

ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

N91-10858

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

Jolen Flores

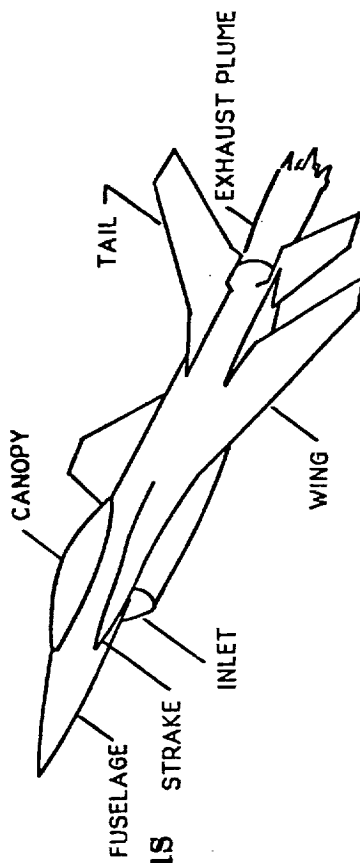
Abstract: The thin-layer, Reynolds-averaged, Navier-Stokes equations are used to simulate the transonic viscous flow about the complete F-16A fighter aircraft. These computations demonstrate how computational fluid dynamics (CFD) can be used to simulate turbulent viscous flow about realistic aircraft 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

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● 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

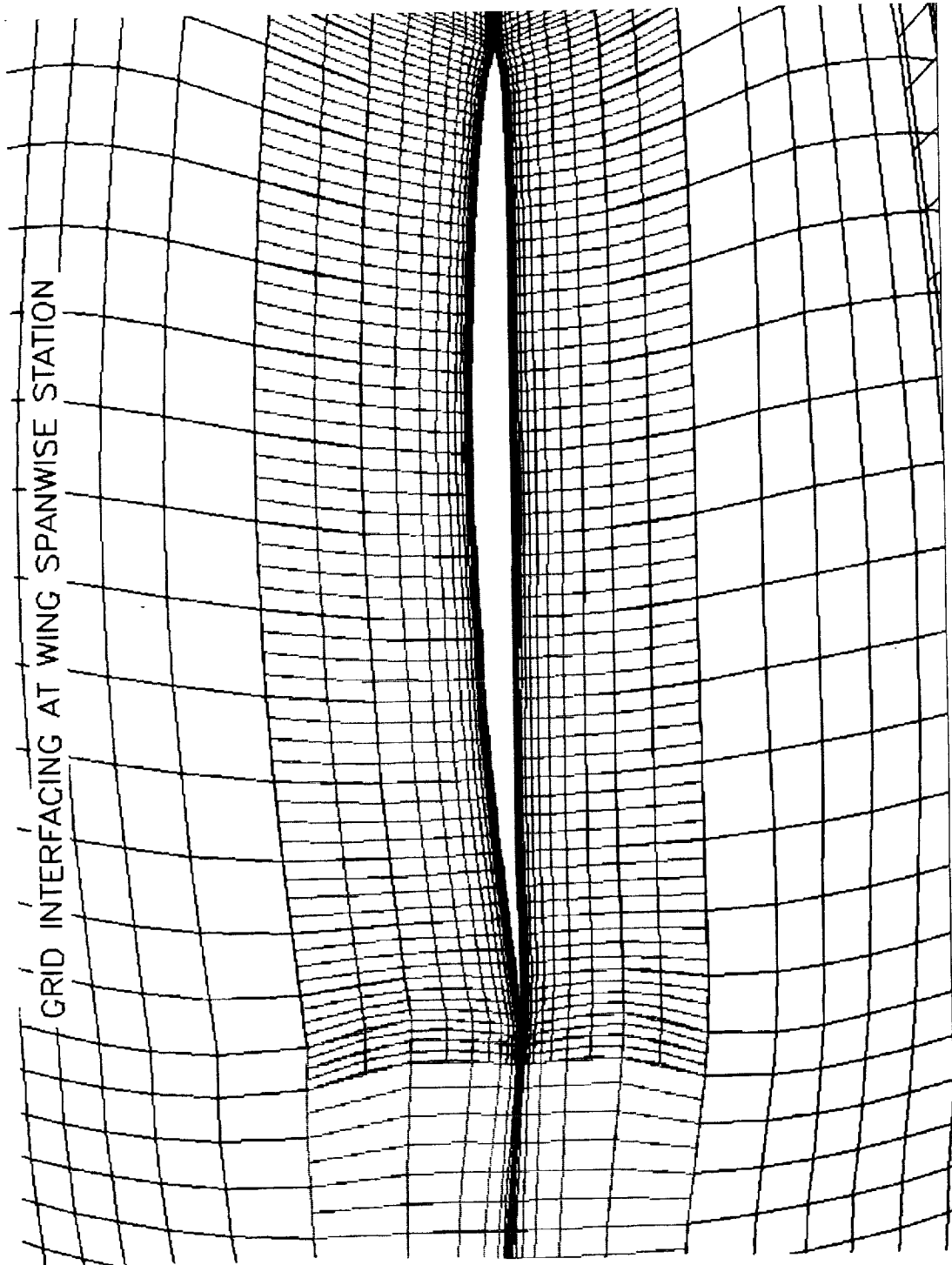
- ▷ Thin-layer Navier-Stokes equations
- ▷ Zonal grid approach
- ▷ Modular program

