SPACE SHUTTLE:
A STATIC STABILITY AND CONTROL INVESTIGATION OF THE NR-GD/C DELTA WING BOOSTER (B-15B-1) AND A REUSABLE NUCLEAR STAGE (RNS)

M = 0.6 - 4.96

by

E. C. Allen, NR

MSFC 14 - INCH TRISONIC WIND TUNNEL

MARSHALL SPACE FLIGHT CENTER

N A S A
SADSAC/SPACE SHUTTLE

WIND TUNNEL TEST DATA REPORT

**CONFIGURATION:** NR-GD/C-0.0031 Scale Delta Wing Booster (B-15B-1) and Reusable Nuclear Stage (RNS)

**TEST PURPOSE:** Static Stability and Control Investigation

**TEST FACILITY:** NASA/MSFC 14 x 14 Inch Trisonic Wind Tunnel

**TESTING AGENCY:** North American Rockwell

**TEST NO. & DATE:** MSFC 497, 7/1/71 - 7/2/71

**FACILITY COORDINATOR:** Jim Weaver (MSFC)

**PROJECT ENGINEER(S):** E. C. Allen (NR)

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**CONTRACT NAS 8-4016**

**AMENDMENT 154**

**DRL 184 - 58**

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Experimental aerodynamic investigations were made in the NASA/MSFC 14 x 14 inch Trisonic Wind Tunnel on a NR-GD/C 0.0031 scale model delta wing booster (B-15B-l) and reuseable nuclear stage (RNS). Three basic configurations were tested (1) the B-15B-l booster alone, (2) the RNS alone, and (3) the booster with the RNS mounted "piggyback". Six component force and moment data were recorded for each of these configurations over an angle of attack range from \(-16^\circ\) to \(4^\circ\) at zero degrees sideslip, and over an angle of sideslip range from \(-10^\circ\) to \(10^\circ\) at zero and \(-6^\circ\) degrees angle of attack. The configurations were tested over a Mach Number range of 0.6 to 5.0 with a nominal Reynolds number of \(6.5 \times 10^6\) per foot except for Mach 1.2 and 3.0 where the Reynolds numbers were \(12.4 \times 10^6\) and \(4.4 \times 10^6\) per foot respectively.

In addition to the basic configuration runs, various control surface (elevon, aileron, and rudder) deflections were also investigated.
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<td>Model Component: Wing - W-14</td>
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<td>Model Component: Canard - C4A</td>
</tr>
<tr>
<td>VIII</td>
<td>Model Component: Vertical Tail - V-7</td>
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</table>
SUMMARY

Experimental aerodynamic investigations were made in the NASA/MSFC 14 x 14 inch Trisonic Wind Tunnel on a NR-GD/C 0.0031 scale model delta wing booster (B-15B-1) and reuseable nuclear stage (RNS). Three basic configurations were tested (1) the B-15B-1 booster alone, (2) the RNS alone, and (3) the booster with the RNS mounted "piggyback". Six component force and moment data were recorded for each of these configurations over an angle of attack range from $-16^\circ$ to $4^\circ$ at zero degrees sideslip, and over an angle of sideslip range from $-10^\circ$ to $10^\circ$ at zero and -6 degrees angle of attack. The configurations were tested over a Mach Number range of 0.6 to 5.0 with a nominal Reynolds number of $6.5 \times 10^6$ per foot except for Mach 1.2 and 3.0 where the Reynolds numbers were $12.4 \times 10^6$ and $4.4 \times 10^6$ per foot respectively.

In addition to the basic configuration runs, various control surface (elevon, aileron, and rudder) deflections were also investigated.
CONFIGURATIONS INVESTIGATED

The following model components were tested either individually or in various combinations.

RNS - reusable nuclear stage.

B19 - basic body for booster B-15B-1, includes eight peripheral rocket engines and fairings

W14 - basic delta wing with an unswept T.E., a 40° twist, and a 3° dihedral.

C4A - basic canard for B-15B-1 booster.

V7 - basic vertical tail for the B-15B-1 booster.

The dataset collation sheets give the various combinations of the components tested. Pertinent dimensional data for each component can be found in the Model Component Description Sheets which follow the figures. Sketches and photographs of the model and model components are shown in Figures 2 through 9.
### Test TWT-497 Data Set Collation Sheet

#### Force - Reusable Nuclear Stage + Booster and Booster Alone

0.0031 Scale - Stability and Control

<table>
<thead>
<tr>
<th>DATA SET IDENTIFIER</th>
<th>CONFIGURATION</th>
<th>SCHED.</th>
<th>CONTROL DEFLECTION</th>
<th>NO. OF RUNS</th>
<th>MACH NUMBERS</th>
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<tr>
<td>R39 01A</td>
<td>B14P14(44)4V7</td>
<td>A 0</td>
<td>0 0 0 OFF</td>
<td>6</td>
<td>0.6 0.95 1.4 1.2 2.99 4.96</td>
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<tr>
<td>02A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01B</td>
<td>-6 B</td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02B</td>
<td></td>
<td></td>
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</tr>
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</tr>
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<td>04A</td>
<td></td>
<td></td>
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</tr>
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<td>05A</td>
<td></td>
<td></td>
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<tr>
<td>06B</td>
<td>-6 B</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>07B</td>
<td>+RNS</td>
<td></td>
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</tr>
<tr>
<td>07A</td>
<td>A 0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>10B</td>
<td></td>
<td></td>
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</tbody>
</table>

#### Coefficients:

- \( \alpha A = -16, -14, -12, -10, -8, -6, -4, -2, 0, 2, 4 \)
- \( \alpha B = -10, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10 \)

#### Schedules:

- SIDPVAR(1)
- SIDPVAR(2)
- NDV
**TEST TWT-497**  
**DATA SET COLLATION SHEET**

**Force-Reusable Nuclear Stage and Booster, and RNS Alone, Stability and Control**

<table>
<thead>
<tr>
<th>DATA SET IDENTIFIER</th>
<th>CONFIGURATION</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>CONTROL DEFLECTION</th>
<th>NO. OF RUNS</th>
<th>MACH NUMBERS</th>
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<tr>
<td>R39 OBB</td>
<td>BMN4CAAV7+RNS</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
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<td>-6</td>
<td>1</td>
<td>0.6</td>
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<tr>
<td>O8B</td>
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<td></td>
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<td></td>
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<td>10</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>12A</td>
<td></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
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<td>-10</td>
<td>1</td>
<td>0.8</td>
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<tr>
<td>13A</td>
<td>RNS ALONE</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>0</td>
<td>4</td>
<td>51/6</td>
</tr>
<tr>
<td>13B</td>
<td></td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>0</td>
<td>4</td>
<td>51/6</td>
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<th>IDPVAR(2)</th>
<th>NDV</th>
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<tbody>
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<td></td>
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</table>

**COEFFICIENTS:**
\[
\alpha = -16, -14, -12, -10, -8, -6, -4, -2, 0, 2, 4
\]

**SCHEDULES:**
\[
\beta = -10, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10
\]
The Marshall Space Flight Center 14" x 14" Trisonic Wind Tunnel is an intermittent blowdown tunnel which operates by high pressure air flowing from storage to either vacuum or atmospheric conditions. A Mach number range from .2 to 5.85 is covered by utilizing two interchangeable test sections. The transonic section permits testing at Mach 0.20 through 2.50, and the supersonic section permits testing at Mach 2.74 through 5.85. Mach numbers between .2 and .9 are obtained by using a controllable diffuser. The range from .95 to 1.3 is achieved through the use of plenum suction and perforated walls. Mach numbers of 1.44, 1.93 and 2.50 are produced by interchangeable sets of fixed contour nozzle blocks. Above Mach 2.50 a set of fixed contour nozzle blocks are tilted and translated automatically to produce any desired Mach number in .25 increments.

Air is supplied to a 6000 cubic foot storage tank at approximately -40°F dew point and 500 psi. The compressor is a three-stage reciprocating unit driven by a 1500 hp motor.

The tunnel flow is established and controlled with a servo actuated gate valve. The controlled air flows through the valve diffuser into the stilling chamber and heat exchanger where the air temperature can be controlled from ambient to approximately 180°F. The air then passes through the test section which contains the nozzle blocks and test region.

Downstream of the test section is a hydraulically controlled pitch sector that provides a total angle of attack range of 20° (±10°). Sting offsets are available for obtaining various maximum angles of attack up to 25°.
Table I lists the tunnel conditions which prevailed during these tests and states the balance accuracies. (The #200 balance was utilized in the booster to record booster alone and booster with RNS loads; the #201 balance was utilized in the RNS during RNS alone runs only). With the exception of two series of runs (data sets R3901A and R3901B) all models utilized grit to fix flow transition. Grit patterns can be seen in Figures 2, 3 and 4. Model base and balance cavity pressures were measured and utilized to correct the balance measured axial force. The correction equations are given in the section on data reduction. Figures 12 and 13 show the base pressure orifice locations. RNS base pressures were recorded only during RNS alone runs and were used to correct only that data.
### Table I
TEST CONDITIONS
TEST TWT-497

<table>
<thead>
<tr>
<th>MACH NUMBER</th>
<th>REYNOLDS NUMBER per unit length</th>
<th>DYNAMIC PRESSURE (pounds/sq. inch)</th>
<th>STAGNATION TEMPERATURE (degrees Fahrenheit)</th>
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<tbody>
<tr>
<td>0.6</td>
<td>$6.5 \times 10^6$</td>
<td>5.58</td>
<td>97</td>
</tr>
<tr>
<td>0.95</td>
<td>$6.8 \times 10^6$</td>
<td>8.18</td>
<td>97</td>
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<td>1.0</td>
<td>$6.7 \times 10^6$</td>
<td>8.33</td>
<td>98</td>
</tr>
<tr>
<td>1.2</td>
<td>$6.6 \times 10^6$</td>
<td>8.98</td>
<td>97</td>
</tr>
<tr>
<td>1.2</td>
<td>$12.4 \times 10^6$</td>
<td>16.60</td>
<td>93</td>
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<td>2.99</td>
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</tr>
<tr>
<td>4.96</td>
<td>$6.1 \times 10^6$</td>
<td>3.40</td>
<td>99</td>
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**BALANCE UTILIZED:** TWT Model 200 and 201, Moment Balances

**CAPACITY:**

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<tr>
<th></th>
<th>200</th>
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<tbody>
<tr>
<td>NF</td>
<td>175 lbs</td>
<td>60 lbs</td>
</tr>
<tr>
<td>SF</td>
<td>150 lbs</td>
<td>20 lbs</td>
</tr>
<tr>
<td>AF</td>
<td>100 lbs</td>
<td>30 lbs</td>
</tr>
<tr>
<td>PM</td>
<td>185 in. lbs</td>
<td>60 in. lbs</td>
</tr>
<tr>
<td>YM</td>
<td>160 in. lbs</td>
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</tr>
<tr>
<td>RM</td>
<td>50 in. lbs</td>
<td>25 in. lbs</td>
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</tbody>
</table>

**ACCURACY:**

- COEFFICIENT
- TOLERANCE: 0.3%

**COMMENTS:**

No satisfactory method is known for determining the absolute accuracy of the final data coefficients.
DATA REDUCTION

The aerodynamic forces and moments measured by the balance were first corrected for weight tares, base and balance cavity pressures, and then reduced to coefficient form in the body axis system utilizing the reference values of Table II. The axial force correction equations utilized were:

\[
C_{AF} = C_A - (C_{AB} + C_{AC})
\]

where

\[
C_{AB} = - \left[ (pb_1 - p_\infty) A_{b1} + (pb_2 - p_\infty) A_{b2} \right] / \rho_\infty S_{REF}
\]

and

\[
C_{AC} = - \left[ (pc - p_\infty) A_c \right] / \rho_\infty S_{REF}
\]
TABLE II
MODEL REFERENCE DIMENSIONS

