N91-10858

A ZONAL NAVIER-STOKES METHODOLOGY FOR FLOW SIMULATION ABOUT A COMPLETE AIRCRAFT

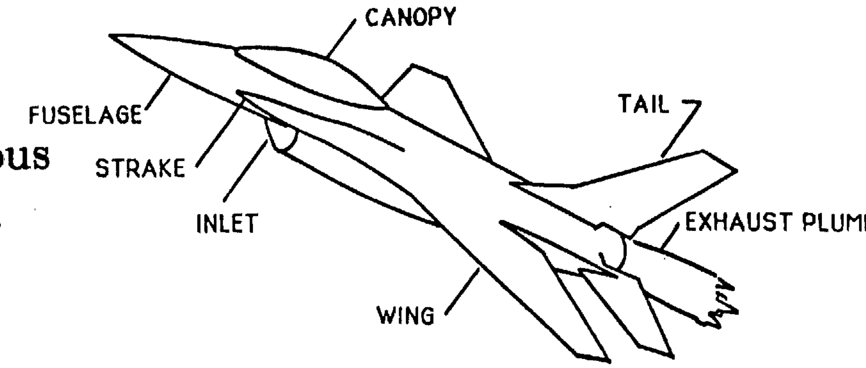
Jolen Flores

Abstract: The thin-layer, Reynolds-averaged, Navier-Stokes equations are used to simulate the transonic viscous flow about the complete F-16A fighter aircraft. These computations demonstrate how computational fluid dynamics (CFD) can be used to simulate turbulent viscous flow about realistic aircraft geometries. A zonal grid approach is used to provide adequate viscous grid clustering on all aircraft surfaces. Zonal grids extend inside the F-16A inlet and up to the compressor face while power on conditions are modeled by employing a zonal grid extending from the exhaust nozzle to the far field. Computations are compared with existing experimental data and are in fair agreement. Computations for the F-16A in side slip are also presented.

Applied Computational Fluids Branch
NASA Ames Research Center
Moffett Field, CA. 94035

Presentation at NASA OAST CFD CONFERENCE
March 7-9, 1989
NASA Ames Research Center

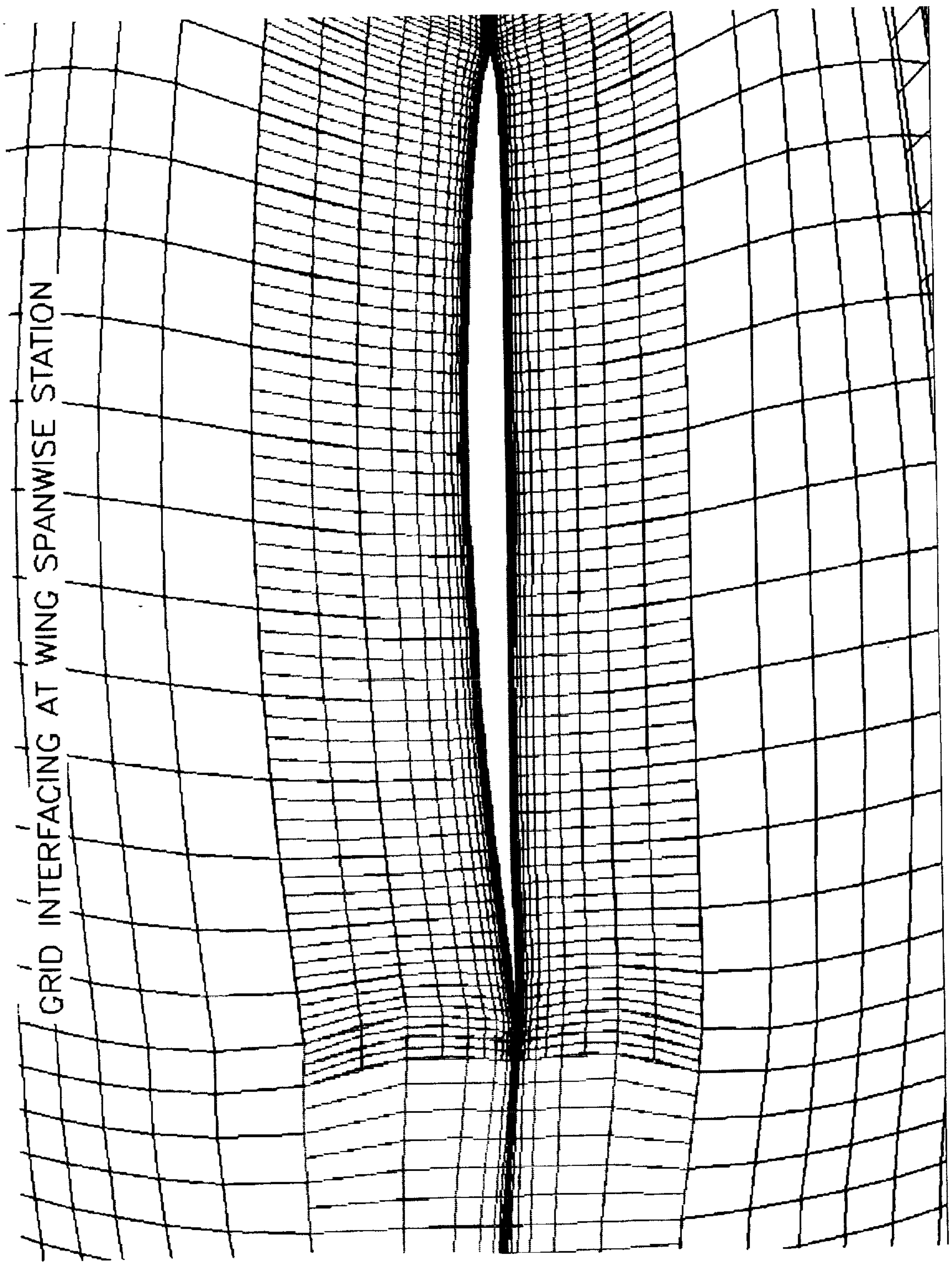
- **OBJECTIVE**
  - ▷ To numerically simulate viscous transonic flow about realistic aircraft configurations.

