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

NASA
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

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

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RELEASE APPROVAL: D. Kem
Aero Thermo Data Group

CONTRACT NAS 8-4016
AMENDMENT 154
DRL 184 - 58

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ABSTRACT

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 reusable 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° to 4° at zero degrees sideslip, and over an angle of sideslip range from -10° to 10° 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 x 10^6 per foot except for Mach 1.2 and 3.0 where the Reynolds numbers were 12.4 x 10^6 and 4.4 x 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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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 reusable 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° to 4° at zero degrees sideslip, and over an angle of sideslip range from -10° to 10° 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 x 10^6 per foot except for Mach 1.2 and 3.0 where the Reynolds numbers were 12.4 x 10^6 and 4.4 x 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 $40^\circ$ twist, and a $3^\circ$ 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 COLLABRATION SHEET**

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

- **PRETEST**
- **POSTTEST**

<table>
<thead>
<tr>
<th>DATA SET IDENTIFIER</th>
<th>CONFIGURATION</th>
<th>SCHEDULE</th>
<th>CONTROL DEFLECTION</th>
<th>NO. OF RUNS</th>
<th>MACH NUMBERS</th>
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<td>819W14C4A7</td>
<td>A 0</td>
<td>0 0 0</td>
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<td>1 1 1</td>
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<tr>
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<td>0</td>
<td>0.6 0.95 1.0 1.2 2.99 4.96</td>
</tr>
</tbody>
</table>

**COEFFICIENTS:**
- \( a = -16, -14, -12, -10, -8, -6, -4, -2, 0, 2, 4 \)
- \( b = -10, -9, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10 \)

**SCHEDULES:**
- IDPVAR(1), IDPVAR(2), NDV
### Test TWT-497 Data Set Collation Sheet

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

<table>
<thead>
<tr>
<th>DATA SET IDENTIFIER</th>
<th>CONFIGURATION</th>
<th>STAT.</th>
<th>CONTROL DEFLECTION</th>
<th>NO. Runs</th>
<th>MACH NUMBERS</th>
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<tr>
<td>R39 08A</td>
<td>BMH4+CAV7+RNS</td>
<td>-6 B</td>
<td>10 -10 0 ON</td>
<td>1</td>
<td>0.6 0.8 1.0 1.2 2.99 4.96</td>
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<tr>
<td>09B</td>
<td></td>
<td>-6 B</td>
<td>-20</td>
<td>1</td>
<td>0.6 0.8 1.0 1.2 2.99 4.96</td>
</tr>
<tr>
<td>12A</td>
<td>Rn MAX</td>
<td>0 0</td>
<td>-</td>
<td>1</td>
<td>0.6 0.8 1.0 1.2 2.99 4.96</td>
</tr>
<tr>
<td>13A RNS ALONE</td>
<td>A 0</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>53/6 52/6 51/6 50/6</td>
</tr>
<tr>
<td>13B</td>
<td>A 0</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>54/6 53/6 52/6 51/6</td>
</tr>
</tbody>
</table>

**Coefficients:**

- $a = -15, -14, -13, -12, -11, -8, -6, -4, -2, 0, 2, 4$
- $b = -10, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10$

**Schedules:**

The table above lists the data set collation sheet for the test TWT-497, detailing the configuration, statistical data, and control deflections along with the number of runs and mach numbers. The configurations include BMH4+CAV7+RNS, RNS ALONE, and RNS with various identifiers. The coefficients and schedules are provided for analysis and further study.
TEST FACILITY DESCRIPTION

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 \(-40^\circ F\) 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 \(180^\circ F\). 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°.
TEST CONDITIONS

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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<tr>
<td>0.6</td>
<td>$6.5 \times 10^6$</td>
<td>5.58</td>
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<td>1.2</td>
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<td>8.98</td>
<td>97</td>
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<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>
<td>$4.4 \times 10^6$</td>
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<tr>
<td>4.96</td>
<td>$6.1 \times 10^6$</td>
<td>3.40</td>
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BALANCE UTILIZED: TWT Model 200 and 201, Moment Balances

CAPACITY:

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<tr>
<td>SF</td>
<td>150 lbs</td>
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<td>AF</td>
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<td>PM</td>
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<td>YM</td>
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<td>RM</td>
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ACCURACY:

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COEFFICIENT TOLERANCE:

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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:

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

where

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

and

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

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<tr>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
<th>BOOSTER ALONE AND BROSTER + RNS</th>
<th>RNS ALONE</th>
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<td>Sref</td>
<td>Ref. Area</td>
<td>15.656 in²</td>
<td>15.656 in²</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>Xc.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>Yc.g.*</td>
<td>Center of Gravity</td>
<td>0.0 in</td>
<td>0.0</td>
</tr>
<tr>
<td>Zc.g.*</td>
<td>Center of Gravity (Water Line)</td>
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<td>Body Length</td>
<td>9.734 in. (B Nose to Wing T.E.)</td>
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<td>Balance Cavity Area</td>
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* See Figures 10 & 11
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<th>COEFFICIENT NAME</th>
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<td>CAF</td>
<td>Forebody Axial Force</td>
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<td>CD</td>
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<tr>
<td>CDB</td>
<td>Base Drag Force</td>
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<tr>
<td>CDF</td>
<td>Forebody Drag Force</td>
<td>-</td>
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<tr>
<td>CL</td>
<td>Lift Force</td>
<td>-</td>
</tr>
<tr>
<td>CN</td>
<td>Normal Force</td>
<td>CN</td>
</tr>
<tr>
<td>CY</td>
<td>Side Force</td>
<td>CY</td>
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<tr>
<td>CL</td>
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<td>Pitching Moment</td>
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<td>L/DF</td>
<td>Lift-To-Forebody Drag Force Ratio</td>
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<td>Normal-To-Axial Force Ratio</td>
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<td>Normal-To-Forebody Axial Force Ratio</td>
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<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>
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<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>
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<td>Elevon Effectiveness In Yaw, Booster Plus RNS</td>
<td>E</td>
<td>Elevator, Aileron</td>
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<tr>
<td>Effect of RNS On Elevon Effectiveness, Yaw</td>
<td>D</td>
<td>Configuration, Grit</td>
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<tr>
<td>Effect of RNS On Elevon Effectiveness, Yaw</td>
<td>E</td>
<td>Configuration, Elevator, and Aileron</td>
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<tr>
<td>Rudder and Elevon Effectiveness In Pitch, Booster Alone (Beta = 0)</td>
<td>C</td>
<td>Rudder, Aileron</td>
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### SUMMARY DATA PLOT INDEX (CONTINUED)

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PLOTTED COEFFICIENTS SCHEDULE</th>
<th>CONDITIONS VARYING</th>
<th>PAGES</th>
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<tr>
<td>Rudder and Elevon Effectiveness In Pitch, Booster Plus RNS (Beta = 0)</td>
<td>C</td>
<td>Rudder, Aileron</td>
<td>102-107</td>
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<tr>
<td>Effect of RNS On Rudder and Elevon Effectiveness (Beta = 0)</td>
<td>C</td>
<td>Configuration, Rudder, and Aileron</td>
<td>108-119</td>
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<tr>
<td>Rudder and Elevon Effectiveness In Yaw, Booster Alone</td>
<td>D, E</td>
<td>Rudder, Aileron</td>
<td>120-126</td>
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<tr>
<td>Rudder and Elevon Effectiveness In Yaw, Booster Plus RNS</td>
<td>E</td>
<td>Rudder, Aileron</td>
<td>127-133</td>
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<tr>
<td>Effect of RNS On Rudder and Elevon Effectiveness</td>
<td>E</td>
<td>Configuration, Rudder and Aileron</td>
<td>134-147</td>
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<tr>
<td>Effect of Angle of Attack, RNS Alone</td>
<td>A</td>
<td>Mach, Alpha</td>
<td>148-159</td>
</tr>
<tr>
<td>Effect of Angle of Sideslip, RNS Alone</td>
<td>F</td>
<td>Mach, Beta</td>
<td>160-175</td>
</tr>
<tr>
<td>Effect of Reynolds Number, Booster Plus RNS</td>
<td>A</td>
<td>Reynolds Number</td>
<td>176-178</td>
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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 \\

