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DATA REPORT OF 0.055-SCALE APOLLO DYNAMIC STABILITY (FD-2) MODEL TESTS IN THE LANGLEY UNITARY PLAN WIND TUNNEL LOW MACH LEG TO DETERMINE FLOW SEPARATOR EFFECTS (PROJECT 398)

(U)

NAS9-150

10 APRIL 1963

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FOREWORD

The investigation of flow separator effects on the FD-2 model was conducted under NASA Apollo Contract NAS9-150 24 and 25 September 1962 in the Langley Unitary Plan Wind Tunnel low Mach leg.

This report was prepared by C. E. Mitchell and C. L. Berthold of the Wind Tunnel Projects Group, Los Angeles Division of North American Aviation, Inc.

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ABSTRACT

Dynamic stability data are presented in both tabular and plotted form for the current launch escape configuration with flow separator disc on and off and with the oscillation center on the design center of gravity. Additional data are presented for the command module reentry configuration with four different oscillation centers. All investigations were made at angles of attack near proposed flight attitudes in the Mach number range of 1.60 to 2.75. Tunnel operating conditions, configuration description, computation equations, and tabular data key are also presented.

This report presents basic wind tunnel data only in order to make the test results available at the earliest possible date. Analysis of results will be reported in a separate publication.

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I. INTRODUCTION

Dynamic stability tests were conducted on the 0.055-scale Apollo FD-2 model in the Langley Unitary Plan Wind Tunnel (low Mach leg) 24 and 25 September 1962. This investigation was made to determine dynamic stability parameters for the command module reentry configuration with different oscillation centers and for a more current launch and configuration (116-inch tower and 280-inch rocket) than used during the previous series of tests.

The launch escape configurations, which were tested at Mach numbers 1.80, 2.16, 2.50, and 2.75, included flow separator disc on and off with the oscillation center on the design center of gravity of the full-scale vehicle. Since the command module reentry configuration had not changed, it was tested only at Mach 1.60 and 2.16 with four different oscillation centers. These data make it possible to conduct an investigation of a method for transferring dynamic coefficients to any desired center-of-gravity location. Spacers were used at the attach point of the model and the balance to obtain the oscillation centers.

Reynolds numbers based on maximum model diameter, were 2.45×10^6 to 3.67×10^6. All dynamic stability derivatives were measured during forced oscillation of the model in pitch with an amplitude of approximately ±2 degrees about the oscillation center. The launch escape configurations were run at nominal angles of attack from +2 to -18 degrees, and the command module was run at angles of attack from 140 to 162 degrees.

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II. DISCUSSION

The dynamic stability test was performed primarily to evaluate dynamic stability characteristics of the current launch escape vehicle (LEV) in the low supersonic speed range. In previous tests at these Mach numbers, physical limitations imposed by the size of the model and the dynamic balance made it impossible to locate the oscillation center ideally on the design center of gravity of the full-scale vehicle. On the current LEV model, the commend module apex was modified within the confines of the tower legs to allow positioning of the balance oscillation center on the design center of gravity. Investigations were made with flow separator disc both on and off (configurations $E_{52}T_{21}C_{19}$ and $E_{51}T_{21}C_{19}$).

Several techniques are currently available for measuring dynamic stability derivatives of models in wind tunnels. This test was performed utilizing what has been termed the inexorable method in which the model is mechanically forced to oscillate about a fixed angle of attack in a single degree of freedom at a known angular frequency and amplitude (±2 degrees) while measurements are made of the moment required to sustain the motion. A more complete description of the apparatus and methods used can be found in References 1 and 4.

The tabular and plotted data are presented in Appendixes A and B in NASA standard coefficient form referred to the body system of axes originating at the oscillation center. Dynamic stability parameters are utilized to indicate aerodynamic damping-in-pitch ($C_{m_q} + C_{m_{\dot{\alpha}}}$) and oscillatory longitudinal stability ($C_{m_\alpha} - k^2 C_{m_{\dot{q}}}$) for tests with oscillations in pitch for the reentry and launch escape configurations. The plotted data presents these parameters as a function of angle of attack.