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
<th>BOOSTER ALONE AND BOOSTER + RNS</th>
<th>RNS ALONE</th>
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<tr>
<td>( S_{ref} )</td>
<td>Ref. Area</td>
<td>15.656 in(^2)</td>
<td>15.656 in(^2)</td>
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<tr>
<td>( c )</td>
<td>M.A.C.</td>
<td>3.095 in.</td>
<td>3.095 in</td>
</tr>
<tr>
<td>( b )</td>
<td>Span</td>
<td>6.099 in.</td>
<td>6.099 in</td>
</tr>
<tr>
<td>( X_{c.g.*} )</td>
<td>Center of Gravity (Fuselage Station)</td>
<td>0.0 in. (Booster Nose)</td>
<td>1.561 in. (From RNS Nose)</td>
</tr>
<tr>
<td>( Y_{c.g.*} )</td>
<td>Center of Gravity</td>
<td>0.0 in.</td>
<td>0.0</td>
</tr>
<tr>
<td>( Z_{c.g.*} )</td>
<td>Center of Gravity (Water Line)</td>
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<td>1.332 in.</td>
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<tr>
<td>( L_B )</td>
<td>Body Length</td>
<td>9.734 in. (B Nose to Wing T.E.)</td>
<td>8.306 in</td>
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<td>( A_{b1} )</td>
<td>Base Area (Upper Half)</td>
<td>0.418 in(^2)</td>
<td>.3655 in(^2)</td>
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<tr>
<td>( A_{b2} )</td>
<td>Base Area (Lower Half)</td>
<td>0.634 in(^2)</td>
<td>.3655 in(^2)</td>
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<tr>
<td>( A_c )</td>
<td>Balance Cavity Area</td>
<td>0.785 in(^2)</td>
<td>.454 in(^2)</td>
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* See Figures 10 & 11
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<th>COEFFICIENT NAME</th>
<th>SADSAC NOMENCLATURE</th>
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<td>CA</td>
<td>Total Axial Force</td>
<td>CA</td>
</tr>
<tr>
<td>CAB</td>
<td>Base Axial Force</td>
<td>CAB</td>
</tr>
<tr>
<td>CAF</td>
<td>Forebody Axial Force</td>
<td>CAF</td>
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<tr>
<td>CD</td>
<td>Total Drag Force</td>
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<tr>
<td>CDB</td>
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<td>CDF</td>
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<tr>
<td>CL</td>
<td>Lift Force</td>
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<td>CN</td>
<td>Normal Force</td>
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<td>CY</td>
<td>Side Force</td>
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<td>Pitching Moment</td>
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<td>N/A</td>
<td>Normal-To-Forebody Axial Force Ratio</td>
<td>N/A</td>
</tr>
<tr>
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<td>SCHEDULE</td>
<td>CONDITIONS VARYING</td>
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<tr>
<td>------------------------------------------------------------</td>
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<td>----------------------------------</td>
</tr>
<tr>
<td>Effect of Grit In Pitch, Booster Alone</td>
<td>A</td>
<td>Grit, Mach</td>
</tr>
<tr>
<td>Effect of Grit In Yaw, Booster Alone</td>
<td>B</td>
<td>Grit, Mach</td>
</tr>
<tr>
<td>Elevon Effectiveness In Pitch, Booster Alone</td>
<td>C</td>
<td>Elevator, Aileron</td>
</tr>
<tr>
<td>Elevon Effectiveness In Pitch, Booster Plus RNS</td>
<td>C</td>
<td>Elevator, Aileron</td>
</tr>
<tr>
<td>Effect of RNS On Elevon Effectiveness, Pitch</td>
<td>C</td>
<td>Configuration, Elevator, and Aileron</td>
</tr>
<tr>
<td>Elevon Effectiveness In Yaw, Booster Alone</td>
<td>D</td>
<td>Grit, Elevator, and Aileron</td>
</tr>
<tr>
<td>Elevon Effectiveness In Yaw, Booster Alone</td>
<td>E</td>
<td>Elevator, Aileron</td>
</tr>
<tr>
<td>Elevon Effectiveness In Yaw, Booster Plus RNS</td>
<td>E</td>
<td>Elevator, Aileron</td>
</tr>
<tr>
<td>Effect of RNS On Elevon Effectiveness, Yaw</td>
<td>D</td>
<td>Configuration, Grit</td>
</tr>
<tr>
<td>Effect of RNS On Elevon Effectiveness, Yaw</td>
<td>E</td>
<td>Configuration, Elevator, and Aileron</td>
</tr>
<tr>
<td>Rudder and Elevon Effectiveness In Pitch, Booster Alone (Beta = 0)</td>
<td>C</td>
<td>Rudder, Aileron</td>
</tr>
<tr>
<td>TITLE</td>
<td>SCHEDULE</td>
<td>CONDITIONS VARYING</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Rudder and Elevon Effectiveness In Pitch, Booster Plus RNS (Beta = 0)</td>
<td>C</td>
<td>Rudder, Aileron</td>
</tr>
<tr>
<td>Effect of RNS On Rudder and Elevon Effectiveness (Beta = 0)</td>
<td>C</td>
<td>Configuration, Rudder, and Aileron</td>
</tr>
<tr>
<td>Rudder and Elevon Effectiveness In Yaw, Booster Alone</td>
<td>D, E</td>
<td>Rudder, Aileron</td>
</tr>
<tr>
<td>Rudder and Elevon Effectiveness In Yaw, Booster Plus RNS</td>
<td>E</td>
<td>Rudder, Aileron</td>
</tr>
<tr>
<td>Effect of RNS On Rudder and Elevon Effectiveness</td>
<td>E</td>
<td>Configuration, Rudder, and Aileron</td>
</tr>
<tr>
<td>Effect of Angle of Attack, RNS Alone</td>
<td>A</td>
<td>Mach, Alpha</td>
</tr>
<tr>
<td>Effect of Angle of Sideslip, RNS Alone</td>
<td>F</td>
<td>Mach, Beta</td>
</tr>
<tr>
<td>Effect of Reynolds Number, Booster Plus RNS</td>
<td>A</td>
<td>Reynolds Number</td>
</tr>
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</table>

**PLOTTED COEFFICIENTS SCHEDULE:**

(A) CN, CAF, & CLM vs. ALPHA

(B) CY, & CYN vs. BETA

(C) CN, CAF, CLM, CY, CYN, & CBL vs. ALPHA

(D) CBL vs. BETA

(E) CY, CYN, XCPY/L, CN, CAF, & CLM vs. BETA

(F) CY, CYN, CBL, & XCPY/L vs. BETA
Notes:
1. Positive directions of force coefficients, moment coefficients, and angles are indicated by arrows.
2. For clarity, origins of wind and stability axes have been displaced from the center of gravity.

Figure 1. Axis systems, showing direction and sense of force and moment coefficients, angle of attack, and sideslip angle.
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Figure 4. Photograph of B-15B-1 Booster Installed in MSFC 14 x 14 Inch Tunnel (Bottom View)
Figure 5. General Arrangement - Reuseable Nuclear Stage
Figure 6. BODY B19 - BOOSTER B-15 B-1 CONFIGURATION
Figure 7. WING W14 - BOOSTER CONFIGURATION
Figure 8. CANTARD - $C_4$
Figure 9. VERTICAL TAIL - V7
Figure 10. Reusable Nuclear Stage Reference c.g. Location
Figure 11. RNS Launch and Booster Alone Reference c.g. Location
Note: Location of pressure taps may vary slightly as installation will be made during test setup.

Figure 12. Location of Base Pressure Taps for RNS Alone.
NOTE: Location of pressure taps may vary slightly as installation will be made during test setup.

Figure 13. Location of Base Pressure Taps for Booster Alone and RNS Launch Configurations
MODEL COMPONENT DESCRIPTION SHEETS
### TABLE IV

**Reuseable Nuclear Stage**

**MODEL COMPONENT:** BODY - RNS

**GENERAL DESCRIPTION:** Reuseable Nuclear Stage is a cone-cylinder body with a nose radius of 35.5 inches.

**Model Scale:** 0.0031

**DRAWING NUMBER:** 2244-202

**DIMENSIONS:**

<table>
<thead>
<tr>
<th>Description</th>
<th>FULL-SCALE</th>
<th>MODEL SCALE</th>
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<tbody>
<tr>
<td>Length, in.</td>
<td>2679</td>
<td>8.306</td>
</tr>
<tr>
<td>Max. Width, in.</td>
<td>396</td>
<td>1.228</td>
</tr>
<tr>
<td>Max. Depth, in.</td>
<td>396</td>
<td>1.228</td>
</tr>
<tr>
<td>Fineness Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Cross-Sectional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apex Angle (Cone), deg.</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>
TABLE V

MODEL COMPONENT: BODY - B-19

GENERAL DESCRIPTION: Body for B-15B Delta Wing Configuration, with circular cross section at nose, fairing to flat bottom at wing. Flats on sides to close gap at canard root forward of hinge line. Fairings over rocket engines.

DRAWING NUMBER: WT-70-105222

DIMENSIONS:  

<table>
<thead>
<tr>
<th></th>
<th>FULL-SCALE</th>
<th>MODEL SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (Nose to Wing T.E.)</td>
<td>2757</td>
<td>9.733</td>
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<tr>
<td>Max. Width</td>
<td>387</td>
<td>1.356</td>
</tr>
<tr>
<td>Max. Depth</td>
<td>453</td>
<td>1.587</td>
</tr>
<tr>
<td>Fineness Ratio</td>
<td>6.08</td>
<td>6.13</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Cross-Sectional</td>
<td>183837</td>
<td>2.252</td>
</tr>
<tr>
<td>Planform</td>
<td>1010612</td>
<td>12.501</td>
</tr>
<tr>
<td>Wetted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>150028</td>
<td>1.840</td>
</tr>
</tbody>
</table>
TABLE VI

MODEL COMPONENT: WING - W14

GENERAL DESCRIPTION: W10 modified to unswept trailing edge and with twist outboard of B. L. 340 linearly increasing to -4 degrees at tip and with leading edge faired into fuselage (W10 is the basic B-15B wing).

DRAWING NUMBER: WT-70-105222

DIMENSIONS:

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<thead>
<tr>
<th>TOTAL DATA</th>
<th>FULL-SCALE</th>
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<td>Area</td>
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<td></td>
</tr>
<tr>
<td>Planform</td>
<td>1241959</td>
<td>15.656</td>
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<tr>
<td>Wetted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span (equivalent)</td>
<td>1739</td>
<td>6.099</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>2.436</td>
<td>2.38</td>
</tr>
<tr>
<td>Rate of Taper</td>
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<td></td>
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<tr>
<td>Taper Ratio</td>
<td>0.106</td>
<td>0.1192</td>
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<tr>
<td>Diehedral Angle, degrees</td>
<td>3 at T. E.</td>
<td>3 at T. E.</td>
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<tr>
<td>Incidence Angle, degrees</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Aerodynamic Twist, degrees</td>
<td>-4</td>
<td>-4</td>
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<tr>
<td>Toe-In Angle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cant Angle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweep Back Angles, degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leading Edge</td>
<td>53</td>
<td>53</td>
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<tr>
<td>Trailing Edge</td>
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<td>0</td>
</tr>
<tr>
<td>0.25 Element Line</td>
<td>44.85</td>
<td>44.85</td>
</tr>
<tr>
<td>Chords:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root (Wing Sta. 0.0)</td>
<td>1291</td>
<td>4.587</td>
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<tr>
<td>Tip, (equivalent)</td>
<td>137</td>
<td>0.547</td>
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<tr>
<td>MAC</td>
<td>869.4</td>
<td>3.095</td>
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<tr>
<td>Fus. Sta. of .25 MAC</td>
<td>3104.9</td>
<td>10.913*</td>
</tr>
<tr>
<td>W.P. of .25 MAC</td>
<td>219</td>
<td>0.766</td>
</tr>
<tr>
<td>B.L. of .25 MAC</td>
<td>136.9</td>
<td>1.126</td>
</tr>
<tr>
<td>Airfoil Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root</td>
<td>NACA - 0010 - 64 (Mod)</td>
<td></td>
</tr>
<tr>
<td>Tip</td>
<td>NACA - 0010 - 64 (Mod)</td>
<td></td>
</tr>
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</table>

EXPOSED DATA

| Area             | 812980     | 10.03       |
| Span, (equivalent)| 1373       | 4.743       |
| Aspect Ratio     | 2.25       | 2.24        |
| Taper Ratio      | 0.1306     | 0.1485      |
| Chords           |            |             |
| Root             | 1048       | 3.684       |
| Tip              | 137        | 0.547       |
| MAC              | 709.1      | 2.504       |
| Fus. Sta. of .25 MAC | 3224.9    | 11.356*     |
| W.P. of .25 MAC  | 222        | 0.824       |
| B.L. of .25 MAC  | 438.6      | 1.572       |