FIGURES
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.
Figure 3. Photograph of Reuseable Nuclear Stage Installed in MSFC 14 x 14 Inch Tunnel
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. CANARD - C4
Figure 9. VERTICAL TAIL - $V_7$
Figure 10. Reuseable 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
<table>
<thead>
<tr>
<th>MODEL COMPONENT: BODY - RNS</th>
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<tbody>
<tr>
<td>GENERAL DESCRIPTION: <strong>Reuseable Nuclear Stage</strong> is a cone-cylinder body with a nose radius of 35.5 inches.</td>
</tr>
<tr>
<td>Model Scale: 0.0031</td>
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<td>DRAWING NUMBER: 2244-202</td>
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<th>MODEL SCALE</th>
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<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>
<tr>
<td>TABLE V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><strong>MODEL COMPONENT:</strong></td>
<td><strong>BODY - B-19</strong></td>
<td></td>
</tr>
<tr>
<td><strong>GENERAL DESCRIPTION:</strong></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>DRAWING NUMBER:</strong></td>
<td>WT-70-105222</td>
<td></td>
</tr>
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<td><strong>DIMENSIONS:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FULL-SCALE</strong></td>
<td><strong>MODEL SCALE</strong></td>
<td></td>
</tr>
<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>
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<tr>
<td>Max. Depth</td>
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<td>Fineness Ratio</td>
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<td>6.13</td>
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<tr>
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<td></td>
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<td>Max. Cross-Sectional Planform</td>
<td>183837</td>
<td>2.252</td>
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<tr>
<td>Wetted</td>
<td>1010612</td>
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<tr>
<td>Base</td>
<td>150028</td>
<td>1.840</td>
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</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:

<table>
<thead>
<tr>
<th>TOTAL DATA</th>
<th>FULL-SCALE</th>
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<td>Area</td>
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<td></td>
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<td>Planform</td>
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<td>Wetted</td>
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<td></td>
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<tr>
<td>Span (equivalent)</td>
<td>1739</td>
<td>6.099</td>
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<tr>
<td>Aspect Ratio</td>
<td>2.436</td>
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<td>Rate of Taper</td>
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<td>Taper Ratio</td>
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<td>0.1102</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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<td>Incidence Angle, degrees</td>
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<td>2</td>
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<tr>
<td>Aerodynamic Twist, degrees</td>
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<td>Toe-In Angle</td>
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<td>Cant Angle</td>
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<td></td>
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<td>Sweep Back Angles, degrees</td>
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<td></td>
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<td>Leading Edge</td>
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<td>53</td>
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<td>Trailing Edge</td>
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<td>0</td>
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<td>0.25 Element Line</td>
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<td>44.85</td>
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<td></td>
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<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>
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<tr>
<td>B.L. of .25 MAC</td>
<td>136.9</td>
<td>1.126</td>
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<tr>
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<tr>
<td>Root</td>
<td>NACA - 0010 - 64 (Mod)</td>
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<tr>
<td>Tip</td>
<td>NACA - 0010 - 64 (Mod)</td>
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<tr>
<td>Root</td>
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<tr>
<td>MAC</td>
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<tr>
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<td>438.6</td>
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* Fuselage stations are relative to an origin 3.500 inches ahead of the nose of B₁₉.
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<th>MODEL COMPONENT: CANARD - C4A</th>
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<td>GENERAL DESCRIPTION: Basic canard for the B-15B Delta Wing Configuration</td>
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### Table VII

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<td>66286</td>
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<tr>
<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>
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<td></td>
</tr>
<tr>
<td>Sweep Back Angles, degrees</td>
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</tr>
<tr>
<td>Leading Edge</td>
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<tr>
<td>Hingeline</td>
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<td>0</td>
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<tr>
<td>Area Moment (Normal to hinge line)</td>
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<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

### DIMENSIONS:

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<td>177306</td>
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<tr>
<td>Inb'd equivalent chord</td>
<td>504</td>
<td>1.723</td>
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<td>Outb'd equivalent chord</td>
<td>252</td>
<td>0.826</td>
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<td>Ratio movable surface chord/total surface chord</td>
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<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>
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<td></td>
</tr>
<tr>
<td>Leading Edge</td>
<td>35</td>
<td>36.40</td>
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<td>Tailing Edge</td>
<td>10</td>
<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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35
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
</tr>
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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; $1/2PV^2$, psi, psf</td>
</tr>
<tr>
<td></td>
<td>Q(PSF)</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>
</tr>
<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>Definition</th>
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<tr>
<td>$S$</td>
<td>wing area; m$^2$, ft$^2$</td>
</tr>
<tr>
<td>$S_{	ext{SREF}}$</td>
<td>reference area; m$^2$, ft$^2$</td>
</tr>
<tr>
<td>$c$</td>
<td>wing mean aerodynamic chord or reference chord; m, ft, in (see $l_{	ext{ref}}$ or LREF)</td>
</tr>
<tr>
<td>$l_{	ext{ref}}$</td>
<td>reference length; m, ft, in.; (see $c$)</td>
</tr>
<tr>
<td>$b_{	ext{ref}}$</td>
<td>wing span or reference span; m, ft, in</td>
</tr>
<tr>
<td>$A_b$</td>
<td>base area; m$^2$, ft$^2$, in$^2$</td>
</tr>
<tr>
<td>c. g.</td>
<td>center of gravity</td>
</tr>
<tr>
<td>MRP</td>
<td>abbreviation for moment reference point</td>
</tr>
<tr>
<td>$X_{	ext{MRP}}$</td>
<td>abbreviation for moment reference point on X-axis</td>
</tr>
<tr>
<td>$Y_{	ext{MRP}}$</td>
<td>abbreviation for moment reference point on Y-axis</td>
</tr>
<tr>
<td>$Z_{	ext{MRP}}$</td>
<td>abbreviation for moment reference point on Z-axis</td>
</tr>
</tbody>
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**NOMENCLATURE** (Continued)

Axis System General

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<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>
<tbody>
<tr>
<td>( N )</td>
<td>normal force</td>
</tr>
<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>( \text{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>
<tr>
<td>( b )</td>
<td>base</td>
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### NOMENCLATURE (Continued)

**Body Axis System**

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<tr>
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<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_N )</td>
<td>CN</td>
<td>normal force coefficient; ( F_N / q_S )</td>
</tr>
<tr>
<td>( C_A )</td>
<td>CA</td>
<td>axial force coefficient; ( F_A / q_S )</td>
</tr>
<tr>
<td>( C_{Ab} )</td>
<td>CAB</td>
<td>base axial force coefficient; [ \frac{-1}{(P_b - P_\omega)/q} \left( A_b / S \right) ]</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 / q_S l_{ref} )</td>
</tr>
<tr>
<td>( C_y )</td>
<td>CY</td>
<td>side force coefficient; ( F_Y / q_S )</td>
</tr>
<tr>
<td>( C_{n} )</td>
<td>CYN</td>
<td>yawing moment coefficient; ( M_Z / q_S b_{ref} )</td>
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<tr>
<td>( C_\ell )</td>
<td>CRL</td>
<td>rolling moment coefficient, ( M_X / q_S b_{ref} )</td>
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</table>
Surface Definitions

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \delta )</td>
<td>HORIZT</td>
<td>horizontal tail incidence; positive when trailing edge down; degrees</td>
</tr>
<tr>
<td>( \delta )</td>
<td></td>
<td>symmetrical surface deflection angle; degrees; positive deflections are:</td>
</tr>
<tr>
<td>AILRON</td>
<td></td>
<td>aileron - total aileron deflection; ((\text{left aileron} - \text{right aileron})/2)</td>
</tr>
<tr>
<td>CANARD</td>
<td></td>
<td>canard - trailing edge down</td>
</tr>
<tr>
<td>ELEVON</td>
<td></td>
<td>elevon - trailing edge down</td>
</tr>
<tr>
<td>ELEVTR</td>
<td></td>
<td>elevator - trailing edge down</td>
</tr>
<tr>
<td>FLAP</td>
<td></td>
<td>flap - trailing edge down</td>
</tr>
<tr>
<td>RUDDER</td>
<td></td>
<td>rudder - trailing edge to the left</td>
</tr>
<tr>
<td>SPOILR</td>
<td></td>
<td>spoiler - trailing edge down</td>
</tr>
<tr>
<td>TAB</td>
<td></td>
<td>tab - trailing edge down with respect to control surface</td>
</tr>
<tr>
<td>( \delta )</td>
<td></td>
<td>antisymmetrical surface deflection angle, degrees; positive trailing edge down:</td>
</tr>
<tr>
<td>AIL-L</td>
<td></td>
<td>left aileron - trailing edge down</td>
</tr>
<tr>
<td>AIL-R</td>
<td></td>
<td>right aileron - trailing edge down</td>
</tr>
<tr>
<td>ELVN-L</td>
<td></td>
<td>left elevon - trailing edge down</td>
</tr>
<tr>
<td>ELVN-R</td>
<td></td>
<td>right elevon - trailing edge down</td>
</tr>
<tr>
<td>SPLR-L</td>
<td></td>
<td>left spoiler - trailing edge down</td>
</tr>
<tr>
<td>SPLR-R</td>
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<td>right spoiler - trailing edge down</td>
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**SURFACE SUBSCRIPTS**