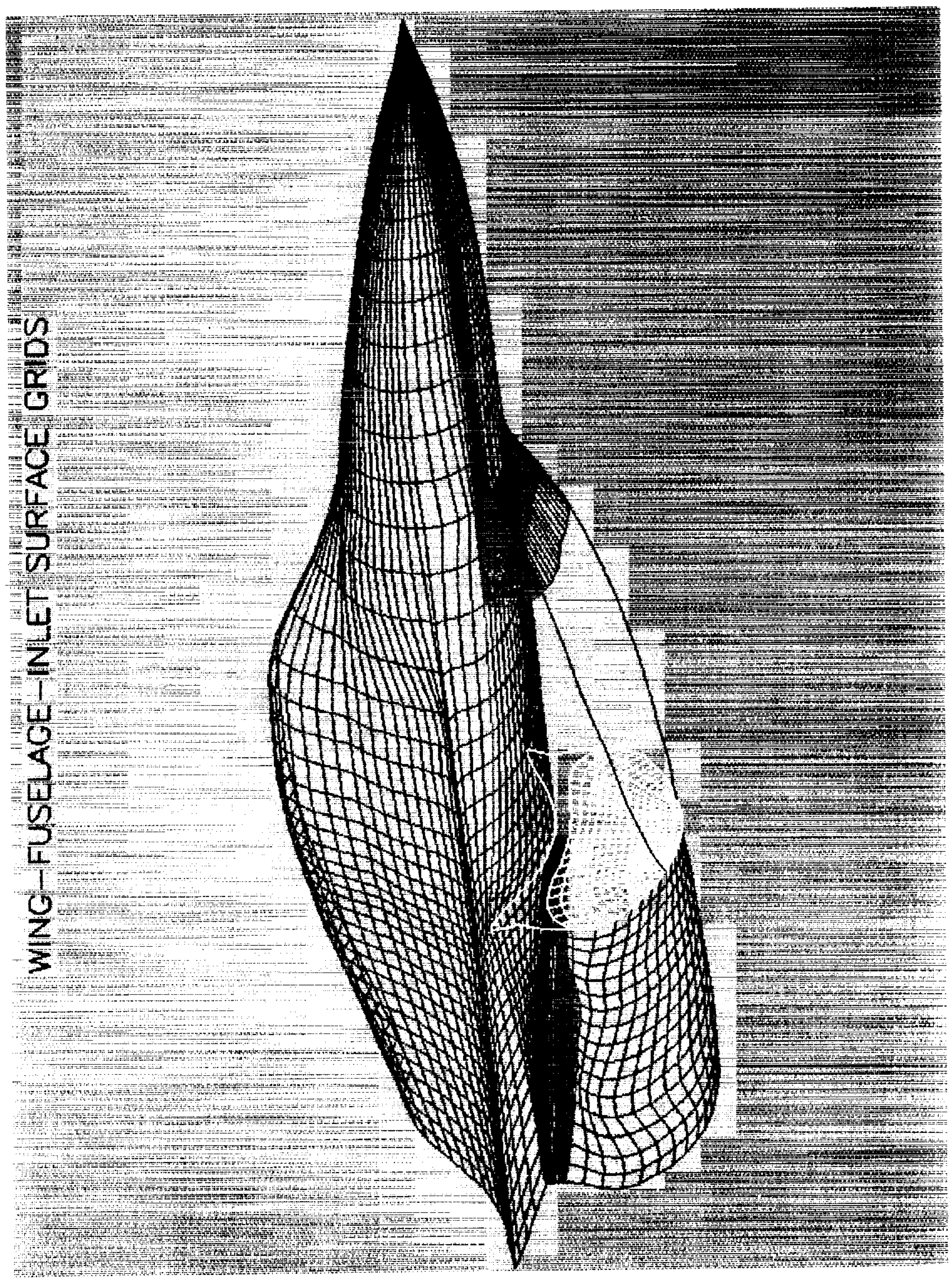


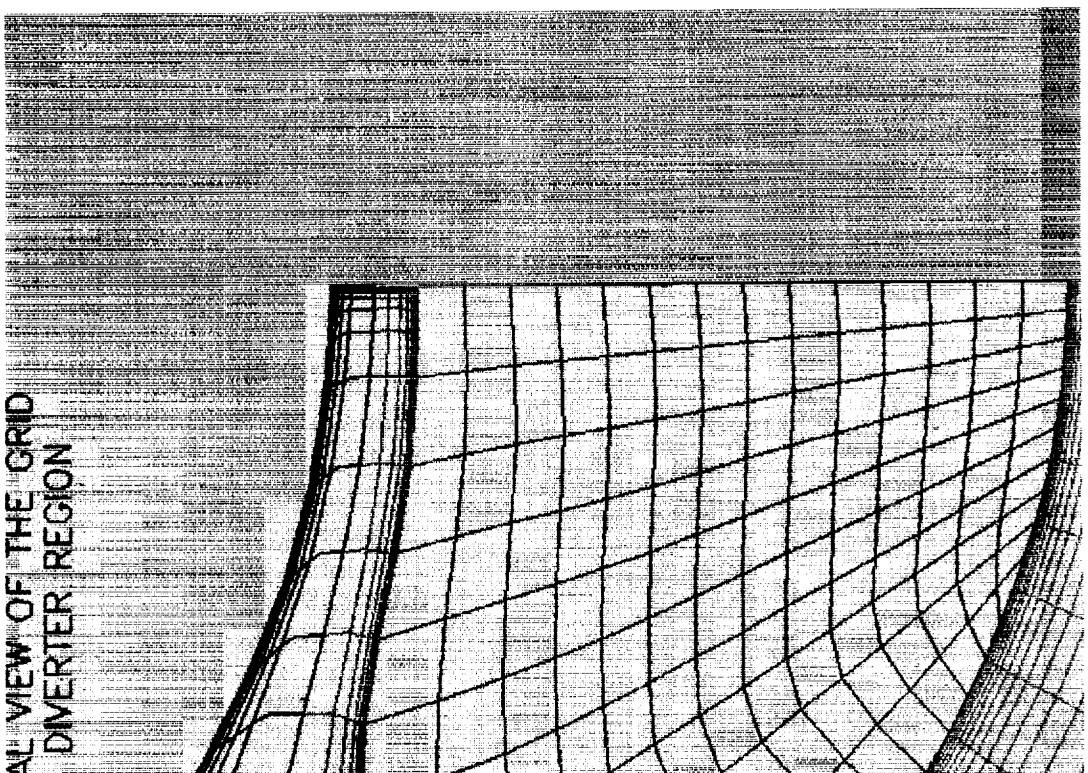
- **MOTIVATION**
  - ▷ Technical demonstration of state-of-the-art CFD research
  - ▷ To provide bench-mark calculations (validated by measurements)
  - ▷ Reveal areas requiring future research emphasis
  - ▷ Catalyst for future cooperative efforts between NAS, aerospace industry and academia
  - ▷ Industrial use for prediction of integrated aircraft performance