* Fuselage stations are relative to an origin 3.500 inches ahead of the nose of B19.
<table>
<thead>
<tr>
<th>TABLE VII</th>
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<tbody>
<tr>
<td><strong>MODEL COMPONENT:</strong></td>
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<tr>
<td><strong>GENERAL DESCRIPTION:</strong></td>
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<td><strong>DRAWING NUMBER:</strong></td>
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<td>Inb'd equivalent chord</td>
<td>341</td>
<td>1.061</td>
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<tr>
<td>Outb'd equivalent chord</td>
<td>36</td>
<td>0.099</td>
</tr>
<tr>
<td>Ratio movable surface chord/total surface chord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At Inb'd equiv. chord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At Outb'd equiv. chord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweep Back Angles, degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leading Edge</td>
<td>60</td>
<td>57.68</td>
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<tr>
<td>Tailing Edge</td>
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<td>0</td>
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<tr>
<td>Hingeline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area Moment (Normal to hinge line)</td>
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<td></td>
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<tr>
<td>Hinge Line Located at 25% of M.A.C. of Exposed Area</td>
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TABLE VIII

MODEL COMPONENT: **VERTICAL TAIL - V7**

GENERAL DESCRIPTION: Basic vertical for B-15B delta wing configuration

DRAWING NUMBER: **WT-70-105222**

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<thead>
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<tr>
<td>Area</td>
<td>177306</td>
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<td>485</td>
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<td>Inb'd equivalent chord</td>
<td>504</td>
<td>1.723</td>
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<tr>
<td>Outb'd equivalent chord</td>
<td>252</td>
<td>0.826</td>
</tr>
<tr>
<td>Ratio movable surface chord/total surface chord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At Inb'd equiv. chord</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>At Outb'd equiv. chord</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweep Back Angles, degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leading Edge</td>
<td>35</td>
<td>36.40</td>
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<td>11.29</td>
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<td>Hingeline</td>
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<td>19.83</td>
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<tr>
<td>Area Moment (Normal to hinge line)</td>
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### NOMENCLATURE

(General)

<table>
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<tr>
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<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
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<tbody>
<tr>
<td>$\alpha$</td>
<td>ALPHA</td>
<td>angle of attack, angle between the projection of the wind $X_w$-axis on the body $X$, $Z$-plane and the body $X$-axis; degrees</td>
</tr>
<tr>
<td>$\beta$</td>
<td>BETA</td>
<td>sideslip angle, angle between the wind $X_w$-axis and the projection of this axis on the body $X$-$Z$-plane; degrees</td>
</tr>
<tr>
<td>$\psi$</td>
<td>PSI</td>
<td>yaw angle, angle of rotation about the body $Z$-axis, positive when the positive $X$-axis is rotated toward the positive $Y$-axis; degrees</td>
</tr>
<tr>
<td>$\phi$</td>
<td>PHI</td>
<td>roll angle, angle of rotation about the body $X$-axis, positive when the positive $Y$-axis is rotated toward the positive $Z$-axis; degrees</td>
</tr>
<tr>
<td>$\rho$</td>
<td></td>
<td>air density; $Kg/m^3$, slugs/ft$^3$</td>
</tr>
<tr>
<td>$a$</td>
<td></td>
<td>speed of sound; m/sec, ft/sec</td>
</tr>
<tr>
<td>$V$</td>
<td></td>
<td>speed of vehicle relative to surrounding atmosphere; m/sec, ft/sec</td>
</tr>
<tr>
<td>$q$</td>
<td>$Q(\psi)$</td>
<td>dynamic pressure; $1/2\rho V^2$, psi, psf</td>
</tr>
<tr>
<td></td>
<td>$Q(\psi F)$</td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>MACH</td>
<td>Mach number; $V/a$</td>
</tr>
<tr>
<td>$RN/L$</td>
<td>$RN/L$</td>
<td>Reynolds number per unit length; million/ft</td>
</tr>
<tr>
<td>$p$</td>
<td></td>
<td>static pressure; psi</td>
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<tr>
<td>$P$</td>
<td></td>
<td>total pressure; psi</td>
</tr>
<tr>
<td>$C_p$</td>
<td>CP</td>
<td>pressure coefficient; $(p-p_\infty)/q$</td>
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### NOMENCLATURE (Continued)

Reference & C. G. Definitions

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<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
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<td>S</td>
<td>SREF</td>
<td>wing area; $m^2, ft^2$</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>reference area; $m^2, ft^2$</td>
</tr>
<tr>
<td>$\bar{c}$</td>
<td>LREF</td>
<td>wing mean aerodynamic chord or reference chord; m, ft, in (see $l_{\text{ref}}$ or LREF)</td>
</tr>
<tr>
<td>$l_{\text{ref}}$</td>
<td>BREF</td>
<td>reference length; m, ft, in.; (see $\bar{c}$)</td>
</tr>
<tr>
<td>$b_{\text{ref}}$</td>
<td></td>
<td>wing span or reference span; m, ft, in</td>
</tr>
<tr>
<td>$A_b$</td>
<td></td>
<td>base area; $m^2, ft^2, in^2$</td>
</tr>
<tr>
<td>c. g.</td>
<td></td>
<td>center of gravity</td>
</tr>
<tr>
<td>MRP</td>
<td>MRP</td>
<td>abbreviation for moment reference point</td>
</tr>
<tr>
<td>XMRP</td>
<td></td>
<td>abbreviation for moment reference point on X-axis</td>
</tr>
<tr>
<td>YMRP</td>
<td></td>
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</tr>
<tr>
<td>ZMRP</td>
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<td>abbreviation for moment reference point on Z-axis</td>
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### NOMENCLATURE (Continued)

**Axis System General**

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<td>F</td>
<td>force; F, lbs</td>
</tr>
<tr>
<td>M</td>
<td>moment; M, in-lb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subscript</th>
<th>Definition</th>
</tr>
</thead>
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<td>normal force</td>
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<tr>
<td>A</td>
<td>axial force</td>
</tr>
<tr>
<td>L</td>
<td>lift force</td>
</tr>
<tr>
<td>D</td>
<td>drag force</td>
</tr>
<tr>
<td>Y</td>
<td>force or moment about the Y axis</td>
</tr>
<tr>
<td>Z</td>
<td>moment about the Z axis</td>
</tr>
<tr>
<td>X</td>
<td>moment about the X axis</td>
</tr>
<tr>
<td>s</td>
<td>stability axis system</td>
</tr>
<tr>
<td>w</td>
<td>wind axis system</td>
</tr>
<tr>
<td>ref</td>
<td>reference conditions</td>
</tr>
<tr>
<td>(\infty)</td>
<td>free stream conditions</td>
</tr>
<tr>
<td>t</td>
<td>total conditions</td>
</tr>
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### Body Axis System

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<th>DEFINITION</th>
</tr>
</thead>
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<tr>
<td>$C_N$</td>
<td>CN</td>
<td>normal force coefficient; $F_N/qS$</td>
</tr>
<tr>
<td>$C_A$</td>
<td>CA</td>
<td>axial force coefficient; $F_A/qS$</td>
</tr>
<tr>
<td>$C_{Ab}$</td>
<td>CAB</td>
<td>base axial force coefficient; $\left[-1\right] \frac{(P_b - P_\omega)/q}{(A_b/S)}$</td>
</tr>
<tr>
<td>$C_{Af}$</td>
<td>CAF</td>
<td>forebody axial force coefficient; $C_A - C_{Ab}$</td>
</tr>
<tr>
<td>$C_m$</td>
<td>CLM</td>
<td>pitching moment coefficient; $M_y/qS \ell_{ref}$</td>
</tr>
<tr>
<td>$C_y$</td>
<td>CY</td>
<td>side force coefficient; $F_y/qS$</td>
</tr>
<tr>
<td>$C_n$</td>
<td>CYN</td>
<td>yawing moment coefficient; $M_z/qS b_{ref}$</td>
</tr>
<tr>
<td>$C_{\ell}$</td>
<td>CRL</td>
<td>rolling moment coefficient, $M_x/qS b_{ref}$</td>
</tr>
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### Surface Definitions

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \iota_t )</td>
<td>horizontal tail incidence; positive when trailing edge down; degrees</td>
</tr>
<tr>
<td>( \delta )</td>
<td>symmetrical surface deflection angle; degrees; positive deflections are:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AILRON</td>
<td>left aileron  - total aileron deflection; (left aileron - right aileron)/2</td>
</tr>
<tr>
<td>CANARD</td>
<td>canard  - trailing edge down</td>
</tr>
<tr>
<td>ELEVON</td>
<td>elevator  - trailing edge down</td>
</tr>
<tr>
<td>ELEVTR</td>
<td>elevator  - trailing edge down</td>
</tr>
<tr>
<td>FLAP</td>
<td>flap  - trailing edge down</td>
</tr>
<tr>
<td>RUDDER</td>
<td>rudder  - trailing edge to the left</td>
</tr>
<tr>
<td>SPOILR</td>
<td>spoiler  - trailing edge down</td>
</tr>
<tr>
<td>TAB</td>
<td>tab  - trailing edge down with respect to control surface</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIL-L</td>
<td>left aileron  - trailing edge down</td>
</tr>
<tr>
<td>AIL-R</td>
<td>right aileron  - trailing edge down</td>
</tr>
<tr>
<td>ELVN-L</td>
<td>left elevon  - trailing edge down</td>
</tr>
<tr>
<td>ELVN-R</td>
<td>right elevon  - trailing edge down</td>
</tr>
<tr>
<td>SPLR-L</td>
<td>left spoiler  - trailing edge down</td>
</tr>
<tr>
<td>SPLR-R</td>
<td>right spoiler  - trailing edge down</td>
</tr>
</tbody>
</table>

### Subscripts

- **e**: aileron
- **b**: base
- **c**: canard
- **e**: elevator or elevon
- **f**: flap
- **r**: rudder or ruddervator
- **s**: spoiler
- **t**: tail

40
## ADDITIONS TO NOMENCLATURE

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
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<tr>
<td>XCPY/L</td>
<td>XCPY/L</td>
<td>center of pressure location based on body length</td>
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<tr>
<td></td>
<td></td>
<td>( \left( X_{cg} - \frac{CYN \cdot b_{ref}}{CY} \right) / l_B )</td>
</tr>
<tr>
<td>( l_B )</td>
<td></td>
<td>body length</td>
</tr>
</tbody>
</table>
TABULATED DATA LISTING

A tabulated data listing, consisting of all aero data sets, both original and those created in arriving at the plotted material to be presented subsequently, is available as an addendum to this report. The tabular listing is made up in two sections:

(a) a brief summary list of all data sets containing the identifier, the descriptor, and the resident dependent variables.

(b) a full list of all data sets containing all resident or selected aerodynamic coefficients of the data sets as well as the above mentioned information.