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III. MODEL DESCRIPTION

To reduce moment-of-inertia effects, the test models were constructed of lightweight materials consistent with the structural integrity as established in Reference 5. The command modules were constructed of aluminum alloy (7075-T6), the escape tower of Armco steel (17-4PH SST), and the escape rocket of magnesium (QQ-M-31). All configurations were aerodynamically smooth. Model assembly drawings are presented in Figures 1 and 2.

The apex of the command module for the LEV configurations was modified within the confines of the tower legs to allow the oscillation center of the balance to be positioned on the design center of gravity of the full-scale vehicle. The $E_{52}T_{21}C_{19}$ configuration is shown in Figure 3. Figure 4 shows the model with the flow separator disc on, and Figure 5 shows the model with the flow separator disc off.

The outward shape of the command module reentry configuration had not been changed from previous tests, but 0.50-inch, 1.00-inch, and 1.75-inch spacers were used at the attach point of the model and balance to allow testing at four oscillation centers, all of which were displaced from the design center of gravity because of space limitations (Figure 6).

To allow pitching through angles of attack near proposed flight attitudes, the models were constructed so that the command module axis of symmetry and balance centerline formed an angle of 30 degrees for the reentry configuration and 8 degrees for the LEV.

MODEL NOMENCLATURE

Model nomenclature used during this investigation is presented in the following tabulation.

Symbol	Description	Drawing No.	Figure No.
E_{51}	Escape motor. Length = 279.65 in., 36° 55' flared skirt.	7121-01072-4, -11	7
E_{52}	Escape motor. Length = 279.65 in., 36° 55' flared skirt with 65-in. diameter flow separator disc and fairing from disc to skirt.	7121-01072-4, -6, -11	7
T_{21}	Tower Structure. Length = 116.1 in.	7121-01072-9	8
C	Command module. Maximum diameter = 154.0 in.	7121-01059	9
C_{19}	Command module. Maximum diameter = 154.0 in. Apex altered to position balance correctly.	7121-01072-3, -5, -7	10

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FULL-SCALE DIMENSIONS

The full-scale dimensions of the test components are presented in the following listing.

Escape Rocket, E_{51}

Total length	279.65 in.
Diameter	26.00 in.
Nose radius	2.00 in.
Nose included angle	30.00 deg
Skirt base diameter	54.60 in.
Skirt flare angle	36.92 deg
Diameter of ring forward of skirt	28.87 in.

Escape Rocket, E_{52}

Same as E_{51} with flow separator disc located 19.16 in. from base of rocket motor and a fairing extending from aft end of disc to flared skirt.

Flow separator disc diameter	65.00 in.
Flow separator disc thickness	2.00 in.
Fairing diameter	51.08 in.

Tower, T_{21}

Total length	116.10 in.
Diameter of longitudinal members (4 members)	3.40 in.
Diameter of cross braces	2.49 in.
Diameter of diagonal braces	2.49 in.
Distance between attachment points	50.18 in.

Command Module, C

Maximum diameter	154.00 in.
Radius of spherical blunt end	184.80 in.
Corner radius	7.58 in.
Nose cone semiangle	33.00 deg
Nose cone vertex radius	15.40 in.
Frontal area	129.35 ft^2