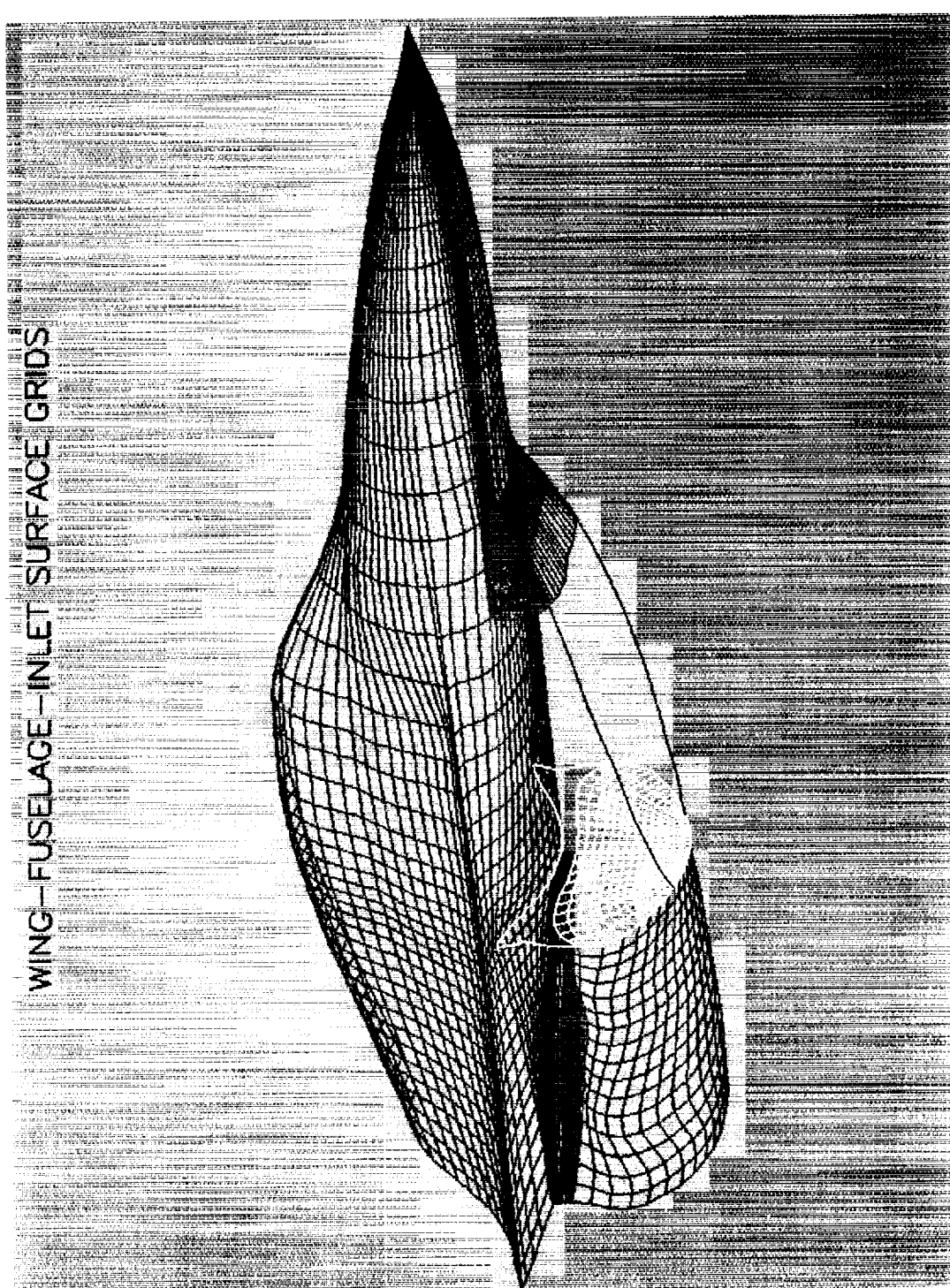
TOP PERSPECTIVE VIEW OF F-16A



Faint, illegible text or markings in the upper left quadrant.