The listing is currently sent on limited distribution to the following organizations:

NASA AMES Mr. V. Stevens
NASA MSFC Mr. Jim Weaver
NR Mr. C. R. Leef

If copies of this listing are desired, please contact the above or the cognizant SADSAC personnel who, for this data, is:

Mr. John Hord
Department 2780
Chrysler Corporation Space Division
New Orleans, La. 70129

(504) 255-2304
PLOTTED DATA
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) □ MSFC49T GE DELTA WING BOOSTER B19W14C4AV7
(A3902A) □ MSFC49T GE DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF 15.6560 50 IN
LREF 3.0950 INCHES
SREF 4.0990 INCHES
XREF 0.0000
ZMRP 0.0000
SCALE 0.0000 SCALE

MACH 0.357
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, $\alpha$, DEGREES

NORMAL FORCE COEFFICIENT, $C_n$

DATA SET SYMBOL CONFIGURATION DESCRIPTION  
(A3901A) Q MSFC497 6D DELTA WING BOOSTER B19W14C4AV7  
(A3902A) M MSFC497 6D DELTA WING BOOSTER B19W14C4AV7  

BETA  GRIT  
0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000  0.000

REFERENCE INFORMATION  
SREF 15.6760 80 IN  
LREF 3.0950 INCHES  
BREF 6.0990 INCHES  
XREF 0.0000  
YREF 0.0000  
ZREF 0.0000  
SCALE 0.0031 SCALE  

MACH 0.952

PAGE 2
**EFFECT OF GRIT IN PITCH, BOOSTER ALONE**

<table>
<thead>
<tr>
<th>DATA SET SYMBOL</th>
<th>CONFIGURATION DESCRIPTION</th>
<th>NORM FORCE COEFFICIENT, CN</th>
<th>ANGLE OF ATTACK, ALPHA, DEGREES</th>
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<tbody>
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<td>(A3901A)</td>
<td>MSFC497 GC DELTA WING BOOSTER B19W4C4AV7</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>(A3902A)</td>
<td>MSFC497 GC DELTA WING BOOSTER B19W4C4AV7</td>
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**REFERENCE INFORMATION**

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- LREF: 3.0950 INCHES
- XREF: 0.0000
- YMRF: 0.0000
- ZMRG: 0.0000
- SCALE: 0.0031 SCALE

**PAGE 3**
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0081 SCALE

MACH 1.193

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) ☑ MSFCA97 6D DELTA WING BOOSTER B12W14C4AV7
(A3902A) ☑ MSFCA97 6D DELTA WING BOOSTER B19W14C4AV7

BETA  GRIT
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0.000  0.000
54.000
EFFECT OF GRIT IN PITCH: BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) MQTTGC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902A) MQTTGC497 GD DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF 15.658 IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
TMRF 0.0000
ZHRF 0.0000
SCALE 0.6031 SCALE

MACH 2.990

EFFECT OF GRIT IN PITCH: BOOSTER ALONE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  GRIT
(AS901A)  MSFC49T GD DELTA WING BOOSTER B19W44C4AV7  0.000  0.000  0.540
(AS902A)  MSFC49T GD DELTA WING BOOSTER B19W44C4AV7  0.000  54.000

REFERENCE INFORMATION
SREF  15.6560 SQ IN
LREF  3.0950 INCHES
BREF  4.9590 INCHES
XREF  0.0000
YREF  0.0000
ZREF  0.0000
SCALE  0.0031 SCALE

MACH  4.959
EFFECT OF GRIT IN PITCH: BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL DESCRIPTION
(A3901A) MSFC497 6C DELTA WING BOOSTER B19W14C4AV7
(A3902A) MSFC497 6D DELTA WING BOOSTER B19W14C4AV7

MACH 0.597

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(A3901A)  Q  MSFC497 GC DELTA WING BOOSTER B19W44C4AV7
(A3902A)  ®  MSFC497 GC DELTA WING BOOSTER B19W44C4AV7

MACH 0.952

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 0.0990 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) Q MSFC497 GD DELTA WING BOOSTER B19W14C4A4X
(A3902A) O MSFC497 GD DELTA WING BOOSTER B19W14C4A4X

BETA GRIT
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0.000 34.000

REFERENCE INFORMATION
BREF 15.8560 SQ IN
LREF 5.0950 INCHES
BREF 6.0990 INCHES
HREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031

MACH 1.193

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EFFECT OF GRIT IN PITCH, Booster Alone

ANGLE OF ATTACK, ALPHA, DEGREES

REFERENCE INFORMATION
SREF 15.0060 IN
LREF 3.0950 INCHES
BREF 0.0930 INCHES
XMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 2.996

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39G1A) MSFC497 GG DELTA WING BOOSTER B19W14C4AV7
(A39D2A) MSFC497 GG DELTA WING BOOSTER B19W14C4AV7

BETA GRIT
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FOREBODY AXIAL FORCE COEFFICIENT, CAF
DATA SET SYMBOL: CONFIGURATION DESCRIPTION
(A3901A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 5.0000 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

PAGE 12
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION BETA GRIT
(A3903A) ♦ MSC497 GD DELTA WING BOOSTER B19M14C4AV7 0.000 0.000
(A3903A) ▲ MSC497 GD DELTA WING BOOSTER B19M14C4AV7 0.000 0.000

REFERENCE INFORMATION
SREF 15.6340 IN
LREF 3.0830 IN
BREF 0.0990 IN
XMRF 0.0000
YMRF 0.0000
ZNRF 0.0000
SCALE 0.0031 SCALE

MACH 0.952

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EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

MACH 0.597

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 0.0990 INCHES
XREF 0.0000
ZREF 0.0000
SCALE 0.0031
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) Δ MSFC497 GD DELTA WING BOOSTER B1W4C4AV7
(A3902A) X MSFC497 GD DELTA WING BOOSTER B1W4C4AV7

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 6.0990 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.005

PITCHING MOMENT COEFFICIENT, CLM

ANGLE OF ATTACK, ALPHA, DEGREES

-1.0 -1.4 -1.8 -2.2 -2.6 -2.0 -1.8 -1.6 -1.4 -1.2 -1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6

-18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6

2.6 2.4 2.2 2.0 1.8 1.6 1.4 1.2 1.0 0.8 0.6 0.4 0.2 0.0 -0.2 -0.4 -0.6 -0.8 -1.0 -1.2 -1.4 -1.6 -1.8 -2.0 -2.2 -2.4 -2.6
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  GRIT
(A3801a)  MSFC497 60 DELTA WING BOOSTER B19W14C4AV7  0.000  0.000
(A3802a)  MSFC497 60 DELTA WING BOOSTER B19W14C4AV7  0.000  0.000

REFERENCE INFORMATION
SREF  12.0000  SQ. IN
LREF  3.0950  INCHES
BREF  6.0990  INCHES
XMRP  0.0000
YMRP  0.0000
ZMRF  0.0000
SCALE  0.0031

MACH  1.193

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EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) & MSFC497 GD DELTA WING BOOSTER B15W14C4A7
(A3902A) $ MSFC497 GD DELTA WING BOOSTER B15W14C4A7

BETA GRIT
0.000 0.000 54.000

REFERENCE INFORMATION
SREF 15.0550 00 IN
LREF 3.0990 INCHES
XREF 6.0990 INCHES
ZREF 0.0000
XRP 0.0000
ZRP 0.0000
SCALE 9.9031 SCALE

MACH 4.959

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EFFECT OF GRIT IN YAW: BOOSTER ALONE

SIDE SLIP ANGLE, \( \beta \), DEGREES

LATERAL FORCE COEFFICIENT, \( C_L \)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901B) MHSFC497 CC DELTA WING BOOSTER B19W14C4AV7
(A3902B) MHSFC497 CC DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SRIF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRF 0.0000
YMRF 0.0000
ZMRF 0.0000
SCALE 6.0021 SCALE

MACH 0.600

\( \alpha = -6.000 \) \( \beta = -6.000 \) \( \delta = 54.000 \)
EFFECT OF GRIT IN YAW, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A59018) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A59026) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

ALPHA GRIT
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-6.0000 -6.0000

REFERENCE INFORMATION

SREF 15.6560 SQ IN
LREF 3.0050 INCHES
BREF 6.0000 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0021 SCALE

PAGE 21
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39019J) HSFC497 GD DELTA WING BOOSTER B19W14C4AV7
AS9020 (A39019J) HSFC497 GD DELTA WING BOOSTER B19W14C4AV7

MACH 1.193

REFERENCE INFORMATION
BREF 15.6360 INCHES
LREF 3.0000 INCHES
REF 8.0000 INCHES
XMRP 0.0000 INCHES
YMRP 0.0000 INCHES
ZMRP 0.0000 INCHES
SCALE 0.0031 INCHES

PAGE 22
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901B) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902B) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

ALPHA GRIT
-6.000 -6.000 54.000

REFERENCE INFORMATION
SREF 15.6162 58 IN
LREF 3.0255 INCHES
BREF 6.0589 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 2.990

PAGE 23
EFFECT OF GRIT IN YAW, BOOSTER ALONE

Data Set Symbol: MSFC497 GD DELTA WING BOOSTER B19M14C4AV7

<table>
<thead>
<tr>
<th>Alpha</th>
<th>Grit</th>
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<tbody>
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Reference Information:
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- LREF: 3.0950 INCHES
- BREF: 6.0990 INCHES
- XMRF: 0.0000
- YMRF: 0.0000
- ZMRF: 0.0000
- SCALE: 0.0031 SCALE

Mach: 4.959
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, \( \beta \), DEGREES

YAWING MOMENT COEFFICIENT, \( C_{yn} \), (BODY AXIS)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(A39028)  MN10A497 GD DELTA WING BOOSTER B19W14C4AV7  ALPHA  GRIT
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REFERENCE INFORMATION
SREF  15.0000  SQ IN
LREF  3.0950  INCHES
BREF  6.0990  INCHES
XMRP  0.0000
YMRP  0.0000
ZMRP  0.0000
SCALE  0.0001  SCALE

MACH  0.951
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3991B) MNSFC497 GD DELTA WING BOOSTER B19W14C4AV?
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REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XHRE 0.0000
YHRE 0.0000
ZHRE 0.0000
SCALE 0.0031 SCALE

MACH 1.602
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A32925) MSFC497 GD DELTA WING BOOSTER B19WJ4C4A7
(A32925) MSFC497 GD DELTA WING BOOSTER B19WJ4C4A7

ALPHA GRIT
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-6.000
-6.000
-6.000
-6.000

REFERENCE INFORMATION
SREF 15.0500 SQ IN
LREF 5.0990 INCHES
BREF 6.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.193

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EFFECT OF GRIT IN YAW, BOOSTER ALONE

DATA SET SYMBOL   CONFIGURATION DESCRIPTION
(A3901B)  MSCC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902B)  MSCC497 GD DELTA WING BOOSTER B19W14C4AV7

MACH  4.959

SIDE SLIP ANGLE, BETA, DEGREES

REFERENCE INFORMATION
SREF  15.6550  IN
LREF  0.0950  INCHES
XREF  0.0000
YREF  0.0000
ZREF  0.0000
SCALE  0.0031  SCALE

PAGE  30
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B39052A) ☐ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A39059A) ▲ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A39062A) ○ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF 15.6560 S Q IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

TABLE 1.107
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION CONFIGURATION DESCRIPTION
(B3902A) M5FC497 6G DELTA WING BOOSTER B19144C4AV7 M5FC497 6G DELTA WING BOOSTER B19144C4AV7
(A3905A) M5FC497 6G DELTA WING BOOSTER B19144C4AV7 M5FC497 6G DELTA WING BOOSTER B19144C4AV7

BETA ELVATR AILRON GRIT
0.000 0.000 0.000 0.000
0.000 0.000 10.000 54.000
0.000 -5.000 15.000 54.000

REFERENCE INFORMATION
LREF 15.8500 SQ IN
XREF 3.0990 INCHES
YREF 6.0990 INCHES
XMRP 0.0000
ZMRP 0.0000
SCALE 0.0021 SCALE

MACH 1.197

PAGE 32
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B3905A) GMSFC497 GD DELTA WING BOOSTER B19W24C4AV7
(A3905A) GMSFC497 GD DELTA WING BOOSTER B19W24C4AV7
(A3906A) GMSFC497 GD DELTA WING BOOSTER B19W24C4AV7

BETA ELEV AILRON GIRT REFERENCE INFORMATION
0.000 0.000 0.000 54.000 LREF 15.000 IN
0.000 0.000 10.000 54.000 LREF 15.000 IN
0.000 -5.000 15.000 54.000 LREF 15.000 IN

MACH 1.197

PAGE 33
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

MACH 1.197

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3902A) MSFC497 GD DELTA WING BOOSTER B18W14C4AV7
(A3905A) MSFC497 GD DELTA WING BOOSTER B13W4C6AV7
(A3906A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

ANGLE OF ATTACK, ALPHA, DEGREES

REFERENCE INFORMATION
SREF 15.6750 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
SCALE 0.0031 SCALE
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  ELEVATION AILRONS  GRIFFIT  REFERENCE INFORMATION
(A3902A)  MSFC497 GD DELTA WING BOOSTER B19W4C4AV7  0.000  0.000  0.000  54.000  SREF  15.6560  SQ IN
(A3902A)  MSFC497 GD DELTA WING BOOSTER B19W4C4AV7  0.000  0.000  10.000  54.000  LREF  3.0950  INCHES
(A3906A)  MSFC497 GD DELTA WING BOOSTER B19W4C4AV7  0.000  -5.000  15.000  54.000  BREF  6.0990  INCHES

SCALE 0.0031

MACH 1.197

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ELEVTON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION