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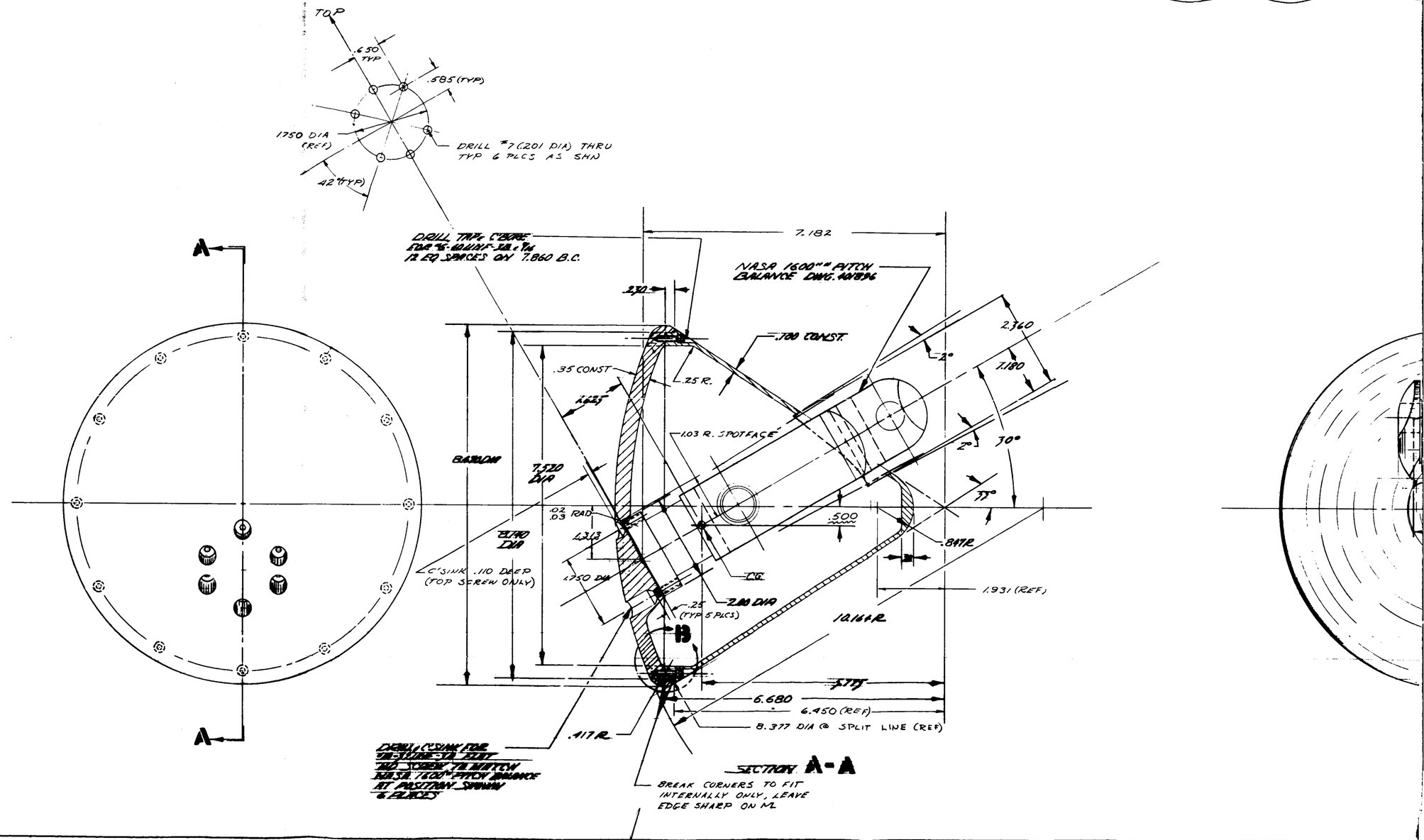
Command Module, C_{19}