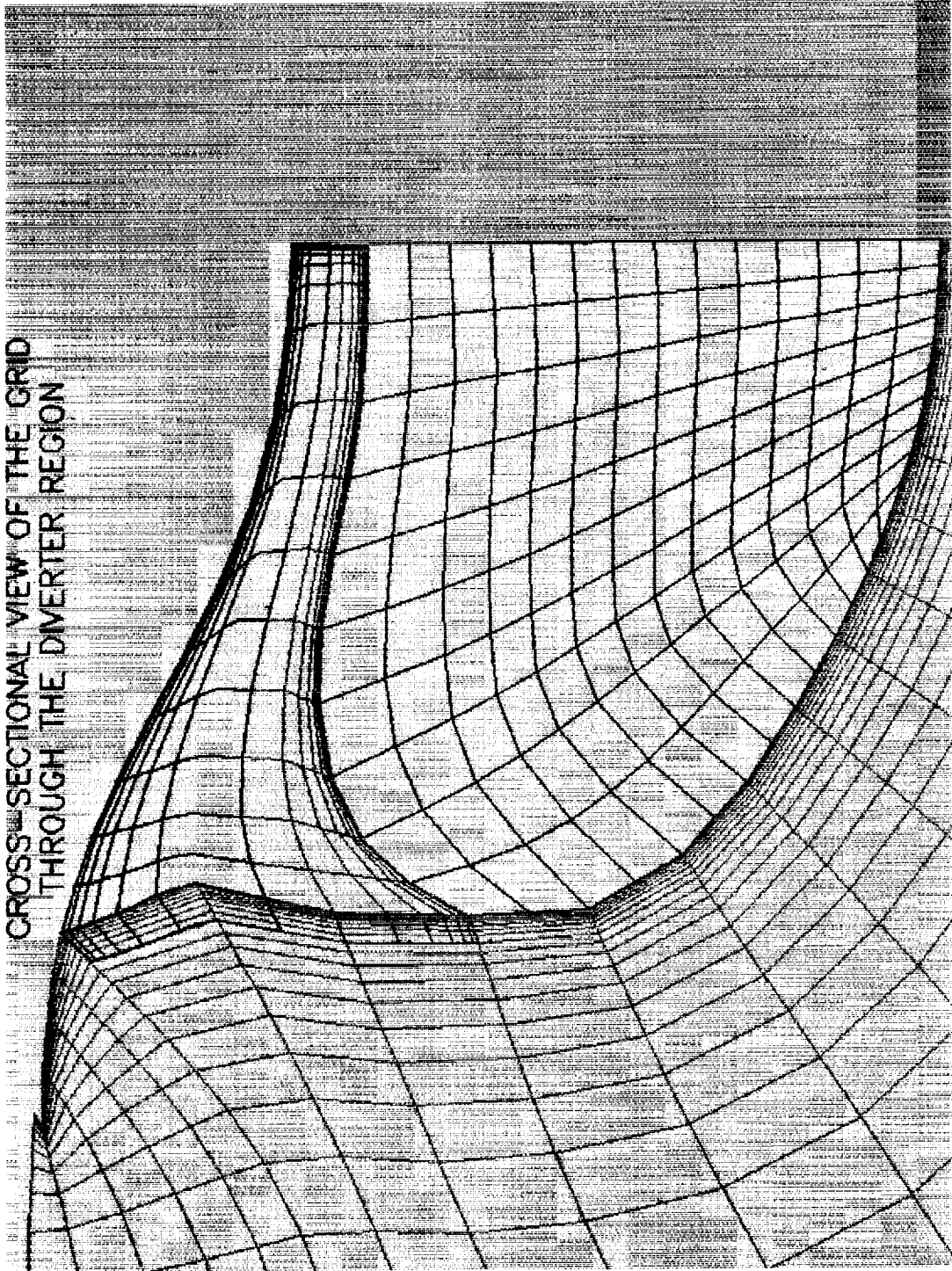
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