(B39QDA) NSFC497 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

(M33QDA) NSFC497 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

(M33QDA) NSFC497 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

BETA ELEVAT AILRON GIRT. REFERENCE INFORMATION

0.000 0.000 0.000 54.000 SREF 15.656 50 IN

0.000 0.000 10.000 54.000 SREF 15.656 50 IN

0.000 -5.000 15.000 54.000 SREF 15.656 50 IN

0.000 -5.000 15.000 54.000 SREF 15.656 50 IN

0.000 0.000 0.000 0.000 SREF 6.096 0 INCH

0.000 0.000 0.000 0.000 SREF 6.096 0 INCH

0.000 0.000 0.000 0.000 SREF 6.096 0 INCH

0.000 0.000 0.000 0.000 SREF 6.096 0 INCH

SCALE 0.000 0.000 0.000 0.000 SCALE

MACH 1.194

PAGE 39
ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  ELVATR  AILRON  GRRIT  REFERENCE INFORMATION
(B3907A)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  0.000  0.000  0.000  54.000  BREF  15.6560  64.000
(AB3908A)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  0.000  0.000  10.000  54.000  LREF  3.0950  INCHES
(AB3909A)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  0.000  -5.000  15.000  54.000  XMRF  0.0000  INCHES

MACH  1.194

PAGE  41
ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

ANGLE OF ATTACK, ALPHA, DEGREES

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B39D7A) NSFC497 NR/GC RNS LAUNCH B19M14C4AV7 + RNS
(A39D8A) NSFC497 NR/GC RNS LAUNCH B19M14C4AV7 + RNS

MACH 1.194

REFERENCE INFORMATION
BREF 15,6356 0 IN
LREF 3.0556 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0021 IN

PAGE 42
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B3Q2A)  A  MSFC497 5G DELTA WING BOOSTER B19W14C4AV7
(B3Q7A)  B  MSFC497 NR/CC RNS LAUNCH B19W14C4AV7 + RNS

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0930 INCHES
XREF 6.0590 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0000 SCALE

MACH 1.197
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
B3507A  NSFC497 6D DELTA WING BOOSTER B19M14C4AV7
B3507A  NSFC497 NK/66 RCS LAUNCH B19M14C4AV7 + RNS

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CA

REFERENCE INFORMATION
SREF 15.0000 89 IN
LREF 3.0000 INCHES
XREF 0.0000 INCHES
YREF 0.0000 INCHES
ZREF 0.0000 INCHES
SCALE 0.0031 SCALE

MACH 1.197

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, C_m

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B3902A) MSFC497 GD DELTA WING BOOSTER B19W14C4AY7
(B3902A) MSFC497 NR/GD RNS LAUNCH B19W14C4AY7 * RNS

BETA ELEV AILRON GRIT REFERENCE INFORMATION
0.000 0.000 0.000 54.000 SREF 15.6560 SQ IN
0.000 0.000 0.000 54.000 LREF 15.6560 INCHES
0.000 0.000 0.000 54.000 MRF 0.000 INCHES
0.000 0.000 0.000 54.000 ZRF 0.000 INCHES
0.000 0.000 0.000 54.000 SCALE 0.0031 SCALE

MACH 1.197

PAGE 45
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION

B90G2A) MSFC497 CC DELTA WING BOOSTER B19W14C4AV7
B90G7A) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

BETA ELVATR AILRON GRIIT REFERENCE INFORMATION
0.000 0.000 0.000 54.000 SREF 13.4560 56 IN
0.000 0.000 0.000 54.000 LREF 3.0850 INCHES
SREF 6.0890 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.197

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B39920) G0 MSPC497 GG DELTA WING BOOSTER B19W14C4AV7
(B3997A) G0 MSPC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.197
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3905A) Q MSFC497 CC DELTA WING BOOSTER B19W14C4AV7
(A3308A) NSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.109

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA DET SYMBOL  CONFIGURATION DESCRIPTION
(A39G0A)  Q  HSFC497 CC DELTA WING BOOSTER B19W14C4A7
(A39D0A)  Z  HSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

MACH  1.189

REFERENCE INFORMATION
SCALE  0.0031
SCALE  0.0000
SHR  0.0000
ZMH  0.0000
LREF  3.0350  INCHES
BREF  6.0700  INCHES
SREF  13.0560  50 IN

BETA  ELEVAT  AILRON  GRIT
0.000  0.000  10.000  54.000
0.000  0.000  10.000  54.000

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3905A) WSC497 GD DELTA WING BOOSTER B18W14C4AV7
A3969A WSC497 NR/GD RNS LAUNCH B18W14C4AV7 + RNS

REFERENCE INFORMATION
BREF 15.6350 SQ IN
LREF 3.0000 INCHES
XRREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.189

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39005A) Q M3FC497 CD DELTA WING BOOSTER B19W4C4AV7
(A39006A) A M3FC497 NR/GR RNS LAUNCH B19W4C4AV7 + RNS

MACH 1.169

REFERENCE INFORMATION
BETA ELYTH AILRON GRIEF SREF 19.000 0.000 0.000 0.000 0.000 99 IN
LREF 1.09950 INCHES
BREF 6.09950 INCHES
XREF 0.00000
YREF 0.00000
ZREF 0.00000
SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(A3905A)  Q  MSFC497 GD DELTA WING BOOSTER B19H54C4AV7
(A3908A)  Q  MSFC497 NR/GD RNS LAUNCH B19H54C4AV7 + RNS

MACH  1.180

REFERENCE INFORMATION
SREF  15.6560  SQ IN
LREF  3.0990  INCHES
XREF  6.0990  INCHES
YHREF  0.0000
ZMREF  0.0000
SCALE  0.0031  SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ROLLING MOMENT COEFFICIENT, CMB (BODY AXIS)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A9905A) N9FC49 T GD DELTA WING BOOSTER B19W14C4AV7
(A9905A) N9FC49T NR/LD RNS LAUNCH B19W14C4AV7 + RNS

REFERENCE INFORMATION
BETA ELEVAT AILRON GRR REFERENCE INFORMATION
0.000 0.000 10.000 54.000 GREF 15.0560 SQ IN
0.000 0.000 16.000 56.000 LREF 3.0990 INCHES
XREF 6.0990 INCHES
YREF 6.0990 INCHES
ZREF 6.0990 INCHES
SCALE 0.0031 SCALE

MACH 1.189

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A38G6A) Q MSFC497 60 DELTA MIST BISW4C4AV7
(A39G9A) MSFC497 NR/60 RNS LAUNCH BISW4C4AV7 + RNS

MACH 1.190
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3906A) O MSFC497 6D DELTA WING BOOSTER B19W14C4AV?
(A3909A) NSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.19G

REFERENCE INFORMATION
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LREF 3.0950 INCHES
BREF 6.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3906A) Q MSFC497 GC DELTA WING BOOSTER B19W14C4AX7 - RNS
(A3903A) ★ MSFC497 NR/GC RNS LAUNCH B19W14C4AX7 + RNS

MACH 1.198

REFERENCE INFORMATION
SREF 15.6560 50 IN
BREF 3.0950 INCHES
XREF 0.0000 INCHES
YREF 0.0000 INCHES
ZREF 0.0000 INCHES
SCALE 0.0031 SCALE
### EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

- **EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH**

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**MACH** 1.196

**SCALE** 0.0031 **SCALE**

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**ANGLE OF ATTACK, ALPHA, DEGREES**

**LATENT FORCE COEFFICIENT, CY**

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**REFERENCE INFORMATION**

- **SEF 6.6360 IN**
- **LREF 3.0950 INCHES**
- **XREF 0.0000 INCHES**
- **YREF 0.0000 INCHES**
- **ZREF 0.0000 INCHES**
- **SCALE 0.0031 SCALE**
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39G6A) Δ MSFC497 CC DELTA WING Booster D19W14C4AV7
(A39G8A) Δ MSFC497 NR/CD RNS LAUNCH D19W14C4AV7 + RNS

BETA ELEVATION AILRON GRIT REFERENCE INFORMATION
0.000 -5.000 15.000 54.000 SREF 15.0560 SQ IN
0.000 -5.000 15.000 54.000 LREF 3.0950 INCHES
5.000 -5.000 15.000 54.000 MREF 6.0950 INCHES
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0.000 0.000 0.000 ZHREF 0.0000
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MACH 1.190
ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR AILRON GRIT  REFERENCE INFORMATION
(D3901D)  Q  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  0.000  04.000  15.6560 SQ IN
(A390581)  X  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  10.000  54.000  3.0950 INCHES
(C39066)  O  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000 -5.000  15.000  54.000  6.0000 INCHES

MACH 1.193

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ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, Beta, Degrees

LATERAL FORCE COEFFICIENT, Cy

MACH 1.202

-0.40
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40

-12
-10
-8
-6
-4
-2
-0
2
4
6
8
10
12

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELEVATR  AILRON  GRIT  REFERENCE INFORMATION
(C3902B) ○  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  0.000  54.000  SREF  15.6560 SQ IN
(C3905B) □  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  10.000  54.000  LREF  3.0950 INCHES
(C3906B) □  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  -5.000  15.000  54.000  XREF  6.0990 INCHES
XREF  0.000
ZMRP  0.000
SCALE  0.0031 SCALE
ELEVOM EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, Beta, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39060) MSFC497 GD DELTA WING BOOSTER B19W4C4AV7
(C39060) MSFC497 GD DELTA WING BOOSTER B19W4C4AV7

ALPHA ELVATR AILRON GRIT
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-6.000 0.000 10.000 54.000
-6.000 -5.000 15.000 54.000
-6.000 -10.000 20.000 54.000
-6.000 -15.000 25.000 54.000

REFERENCE INFORMATION
MACH 1.202
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031

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ELEVON EFFECTIVENESS IN YAW: BOOSTER ALONE

SIDE SLIP ANGLE, Beta, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E39062) ** MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C39058) □ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C39066) □ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

ALPHA ELVATR AILRON GRIT REFERENCE INFORMATION
-6.00 0.000 0.000 54.000 SREF 11.6560 SQ IN
-6.00 0.000 10.000 54.000 LREF 3.0950 INCHES
-6.00 -5.000 15.000 54.000 BREF 6.0990 INCHES
XMRP 0.0000
XMRB 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 1.202

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ELEVON EFFECTIVENESS IN YAW. BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) Q MSFC497 GD DELTA WING BOOSTER B1SW14C4AV7
(C3905B) O MSFC497 GD DELTA WING BOOSTER B1SW14C4AV7

ALPHA  ELEVAT AILRON GRIT  REFERENCE INFORMATION
-6.000  0.000  0.000  54.000 SREF 15.6500 50 IN
-6.000  0.000 10.000  54.000 LREF 3.0950 INCHES
-6.000  -3.000 15.000  54.000 BREF 6.0990 INCHES

SCALE 0.0031 SCALE

MACH 3.202
ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR  AILRON  GRIT  REFERENCE INFORMATION
(E3902B)  MSFC497 GD DELTA WING BOOSTER BIST14C4AV7  -6.000  0.000  0.000  54.000  ZREF  15.6560  SQ IN
(C3905B)  MSFC497 GD DELTA WING BOOSTER BIST14C4AV7  -6.000  0.000  16.000  54.000  ZREF  15.6560  INCHES
(C3906B)  MSFC497 GD DELTA WING BOOSTER BIST14C4AV7  -6.000  -3.000  15.000  54.000  ZREF  6.0990  INCHES

SCALE 0.0021  SCALE

MACH 1.202

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ELEVON EFFECTIVENESS IN YAW: BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39078) MSFC497 NR/6D RNS LAUNCH B19814C4AV7 * RNS
(C39088) MSFC497 NR/6D RNS LAUNCH B19814C4AV7 * RNS

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

MACH 1.199

REFERENCE INFORMATION
SREF 15.6560 INCHES
LREF 3.0950 INCHES
XREF 0.00000
ZREF 0.00000
SCALE 0.0031 INCHES
ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
IC396D7 HSF497 NR/GD RNS LAUNCH BI9W14C4AV7 + RNS
IC397D8 HSF497 NR/GD RNS LAUNCH BI9W14C4AV7 + RNS
IC398D9 HSF497 NR/GD RNS LAUNCH BI9W14C4AV7 + RNS

REFERENCES INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
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MACH 1.189
### Side Slip Angle, Beta, Degrees

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### Elevation Effectiveness in Yaw, Booster Plus RNS