- **APPROACH**
  - ▷ Thin-layer Navier-Stokes equations
  - ▷ Zonal grid approach
  - ▷ Modular program


TOP PERSPECTIVE VIEW OF F-16A

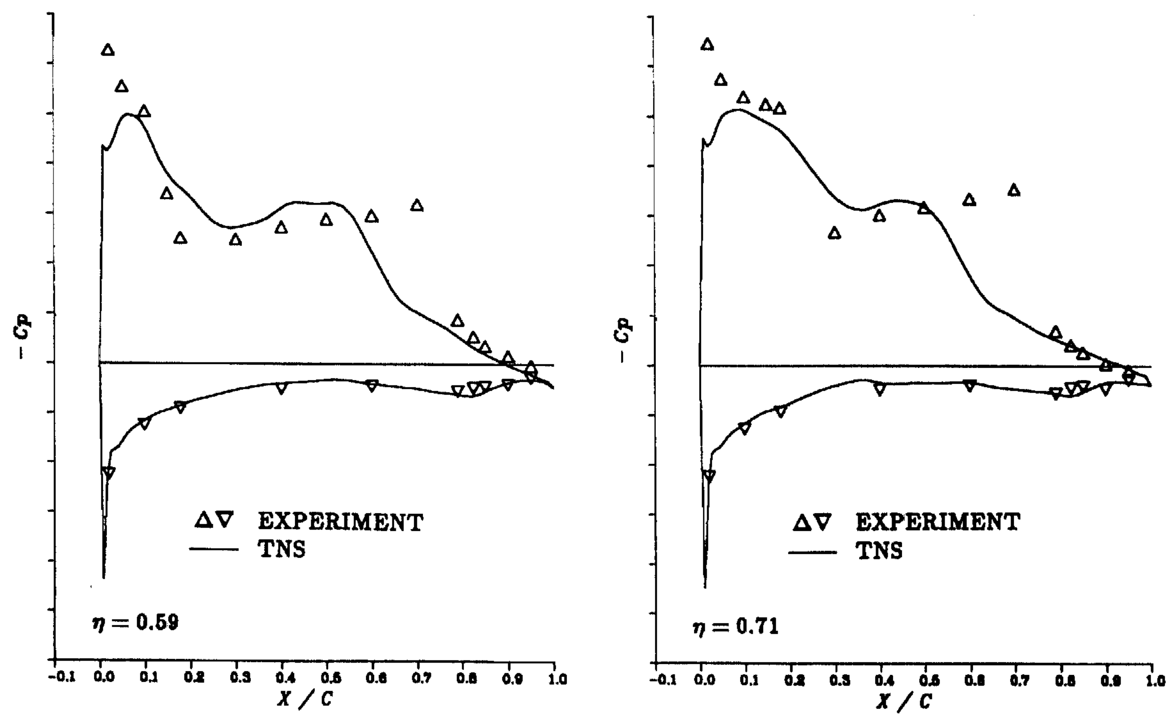

GRID INTERFACING AT WING SPANWISE STATION


WING—FUSELAGE—INLET SURFACE GRIDS


CROSS-SECTIONAL VIEW OF THE GRID
THROUGH THE DIVERTER REGION