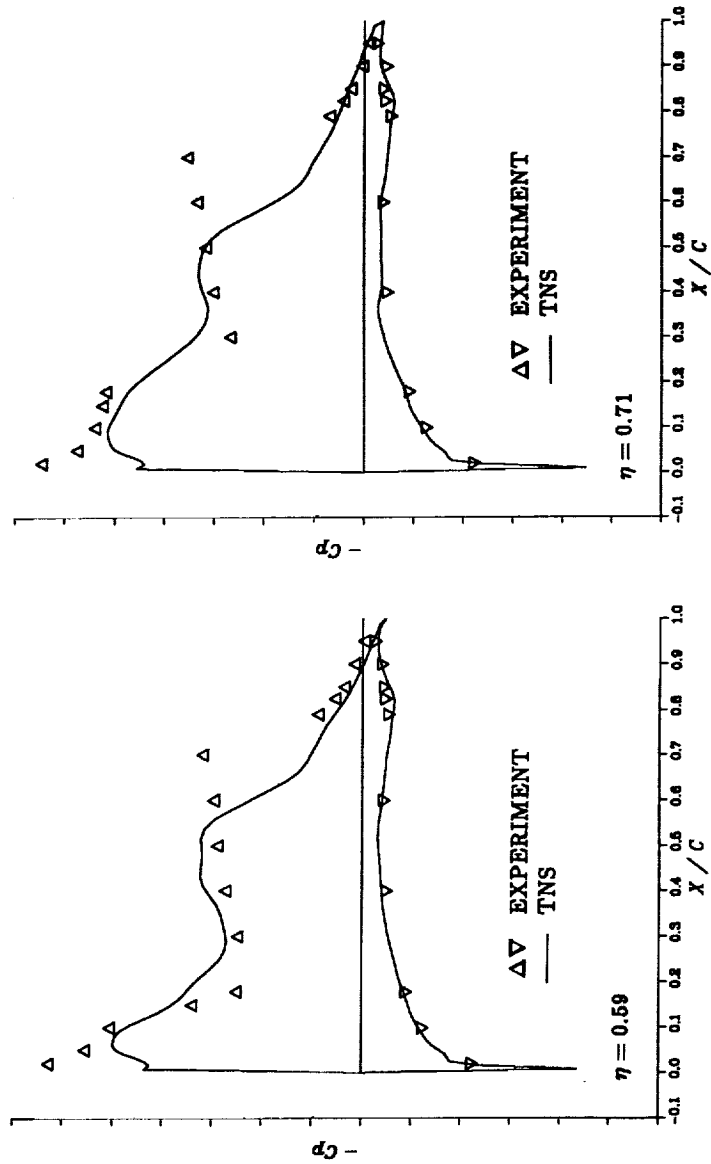
WING—FUSELAGE—INLET SURFACE GRIDS