<table>
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<th>DEFINITION</th>
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<tr>
<td>e</td>
<td>aileron</td>
</tr>
<tr>
<td>b</td>
<td>base</td>
</tr>
<tr>
<td>c</td>
<td>canard</td>
</tr>
<tr>
<td>e</td>
<td>elevator or elevon</td>
</tr>
<tr>
<td>f</td>
<td>flap</td>
</tr>
<tr>
<td>r</td>
<td>rudder or ruddervator</td>
</tr>
<tr>
<td>s</td>
<td>spoiler</td>
</tr>
<tr>
<td>t</td>
<td>tail</td>
</tr>
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</table>

40
### ADDITIONS TO NOMENCLATURE

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>SADSAC SYMBOL</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>XCPY/L</td>
<td>XCPY/L</td>
<td>center of pressure location based on body length</td>
</tr>
<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>
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 BETA GRIT
(A3901A) MSFC497 GD DELTA WING BOOSTER B13W14C4AY7 0.000 0.000
(A3902A) MSFC497 GD DELTA WING BOOSTER B15W14C4AY7 0.000 0.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 4.0990 INCHES
YREF 0.0000
ZMRF 0.0000
SCALE 0.0031 SCALE

MACH 0.397

PAGE 1
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) MSFC497 6D DELTA WING BOOSTER B19W1C4AV7
(A3902A) MSFC497 6D DELTA WING BOOSTER B19W1C4AV7

MACH 0.952

REFERENCE INFORMATION
SREF 15.6250 80 IN
LREF 3.0950 INCHES
BREF 6.0950 INCHES
XRFP 0.0000
YRFP 0.0000
ZHRP 0.0000
SCALE 0.0001 SCALE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

BETA 0.000 0.000 64.000
GRIT 0.000 0.000 84.000
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  GRIT
(A390A)  MSFC49T GC DELTA WING BOOSTER B19W14C4AV7  0.000  54.000
(B390A)  MSFC49T GC DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF  15.6560  SQ IN
SREF  3.0950  INCHES
SREF  6.0990  INCHES
XMRF  0.0000
YMRF  0.0000
ZMRF  0.0000
SCALE  0.0031  SCALE

MACH  1.605

PAGE 3
EFFECT OF GRIT IN PITCH. BOOSTER ALONE

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  GRIT
(A39G01A)  MSFC497 GD DELTA WING BOOSTER 0.000 0.000
(A39G02A)  MSFC497 GD DELTA WING BOOSTER 0.000 0.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 0.0000 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0051

MACH 1.193

PAGE 4
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3B01A) ☐ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3B02A) ☐ MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

BETA      GRIT
0.000      0.000
0.000      54.000

REFERENCE INFORMATION
MREF 15.6350
LREF 3.0950
BREF 6.0990
YRFP 0.0000
ZHRF 0.0000
SCALE 0.001

MACH 2.990

PAGE 5
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(A5801A)  MSFC497 GD DELTA WING BOOSTER B19W14C4AVT
(A5802A)  MSFC497 GD DELTA WING BOOSTER B19W14C4AVT

BETA  GRIT
0.000  0.000  54.000

REFERENCE INFORMATION
BREF  15.6560  SQ IN
LREF  3.0950  INCHES
XREF  6.0990  INCHES
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 CONFIGURATION DESCRIPTION
(A3901A) MSFC97 6C DELTA WING BOOSTER B19W14C4AV7
(A3902A) MSFC97 6D DELTA WING BOOSTER B19W14C4AV7

MACH 0.597

REFERENCE INFORMATION
XREF 15.4550 SQ IN
XREF 3.0030 INCHES
XREF 6.0000 INCHES
XREF 0.0000
SCALE 0.0001 SCALE

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EFFECT OF GRIT IN PITCH, BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A30901A) MSFC497 60 DELTA WING BOOSTER B19W44C4AV7
(A30902A) MSFC497 60 DELTA WING BOOSTER B19W44C4AV7

MACH 1.005

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

PAGE 9
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 GD DELTA WING BOOSTER B19W14C4A5
(A3902A) W MSFC497 GD DELTA WING BOOSTER B19W14C4A5

BETA GRIT
0.000
0.000 54.000

REFERENCE INFORMATION
BREF 15.0560 SQ IN
LREF 3.0050 INCHES
BREF 6.0090 INCHES
ZHRP 0.0000
ZHRF 0.0000
SCALE 0.0031 SCALE

MACH 1.193

PAGE 10
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39G1A) GMSF1497 GG DELTA WING BOOSTER B19W14C4AV7
(A39G2A) GMSF1497 GG DELTA WING BOOSTER B19W14C4AV7

REFERENCE INFORMATION
SREF 15.096G 50 IN
LREFF 3.0950 INCHES
BREF 0.0990 INCHES
XMRF 0.0000
ZMRF 0.0000
SCALE 0.0031 SCALE

MACH 2.99G

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EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL: CONFIGURATION DESCRIPTION
(A3901A) Q MSFC497 GE DELTA WING BOOSTER B19M14C4AV7
(A3902A) Q MSFC497 GE DELTA WING BOOSTER B19M14C4AV7

BETA  GRIT
0.000  0.000

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

MACH  4.959
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  GRIT
(A3503A)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  0.000  4.000
(A3502A)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  0.000  4.000

MACH  0.952

REFERENCE INFORMATION
SREF  15.6560  IN
LREF  3.0010  INCHES
BREF  0.6890  INCHES
XREF  0.0000
YREF  0.0000
ZREF  0.0000
SCALE  0.0031  SCALE
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL
(A39014) Q MSFC497 6D DELTA WING BOOSTER B19W14C4A7
(A39024) MSFC497 6D DELTA WING BOOSTER B19W14C4A7

BETA GRIT
0.000 0.000

REFERENCE INFORMATION
SRef 15.6560 SQ IN
LREF 1.0990 INCHES
XRef 6.0990 INCHES
ZRef 0.0000
SCALE 0.0031 SCALE

MACH 0.597
EFFECT OF GRIT IN PITCH, BOOSTER ALONE

ANALYSIS OF ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901A) G MSCF497 66 DELTA WING BOOSTER B19W14C4AV7
(A3902A) G MSCF497 66 DELTA WING BOOSTER B19W14C4AV7

MACH 1.193

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 SCALE

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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) 1 MSFC497 GD DELTA WING BOOSTER B18M14C4AV7
(A3902A) 1 MSFC497 GD DELTA WING BOOSTER B18M14C4AV7

BETA GRIT
0.000 0.000 54.000

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

MACH 2.990

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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

BETA GRIT
0.000 0.000 54.000

REFERENCE INFORMATION
SREF 15.0550 SQ IN
LREF 6.0990 INCHES
XREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 4.959
EFFECT OF GRIT IN YAW, BOOSTER ALONE

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  GRIT
(A39018)  M5FC497 60 DELTA WING BOOSTER B15W1444AY7  -6.000  -6.000  $4.000
(A39028)  M5FC497 60 DELTA WING BOOSTER B15W1444AY7

REFERENCE INFORMATION
SREF  15.6560  SQ IN
LREF  3.0950  INCHES
BREF  6.0990  INCHES
XMRP  0.0000
ZMRP  0.0000
SCALE  0.0031  SCALE

MACH  0.600
EFFECT OF GRIT IN YAW, BOOSTER ALONE

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<th>CONFIGURATION DESCRIPTION</th>
<th>ALPHA</th>
<th>GRIT</th>
</tr>
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<tbody>
<tr>
<td>(A59018)</td>
<td>MSFC497 GD DELTA WING BOOSTER B19W44C4AV7</td>
<td>-6.000</td>
<td>54.000</td>
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<td>(A59028)</td>
<td>MSFC497 GD DELTA WING BOOSTER B19W44C4AV7</td>
<td>-6.000</td>
<td>54.000</td>
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REFERENCE INFORMATION

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<td>0.0001</td>
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MACH 0.951
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL
(A39018) Q MSFC497 6D DELTA WING BOOSTER B19W4C4AVT
(A39028) MSFC497 6D DELTA WING BOOSTER B19W4C4AVT

ALPHA GRIT
-6.000 -6.000 54.000

REFERENCE INFORMATION
QREF 15.6560 SQ IN
LREF 3.0950 INCHES
XREF 6.0990 INCHES
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0021 SCALE

MACH 1.002
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(A39019J)  MSFC497 CC DELTA WING BOOSTER B19W14C4AV7
(A3902B)  MSFC497 CC DELTA WING BOOSTER B19W14C4AV7

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  SCALE

PAGE  22

MACH  1.193
EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETI, DEGREES

LATERAL FORCE COEFFICIENT, C\textsubscript{Y}

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39011B) O MSFC497 DD DELTA WING BOOSTER B19M14C4AV7
(A3902B) X MSFC497 DD DELTA WING BOOSTER B19M14C4AV7

REFERENCE INFORMATION
SREF 15.6162 IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 0.0000
YMRP 0.0000
ZMRP 0.0000
SCALE 0.0031

