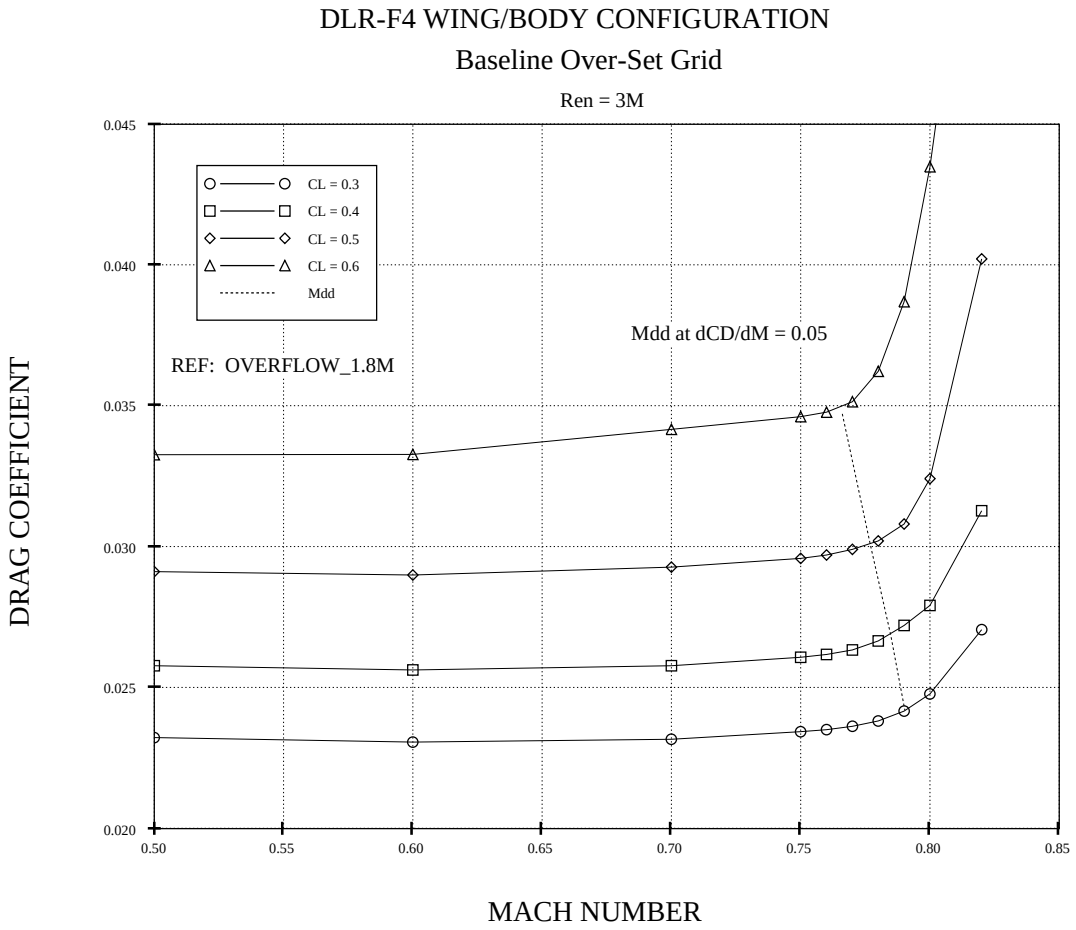
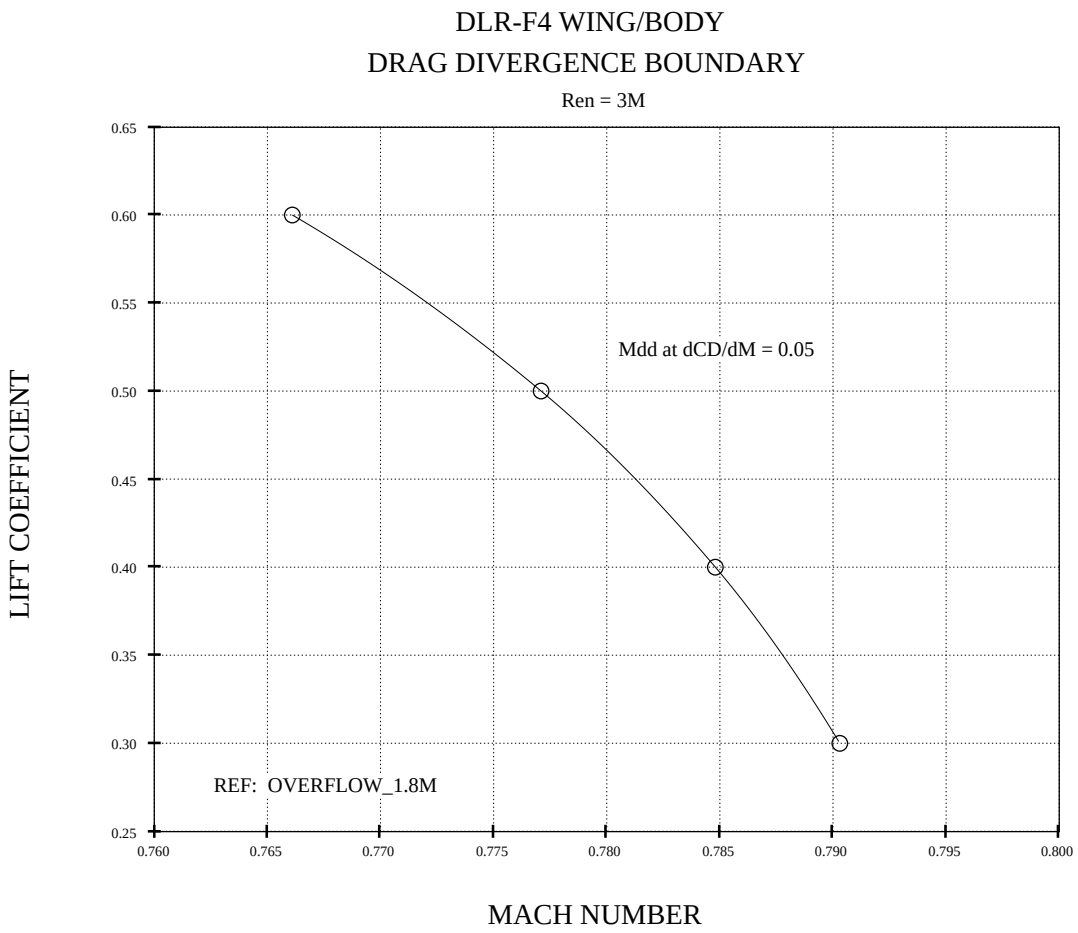