CROSS-SECTIONAL VIEW OF THE GRID
THROUGH THE DIVERTER REGION



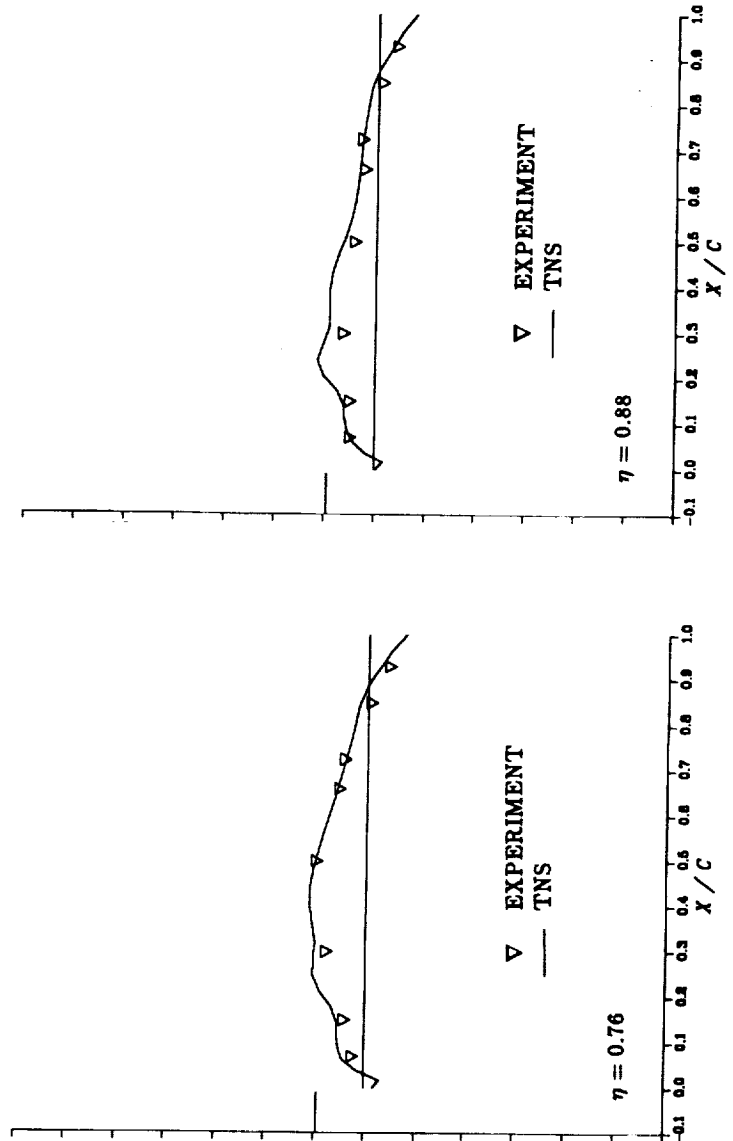
F-16A WING PRESSURE COEFFICIENT COMPARISONS

$M_\infty = 0.9, \alpha = 6.0^\circ, Re_c = 4.5 \times 10^6$



VERTICAL TAIL PRESSURE COEFFICIENT COMPARISONS

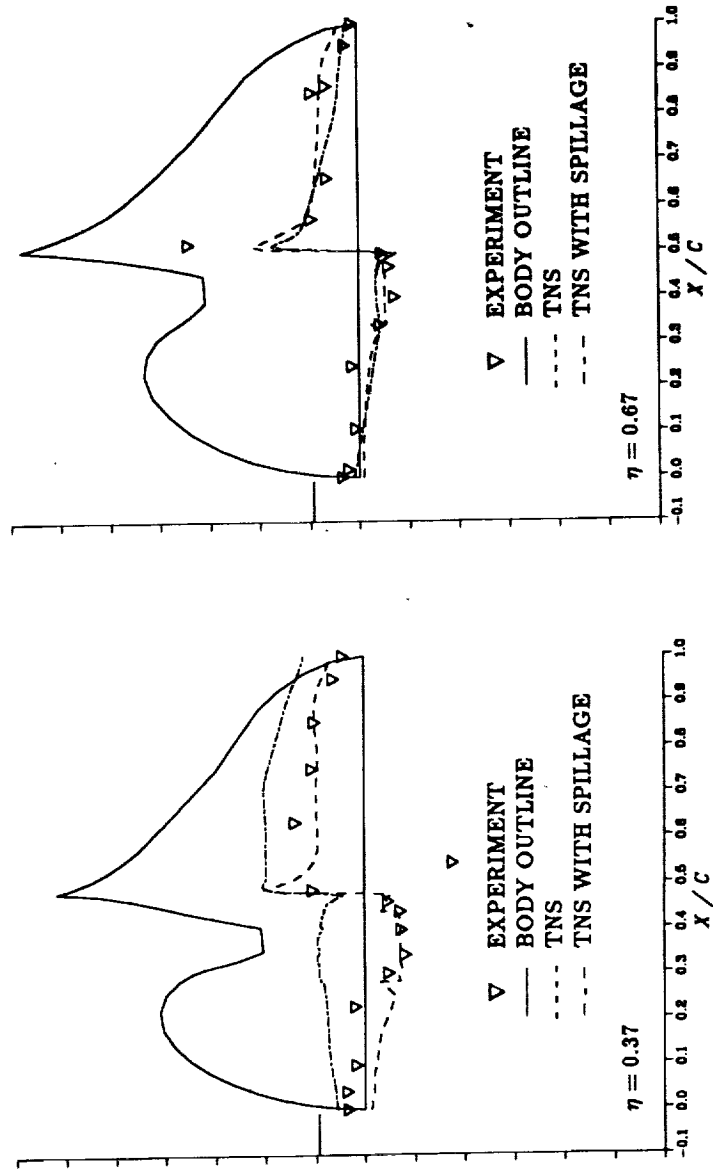
$M_\infty = 0.9, \alpha = 6.0^\circ, Re_c = 4.5 \times 10^6$