MACH 2.590

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EFFECT OF GRIT IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL   CONFIGURATION DESCRIPTION               ALPHA            GRIT
(A3901B)          MSFC497 6C DELTA WING BOOSTER B19M14C4AV7  -1.000            S
(A3902B)          MSFC497 6C DELTA WING BOOSTER B19M14C4AV7  -1.000            S

REFERENCE INFORMATION
SRER 15.6360 SQ IN
LREF 3.0950 INCHES
BREF 6.0399 INCHES
XMRP 0.0000
XMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 4.959
EFFECT OF GRIT IN YAW, BOOSTER ALONE

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901B) \( \Delta \) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3902B) \( \Delta \) MSFC497 GD DELTA WING BOOSTER B15W14C4AV7

ALPHA GRIT
-6.000 -6.000
-6.000 54.000

REFERENCE INFORMATION
SREF 15.6560 50 IN
LREF 3.0990 INCHES
BREF 6.0990 INCHES
XMRF 0.0000
YMRF 0.0000
ZMRF 0.0000
SCALE 0.0031 SCALE

MACH 0.600

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EFFECT OF GRIT IN YAW, BOOSTER ALONE

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

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39018) R MSFC497 DD DELTA WING BOOSTER B19W14C4AV7
(A39028) R MSFC497 DD DELTA WING BOOSTER B19W14C4AV7

ALPHA GRIT
-6.000 -6.000 54.000

REFERENCE INFORMATION
BREF 15.0950 SQ IN
LREF 3.0950 INCHES
XREF 6.0990 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 0.951

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EFFECT OF Grit IN Yaw, BOOSTER ALONE

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

YAWING MOMENT COEFFICIENT, \( c_m \) (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3962B) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
\( \alpha \) \( -6.00 \) \( G \)
\( -6.00 \) \( 54.00 \)

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

MACH 1.502

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EFFECT OF GRIT IN YAW, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3901B) MSFC497 GD DELTA WING BOOSTER B1914C4AV7
(A3902B) MSFC497 GD DELTA WING BOOSTER B1914C4AV7

MACH 2.095

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

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN [BODY AXIS]
EFFECT OF GRIT IN YAW, BOOSTER ALONE

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

MACH  4.959

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SCALE  0.0031 SCALE
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

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FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

REFERENCE INFORMATION

MACH 1.197
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

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

MACH 1.197

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM
ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE

ANGE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA   ELEVAT  AILRON GIRT REFERENCE INFORMATION

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SCALE  0.0031  SCALE

MACH  1.197

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ANGLE OF ATTACK, ALPHA, DEGREES
ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

DATA SET SYMBOL
(B3908A) M9FC497 NR/GD RNS LAUNCH B19W14C4AVF + RNS
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REFERENCE INFORMATION
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MACH 1.194
ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

YAWING MOMENT COEFFICIENT, CYL (BODY AXIS)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION BETA ELEVAT AILERON GRIT REFERENCE INFORMATION
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(A3909A) × MS4697 NR/GO RNS LAUNCH B19W14C4AV7 + RNS 0.000 0.000 10.000 54.000 BREF 3.0950 INCHES

MACH 1.194

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ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B3907A) ○ MSC497 NR/GO RNS LAUNCH B19M14C4AV7 + RNS
(A3908A) ○ MSC497 NR/GO RNS LAUNCH B19M14C4AV7 + RNS

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MACH 1.194

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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(B3907A) NSFC497 NR/GR NGS LAUNCH B19W1C4AV7 + RNS

MACH 1.397

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

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL: B3902A
CONFIGURATION DESCRIPTION: MSFC497 GD DELTA WING BOOSTER B19W14C4AY7

CONFIGURATION DESCRIPTION: MSFC497 NR/GD RNS LAUNCH B19W14C4AY7 + RNS

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  - LREF: 0.0500 INCHES
  - XREF: 0.0000 INCHES
  - ZREF: 0.0000 INCHES
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MACH: 1.197
EFFECT OF RNS ON ELEVON EFFECTIVENESS. PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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REFERENCE INFORMATION
RERF 15.6560 IN
XREF 3.0995 INCHES
YREF 4.0000 INCHES
ZREF 0.0000 INCHES
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
(839G2x) G MSP/497 GG DELTA WING BOOSTER B19W14C4AV7
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MACH 1.197

REFERENCE INFORMATION

SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3905A) □ MSFC497 CC DELTA WING BOOSTER B19W14CA8V7
(A3908A) □ MSFC497 NR/GO RNS LAUNCH B19W14CA8V7 + RNS

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
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SCALE 0.0031 SCALE

MACH 1.109

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

DATA DET SYMBOL CONFIGURATION DESCRIPTION
(A3905A) (A3903A) MSFC497 CC DELTA WING BOOSTER B19W14C4AV7 + RNS

MACH 1.189

REFERENCE INFORMATION
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LREF 3.0950 INCHES
XHREF 0.0000
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SCALE 0.0031 SCALE
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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(A39GGA) WSC407 NR/GD RNS LAUNCH B19WI4C4AV7 + RNS

MACH 1.189

REFERENCE INFORMATION
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BREF 0.0990 INCHES
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SCALE 0.0031
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  ELEVON  AILRON  GRIT  REFERENCE INFORMATION
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MACH  1.169

SCALE  0.0031
### EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

#### Chart Details:
- **Title:** Effect of RNS on Elevon Effectiveness, Pitch
- **Axes:**
  - Y-axis: Rolling Moment Coefficient, Cm (Body Axis)
  - X-axis: Angle of Attack, Alpha, Degrees

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- **Configuration Description:** NSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

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- Ailron
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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(13886A) Q MSFC497 GE DELTA WING BOOSTER B19W464A
(13999A) MSFC497 NAV RNS LAUNCH B19W464A + RNS

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

MACH 1.190
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3909A) Q MSFC497 GC DELTA WING Booster B19W14C4AV7
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MACH 1.19G
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  BETA  ELEVON AILRON  GRIT  REFERENCE INFORMATION
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(A3909A)  MSFC497 NR/GD RNS LAUNCH B19W444AV7 + RNS  0.000  -5.000  15.000  54.000  LREF  3.090  INCHES

MACH  1.196

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39G6A) MSFC497 CC DELTA WING BOOSTER B19W14C4AV7
(A39G9A) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES
EFFECT OF RNS ON ELEVON EFFECTIVENESS, PITCH

ANGLE OF ATTACK, ALPHA, DEGREES

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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MACH 1.190
ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, $\beta$, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(D3901B)  MSFC497 GD DELTA WING BOOSTER B19MI4C4AV7
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REFERENCE INFORMATION
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ZMRF  0.0000
SCALE  0.0031  SCALE

MACH  1.193

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ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

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

LATERAL FORCE COEFFICIENT, \( c_y \)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, Beta, DEGREES

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(C3906B) MSFC497 GC DELTA WING BOOSTER B19W14C4AV7 -6.000 -5.000 15.000 54.000 HREF 6.0990 INCHES

MACH 1.202

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ELEVON EFFECTIVENESS IN YAW: BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(E3902B)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
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ALPHA  ELEVAT  AILRON  GRIT
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MACH  1.262
ELEVON EFFECTIVENESS IN YAW: BOOSTER PLUS RNS

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SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

MACH 1.199

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ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3907B) W MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS
(C39088) A MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS
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MACH 1.199

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ELEVON EFFECTIVENESS IN YAW. BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
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MACH 1.199

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ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

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MACH 1.399

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ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELEVAT AILRON  GRIT  REFERENCE INFORMATION
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(Y39G9B)  MSC497 NR/GO RNS LAUNCH B19W14C4AV7* RNS  -6.000 0.000 10.000 54.000  LREF 3.0950  INCHES
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MACH 1.199

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LREF 3.0950  INCHES
BREF 6.0390  INCHES
SREF  -6.000
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BREF  0.0000
SCALE 0.0031

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ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
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ALPHA  ELEVAT  AILRON  GRIT  REFERENCE INFORMATION
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-YHAP  6.0000
-ZHAP  0.0000
-Scale  0.0031  Scale

MACH  1.199

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) \( \Omega \) MSFC497 6G DELTA WING BOOSTER B19W14C4AVF + RNS
(D3907B) \( \Omega \) MSFC497 NR/GD RNS LAUNCH B19W14C4AVF + RNS

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3982B) ☐ MSFC497 GC DELTA WING - BOOSTER B19H4C4AV?
(E3982B) ☑ MSFC497 NR/GO RNS LAUNCH B19H4C4AV? + RNS

ALPHA ELEVON AILRON GRIT REFERENCE INFORMATION
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-6.000 0.000 0.000 54.000 LREF 3.0990 INCHES
1.200 0.000 0.000 0.000 ZREF 0.0000 INCHES
0.0000 0.000 0.000 0.000 ZMRP 0.0000 SCALE 0.0001 SCALE

MACH 1.202

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E39020) MSFC417 G0 DELTA WING BOOSTER B19WJ4C4AV7
(M390179) MSFC417 MR/GD RNS LAUNCH B19WJ4C4AV7 + RNS