**Mach**: 1.199

**Reference Information**

- SREF 15.6550 50 IN
- LREF 3.9950 INCHES
- BREF 6.0000 INCHES
- XMRP 0.0000
- YMRP 0.0000
- ZMRP 0.0000
- SCALE 0.0001

**Page**: 71
ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELEVAT AILRON GRIT  REFERENCE INFORMATION
(C39D7B)  MSFC497 NR/GO RNS LAUNCH BI9W14C4AV7  RNS  -6.000 0.000 0.000 54.000  SREF 13.6150 50 IN
(C389GB)  MSFC497 NR/GO RNS LAUNCH BI9W14C4AV7  RNS  -6.000 0.000 10.000 54.000  LREF 3.0390 INCHES
(C39G9B)  MSFC497 NR/GO RNS LAUNCH BI9W14C4AV7  RNS  -6.000 -5.000 15.000 54.000  BREF 6.0390 INCHES

MACH 1.199
ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES
FOREBODY AXIAL FORCE COEFFICIENT, CAF

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C997G) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS
(C9508B) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS
(C9509B) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

ALPHA  ELVATR  AILRON  GRIT  REFERENCE INFORMATION
-6.000  0.000  0.000  54.000  SREF  15.6560  00 IN
-6.000  0.000  16.000  54.000  1REF  3.0890  INCHES
-6.000  -5.000  15.000  54.000  2REF  6.0990  INCHES
XHAP  0.0000
YHAP  6.0000
ZHAP  0.0000
SCALE  0.0031  SCALE

MACH  1.190

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C39018)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C39078)  MSFC497 N&G& RNS LAUNCH B19W14C4AV7 + RNS

ALPHA  ELEVON  AILRON  GRIT
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REFERENCE INFORMATION
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LREF  3.0950  INCHES
BREF  6.0990  INCHES
THREF  0.0000
YHREF  0.0000
SCALE  0.0011  SCALE

MACH  1.193
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) MSFC497 60 DELTA WING BOOMER B1964C4AV7 + RNS
(C3907B) MSFC497 NR/GD RNS LAUNCH B1964C4AV7 + RNS

MACH 1.202
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E39028) □ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(D39078) □ MSFC497 M1/GD RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.202

REFERENCE INFORMATION
SCALE 0.0031 SCALE

SREF 3.0090 INCHES
ZMRF 0.0000

YREF 0.0000
ZMRF 0.0000

SCALE 0.0000

REFERENCE INFORMATION

SREF 15.6560 IN
ZMRF 0.0000

SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL CONFIGURATION DESCRIPTION ALPHAI ELEVAO AILRONE GRIE REFERENCE INFORMATION
(E39628) MSFC497 GG DELTA WING BOOSTER B19W14C4AV7 -0.000 0.000 0.000 0.000 SREF 12.4550 58 IN
(E395078) MSFC497 NR/CC RNS LAUNCH B19W14C4AV7 + RNS -0.000 0.000 0.000 0.000 54.000 LREF 0.0930 INCHES
BREF 0.0930 INCHES
XREF 0.0930 INCHES
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ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.202

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, $\beta$, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, $C_{af}$

DATA SET SYMBOL | CONFIGURATION DESCRIPTION | ALPHA | ELEVATOR | AILERON | GEAR | REFERENCE INFORMATION
--- | --- | --- | --- | --- | ---
(C3902B) | M5FC087 69 DELTA WING BOOT 815W14C4AV7 + RNS | -6.000 | 0.000 | 0.000 | 54.000 | SREF 15.6560 SQ IN
(C3907B) | M5FC087 NR/GD RNS LAUNCH 815W14C4AV7 + RNS | -6.000 | 0.000 | 0.000 | 54.000 | LREF 3.0950 INCHES

MACH 1.202

SCALE 0.0031
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(D3907B) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.202

REFERENCE INFORMATION
SREF 15.6560 SD IN
LREF 3.0950 INCHES
XREF 0.0000 INCHES
YREF 0.0000 INCHES
ZREF 0.0000 INCHES
SCALE 0.0031 SCALE

ALPHA ELVATR AILRON GIRT
-6.000 0.000 0.000 54.000
-6.000 0.000 0.000 54.000
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, \( \beta \), DEGREES

LATERAL FORCE COEFFICIENT, \( c_L \)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  \( \alpha \)  ELVATR  AILRON  GRIT  REFERENCE INFORMATION
(C3905B)  MSFC49T GC DELTA WING ROCKET BISW14AV7  -6.000  0.000  10,000  54,000  SRFC  15.6540  50 IN
(C3908B)  MSFC49T NR/OG RNS LAUNCH BISW14AV7 + RNS  -6.000  0.000  10,000  54,000  LREF  3.0950  INCHES
          RREF  6.0990  INCHES
          XHRF  0.0000
          YMRF  0.0000
          ZHRF  0.0000
          SCALE  0.0031
         
MACH  1.195

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39058) Q MSFC497 GC DELTA WING BOOSTER B19W14C4AV7
(C39060) MSFC497 NR/6C RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.195

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 6.0990 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0050 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, DEGREES

XCPV/L

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3908B) MSFC497 GD DELTA WING BOOST B19W14C4AV7
(C3908B) MSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.195

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRF 0.0000
YMRF 0.0000
ZMRF 0.0000
SCALE 0.0001 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL	CONFIGURATION DESCRIPTION
(C3905B) MSFC497 CD DELTA WING BOOSTER B19W14C4AV7 + RNS
(C3906B) MSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.195
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, \( \beta \), DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION

C3905D)  Q  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

C3900B)  Q  MSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELEVAT ALLRON SHIT

REFERENCE INFORMATION

SREF 15.6960 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.195

PITCHING MOMENT COEFFICIENT, CLM

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(c3966c)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(c390db)  MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

MACH  1.195

REFERENCE INFORMATION
ALPHA  ELEVAT  AILRON  GRIT  SREF  LREF
-6.000  -5.000  15.000  54.000  3.0950  54.000
-6.000  -5.000  15.000  54.000

BREF  6.0990
XMRP  0.0000
ZMRP  0.0000
SCALE  0.0031
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39098) Q MSFC497 6C DELTA WING BOOSTER BIS9M144AV
(C39098) B MSFC497 NR/6C RNS LAUNCH BIS9M144AVT + RNS

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 0.0000 INCHES
YMRP 0.0000
ZMRF 0.0000
SCALE 0.0031 SCALE

MACH 1.193

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

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<td>HSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS</td>
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- BREF 3.0950 INCHES
- XREF 0.0000 INCHES
- YREF 0.0000 INCHES
- ZWRF 0.0000
- SCALE 0.0031

MACH 1.193
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, \( \beta \), DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C39G8B)  \( \Delta \)  MSFC497 60 DELTA WING BOOSTER B19W14C4AV7
(C39G9B)  \( \Delta \)  MSFC497 NR/60 RNS LAUNCH B19W14C4AV7 + RNS

\( \alpha \), \( \varepsilon \), \( \gamma \), \( \delta \), \( \epsilon \)

REFERENCE INFORMATION

\( \alpha \), \( \varepsilon \), \( \gamma \), \( \delta \), \( \epsilon \)

SCALE 0.0051

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETAI, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3966B) M SFC497 GG DELTA WING BOOSTER B19W14C4AV7
(C3998B) MSFC497 MR/60 RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELVATR AILRON GIRT REFERENCE INFORMATION
-6.000 -5.000 15.000 54.000 SREF 15.000 S IN
LREF 3.0990 INCHES
MREF 6.0990 INCHES
XMRF 0.0000
YMRF 0.0000
ZMRF 0.0000
SCALE 0.0031 SCALE

MACH 1.193
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, \( \theta \), DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, \( C_{AF} \)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39068) A MSFC497 CC DELTA WING ROCKET BISW14CAV7
(C39092) Q MSFC49F NR/OD RNS LAUNCH BISW14CAV7 + RNS

ALPHA ELEVON AILRORN GRIT REFERENCE INFORMATION
-6.000 -6.000 15.000 54.000 REF 15.6560 IN
-6.000 -6.000 15.000 54.000 LREF 3.0950 INCHES
XREF 0.0000 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0001 SCALE

MACH 1.193

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Rudder and Elevon Effectiveness in Pitch: Booster Alone ($\beta = 0$)

Normal Force Coefficient, CN vs. Angle of Attack, $\alpha$, Degrees

Data Set Symbol Configuration Description

Mach 1.197
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(03992A) MSFC497 GC DELTA WING BOOSTER B19W14C4AV7
(14992A) MSFC497 GC DELTA WING BOOSTER B19W14C4AV7
(13904A) MSFC497 GC DELTA WING BOOSTER B19W14C4AV7

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ELEVATAIL Rudder GRIT
0.000 0.000 1.000 54.000
SREF 15.6560 SQ IN
LREF 3.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0051

MACH 1.197

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RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE ($\beta = 0$)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ELEVAT  AILRON  Rudder  GRIT  REFERENCE INFORMATION
(B3902A)  MSFC497 GD DELTA WING BOOSTER B16W14C4AV7  0.000  0.000  0.000  54.000  REF  15.6560  60 IN
(A3903A)  MSFC497 GD DELTA WING BOOSTER B16W14C4AV7  0.000  0.000  10.000  54.000  LREF  3.0950  INCHES
(A3904A)  MSFC497 GD DELTA WING BOOSTER B16W14C4AV7  0.000  10.000  10.000  54.000  XREF  6.0990  INCHES

REFERENCE INFORMA  ION  SCALE  0.0031  SCALE

MACH  1.197
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE (BETA=0)

DATA SET SYMBOL | CONFIGURATION DESCRIPTION | ELEVATOR | AILERON | RUDDER | GRIT | REFERENCE INFORMATION
(A3904A) | MSFC497 GD DELTA WING BOOSTER B19W14C4AV7 | 0.000 | 0.000 | 0.000 | 0.000 | SREF 15.6560 SQ IN
(A3903A) | MSFC497 GD DELTA WING BOOSTER B19W14C4AV7 | 0.000 | 0.000 | 10.000 | 0.000 | LREF 3.0930 INCHES
(A3903A) | MSFC497 GD DELTA WING BOOSTER B19W14C4AV7 | 0.000 | 10.000 | 10.000 | 0.000 | BREF 6.0990 INCHES

SCALE: 0.0035
MACH: 1.197

REFERENCE INFORMATION:
SREF 15.6560 SQ IN
LREF 3.0930 INCHES
BREF 6.0990 INCHES
SCALE 0.0035

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RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS (BETA=0)

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0091 SCALE

MACH 1.194

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B39G7A) ○ MSFC497 NR/GO RNS LAUNCH B16W14C4AV7 + RNS
(A39B11A) ☐ MSFC497 NR/GO RNS LAUNCH B16W14C4AV7 + RNS
(A39B16A) ☐ MSFC497 NR/GO RNS LAUNCH B16W14C4AV7 + RNS

ELEVATOR AILRONS RUDDER GRIT
0.000 0.000 0.000 54.000 SREF 15.6560 SQ IN
0.000 0.000 10.000 54.000 LREF 3.0950 INCHES
0.000 10.000 10.000 54.000 BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0091 SCALE
Rudder and Elevon Effectiveness in Pitch, Booster Plus RNS (Beta=0)

Data Set Symbol Configuration Description
(B3907A) NSFC497 NR/GO RNS LAUNCH B19M14C4AV7 + RNS
(A3910A) NSFC497 NR/GO RNS LAUNCH B19M14C4AV7 + RNS
(A3910A) NSFC497 NR/GO RNS LAUNCH B19M14C4AV7 + RNS

Elevat Aileron Rudder Grt
0.000 0.000 0.000 54.000
0.000 0.000 10.000 56.000
0.000 10.000 10.000 54.000

Reference Information
-SREF 15.6560 SQ IN
-XREF 3.0990 INCHES
-YREF 0.0000
-ZREF 0.0000
-Scale 0.0031 SCALE

Mach 1.194
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS (Beta=0)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
1 (3907A) MSFC497 NR/CG RNS LAUNCH B19W14C4AV7 + RNS
1 (3910A) MSFC497 NR/CG RNS LAUNCH B19W14C4AV7 + RNS

REFERENCE INFORMATION

MACH 1.194

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION

ELVAIL AILRON RUDDER GRIT REFERENCE INFORMATION

MACH 1.187
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ELVATR  AILRON  RUDDER  GRIP  REFERENCE INFORMATION
(A3903A)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  0.000  0.000  10.000  54.000  SREF  15.6550  50 IN
(A3911A)  MSFC497 NR/OD RNS LAUNCH B19W14C4AV7 + RNS  0.000  0.000  10.000  54.000  LREF  3.0950  INCHES