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INLET/DIVERTER PRESSURE COEFFICIENT COMPARISONS

$M_\infty = 0.9, \alpha = 6.0^\circ, Re_c = 4.5 \times 10^6$



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PRESSURE CONTOURS ON UPPER SURFACE OF F-16A
(Mach=0.9, Alpha=6.0°, Beta=0.0°, $Re_c=4.5 \times 10^6$)



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1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

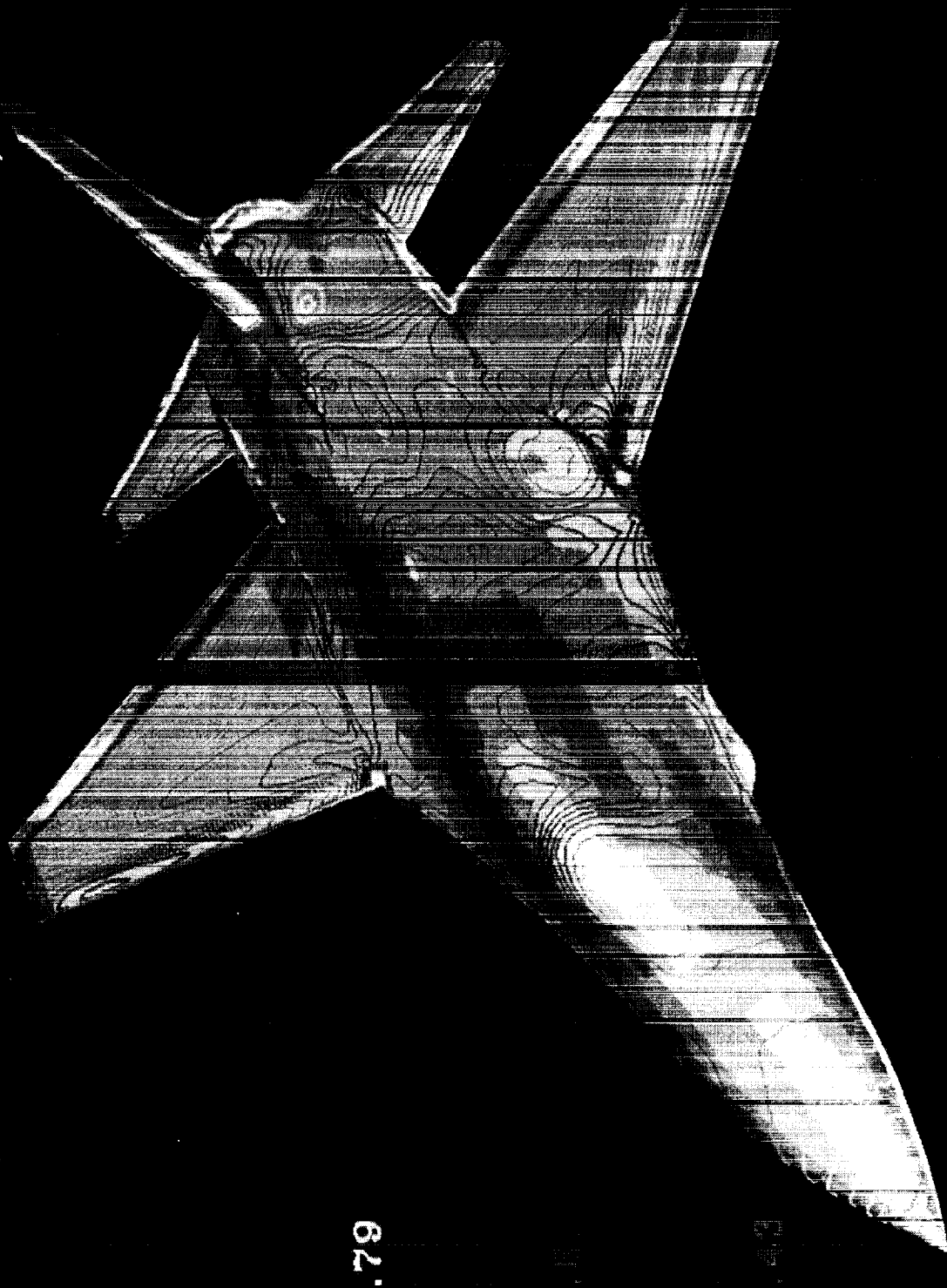
2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

