1970

Presentation by Bobby Berricr to Robert Seamans-
(Secretary of the Air Force) and Neil Armstrong (Deputy Associate
Administrator for Aeronautics)
RECENT LRC WIND TUNNEL STUDIES OF F-15 DRAG
F-15 DATA PRESENTATION

DRAG BUILD-UP PROCEDURE

REFERENCE AERODYNAMIC DATA---STING MOUNTED AERODYNAMIC MODEL

STING AND DISTORTION INCREMENTS---STRUT MOUNTED MODEL

JET INTERFERENCE INCREMENTS---STRUT MOUNTED PROPULSION MODEL

ALTERNATE CONFIGURATIONS FOR DRAG REDUCTION
A. Sting Mounted Aerodynamic Model
(4.7 and 7.5-percent) AEDC, MCAIR, LRC

B. Strut Mounted Aerodynamic Model
(4.7-percent) MCAIR, LRC

C. Strut Mounted Propulsion Model
(4.7-percent) MCAIR, LRC

DRAG POLAR BUILD-UP

1 ref. drag polar
2 $R_e$ corr.
3 crud drag and $m$ corr.
4 $\Delta C_{D,d}$ corr.
5 $\Delta C_{D,j}$ corr.

Performance estimate
Comparison of cruise and low Mach A/B nozzle external contours
REFERENCE AERODYNAMIC DATA

WIND TUNNEL DRAG POLAR
DRAG COMPARISON AT M = 0.85
$R_{n}/\text{FT} = 3.85 \times 10^6$

- 16 FT. (FEB. 1971)
- 8 FT. (AUG. 1969)
STING AND DISTORTION INCREMENTS

STRUT MOUNTED PROPULSION AND AERODYNAMIC MODELS

SWEPT STRUT
Sting and Distortion Increments, Cruise Nozzle, Swept Strut

Flow-through pressure ratio

\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[-\Delta C_{D,d} \]

\[M\]

- LRC propulsion model
- MCAIR propulsion model
- Performance baseline
Sting and Distortion Increments, Cruise Nozzle, Swept Strut

Flow-through pressure ratio

\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ \Delta C_{D, d} \]

- LRC propulsion model
- MCAIR propulsion model
- MCAIR aero. model ('E' strut)
- MCAIR aero. model
- Performance baseline

\[ M = 0.6 \quad 0.7 \quad 0.8 \quad 0.9 \quad 1.0 \]
Sting and Distortion Increments, Cruise Nozzle, Swept Strut

Flow-through pressure ratio

\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

- LRC propulsion model
- MCAIR propulsion model
- MCAIR aero. model ("E" strut)
- LRC aero. model
- MCAIR aero. model
- Performance baseline
Sting and Distortion Increments, Low Mach A/B Nozzle, Swept Strut

Flow-through pressure ratio

\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ \Delta C_{D,d} \]

\[ M \]

MCAIR aero. model

Performance baseline
Sting and Distortion Increments, Low Mach A/B Nozzle, Swept Strut

Flow-through pressure ratio

$\alpha = 0^\circ$, $\delta_h = 0^\circ$

\[ \Delta C_{D,d} \]

- LRC aero. model
- MCAIR aero. model
- Performance baseline
STING AND DISTORTION INCREMENTS

STRUT MOUNTED AERODYNAMIC MODEL

STRAIGHT STRUT
Sting and Distortion Increments, Cruise Nozzle, Straight Strut

Flow-through pressure ratio
\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ M \]

\[ \Delta C_D, d \]

MCAIR aero. model

Performance baseline
Sting and Distortion Increments, Cruise Nozzle, Straight Strut

Flow-through pressure ratio
\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ \Delta C_{D,d} \]

\[
\begin{align*} 
\text{MCAIR aero. model} \\
\text{LRC aero. model} \\
\text{Performance baseline} 
\end{align*}
\]
Sting and Distortion Increments, Low Mach A/B Nozzle, Straight Strut

Flow-through pressure ratio
\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ \Delta C_{D,d} \]

MCAIR aero. model

Performance baseline

\[ M \]
Sting and Distortion Increments, Low Mach A/B Nozzle, Straight Strut

Flow-through pressure ratio
\[ \alpha = 0^\circ \quad \delta_h = 0^\circ \]

\[ \Delta C_{D,d} \]

-0.0020

-0.0000

0

0.0000

0.0020

0.0040

M

0.6

0.7

0.8

0.9

1.0

MCAIR aero. model

LRC aero. model

Performance baseline
EFFECT OF SUPPORT ON $\Delta C_{D,d}$

$a = \delta_h = 0^\circ$

Cruise Nozzle

$\Delta C_{D,d}$

Low Mach A/B Nozzle

- Straight Strut
- Swept Strut
- Straight strut corr. for est. buoyancy
JET INTERFERENCE INCREMENTS

STRUT MOUNTED PROPULSION MODEL
JET INTERFERENCE INCREMENTS - SWEPT STRUT

Propulsion Model

\( \alpha = 0^\circ \quad \delta_h = 0^\circ \)

\[ \Delta C_{D,j} = C_{D, \text{engine PR}} - C_{D, \text{flow-through PR}} \]

CRUISE NOZZLE

- ○ LRC propulsion model
- □ MCAIR propulsion model

LOW MACH A/B NOZZLE

\[ \Delta C_{D,j} \]

\[ 0 \text{ to } 0.0020 \]

\[ \begin{array}{c}
0.6 \\
0.7 \\
0.8 \\
0.9 \\
1.0
\end{array} \]

\[ M \]
SUMMARY - LRC DRAG STUDIES OF BASELINE CONFIGURATION

- Drag of sting mounted model approximately same as for '69 proposal configuration at
  \( M = 0.85 \).

- Propulsion model tests believed to have given erroneous indication of drag increments
  required to account for aft end distortion and sting interference of sting mounted models.
  Jet interference increments obtained with true airplane aft end, however, appear correct
  and in good agreement between LRC and McAIR tests.

- LRC and McAIR strut-mounted model tests in good agreement re drag increments required
  to correct sting mounted model data for aft-end distortion and sting effects. Increments
  essentially same for two types of support struts and insensitive to use of open or faired
  inlets.

- For \( M = 0.85 \) cruise, estimate of total aft-end drag coefficient correction to sting mounted
  model data has decreased from 0.0066 to 0.0033. This value exceeds current performance
  baseline by 0.0033.
ALTERNATE CONFIGURATIONS
EFFECT OF ALTERNATE CONFIGURATIONS ON $C_{mo}$

$\delta_h = 0^\circ$, Straight Strut

- $M = 0.60$
- $M = 0.80$
- $M = 0.85$
- $M = 0.90$
SUMMARY - LRC DRAG STUDIES OF ALTERNATE CONFIGURATIONS

- All alternate configurations resulted in drag reductions at subsonic speed.

- Largest M = 0.85 drag reduction ($\approx 0.0023$) obtained by removing ventral fins and by adding larger vertical tails and variable knif-edge fairings between nozzles and booms (alternate 6). Favorable $C_{m0}$ shift results in additional reduction in trim drag at cruise (McAIR est. $\approx 0.0005$).

- LRC estimate of total aft-end drag increment for $M = 0.85$ cruise with alternate 6 is $0.0005$ (McAIR baseline, 0). Effect of change on supersonic drag and spin characteristics under study.

- Potential exists for significant reduction of supersonic drag through use of variable geometry devices to remove subsonic-type camber and revised area ruling.