MACH  1.107

REFERENCE INFORMATION
SREF  15.6550  50 INCHES
LREF  3.0950  INCHES
XREF  0.0000
YREF  0.0000
ZREF  0.0000
SCALE  0.0031

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (\(\beta = 0\))

ANGLE OF ATTACK, ALPHA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
\(\Delta\) MSFC497 60 DELTA WING BOOSTER B18W14C4AV7
\(\bigtriangleup\) MSFC497 NR/GC RNS LAUNCH B18W14C4AV7 + RNS

MACH 1.187

REFERENCE INFORMATION

\(\text{ELEV}\) 0.000 0.000 10.000 54.000
\(\text{AILR}\) 0.000 0.000 10.000 54.000
\(\text{RUDD}\) 0.000 0.000 10.000 54.000
\(\text{GRIT}\) 0.000 0.000 10.000 54.000

BREF 0.0990 INCHES
XREF 0.0990 INCHES
YMRF 0.0000
ZMRF 0.0000
SCALE 0.0031

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A) MSF4097 6C DELTA WING BOOSTER B19W14C4AV7
(A3911A) MSF4097 NR/CG RNS LAUNCH B19W14C4AV7 + RNS

MACN 1.187

REFERENCE INFORMATION
SREF 15.656G INCH
BREF 3.099G INCH
VHREF 0.000G
ZHREF 0.000G
SCALE 0.0031 SCALE
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION ELEVATOR AILRONS RUDDER GRIT REFERENCE INFORMATION
(A3903A) GS MSFC497 GD DELTA WING BOOSTER B15W14C4AY7 0.000 0.000 10.000 54.000 SREF 15.6560 64 IN
(A3911A) MSFC497 NR/60 RNS LAUNCH B15W14C4AY7 + RNS 0.000 0.000 10.000 54.000 LREF 3.0950 INCHES
MACH 1.187

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ELVATR  AILRON  RUDDER  GRT  REFERENCE INFORMATION
(A3966A)  Q  MSFC497 60 DELTA WING BOOSTER B19W4C4AVT  0.000 10.000 10.000 54.000 SREF 11.6660 $0.00  IN
(A3966A)  MSFC497 HX/6C RNS LAUNCH B19W4C4AVT + RNS  0.000 10.000 10.000 54.000 LREF 4.0950 INCHES
MACH 1.187

REFERENCE INFORMATION
SREF 15.6560 INCHES
XREF 3.0950 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 INCHES

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3904A) MSFC497 60 DETA MING BOOSTER B19W14C4A7
(A3910A) MSFC497 NR/4D RNS LAUNCH B19W14C4A7 + RNS

ELEV AILRON RUDDER GRIT REFERENCE INFORMATION
0.000 10.000 10.000 54.000 SREF 17.6560 56 IN
0.000 10.000 10.000 54.000 LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRF 0.0000
YMRF 0.0000
ZNRF 0.0000
SCALE 0.0031 SCALE

MACH 1.187

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A390A) 0 MSFC4764 DELTA WING ROOSTER BISW44C4AV7
(A3910A) MSFC4764/6/0 TS LUNCH BISW44C4AV7 + RNS

ELEVATOR AIIRON RUDDR GRII REFERENCE INFORMATION
0.000 10.000 10.000 94.000 REF 15.6560 SQ IN
0.000 10.000 10.000 94.000 LREF 3.0950 INCHES
0.000 6.0960 INCHES
0.000 0.000
0.000 0.000
0.000 0.000
SCALE 0.0031 SCALE

MACH 1.107

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION  ELVATR ALTRON RUDDER GRIIT  REFERENCE INFORMATION
(A3950A) MSFC497 CD DELTA WING BOOSTER B19W14G4AV7 0.000 10.000 10.000 54.000  SREF 35.6550 SQ IN
(A3950A) N:497 NR/CD RNS LAUNCH B19W14G4AV7 + RNS 0.000 10.000 10.000 54.000  BREF 3.0050 INCHES
MACH 1.187
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0005 SCALE

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) MHSGC497 GD DELTA WING BOOSTER BISW1484AY7
(A3903B) MHSGC497 GD DELTA WING BOOSTER BISW1484AY7

SIDE SLIP ANGLE, BETA, DEGREES

ROLLING MOMENT COEFFICIENT, Cm (BODY AXIS)

MACH 1.193

REFERENCE INFORMATION
SREF 15.0560 SQ IN
LREF 3.0050 INCHES
XREF 6.0050 INCHES
YMPR 0.0000
ZMPR 0.0000
SCALE 0.0031 SCALE

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA ELVATR AILRON RUDDER REFERENCE INFORMATION
(E3802B)   MSFC497 CC DELTA WING BOOSTER B1WJ4C4AV7  -6.000 0.000 0.000 0.000 LREF 15.6500 SQ IN
(C3802B)  MSFC497 CC DELTA WING BOOSTER B1WJ4C4AV7  -6.000 0.000 0.000 10.000 LREF 3.0990 INCHES
(C3804B)  MSFC497 CC DELTA WING BOOSTER B1WJ4C4AV7  -6.000 0.000 10.000 10.000 XREF 6.0990 INCHES
MACH 3.002

SCALE 0.005

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) ○ MSFC497 GD DELTA WING BOOSTER B19W414C44AV7
(C3903B) ○ MSFC497 GD DELTA WING BOOSTER B19W414C44AV7
(C3904B) ○ MSFC497 GD DELTA WING BOOSTER B19W414C44AV7

MACR 1.202

REFERENCE INFORMATION

SCALE 0.2031  SCALE
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) ○ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C3903B) ▲ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C3904B) ▲ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

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MACH 1.202
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39020) MSFC497 CD DELTA WING BOOSTER BISWIC4AV7
(C39033) MSFC497 CD DELTA WING BOOSTER BISWIC4AV7
(C39046) MSFC497 CD DELTA WING BOOSTER BISWIC4AV7

MACH 1.202

REFERENCE INFORMATION
SREF 15.6560 SQ IN
SREP 3.0950 INCHES
ZMRP 0.0000
SCALE 0.0031 SCALE
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C30076) 💡 MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS
(C30116) 💡 MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS
(C30106) 💡 MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

REFERENCE INFORMATION
SREF 15.6560 59 IN
LREF 3.0950 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0001 SCALE

MACH 1.199

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(D39078) ○ M3FC4ST NR/GC RNS LAUNCH B1SW14C4AVT + RNS
(C39118) ○ M3FC4ST NR/GC RNS LAUNCH B1SW14C4AVT + RNS
(C39168) ○ M3FC4ST NR/GC RNS LAUNCH B1SW14C4AVT + RNS

ALPHA ELVATR AILRON RUDDER REFERENCE INFORMATION
-6.000 0.000 0.000 0.000 15.6560 SQ IN
-6.000 0.000 0.000 10.000 6.0950 INCHES
-6.000 0.000 10.000 10.000 6.9950 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 1.198
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3901B) MSFC497 NR/6D RNS LAUNCH B181464AV7 + RNS
(C3911B) MSFC497 NR/6D RNS LAUNCH B181464AV7 + RNS
(C3913B) MSFC497 NR/6D RNS LAUNCH B181464AV7 + RNS

ALPHA ELEVATE AILRONE RuddE RERERENCE INFORMATION
-6.000 0.000 0.000 0.000 REF 15.0550 INCHES
-6.000 0.000 0.000 10.000 LREF 10.0900 INCHES
-6.000 0.000 10.000 10.000 XREF 0.0000

XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0001 SCALE

MACH 1.199

SIDE SLIP ANGLE, BETA, DEGREES
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, $\beta$, DEGREES

NORMAL FORCE COEFFICIENT, $c_n$

DATA SET SYMBOL | CONFIGURATION DESCRIPTION | $\alpha$ | $\delta_{elev}$ | $\delta_{ail}$ | $\delta_{rudder}$ | REFERENCE INFORMATION
---|---|---|---|---|---|---
(C3907) | MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS | -6.000 | 0.000 | 0.000 | 0.000 | $15.656c$ SQ IN
(C3907B) | MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS | -6.000 | 0.000 | 0.000 | 0.000 | $15.656c$ INCHES
(C3910B) | MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS | -6.000 | 0.000 | 0.000 | 0.000 | $3.099c$ INCHES

MACH 1.199

SCALE 0.0031
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELEV    AILRON Rudder  REFERENCE INFORMATION
(C3907B)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  -6.000 0.000 0.000 0.000  SREF  15.6500 SQ IN
(C3911A)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  -6.000 0.000 0.000 10.000  LREF  3.0950 INCHES
(C3910B)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS  -6.000 0.000 10.000 10.000  BREF  1.0990 INCHES

MACH 1.199

PAGE 133
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, \( \beta \), DEGREES

LATERAL FORCE COEFFICIENT, \( C_y \)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3903B) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C3911B) MSFC497 NR/CD RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.192

REFERENCE INFORMATION
\( SREF \) 15.6560 SQ IN
\( LREF \) 3.0950 INCHES
\( XMRP \) 0.0000
\( YMRP \) 0.0000
\( ZMRP \) 0.0000
\( SCALE \) 0.0031
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C3903B)  M5FC497 CC DELTA WING BOOSTER B19W14C4AY7
(C3911B)  M5FC497 NR/60 RNS LAUNCH B19W14C4AV7 + RNS

MACH  1.192
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, \( \beta \), DEGREES

ROLLING MOMENT COEFFICIENT, \( C_{BL} \) (BODY AXIS)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
\( C39038 \)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
\( C39118 \)  MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

ALPHA  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
-6.000  0.000  0.000  10.000  SREF  15.6560  SQ IN
-6.000  0.000  0.000  10.000  LREF  3.0950  INCHES

MACH  1.192

PAGE  136
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3903B)  
(C3911B)  

MACH 1.192

REFERENCE INFORMATION
SCALE 0.0031
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3803B)  Q  NSEFC497 SQ DELTA WING BOOSTER B19W14C4AV7
(C3811C)  Q  NSEFC497 NA66C RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.192

SIDE SLIP ANGLE, BETA, DEGREES
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, $\beta$, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAH

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPH $A$  ELV $A$  AIL $A$  RUD $D$  REFERENCE INFORMATION
(C3903B)  MSFC497 60 DELTA WING BOOSTER B19W14C4AV 7  -6.000 0.000 0.000 10.000 $S_{REF}$ 15.6560 54 IN
(C3911B)  MSFC497 60 DELTA WING LAUNCH B19W14C4AV 7 + RNS  -6.000 0.000 0.000 10.000 $L_{REF}$ 3.0950 INCHES

MACH 1.192

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
(C390238)  NSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  0.000  10.000  MREF  15.6560  90 IN
(C39113B)  NSFC497 NR/GE RNS LAUNCH B19W14C4AV7 + RNS  -6.000  0.000  0.000  10.000  LREF  15.0960  INCHES

MACH 1.192

SCALE 0.0031 SCALE
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39040) δ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C39100) δ MSFC497 NR/CG RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELEVATOR AILRONE Rudder Reference Information
-6.000 0.000 10.000 10.000
-6.000 0.000 10.000 10.000
BREF 15.6500 50 IN
LREF 0.0950 INCHES
XHBF 0.0000
YHBF 0.0000
ZHBF 0.0000
SCALE 0.0031 SCALE

MACH 1.194
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) MSFC497 60 DELTA WING BOOSTER B19W14A4AV7
(C3910G) MSFC497 NR/CD RNS LAUNCH B19W14A4AV7 + RNS

MACH 1.194

PAGE 142
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, \( \beta \), DEGREES

ROLLING MOMENT COEFFICIENT, \( C_{BL} \) (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) R M94C497 GD DELTA WING BOOSTER B19W14C4AV7
(C3910B) R M94C497 NR/50 RNS LAUNCH B19W14C4AV7 + RNS

REFERENCE INFORMATION
\( S_{REF} \) 15.6560 SQ IN
\( L_{REF} \) 3.0950 INCHES
\( X_{REF} \) 6.0990 INCHES
\( Y_{REF} \) 0.0000 INCHES
\( Z_{REF} \) 0.0000 INCHES
SCALE 0.0031 SCALE

MACH 1.196

PAGE 143
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, \( \beta \), DEGREES