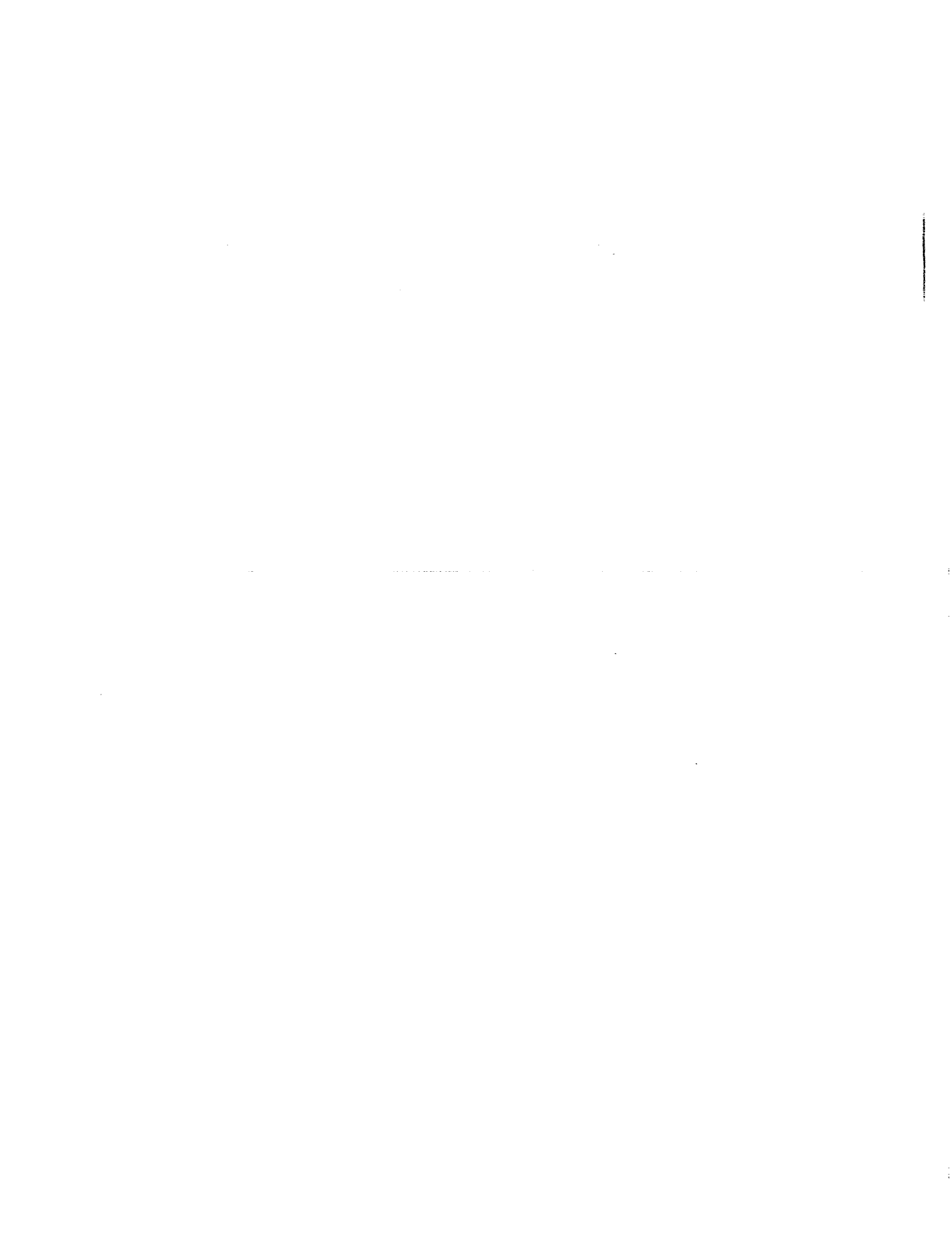
3. The third part of the document focuses on the role of technology in data management and analysis. It discusses how modern software solutions can streamline data collection, storage, and analysis processes, thereby improving efficiency and accuracy.

4. The fourth part of the document addresses the challenges associated with data management, such as data quality, security, and privacy. It provides strategies to mitigate these risks and ensure that the data remains reliable and secure throughout its lifecycle.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It stresses the importance of a data-driven approach in decision-making and the need for continuous monitoring and improvement of data management practices.