ALPHA ELEVON AILRON GRIT REFERENCE INFORMATION
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-6.000 0.000 0.000 54.000 55.000 SQ IN

MACH 1.202
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

NORMAL FORCE COEFFICIENT, CN

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E39666) MSCP497 GE DELTA WING BOOSTER B19W14C4AV7
(M39578) MSCP497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELEVON AILRON GRIT
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REFERENCE INFORMATION
SREF 12.6550 39 INCHES
LREF 3.0950 INCHES
XREF 0.0000 INCHES
YREF 0.0000 INCHES
ZREF 0.0000 SCALE
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, CAF

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(E3992B) Δ MSFC497 GO DELTA WING BOOSTER B19WI4C4AV7
(C3997B) MSFC497 NR/GD RNS LAUNCH B19WI4C4AV7 + RNS

MACH 1.202

REFERENCE INFORMATION
SREF 15.6560 SQ IN
BREF 3.0950 INCHES
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SCALE 0.0031
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

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

PITCHING MOMENT COEFFICIENT, \( CL \)

ELEVATR AILRAN

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

ALPHA ELEVATR AILRAN
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-0.000 0.000 0.000 0.000

REFERENCE INFORMATION
XREF 15.6560 50 IN
YREF 3.0500 INCHES
ZREF 0.0000 INCHES
SCALE 0.0031 SCALE

MACH 1.202
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C3905B)  MSFC497 GC DELTA WING BOOSTER B1SW14C4AV7
(C3908B)  MSFC497 NR/GO RNS LAUNCH B1SW14C4AV7 + RNS

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MACH 1.195

PAGE 82
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

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

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION

(C39G6B) MSFC497 6G DELTA WING BOOSTER B19W46C4AV7
(C39G6B) MSFC497 NR/46 RNS LAUNCH B19W46C4AV7 + RNS

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REFERENCE INFORMATION

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SCALE 0.0031 SCALE

MACH 1.195

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL CONFIGURATION DESCRIPTION
C3905B MSFC497 GD DELTA WING BOOSTER B15W14C4AV7
C3906B MSFC497 RR/GD RNS LAUNCH B15W14C4AV7 + RNS

ALPHA ELVATR AILRON GRIT REFERENCE INFORMATION
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-6.000 0.000 10.000 34.000 LREF 3.0950 INCHES
XREF 5.0900 INCHES
XMRP 0.0000
ZMRP 0.0000
SCALE 0.0031 SCALE

MACH 1.195

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, DEGREES

REFERENCE INFORMATION
- LREF 3.0950 INCHES
- BREF 6.0990 INCHES
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EFFECTIVE REFS. 15.6560

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PITCHING MOMENT COEFFICIENT, CLM

Aircraft symbols and configuration descriptions are provided for additional detail.
EFFECT OF RNS ON ELEVON EFFECTIVENESS: YAW

SIDE SLIP ANGLE, BETA, DEGREES

LATERTAL FORCE COEFFICIENT, CY

DATA SET SYMBOL
(C390EB) MFC497 GD DELTA WING BOOSTER B19W14C4AY7
(C39DOB) MFC497 NR/GD RNS LAUNCH B19W14C4AY7 + RNS

REFERENCE INFORMATION
- ALPHA
- ELVATR
- AILRON
- GRIT
- SREF
- BREF
- XREF
- ZMRP
- SCALE
- MACH 1.195

REFERENCE INFORMATION
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89
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

---

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3908) Q MSFC497 6C DELTA WING ROOSTER B1614C4AVT
(C3908B) Q MSFC497 NR/IC RNS LAUNCH B1614C4AVT + RNS

ALPHA ELEVATAILRON GRIT REFERENCE INFORMATION
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XREF 6.0000 INCHES
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.193

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL | CONFIGURATION DESCRIPTION | ALPHA | ELEVATE AILRON | GRT | REFERENCE INFORMATION
(C3906B) Q | HSFC497 DELTA WING BOOSTER B19W14C4AV7 | 6.00 | 5.00 | 15.00 | 54.00 | SRE 15.0560 SQ IN
(C3909B) A | HSFC497 RNS LAUNCH B19W14C4AV7 + RNS | 6.00 | 5.00 | 15.00 | 54.00 | SREF 6.0990 INCHES

MACH 1.193
EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39G6B) MSFC497 6G DELTA WING BOOSTER B19W14C4AV7
(C39G9B) MSFC497 MR/6G RNS LAUNCH B19W14C4AV7 + RNS

REFERENCE INFORMATION
SREF 15.0000 50 IN
LREF 3.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0001 SCALE

MACH 1.193

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EFFECT OF RNS ON ELEVON EFFECTIVENESS, YAW

SIDE SLIP ANGLE, BETA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3096B)  G MSFC497 CD DELTA WING BOOOSTER B18W24C4AV7
(C3096B)  G MSFC497 NR/GO RNS LAUNCH B18W24C4AV7 + RNS

MACH 1.193

REFERENCE INFORMATION
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SCALE 0.0000 SCALE
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE (BETA=0)

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(03902A) MSFC497 CD DELTA WING BOOSTER B19W14C4AV7
(13902A) MSFC497 CD DELTA WING BOOSTER B19W14C4AV7
(13904A) MSFC497 CD DELTA WING BOOSTER B19W14C4AV7

ANGLE OF ATTACK, ALPHA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

MACH 1.197

REFERENCE INFORMATION
SREF 15.6560 SQ IN
XREF 6.0990 INCHES
YREF 6.0990 INCHES
ZREF 6.0990 INCHES
SCALE 0.0031 SCALE
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE (BETA=0)

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
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(A3902A)  O  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3904A)  O  MSFC497 6D DELTA WING BOOSTER B19W14C4AV7

ANGLE OF ATTACK, ALPHA, DEGREES

LATERAL FORCE COEFFICIENT, CY

REFERENCE INFORMATION
SREF 35.6360  50 IN
BREF 3.0990  INCHES
XMRP 0.0000
ZMRP 0.0000
SCALE 0.0031  SCALE

PAGE  99
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER ALONE (BETA=0)

ANGLE OF ATTACK, ALPHA, DEGREES

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
A390DA) MSFC497 6D DELTA WING BOOSTER B19M14C4AV7
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ELVATR AIREON RUDDER GRIT REFERENCE INFORMATION
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0.000 10.000 10.000 54.000 BREF 4.0999 INCHES
XREF 0.000
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SCALE 0.0001 SCALE

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

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ELEVAT  AILRON  RUDDER  GRIT  REFERENCE INFORMATION
(B39S07A)  MSFC497 NR/0D RNS LAUNCH B19W14C4AV7 + RNS  0.000  0.000  0.000  54.000  SREF  15.6960  50 IN
(A39D11A)  MSFC497 NR/0D RNS LAUNCH B19W14C4AV7 + RNS  0.000  0.000  10.000  54.000  LREF  6.0000  INCHES
(A39D16A)  MSFC497 NR/0D RNS LAUNCH B19W14C4AV7 + RNS  0.000  10.000  10.000  54.000  BREF  6.0000  INCHES
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SCALE  0.0001  SCALE

MACH 1.184

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B3907A) ○ MSFC497 NR/60 RNS LAUNCH BI9M14C4AV7 + RNS
(A3910A) ● MSFC497 NR/60 RNS LAUNCH BI9M14C4AV7 + RNS
(A3910A) ○ MSFC497 NR/60 RNS LAUNCH BI9M14C4AV7 + RNS

ELEVATOR ALTIMETER RUDDER GRIT
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REFERENCE INFORMATION
REF 15.6560 SQ IN
BREF 3.0950 INCHES
XREF 6.0990 INCHES
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SCALE 0.0031 SCALE

MACH 1.194

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION ELEVAT AILRON RUDDER GRIT REFERENCE INFORMATION
(390AF) ○ NSFC497 NR/CG RNS LAUNCH 819W14C4AV7 + RNS 0.000 0.000 0.000 54.000 SREF 15.6560 SQ IN
(391AD) ○ NSFC497 NR/CG RNS LAUNCH 819W14C4AV7 + RNS 0.000 0.000 10.000 54.000 LREF 3.0950 INCHES
MACH 1.194
SCALE 0.0031 SCALE
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS (BETA=0)

ANGLE OF ATTACK, ALPHA, DEGREES

LATERN FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3910A) MSFC497 NR/HD RNS LAUNCH B19W14C4AV7 + RNS 0.000 0.000 0.000 54.000 SREF 15.6560 SQ IN
(A3911A) MSFC497 NR/HD RNS LAUNCH B19W14C4AV7 + RNS 0.000 0.000 10.000 54.000 LREF 3.0950 INCHES
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SCALE 0.0031 SCALE