DRAG-RISE


DLR-F4 WING/BODY CONFIGURATION
Baseline Over-Set Grid
Ren = 3M
CL = 0.3
CL = 0.4
CL = 0.5
CL = 0.6
Mdd
Mdd at dCD/dM = 0.05
REF: OVERFLOW_1.8M
DRAG COEFFICIENT
0.045
0.040
0.035
0.030
0.025
0.020
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
MACH NUMBER

DRAG-RISE


DLR-F4 WING/BODY
DRAG DIVERGENCE BOUNDARY
Ren = 3M
LIFT COEFFICIENT
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
Mdd at dCD/dM = 0.05
REF: OVERFLOW_1.8M
0.760
0.765
0.770
0.775
0.780
0.785
0.790
0.795
0.800
MACH NUMBER

DRAG-RISE

- **BREGUET-RANGE EQUATION**

$$Range = \frac{M * L}{D} * \frac{a}{SFC} * \ln\left(\frac{W_0 + W_f}{W_0}\right)$$

where,

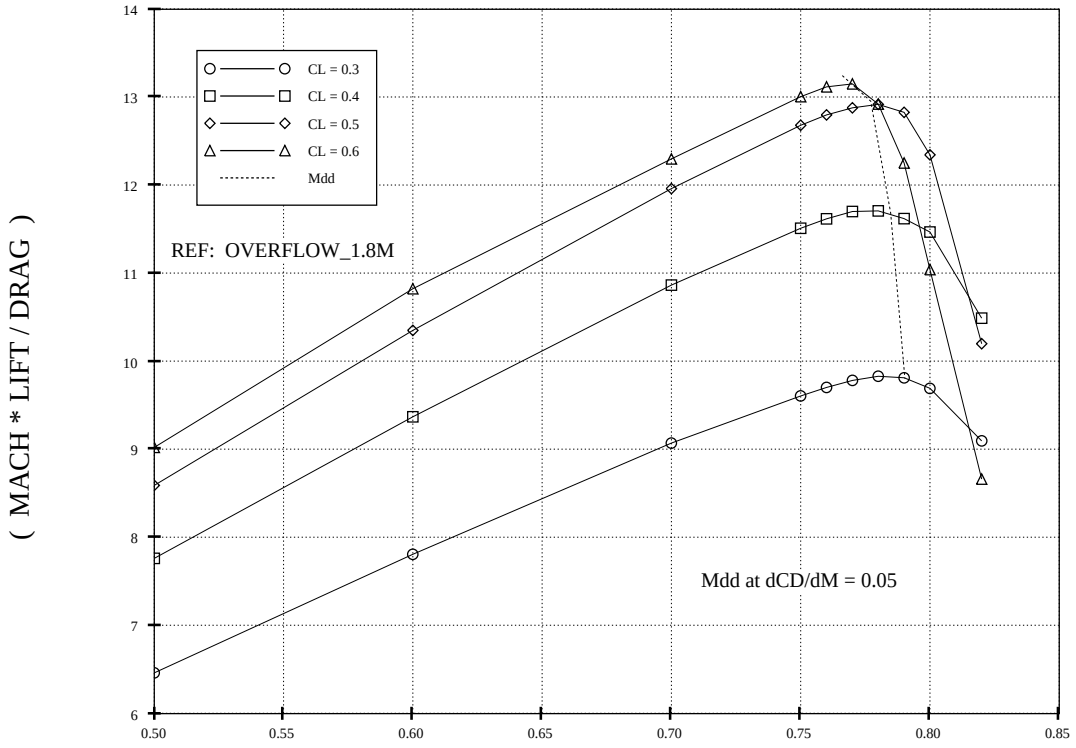
M	is Mach Number,
L	is Lift,
D	is Drag,
a	is Speed of Sound,
SFC	is Specific Fuel Consumption,
W_0	is Weight of Aircraft at Landing,
W_f	is Weight of Fuel Burnt.

DRAG-RISE

DLR-F4 WING/BODY CONFIGURATION

Baseline Over-Set Grid

Ren = 3M



SUMMARY

- **OVERFLOW SOLUTIONS**
  - Drag Polars = 10
  - Drag-Rises = 4
  - Solutions = 53
  - About One Month Total Wall Clock
- **APPLIED CFD-TO-TEST CORRECTIONS**
  - FLO22 With & Without Laminar Runs
- **ACCURATE OVERFLOW DRAG POLARS**
  - Fall Within Test Data Scatter, $0.2 \leq C_L \leq 0.6$
  - Polar Slope ($e_{viscous}$) Slightly Off