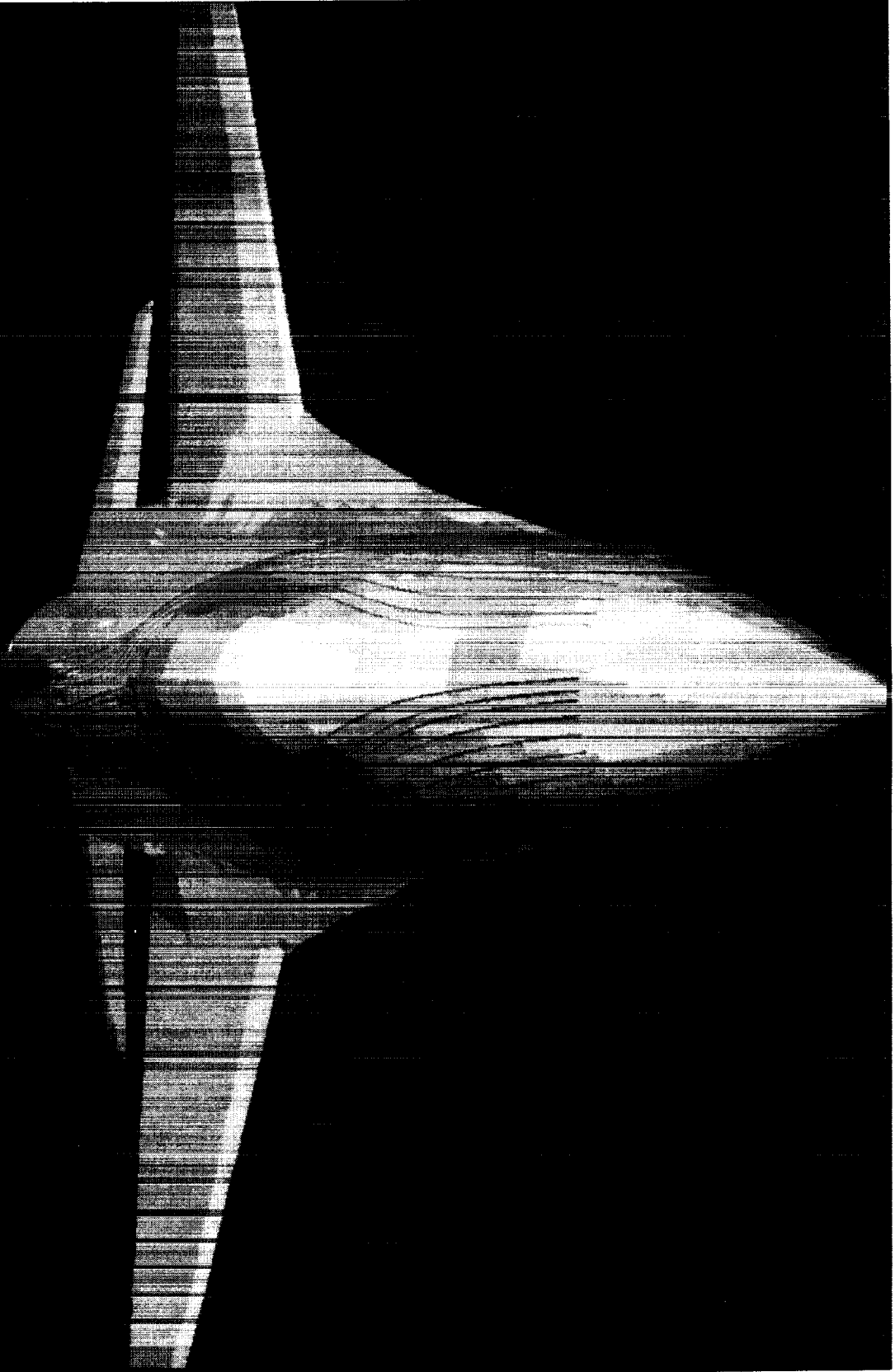
PRESSURE CONTOURS ON UPPER SURFACE OF F-16A
(Mach=0.9, Alpha=6.0°, Beta=5.0°, Re = 4.5x10⁶)





CROSS-FLOW INFLUENCE ON UNRESTRICTED PARTICLE TRACES

(Mach=0.9, Alpha=6.0°, Beta=5.0°, $Re_c = 4.5 \times 10^6$)



SUMMARY

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

$$\underline{\beta = 0.0^\circ}$$

- ▷ 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

$$\underline{\beta = 5.0^\circ}$$

- ▷ Pressure contours/particle traces indicate proper physical trends

1