MACH 1.196

REFERENCE INFORMATION

SCALE 0.0021 SCALE

PAGE 105
RUDDER AND ELEVON EFFECTIVENESS IN PITCH, BOOSTER PLUS RNS (BETA=0)

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MACH 1.194

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

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION

(B3907A) □ MFC697 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

(A3911A) △ MFC697 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

(A3910A) ◇ MFC697 NR/GD RNS LAUNCH B19M14C4AV7 + RNS

MACH 1.154
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

NORMAL FORCE COEFFICIENT, CN

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3913A) MSFC497 NR/CD RNS LAUNCH B19W14C4AV7 + RNS

ELEV AILRON RUDDER GRIT REFERENCE INFORMATION
0.000 0.000 10.000 54.000 LREF 15.6560 SQ IN
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MACH 1.187

REFERENCE INFORMATION
SREF 15.6560 INCHES
LREF 3.0950 INCHES
ZREF 0.0000 INCHES
XREF 0.0000 INCHES
SCALE 0.0000 SCALE

PAGE 10B
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

FOREBODY AXIAL FORCE COEFFICIENT, CAF

ANGLE OF ATTACK, ALPHA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A)  Q  MSFC497 GD DELTA WING BOOOSTER B166I4C4A6V7
(A3911A)  H  MOFC497 NR/CC RNS LAUNCH B166I4C4A6V7 + RNS

MACH 1.107

REFERENCE INFORMATION
GRIF 54,000
LREF 54,000
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XREF 0.0000
YREF 0.0000
SCALE 0.0001 SCALE
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

ANGLE OF ATTACK, ALPHAL, DEGREES

PITCHING MOMENT COEFFICIENT, CL.M

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A) MSFC497 GD DELTA WING BOOGER B19W14C4AV7
(A3911A) MSFC497 NR/GD RNS LAUNCH B19W14C4AV+ RNS

ELEVATOR AILERON RUDDER GUT
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0.000 0.000 10.000 54.000

REFERENCE INFORMATION
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LREF 3.0950 INCHES
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SCALE 0.0031 SCALE

MACH 1.107

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

ANGLE OF ATTACK, ALPHA, DEGREES

LATERNAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION ELEVATORS AILRONS RUDDER GRIT REFERENCE INFORMATION
(A3903A) MSFC497 GD DELTA WING BOOSTER B19W14C4AV7
(A3911A) MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.187

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A) MSFC497 GC DELTA WING BOOSTER B19W14C44V7
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ELEV AILRON RUDDER GRIT REFERENCE INFORMATION
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BREF 6.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3903A) MSFC497 GD DELTA WING BOOSTER B16244C4X7
(A3911A) MSFC497 MR/GD RNS LAUNCH B16244C4X7 + RNS

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

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ELEVATOR  AILRONS  RUDDER  G刃T  REFERENCE INFORMATION
(MSFC49036)  MSFC49036 DELTA MING BOOSTER B19W46C4AV  0.000  10.000  10.000  54.000  SREF  11.656  0 IN
(A3380A)  MSFC49036 N/A/60 MK 4 RNS LAUNCH B19W46C4AV  0.000  10.000  10.000  54.000  LREF  3.0950 INCHES

MACH 1.187

REFERENCE INFORMATION
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YREF 0.0000
ZREF 0.0000
SCALE 0.0031

REFERENCE INFORMATION
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031

ANGLE OF ATTACK, ALPHA, DEGREES
NORMAL FORCE COEFFICIENT, CN

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

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A3904A) Q MSFC497 G0 DELTA WING BOOSTER B19W14C4AV7
(A3910A) MSFC507 NR/CD RNS LAUNCH B19W14C4AV7 + RNS

ELVATR AILRON RUDDER GRIT
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REFERENCE INFORMATION
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BREF 6.0990 INCHES
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YRF 0.0000
ZMR 0.0000
SCALE 0.0031 SCALE

MACH 1.107

PAGE 115
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS (BETA=0)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(A39GDA) D M6FC447 GG DELTA WING BOOSTER BISW44C4AV7
(A39GDA) D M6FC447 NR/GO RNS LAUNCH BISW44C4AV7 + RNS

ELVATR AILRON RUDDER GRIT
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REFERENCE INFORMATION
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LREF 3.0590 INCHES
XHREF 6.0950 INCHES
YHREF 0.0000
ZMREF 0.0000
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
(A3910A)         MSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS
(A3994A)         MSFC497 GD DELTA WING BOOSTER B19W14C4AV7

ANGEL OF ATTACK, ALPHA, DEGREES

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                  ELVATR  AILRON  RUDDER  GRIT
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ZMPF  0.0000
SCALE  0.0051  SCALE

MACH  1.107

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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
(A39OA) Q MSFC497 6G DELTA WING BOOSTER B19W14G7AV7
(A390DA) MSFC497 NR/GD RNS LAUNCH B19W14G7AV7 + RNS

MACH 1.187

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PAGE 119
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39349) M5C497 GD DELTA WING BOOSTER B1SW14C4AY7 ALPHAL ELEVATRAILRON RUDDER REFERENCE INFORMATION
(A39349) M5C497 GD DELTA WING BOOSTER B1SW14C4AY7 MACH 1.193

ROLLING MOMENT COEFFICIENT, CMB (BODY AXIS)

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

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

DATA SET SYMBOL | CONFIGURATION DESCRIPTION | \( \alpha \) | ELVAT | AILRON | RUDDER | REFERENCE INFORMATION |
--- | --- | --- | --- | --- | --- |
(E3902B) | MSFC497 CC DELTA MING BOOSTER B19W14C4AV7 | -6.000 | 0.000 | 0.000 | 10.000 | REF 15.6560 SQ IN |
(C3903B) | MSFC497 CC DELTA MING BOOSTER B19W14C4AV7 | -6.000 | 0.000 | 0.000 | 10.000 | \( X_{REF} \) 3.0980 INCHES |
(C3904B) | MSFC497 CC DELTA MING BOOSTER B19W14C4AV7 | -6.000 | 0.000 | 0.000 | 10.000 | \( X_{MRP} \) 0.0000 |
MACH 1.202

SCALE 0.0031 | 0.0031 |
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E39028) O MSFC497 GD DELTA WING BOOSTER B19W44C4A4V7
(C3903B) O MSFC497 GD DELTA WING BOOSTER B19W44C4A4V7
(C3904B) O MSFC497 GD DELTA WING BOOSTER B19W44C4A4V7

ALPHA ELEV AILRON RUDDER REFERENCE INFORMATION
-6.000 0.000 0.000 0.000 LREF 15.6360 SQ IN
-6.000 0.000 0.000 0.000 LREF 3.0950 INCHES
-6.000 0.000 0.000 0.000 LREF 6.0990 INCHES
XMRP 0.000
YMRP 0.000
ZMRP 0.000
SCALE 0.0031 SCALE

MACH 1.202

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(E3902B) ○ MBFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C3903B) □ MBFC497 GD DELTA WING BOOSTER B19W14C4AV7
(C39040) □ MBFC497 GD DELTA WING BOOSTER B19W14C4AV7

ALPHA ELVATR AILRON RUGGER REFERENCE INFORMATION
-6.000 0.000 0.000 0.000 SREF 15.6560 SQ IN
-6.000 0.000 0.000 0.000 LREF 3.0950 INCHES
-6.000 0.000 10.000 10.000 XREF 6.0990 INCHES
XMRP 0.0000 YMRF 0.0000 ZMRF 0.0000 SCALE 0.0031 SCALE

MACH 1.202
Rudder and Elevon Effectiveness in Yaw, Booster Alone

Side Slip Angle, beta, Degrees

Data Set Symbol Configuration Description
(E39028) ○ MSFC497 6C Delta Wing Booster B19W14C4AV7 α, Elevator, Aileron, Rudder
(E39038) ○ MSFC497 6C Delta Wing Booster B19W14C4AV7
(E39048) ○ MSFC497 6C Delta Wing Booster B19W14C4AV7

Reference Information
SRF 15.656G g/s
LRF 3.0950 inches
XMPF 0.0000
YMPF 0.0000
ZMPF 0.0000
Scale 0.0031

Mach 1.202

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER ALONE

SIDE SLIP ANGLE, BETA, DEGREES

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39007) MSFC497 GD DELTA WING BOOSTER B1SW14C4AV7
(C39038) MSFC497 GD DELTA WING BOOSTER B1SW14C4AV7
(C39040) MSFC497 GD DELTA WING BOOSTER B1SW14C4AV7

MACI 1.002

REFERENCE INFORMATION

MACH 1.002

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

LATERNAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3907B) MSFC497 NR/DC RNS LAUNCH BIDWI4C4AV7 + RNS
(C3911B) MSFC497 NR/DC RNS LAUNCH BIDWI4C4AV7 + RNS
(C3913C) MSFC497 NR/DC RNS LAUNCH BIDWI4C4AV7 + RNS

