TRANSITION WORKSHOP
MAY 25, 1989
BASIC RESULTS
SLOTTED LFC MODEL
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AIRFOIL DESIGN PARAMETERS

Free-stream design conditions

\[
M_\infty = 0.82 \\
\Lambda = 23^\circ \\
c = 7.07 \text{ ft} \\
R_c = 20 \times 10^6 \\
c_t = 0.47
\]

Design conditions normal to leading edge

\[
M_N = 0.755 \\
c_N = 6.508 \text{ ft} \\
R_{c,N} = 16.9 \times 10^6 \\
(t/c)_N = 13.0 \text{ percent} \\
c_{t,N} = 0.55
\]
PANEL ARRANGEMENT

UPPER PANELS

- Forward: 0 - 26.6 %c
- Center: 26.6 - 58.7 %c
- Aft: 58.7 - 89.1 %c

LOWER PANELS

- Forward: 0 - 24.4 %c
- Center: 24.4 - 55.6 %c
- Aft: 55.6 - 89.1 %c
MEASURED AND PREDICTED PRESSURE DISTRIBUTIONS FOR SLOTTED LFC MODEL

<table>
<thead>
<tr>
<th>$R_c \times 10^6$</th>
<th>$\alpha$, deg</th>
<th>$M_\infty$</th>
<th>$C_{L\infty}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.51</td>
<td>0.8216</td>
<td>0.53</td>
</tr>
<tr>
<td>20</td>
<td>0.51</td>
<td>0.8200</td>
<td>0.47</td>
</tr>
</tbody>
</table>

$C_p$, sonic

$M_{wall, above} \approx 0.995$

$M_{wall, below} \approx 0.887$
SPANWISE PRESSURE DISTRIBUTIONS, $M_\infty = 0.82$

$R_C = 10 \times 10^6$

Ceiling

$C_P$

$2Z/B = 0$

$x/C$

Values range from 0 to 1.0
TRANSITION PATTERN ON UPPER SURFACE - SLOTTED MODEL

$R_c = 10 \times 10^6$
COMPARISON OF MEASURED AND PREDICTED SUCTION DISTRIBUTIONS

$M_\infty = 0.82$, $R_c = 10 \times 10^6$
TRANSITION PATTERN ON UPPER SURFACE - SLOTTED MODEL

$R_c = 20 \times 10^6$

Airflow

- Thin film
- Edge of turbulent wedge
- Transition zone
- Fully turbulent
- Fully laminar
- Joint
- Edge of turbulent wedge
MEASURED AND PREDICTED PRESSURE DISTRIBUTIONS FOR SLOTTED LFC MODEL

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<tr>
<td>20</td>
<td>0.51</td>
<td>0.8226</td>
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SPANWISE PRESSURE DISTRIBUTIONS, $M_\infty = 0.82$

$R_C = 20 \times 10^6$

Ceiling

$C_P$

$2Z/B = 0$

$X/C$
EFFECT OF REYNOLDS NUMBER ON EXPERIMENTAL PRESSURE DISTRIBUTION, SLOTTED MODEL

Graph showing the effect of Reynolds number on pressure distribution with different symbols indicating the values of $R_e \times 10^6$ and $M_\infty$:

- Circle: $R_e \times 10^6 = 10$, $M_\infty = 0.8218$
- Square: $R_e \times 10^6 = 20$, $M_\infty = 0.8228$

The graph plots $C_p$ against $x/c$. The design curve is also shown for comparison.
WHY DIDN'T THEY?

- DECREASE MACH NUMBER?
- DECREASE ANGLE OF ATTACK?
- CHANGE FLAP SETTINGS?
- CHANGE SUCTION DISTRIBUTION?
- CHANGE AIRFOIL CONTOURS?
- CHANGE LINER CONTOURS?
SKETCH OF FLOW REGION BETWEEN MODEL UPPER SURFACE AND LINER

LINER WALL

SUPersonic CHANNEL

THROAT
SENSITIVITY OF FLOW TO SMALL VARIATIONS IN MACH NUMBER NEAR THE DESIGN MACH NUMBER

Theory, design
Upper surface
Lower surface

(a) M = 0.8225
(b) M = 0.8221
(c) $M = 0.8220$

(d) $M = 0.8217$
Theory, design
Upper surface
Lower surface

Cp

"Operational
design
conditions"

(e) M = 0.8216

(f) M = 0.8215
(g) $M = 0.8214$

(h) $M = 0.8207$
SKETCH OF FLOW REGION
BETWEEN MODEL UPPER SURFACE AND LINER

LINER WALL
SUPersonic CHANNEL
THROAT
TRANSITION LOCATION
LOWER SURFACE OF SLOTTED MODEL

Transition location, percent chord

Most forward turbulent film

Transition zone

Most rearward laminar film

Reynolds number

0 10 12 14 16 18 20 x10^6
MEASUREMENT VARIATION OF DRAG WITH $R_c$/SWEPT LFC AIRFOIL

Slotted suction surface, $M_\infty = 0.82$
CONCLUDING REMARKS

- Successful in achieving design pressure distribution.

- Full chord laminar flow maintained through large supersonic zone at 10 million Reynolds number

- Substantial reduction in drag achieved.