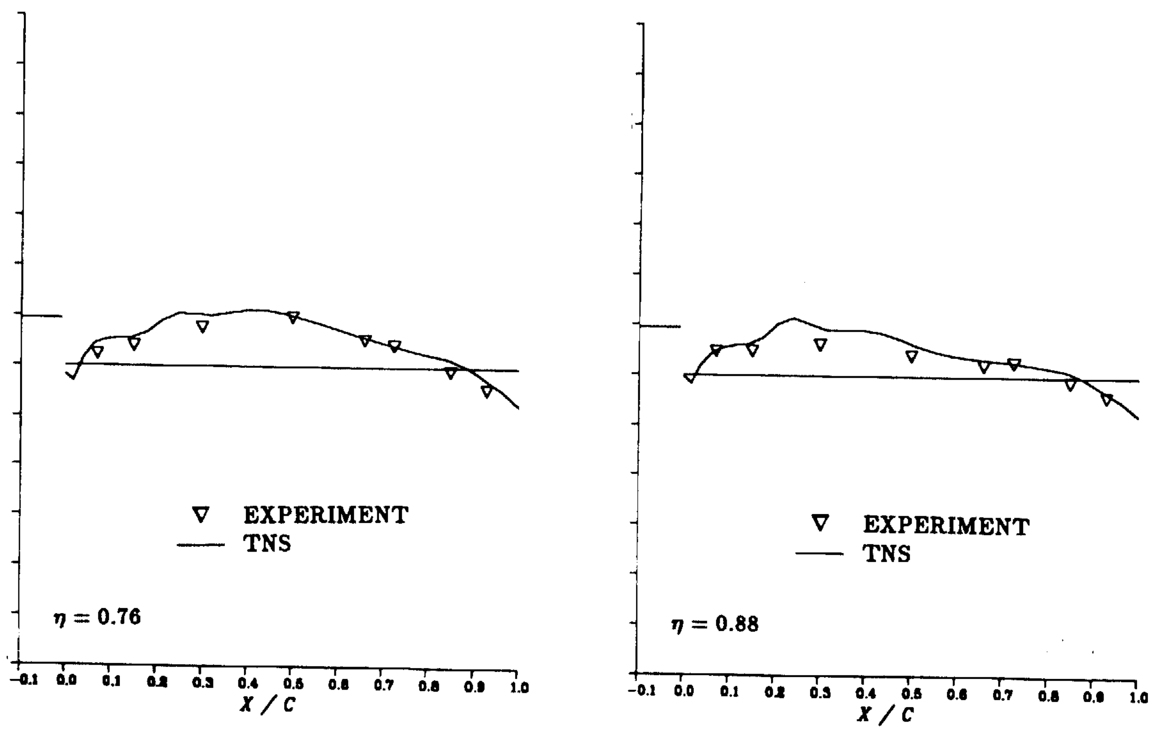
F-16A WING PRESSSURE COEFFICIENT COMPARISONS

$M_\infty = 0.9, \alpha = 6.0°, Re_c = 4.5X10^6$



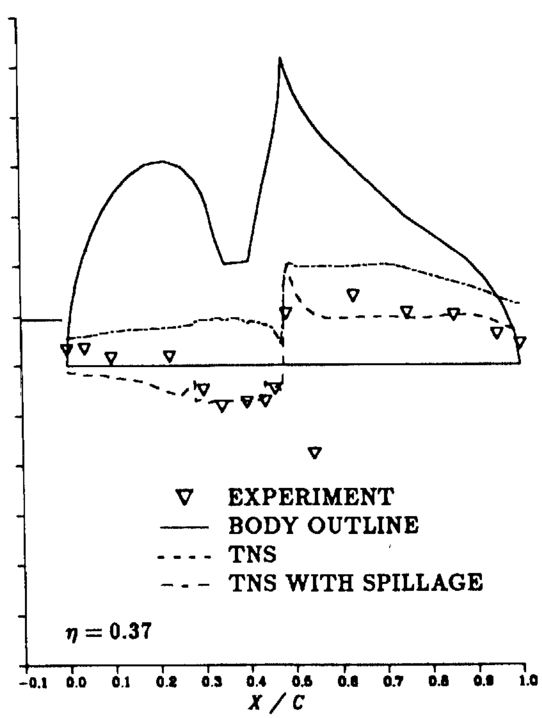
VERTICAL TAIL PRESSURE COEFFICIENT COMPARISONS

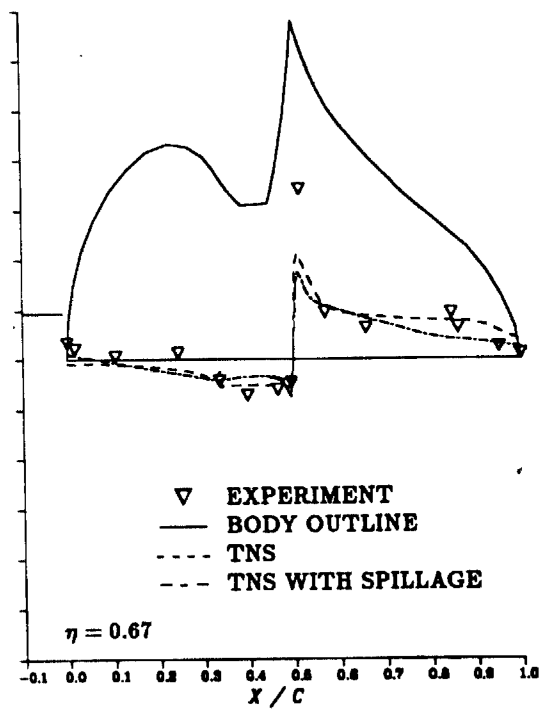
$$M_\infty = 0.9, \alpha = 6.0°, Re_c = 4.5X10^6$$