ALPHA ELEVAT. AILRON RUDDER REFERENCE INFORMATION
-6.000 0.000 0.000 0.000 SREF 15.6560 SA IN
-6.000 0.000 0.000 10.000 LREF 3.0050 INCHES
-6.000 0.000 10.000 10.000 LRFF 6.0890 INCHES
-6.000 0.000 0.000 0.000 LRFF 0.0000 INCHES
0.000 0.000 0.000 0.000 SCALE 0.0031 SCALE

MACH 1.198

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

YAWING MOMENT COEFFICIENT, CYN [BODY AXIS]

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3910B) ☽ MSFC497 NR/CD RNS LAUNCH B19W14C4A67 + RNS
(C39110B) ☽ MSFC497 NR/CD RNS LAUNCH B19W14C4A67 + RNS

ALPHA ELEVATR AILERON RUDDER REFERENCE INFORMATION
-6.000 0.000 0.000 0.000 GREF 15.6250 50 IN
-6.000 0.000 0.000 10.000 GREF 3.0950 INCHES
-6.000 0.000 10.000 10.000 GREF 0.0990 INCHES
XREF 0.0000
YREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.199
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELEVAT  AILRON  RUDDER  REFERENCE INFORMATION
(D39078)  M3FC497 NR/GC RNS LAUNCH B15B4C4AV7 + RNS  -6.000  0.000  0.000  0.000  SREF  15.656 SQ IN
(C39110)  M3FC497 NR/GC RNS LAUNCH B15B4C4AV7 + RNS  -6.000  0.000  0.000  0.000  SREF  3.000 INCHES
(C39110)  M3FC497 NR/GC RNS LAUNCH B15B4C4AV7 + RNS  -6.000  0.000  10.000  10.000  SREF  6.0990 INCHES

MACH 1.199
RUDDER AND ELEVON EFFECTIVENESS IN YAW: BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETAS, DEGREES

NORMAL FORCE COEFFICIENT, CN

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(G3907B) MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS
(G3911B) MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS
(G3910B) MSFC497 NR/GC RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELVATR AILRON RUDDER REFERENCE INFORMATION
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-6.000 0.000 0.000 0.000 LREF 3.0990 INCHES
-6.000 0.000 10.000 10.000 LREF 3.0990 INCHES
0.000 0.000
0.000
0.000
0.0031

SCALE

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RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, BETA, DEGREES

FOREBODY AXIAL FORCE COEFFICIENT, CAF

DATA SET SYMBOL CONFIGURATION DESCRIPTION ALPHA ELEVATORAILRORN RUDDER REFERENCE INFORMATION
(C397GB) ○ MSFC497 NR/GD RNS Launch B19M14C4AV7 + RNS -6.000 0.000 0.000 0.000 SREF 13.0000 SQ IN
(C3918B) ○ MSFC497 NR/GD RNS Launch B19M14C4AV7 + RNS -6.000 0.000 0.000 10.000 LREF 3.0000 INCHES
(C397GB) ○ MSFC497 NR/GD RNS Launch B19M14C4AV7 + RNS -6.000 0.000 10.000 10.000 LREF 6.0990 INCHES
MACH 1.199
RUDDER AND ELEVON EFFECTIVENESS IN YAW, BOOSTER PLUS RNS

SIDE SLIP ANGLE, Beta, Degrees

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(D39076)  NSFC497 NR/GC RNS LAUNCH B12W14C4AV7 + RNS
(C39118)  NSFC497 NR/GC RNS LAUNCH B12W14C4AV7 + RNS
(C3910B)  NSFC497 NR/GC RNS LAUNCH B12W14C4AV7 + RNS

ALPHA  ELEVAT  AILROM  RUDDER  REFERENCE INFORMATION
-6.000  0.000  0.000  5.000  SREF  15.6560 SQ IN
-5.000  0.000  0.000  10.000  LREF  3.0950 INCHES
-6.000  0.000  10.000  10.000  XREF  6.0990 INCHES
0.000   0.000
0.000   0.000
0.000   0.000
0.0031 SCALE

MACH 1.199

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3905B) RSFC407 GD DELTA WING BOOSTER B19W14C4AV7
(C3915B) RSFC407 NR/CD RNS LAUNCH B19W14C4AV7 + RNS

MACH 1.192

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

SREF 6.0990 INCHES
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C3903B)  M5FC497 60 DEFLA WING BOOSTER B19W14C4AV7  ALPHA  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
(C3911B)  M5FC497 60 RNS LAUNCH B19W14C4AV7 + RNS  -6.000  0.000  0.000  10.000  SREF  3.0950 INCHES
          SREF  3.0950 INCHES
          XREF  6.0990 INCHES
          YRHF  0.0000
          ZNRF  0.0000
          SCALE  0.0031 SCALE

MACH  1.192

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

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

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

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
(C393)  MSFC497 GD DELTA WING BOOSTER B19W14C4AV7  -6.000  0.000  0.000  10.000  SREF  15.8560  SQ IN
(C391)  MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS  -6.000  0.000  0.000  10.000  LREF  3.0950  INCHES

REFERENCE  INFORMA TION  
SREF  15.8560  SQ IN
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) O MSFC447 GD DELTA WING BOOSTER B19W14CAA47
(C3911B) ▲ MSFC447 NR/GD RNS LAUNCH B19W14CAA47 + RNS

MACH 1.192
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, $\beta$, DEGREES

NORMAL FORCE COEFFICIENT, $c_n$

DATA SET SYMBOL  CONFIGURATION DESCRIPTION  ALPHA  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
(C3903B)  MSFC497 GD DELTA WING BOOSTER B19W44AV7  -6.000  0.000  0.000  10.000  SREF  15.6560  SQ IN
(C3911B)  MSFC497 NASA RAD RNS LAUNCH B19W44AV7 + RNS  -6.000  0.000  0.000  10.000  BREF  3.0950  INCHES
ALPHAS  ELVATR  AILRON  RUDDER  REFERENCE INFORMATION
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YMRP  0.0000
ZMRP  0.0000
SCALE  0.0031

PAGE  138
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

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

REFERENCE INFORMATION
- SREF: 15.6560 IN
- LREF: 3.9950 INCHES
- XREF: 6.0990 INCHES
- YREF: 0.0000
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- SCALE: 0.0031 SCALE

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3903B) MSFC497 60 DELTA WING BOOSTER B19W14C4AV7
(C3911B) MSFC497 NR/GO RNS LAUNCH B19W14C4AV7 + RNS

ALPHA ELEV AILRON RUDDER REFERENCE INFORMATION
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MACH 1.192

PAGE 139
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12
SIDE SLIP ANGLE, \beta, DEGREES

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YAWING MOMENT COEFFICIENT, \text{cyn} (BODY AXIS)

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3904B) δ MSFC497 GG DELTA WING BOOSTER B19H14C4AV7
(C3910B) δ MSFC497 NR/GO RNS LAUNCH B19H14C4AV7 + RNS

ALPHA ELVATR AILRON RUDDER REFERENCE INFORMATION
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YMRP 0.000
ZMRP 0.000
SCALE 0.0031 SCALE

MACH 1.194

PAGE 142
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C39444) Q  MSF497 GD DELTA WING BOOOSTER B16W14C4AV7
(C39108)  MSF497 NR/SD RNS LAUNCH B16W14C4AV7 + RNS

ALPHA  ELEVATION  AILRORN  RUDDER  REFERENCE INFORMATION
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XREF  6.0990  INCHES
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MACH  1.194

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EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL  CONFIGURATION DESCRIPTION
(C3904B)  MSFC497 CD DELTA WING BOOSTER B15W14CAV7
(C3910E5)  MSFC497 NR/GC RNS LAUNCH B15W14CAV7 + RNS

MACH  1.196

PAGE  145
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C39560B) Q MSFC487 GD DELTA WING BOOSTER B19W14C4AV7
(C39560B) Q MSFC487 NR/SC RNS LAUNCH B19W14C4AV7 + RNS

SIDE SLIP ANGLE, BETA, DEGREES

MACH 1.194

REFERENCE INFORMATION
LREF 15.6500 SQ IN
BREF 3.0950 INCHES
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YMRP 0.0000
SCALE 0.0031 SCALE
EFFECT OF RNS ON RUDDER AND ELEVON EFFECTIVENESS

SIDE SLIP ANGLE, $\beta$, DEGREES

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MACH 1.124
EFFECT OF ANGLE OF ATTACK, RNS ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

NORMAL FORCE COEFFICIENT, CN

SYMBOL HACH PARAMETRIC VALUES
Q 0.601 BETA 0.000 654.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0960 INCHES
XREF 1.5610 INCHES
YREF 0.0000 INCHES
ZMREF -1.3320 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE H

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  PARANETRIC VALUES
O  1.002  BETA  0.000  GRIT  54.000

