TAB CONTRIBUTIONS TO UNDERSTANDING
AND SUGGESTIONS FOR FUTURE WORK

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WIND TUNNEL OFF-SURFACE FLOW VISUALIZATION OF THE F/A-18

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High Alpha Technology Program (HATP) Workshop
November 1-2, 1989
NASA Ames-Dryden Flight Research Facility
WIND TUNNEL PRESSURE DISTRIBUTIONS
ON THE F/A-18

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EXPERIMENTAL INVESTIGATION

- Laser Vapor Screen Technique
- 6 Percent-Scale Model
  - Baseline high-\(\alpha\) configuration
  - Forebody strakes (symmetric, asymmetric)
  - Nose boom
  - LEX fences
- DTRC 7- by 10-Foot Transonic Tunnel
- \(Re_c = 1 \times 10^6\)
- \(M_\infty = 0.20 \text{ to } 0.90\)
- \(\alpha = 10^\circ \text{ to } 50^\circ\)
- \(\beta = -10^\circ \text{ to } +10^\circ\)
ANGLE OF ATTACK EFFECT
ON F-18 LEX UPPER SURFACE STATIC PRESSURES
\( M_\infty = 0.4, \text{F.S. 142} \)

- CP station

Onset of vortex breakdown at this station \((\alpha = 45^\circ)\)

Port LEX

Starboard LEX

\( \alpha, \text{deg} \)
- 10.03
- 15.03
- 20.05
- 24.92
- 30.05
- 35.04
- 39.93
- 45.09

\( C_{pu} \)

Y/S (F.S. 253)
MACH NUMBER EFFECT
ON F-18 LEX UPPER SURFACE STATIC PRESSURES
α = 30°, F.S. 253

C_p station

Port LEX

Starboard LEX

C_p (M_∞ = 0.6)

Y/S (F.S. 253)

M_∞

○ 0.20
□ 0.30
◇ 0.40
▲ 0.60
▼ 0.70
□ 0.80
○ 0.90
F-18 FOREBODY SURFACE STATIC PRESSURE DISTRIBUTION
\[ \alpha = 50^\circ, \ M_\infty = 0.6, \ F.S. \ 142 \]
MACH NUMBER EFFECT
ON F-18 FOREBODY SURFACE STATIC PRESSURES
\( \alpha = 40^\circ, \text{F.S. 142} \)

\[ C_p \text{ station} \]

\[ \begin{align*}
C_p^* (M_\infty = 0.8) \\
\text{Stronger vortex "footprints" at } M_\infty = 0.8 \\
\text{Earlier primary separation at } M_\infty = 0.8
\end{align*} \]

\[ \theta, \text{deg (F.S. 142)} \]

\[ M_\infty \]
- 0.60
- 0.80
SUMMARY

- LEX vortex footprints (including burst vortex) are clearly identified at subsonic speeds
- Transonic pressure distributions are less revealing
- LEX vortex is highly compressible
SUMMARY

- Vortex flow behavior (development, location, breakdown, vortex/tail interactions) observed in the wind tunnel is representative of the flow field about the full-scale aircraft.
- Vortex breakdown is insensitive to the Mach number up to $M_\infty=0.6$.
- Vortex position and cross-sectional shape are sensitive to the Mach number.
SUMMARY

- Forebody vortex footprints are manifested in pressure distributions
- Pressure distributions are indicative of turbulent boundary layer
- Transonic flow mechanisms first apparent on forebody at $M_\infty=0.80$
HATP GROUND TEST ISSUES

- F-18 development program brought into question credibility of ground testing facilities
  - 16 percent model predicted lateral instability
  - 6 percent model did not

- Testing in 14- by 22-ft tunnel continued discrepancies
  - Pressure data
  - Lateral stability not night and day
ISSUES, CONT'D

- Possible factors leading to discrepancies
  - Tunnel turbulence
  - Geometric fidelity
  - Surface finish
  - Surface penetrations
  - Mach number
  - Pressure taps themselves
PLANS TO ADDRESS ISSUES

- **TAB** to conduct gritting study on ogive/cylinder model
- Need wing, LE flap, horizontal tail pressure data and oil flows
- Need new 16 percent pressure-instrumented forebody test
- Need to get McAir 6 percent F-18 back again or need to build low-speed 6 percent F-18
- Building a low-speed version would solve several problems
  - Model availability
  - Geometric fidelity
  - Surface finish
- TAB has plans to test F-18 forward fuselage alone
INFLUENCE OF $R_n$ ON INTEGRATED SIDE FORCE

3.5 T-O/CYL, $\alpha = 50^\circ$, roll orientation to maximize $C_Y$

$|C_Y|_{\text{max}}$

$R_n$