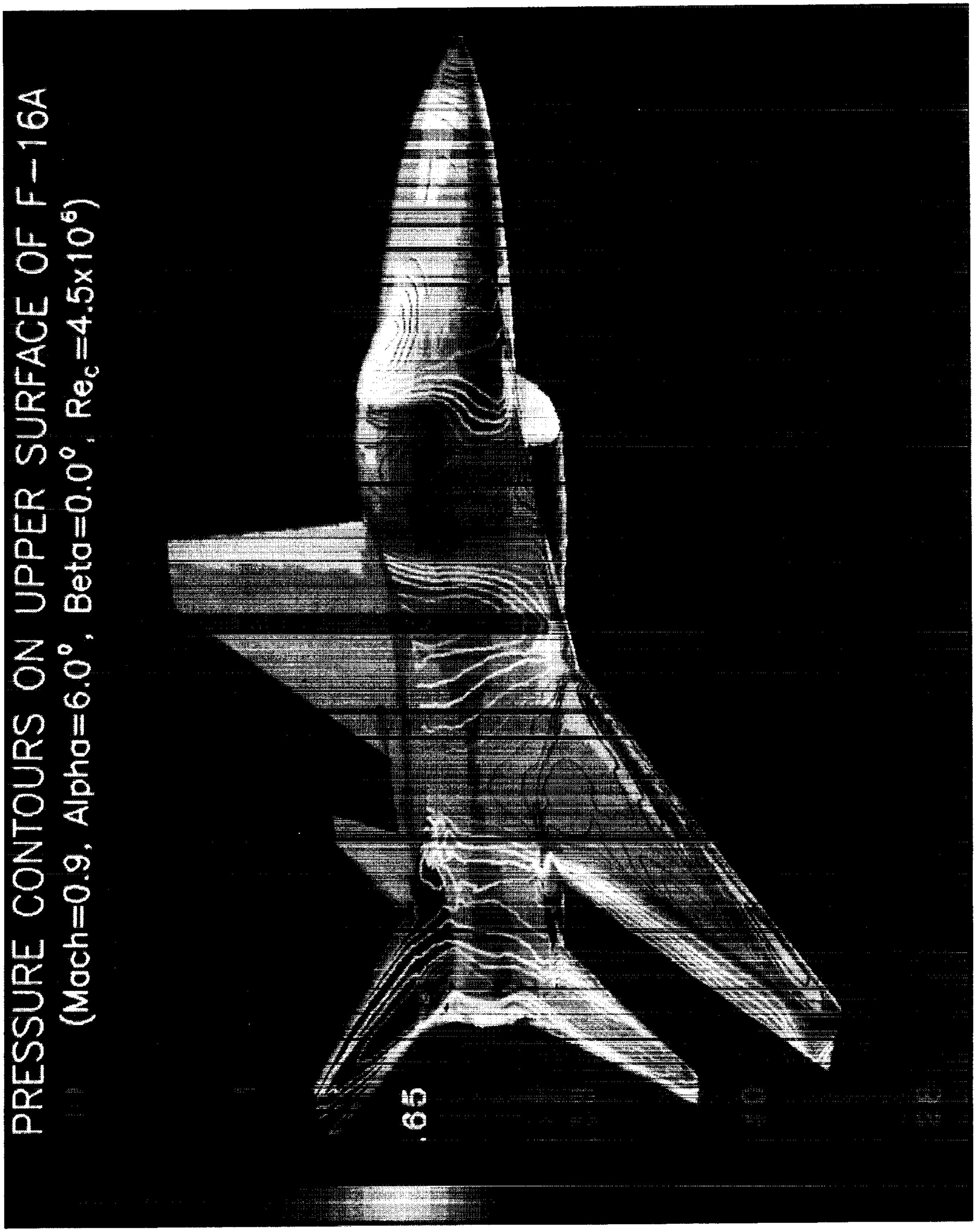


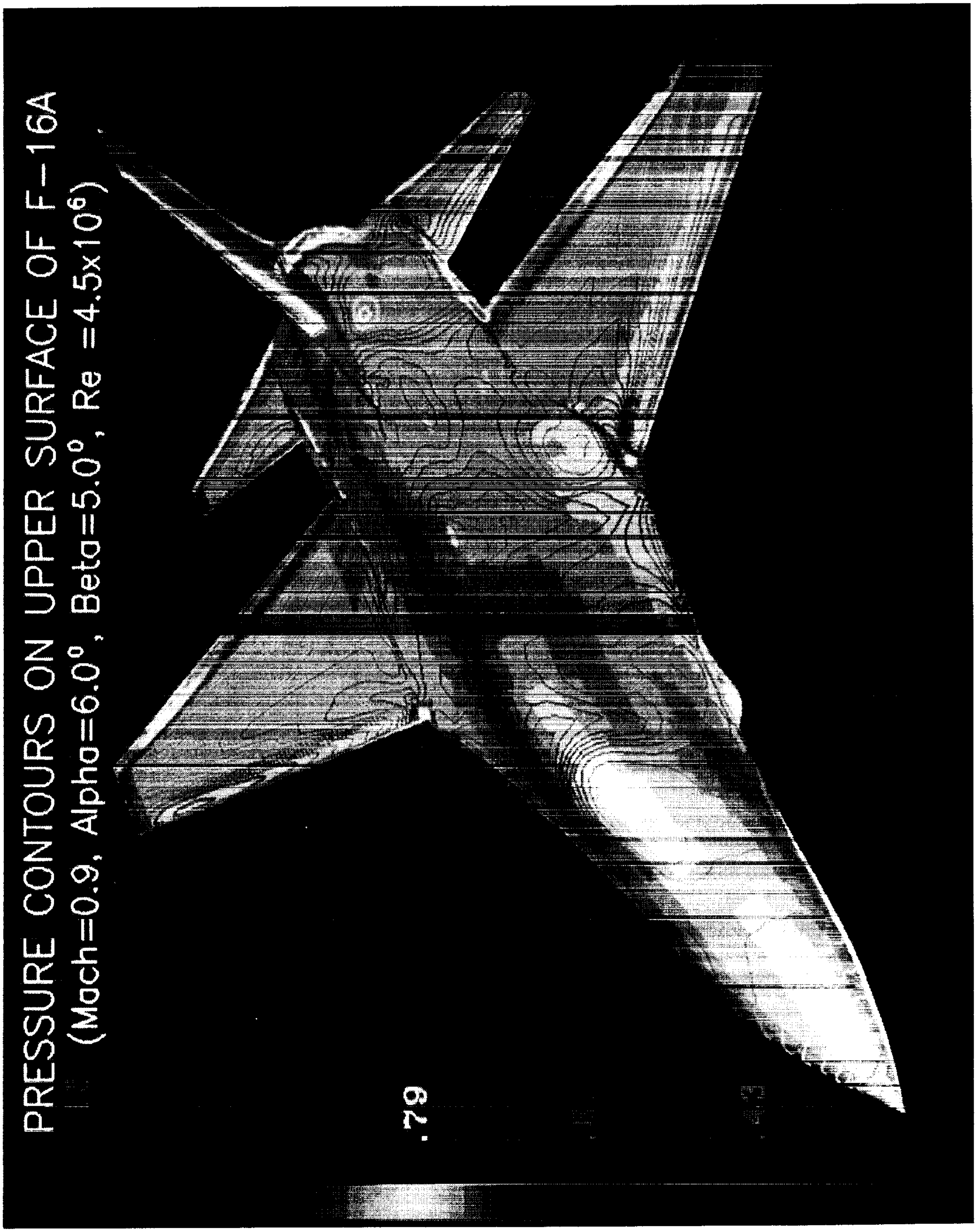
INLET/DIVERTER PRESSURE COEFFICIENT COMPARISONS