REFERENCE INFORMATION
SREF  15.6560  SO IN
LREF  3.0950  INCHES
BREF  6.0990  INCHES
XMRF  1.5610  INCHES
YMRF  0.0000
ZMRF  -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     0.000     54.000

REFERENCE INFORMATION
SREF  15.6560  50 IN
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BREF  6.0995  INCHES
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YNRP  0.0000  INCHES
ZNRP  -1.3320  INCHES
SCALE  0.0031  SCALE

DATA MRT. CODE  M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

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

SYMBOCL MACH 0.601 BETA 0.000 GRIFF 54.000

REFERENCE INFORMATION

SREF 15.6250 50 IN
LREF 3.0000 INCHES
XREF 1.5610 INCHES
YREF 0.0000
ZREF 1.3320 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE M

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(A3913A) 28 AUG 71 PAGE 152
EFFECT OF ANGLE OF ATTACK, RNS ALONE

SYMBOL MACH PARAMETRIC VALUES
O 0.954 0.000 54.000

REFERENCE INFORMATION
BREF 15.650 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
YRFP 1.5610 INCHES
ZMRF 1.3320 INCHES
SCALE 0.0031 SCALE

DATA MIST. CODE M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS
EFFECT OF ANGLE OF ATTACK, RNS ALONE

![Graph showing the effect of angle of attack on force coefficient](image)

**Parameter Information**
- Symbol: β
- Mach: 1.002
- Beta: 0.000
- Grit: 54,000
- Scale: 0.0031

**Reference Information**
- SREF: 15.0000 SL IN
- LREF: 4.0500 INCHES
- BREF: 4.0990 INCHES
- ZHREF: 0.0000 INCHES
- SCALE: 0.0031 SCALE

**Data Hist. 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

REFERENCE INFORMATION

SREF 15.0000 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 MIST. CODE M
MSFC497 NR REUSABLE NUCLEAR STAGE RNS (A3913A) 28 AUG 71 PAGE 156
EFFECT OF ANGLE OF ATTACK, RNS ALONE

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

SYMBOL MACH PARAMETRIC VALUES
Q  0.954 BETA 0.000 GIRT 54.000

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

DATA HIST. CODE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

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

ANGLE OF ATTACK, ALPHA, DEGREES

PITCHING MOMENT COEFFICIENT, CLM

SYMBOL MACH  PARAMETRIC VALUES
O  1.002  BETA  0.050  SREF  54.000

REFERENCE INFORMATION
SREF  15.6560  SQ IN
LREF  3.0950  INCHES
XREF  6.0990  INCHES
XREF  1.5610  INCHES
YMRF  0.0000  INCHES
ZMRF  1.3320  INCHES
SCALE  0.0031  SCALE

DATA HIST. CODE  MSFC497  NR REUSABLE NUCLEAR STAGE RNS

(A3913A)  28 AUG 71  PAGE  158
EFFECT OF ANGLE OF ATTACK, RNS ALONE

PITCHING MOMENT COEFFICIENT, CLM

ANGLE OF ATTACK, ALPHA, DEGREES

SYMBOL MACH
Q 1.191 BETA
PARAMETRIC VALUES
0.000 GRT 54.000

REFERENCE INFORMATION
SREF 12.6150 IN
LREF 3.0990 INCHES
NREF 6.0990 INCHES
YMRF 0.0000
ZMRF 1.5300 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, BETAS, DEGREES

LATERAL FORCE COEFFICIENT, CY

PARAMETRIC VALUES

REFERENCE INFORMATION

SYMBOL MACH 0.604 ALPHA 6.000 GRID 54.000

DATA HIST. CODE MSFC497 NR REUSABLE NUCLEAR STAGE RNS

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

SIDE SLIP ANGLE, BETA, DEGREES

LATERAL FORCE COEFFICIENT, CY

SYMBOL MACH PARAMETRIC VALUES
Q 0.954 ALPHA 6.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0930 INCHES
BREF 6.6990 INCHES
XMRF 1.0610 INCHES
YMRF 0.0000 INCHES
SCALE 0.0020 SCALE

DATA HIST. CODE N4E
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

SYMBOL MACH PARAMETRIC VALUES
O 1.196 ALPHA - 6.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0950 INCHES
BREF 6.0990 INCHES
XMRP 1.2610 INCHES
ZMRP 0.6000 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE MSE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C3913B) 28 AUG 71 PAGE 163
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

PARAMETRIC VALUES

ALPHA  6.00

REFERENCE INFORMATION

SREF  15.6560  SQ IN
LREF  3.0950  INCHES
XREF  6.0990  INCHES
YREF  0.0000  INCHES
ZREF  1.3320  INCHES
SCALE  0.0031  SCALE
EFFECT OF ANGLE OF SIDESLIP: RNS ALONE

YAWING MOMENT COEFFICIENT, CYN (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAME TRIC VALUES
O 1.003 ALPHA = 6.000 CURT 54.000

REFERENCE INFORMATION
DREF 15.6560 50 IN
LREF 3.0990 INCHES
BREF 6.0990 INCHES
YMRP 1.5610 INCHES
ZMRP 1.3320 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE MSF

MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C3913B) 28 AUG 71 PAGE 166
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAMETRIC VALUES
O 0.604 ALPHAM - 6.000 GRIT 54.000

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0990 INCHES
BREF 6.0990 INCHES
XMRP 1.5610 INCHES
YMRP 0.0000 INCHES
ZMRP - 1.5610 INCHES
SCALE 0.0031 SCALE

DATA HIST. CODE RNS

MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C3913B) 28 AL3 71 PAGE 168
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

PARAMETRIC VALUES

SYMBOL MACH ALPHA GRIT

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

REFERENCE INFORMATION
SREF 15.6560 10 INCHES
LREF 3.0950 INCHES
XREF 6.0990 INCHES
YREF 1.5610 INCHES
ZREF 0.0000 INCHES
SCALE 0.0031 SCALE

(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
Q 1.003 ALPHA - 6.000 GURT 54.000

REFERENCE INFORMATION
SREF 15.0560 SQ IN
LREF 3.0990 INCHES
BREF 6.0090 INCHES
XMRF 1.5610 INCHES
YHRF 0.0000 INCHES
ZHRF - 1.3320 INCHES
SCALE 0.0031 SCALE

DATA MIST. CODE NOE
MSFC497 NR REUSABLE NUCLEAR STAGE RNS

(C39138) 28 AUG 71 PAGE 170
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

ROLLING MOMENT COEFFICIENT, CBL (BODY AXIS)

SIDE SLIP ANGLE, BETA, DEGREES

SYMBOL MACH PARAMEIRIC VALUES
O 1.196 ALPHA - 6.000 GRIHT 54.000

REFERENCE INFORMATION
SREF 15.6950 50 IN
LREF 3.0990 INCHES
BREF 6.0990 INCHES
XMRP 1.5610 INCHES
YMRP 0.0000 INCHES
ZMRP - 1.3320 INCHES
SCALE 0.0051 SCALE

DATA HIST. CODE N56

MSFC497 NR REUSABLE NUCLEAR STAGE RNS (C3913B) 28 AUG 71 PAGE 171
EFFECT OF ANGLE OF SIDESLIP, RNS ALONE

SIDE SLIP ANGLE, BETA, DEGREES

REFERENCE INFORMATION
SREF IN
LREF INCHES
DREF INCHES
XREF INCHES
YREF INCHES
ZREF INCHES
SCALE

DATA HIST. CODE MR
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  ALFMA  6.000  GRIT  54.000

REFERENCE INFORMATION

REFERENCE INFORMATION

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
(C3907A)  MSFC+97 NR/GO RNS LAUNCH B19W14C4A7 + RNS
(A3912A)  MSFC+97 NR/GO RNS LAUNCH B19W14C4A7 + RNS

MACH 1.194

REFERENCE INFORMATION
SREF 15.6560 SQ IN
LREF 3.0910 INCHES
BREF 6.0990 INCHES
XNRP 0.0000
YNRP 0.0000
ZHRF 0.0000
SCALE 0.0031 SCALE
EFFECT OF REYNOLDS NUMBER, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C3907A) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS
(A3912A) MSFC497 NR/GD RNS LAUNCH B19W14C4AV7 + RNS

REFERENCE INFORMATION
SREF 15.045G 50 IN
LREF 3.0986 INCHES
BREF 6.0996 INCHES
XREF 0.0000
ZREF 0.0000
SCALE 0.0031 SCALE

MACH 1.194

PAGE 177
EFFECT OF REYNOLDS NUMBER, BOOSTER PLUS RNS

DATA SET SYMBOL CONFIGURATION DESCRIPTION
(C390?A) MSFC497 NR/GD RNS LAUNCH B15W14C4AV7 * RNS
(A3912A) MSFC497 NR/GD RNS LAUNCH B15W14C4AV7 * RNS

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

MACH 1.194

PITCHING MOMENT COEFFICIENT, CLM

ANGLE OF ATTACK, ALPHA, DEGREES