XCPY/L

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39040) MSFC407 GD DELTA MING BOOSTER BISW44C4AV7
(C3910D) MSFC497 NR/GD RNS LAUNCH BISW44C4AV7 + RNS

\[ \begin{align*}
\text{ALPHA} & \quad \text{ELEVAT} & \quad \text{AILLROM} & \quad \text{RUDDER} \\
-6.000 & \quad 0.000 & \quad 10.000 & \quad 10.000 \\
-6.000 & \quad 0.000 & \quad 10.000 & \quad 10.000 \\
\end{align*} \]

REFERENCE INFORMATION
SREF 15.6560 SQ IN
BREF 1.0980 INCHES
XREF 0.0000 INCHES
YREF 0.0000 INCHES
ZREF 0.0000 INCHES
SCALE 0.0001 SCALE

MACH 1.104

PAGE 144
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

NORMAL FORCE COEFFICIENT, CN

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) MSFC497 CD DELTA WING BOOSTER B19W14C4AV7
(C3910B) MSFC497 N/A/0/0 RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.194
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR  AILRORN  RUDDER  REFERENCE INFORMATION
(C3944B)  Q  MSFC497 GD DELTA WING BOOSTER B19W444AVTT  -6.000  0.000  10.000  10.000  BREF  15.6500 S0 IN
(C39450)  Q  MSFC497 NR/GE RNS LAUNCH B19W444AVTT + RNS  -6.000  0.000  10.000  10.000  LREF  3.0950 INCHES

MACH  1.194

SCALE  0.0031 SCALE
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) RS MSFC497 60 DELTA WING BOOSTER B19W14C4AV7
(C39108) R MSFC497 NR/66 RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELVATR AILRON RUDDER REFERENCE INFORMATION

SCALE

PAGE 147
EFFECT OF ANGLE OF ATTACK, RNS ALONE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

REFERENCE INFORMATION
SREF 15.6560 SG IN
LREF 3.0930 INCHES
BREF 6.6990 INCHES
XREF 1.3610 INCHES
YMP 0.0000 INCHES
ZMP -1.3320 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 148
EFFECT OF ANGLE OF ATTACK, RNS ALONE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

SYMBOL MACH BETA PARAMETRIC VALUES
O 1.002 0.000 0.000 0.000 0.000

REFERENCE INFORMATION
SREF 15.6560 30 IN
LREF 3.0950 INCHES
BREF 6.0950 INCHES
XREF 2.0950 INCHES
YREF 0.0000 INCHES
ZREF -1.3200 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS (A3913A) 28 AUG 71 PAGE 150
EFFECT OF ANGLE OF ATTACK, RNS ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

SYMBOL MACH PARAMETRIC VALUES
O 1.191 O.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 50 IN
LREF 3.0550 INCHES
BREF 6.0995 INCHES
XMRP 1.5610 INCHES
ZMRF 0.0000
SCALE 0.0031 SCALE

DATA MIST. CODE M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 151
EFFECT OF ANGLE OF ATTACK, RNS ALONE

FOREBODY AXIAL FORCE COEFFICIENT, C₂ₐₐₜ

ANGLE OF ATTACK, ALPHA, DEGREES

SYMBOL
MACH
BETA
PARAMETRIC VALUES
Q
0.954
- BETA
0.000
GRT
0.000

REFERENCE INFORMATION
SREF
15.650
50 IN
LREF
3.0950
INCHES
BREF
6.0990
INCHES
XREF
1.5610
INCHES
YREF
0.0000
INCHES
ZREF
0.0000
INCHES
SCALE
0.0031
SCALE

DATA MISTIC CODE

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 153
EFFECT OF ANGLE OF ATTACK, RNS ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

SYMBOL MACH PARAMETRIC VALUES REFERENCE INFORMATION
O 1.002 BETA 0.000 CRIT 54.000 SREF 15.0060 38 IN

DATA MIST. CODE M

MSFC497 NR REUSABLE NUCLEAR STAGE RNS (A3913A) 28 AUG 71 PAGE 154
EFFECT OF ANGLE OF ATTACK, RNS ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

PARAMETRIC VALUES

REFERENCE INFORMATION

DATA HIST. CODE M

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A)  28 AUG 71  PAGE  155
EFFECT OF ANGLE OF ATTACK, RNS ALONE

PITCHING MOMENT COEFFICIENT, CLM

ANGLE OF ATTACK, ALPHA, DEGREES

SYMBOL MACH PARAMETRIC VALUES
0 0.601 BETA 0.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.0560 SQ IN
QREF 3.9950 INCHES
BREF 4.0990 INCHES
XMRP 1.5610 INCHES
ZMRF 0.0000 INCHES
SCALE 0.0031 SCALE

DATA MIST. CODE M
MSFC 497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 156
EFFECT OF ANGLE OF ATTACK, RNS ALONE

SYMBOL MACH  PARAMETRIC VALUES
O  0.954  BETA  0.000  QURIT  54.000

REFERENCE INFORMATION
SREF  15.655  83  IN
LREF  3.0055  INCHES
BREF  6.0599  INCHES
XREF  1.5610  SCALE
YREF  0.0000  SCALE
ZREF -1.3320  SCALE
SCALE  0.0031  SCALE

DATA HIST. CODE N
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A)  28 AUG 71  PAGE  157
EFFECT OF ANGLE OF ATTACK, RNS ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

PARAMETRIC VALUES
- SYMBOL MACH
- Q 1.191
- BETA 0.000
- GRIT 54.000

REFERENCE INFORMATION
- SREF 12.0150 SCALE
- LREF 3.0950 INCHES
- XREF 1.9510 INCHES
- YREF 0.0000
- ZREF 1.5610 INCHES
- SCALE 0.0031 SCALE

DATA MIST. CODE M

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 159
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

SYMBOL MACH PARAMETRIC VALUES
O 0.604 ALPHA = 0.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 IN
LREF 3.0930 INCHES
BREF 6.0890 INCHES
XREF 1.5610 INCHES
YREF 0.0000 INCHES
ZREF -1.3320 INCHES
SCALE 0.0031 SCALE

DATA MIST. CODE M0E

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C3913B) 28 AUG 71 PAGE 160
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SYMBOL  MACH  PARAMETRIC VALUES
Q        0.954  ALPHA = 6.000  QRIT = 54.000

REFERENCE INFORMATION
SREF  15.6560  SQ IN
LREF  3.0930  INCHES
BREF  6.0990  INCHES
XREF  1.5610  INCHES
YREF  0.3200  INCHES
ZREF  1.5320  INCHES
SCALE  0.0021  SCALE

DATA HIST. CODE  M4E

MSFC497 NR REUSABLE NUCLEAR STAGE RNS  (C39138)  28 AUG 71  PAGE 161
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

REFERENCE INFORMATION

SREF 15.6500  SQ IN
LREF 3.0950  INCHES
BREF 6.0960  INCHES
XREF 1.2610  INCHES
YREF 0.0000  INCHES
ZREF -1.5320  INCHES
SCALE 0.0031  SCALE

DATA HIST. CODE  MSE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C39138) 28 AUG 71  PAGE 163
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

SYMBOL  Mach  PARAMETRIC VALUES
Q  0.604  ALPHA  6.600  GRIT  54.000

REFERENCE INFORMATION
SREF  15.6560  SQ IN
LREF  3.0950  INCHES
BREF  6.0990  INCHES
JNRF  1.5010  INCHES
ZRF  0.0006  INCHES
SCALE  0.0031  SCALE

DATA MIST. CODE  NOE

MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C3913B) 28 AUG 71 PAGE 164
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

PARAMETRIC VALUES

SYMBOL MACH ALPHA CRIT

REFERENCE INFORMATION

DATA HIST. CODE

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C3913) 28 AUG 71 PAGE 165
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

PARAMETRIC VALUES

SYMBOL   MACH   ALPHA   -   6.000   GRR   54.000

REFERENCE INFORMATION

DXREF   15.6560   50   IN
LREF   3.0950   INCHES
BREF   6.0990   INCHES
YREF   1.5610   INCHES
ZREF   0.0000   INCHES
SCALE   0.0031   SCALE

DATA HIST. CODE NR

MSFC497 NR REUSABLE NUCLEAR STAGE RNS
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, Beta, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

SYMBOL MACH PARAMETRIC VALUES
Q 1.196 Alpha = 6.000 Griz 54.000

REFERENCE INFORMATION
BBEF 3.0560 80 IN
BREF 3.0050 INCHES
HRBP 1.2610 INCHES
THRP 0.0000
SCALE 0.0031 SCALE

DATA MIST. CODE MOE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C3913B) 28 AUG 71 PAGE 167
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, \( \beta \), DEGREES

SYMBOL MACH PARAMETRIC VALUES
Q 0.604 \( \alpha \) = 6.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XREF 1.5610 INCHES
YREF 0.0000 INCHES
ZREF - 1.3320 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE 94E
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C39138) 28 AL3 71 PAGE 168
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAMETRIC VALUES
Q 0.954 ALPHA = 6.000 GRIT = 64.000

REFERENCE INFORMATION
SREF 15.6560 IN
LREF 3.0950 IN
BREF 6.0990 IN
XREF 1.5610 IN
YREF 0.0000 IN
ZREF 3.3200 IN
SCALE 0.0031 SCALE

DATA HIST. CODE M&E
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C3913B) 28 AUG 71 PAGE 169
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAMETRIC VALUES
O 1.196 ALPHA - 6.000 GRIJT 54.000

REFERENCE INFORMATION
SREF 15.6560 50 IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 1.5610 INCHES
YMRP 0.0000 INCHES
ZMRP -1 3320 INCHES
SCALE 0.0051 SCALE

DATA HIST. CODE #06
MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C3913B) 28 AUG 71 PAGE 171
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDESLIP ANGLE, DEGREES

SYMBOL MACH PARAMETRIC VALUES
Q 0.604 ALPHA 0.000 CRIT 0.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0990 INCHES
BREF 6.0990 INCHES
XMRP 1.5610 INCHES
ZMRP 1.3220 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE NSE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C39138) 28 AUG 71 PAGE 172
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SYMBOL MACH
O 0.934 ALPHA - 6.000 Grid -54.000

PARAMETRIC VALUES

REFERENCE INFORMATION
SREF 15.6560 50 IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XREF 1.5610 INCHES
ZMPP 0.0000 INCHES
SCALE 0.0051 SCALE

DATA HIST. CODE NR
MSFC497 NR REUSABLE NUCLEAR STAGE RNS
(C3913B) 28 AUG 71 PAGE 173
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

REFERENCE INFORMATION
SREF 15.6580 50 IN
LREF 5.0950 INCHES
XREF 1.5610 INCHES
YREF - 0.0000 INCHES
ZMRF 1.3320 INCHES
SCALE 0.0031 SCALE

PARAMETRIC VALUES
Q 1.0000
ALPHA 6.0000
GROSS 54.000

DATA HIST. CODE 099
MSFC497 NR REUSABLE NUCLEAR STAGE RNS
(C39138) 28 AUG 71  PAGE 174
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAMETRIC VALUES
Q 1.196 ALPHA 6.000 GRI 54.000

REFERENCE INFORMATION
SREF 15.6560 IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XREF 1.5610 INCHES
YREF 0.0000
ZREF 1.5320 INCHES
SCALE 0.0031 SCALE

DATA MIST. CODE MRE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C39138) 28 AUG 71 PAGE 175
EFFECT OF REYNOLDS NUMBER, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C390TA) NSFC+97 NR/CC RNS LAUNCH B19W14C4AV7 * RNS
(A3912A) NSFC+97 NR/CC RNS LAUNCH B19W14C4AV7 * RNS

BETA GRIT RN/L
0.000 54.000 6.500
0.000 54.000 12.400

REFERENCE INFORMATION
GREF 15.6560 SQ IN
LREF 3.0910 INCHES

SCALE 0.0031 SCALE

MACH 1.184

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### EFFECT OF REYNOLDS NUMBER, BOOSTER PLUS RNS

#### DATA SET SYMBOL CONFIGURATION DESCRIPTION

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<td>(A3812A)</td>
<td>A</td>
<td>MSFC497 NR/GD RNS LAUNCH B15W14C4AV7 + RNS</td>
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#### REFERENCE INFORMATION

- DREF: 15.6550 IN
- LREF: 3.0950 INCHES
- XREF: 0.0000 INCHES
- YREF: 0.0000 INCHES

#### SCALE

- 0.0031 SCALE

### ANGLE OF ATTACK, ALPHA, DEGREES

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### PITCHING MOMENT COEFFICIENT, CLM

- MACH 1.194

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