BASELINE RIGID SEMISPAN MODEL TEST COMPLETED IN TDT FOR HSR AEROELASTICITY PROGRAM

- Configurations
  - Engine nacelles on/off
  - East wall slots open/closed

- Data
  - Wing pressures
  - Fuselage pressures
  - Aerodynamic loads
  - Wing-tip deflections

- Test Conditions
  - R-12
  - $M = 0.70 - 1.15$
  - $\alpha = -2^\circ \rightarrow +8^\circ$

Wing Surface Pressures
- Upper Surface
- Lower Surface

Aerodynamic Loads
- $C_L$ vs $\alpha$
- $C_D$
- $C_L$ vs $C_M$
HSR ACTIVE CONTROLS TESTBED SUCCESSFULLY TESTED ON STING IN TDT

Stability Derivatives
(q=40 psf)

<table>
<thead>
<tr>
<th></th>
<th>Measured Nacelles</th>
<th>No Nacelles</th>
<th>Calculated No Nacelles</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{L_\alpha}$</td>
<td>2.15</td>
<td>2.30</td>
<td>1.81</td>
</tr>
<tr>
<td>$C_{L_\delta e}$</td>
<td>-0.157</td>
<td>-0.130</td>
<td>-0.08</td>
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<tr>
<td>$C_{I_\delta ai}$</td>
<td>0.008</td>
<td>0.007</td>
<td>0.009</td>
</tr>
<tr>
<td>$C_{I_\delta ao}$</td>
<td>0.026</td>
<td>0.030</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Balance
SELECTED WING-STORE FLUTTER INVESTIGATIONS IN THE TRANSONIC DYNAMICS TUNNEL

F-111 (1960's)

F-16 (1970's)

TRANSONIC DYNAMICS TUNNEL

A-6 (1980's)

F/A-18 E/F (1990's)
CONTROL SURFACE FREE PLAY EFFECTS ON FLUTTER STUDIED IN TDT

Free play mechanism

Pitch stiffness spring

Flow

![Diagram showing the effects of free play on flutter conditions.](image)

- **Nominal pitch stiffness**
- **0.79 Nominal pitch stiffness**

Free Play:
- ○ No free play
- □ 2x mil spec
- ▲ 4x mil spec
- ◊ 6x mil spec

No flutter conditions

$q$, psf

$M$
OPEN-LOOP SYSTEM CHARACTERISTICS OF THE BENCHMARK ACTIVE CONTROLS MODEL MEASURED

Mach = .77, Alpha = 0°, 60% Span Upper Surface

Upper Spoiler, deg
-43°
-20°
0°

Transition strip
FLIGHT TEST SHOWS MODIFIED OV-10 AIRCRAFT FREE OF FLUTTER

Strip chart records
aileron stick rap
altitude = 5000 feet, velocity = 330 keas

Acceleration, g's
Left wing tip
Time
Damped response

Acceleration, g's
Right boom
Time
LEARJET 45 FLUTTER CLEARED IN THE LANGLEY TRANSONIC DYNAMICS TUNNEL

Scaled tunnel conditions cleared as compared to actual flight envelope

Flutter points for modified wing configuration