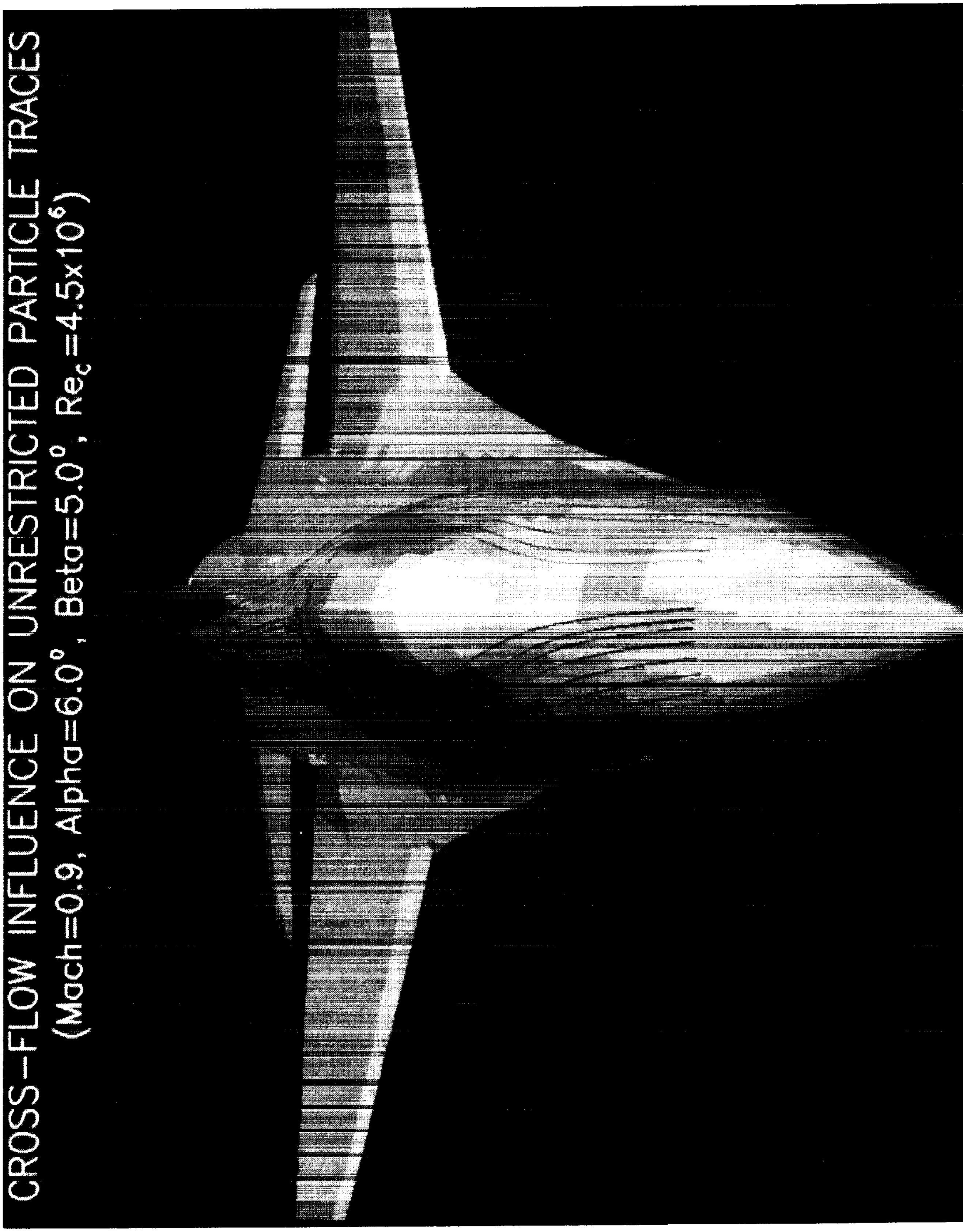
$M_\infty = 0.9, \alpha = 6.0°, Re_c = 4.5X10^6$






PRESSURE CONTOURS ON UPPER SURFACE OF F-16A
(Mach=0.9, Alpha=6.0°, Beta=0.0°, Re_c=4.5x10^6)
.65


PRESSURE CONTOURS ON UPPER SURFACE OF F-16A
(Mach=0.9, Alpha=6.0°, Beta=5.0°, Re =4.5x10⁶)
.79


CROSS-FLOW INFLUENCE ON UNRESTRICTED PARTICLE TRACES
(Mach=0.9, Alpha=6.0°, Beta=5.0°, Re_c=4.5x10^6)

SUMMARY

- Benchmark Navier-Stokes simulation of a complete aircraft including sideslip

$\underline{\beta = 0.0°}$

▷Good comparison with C_P, C_L, and C_D

▷Successful implementation of internal inlet grids

▷Successful simulation of power-on conditions

▷Convergence in 5000 iterations/ 25 hours of cpu

$\underline{\beta = 5.0°}$

▷Pressure contours/particle traces indicate proper physical trends