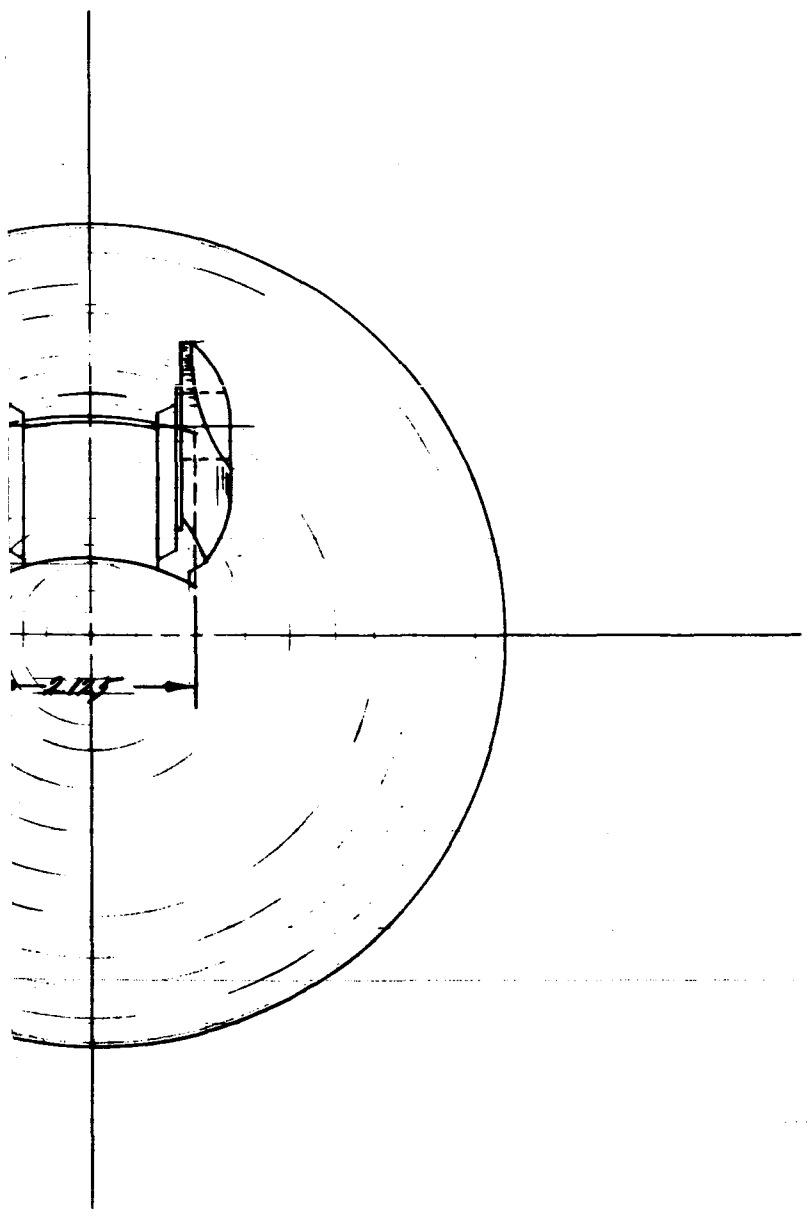
Same as C except apex was modified within the confines of the tower legs to allow the oscillation center of the balance to be positioned on the design center of gravity of the full-scale vehicle.

[redacted]

[redacted]



TOP
.650 TYP
.585 (TYP)
1.750 DIA (REF)
DRILL #7 (.201 DIA) THRU TYP 6 PLCS AS SHN
42° (TYP)
DRILL TAP & C'BORE FOR #6-40 UNF-3B x 9/16 12 EQ SPACES ON 7.860 B.C.
7.182
NASA 1600"# PITCH BALANCE DWG. 401896
.230
.700 CONST.
2.360
2°
7.180
.35 CONST
.25 R.
1.03 R. SPOTFACE
30°
2°
33°
7.520 DIA
.02 .03 RAD
.500
.847R
8.140 DIA
C'SINK .110 DEEP (TOP SCREW ONLY)
1.750 DIA
CG
2.00 DIA
.25 (TYP 5 PLCS)
1.931 (REF)
10.164R
B
6.680
6.450 (REF)
8.377 DIA @ SPLIT LINE (REF)
.417R
A
A
SECTION A-A
BREAK CORNERS TO FIT INTERNALLY ONLY, LEAVE EDGE SHARP ON ML



2. MAT'L 7075-T6 ALUM
1. MODEL FACTOR = .055
NOTES UNLESS OTHERWISE SPECIFIED

REL No	2
DATE	2-13-62
JOB No	242-518

[redacted]

REL #2	REVISED BASE ATTACHMENT & ADDED DIMEN	2-13-62

REQD	REQD	PART NO.	DESC	MATERIAL	SIZE	ZONE	MAT'L SPEC	QTY PER END ITEM	USED ON	NEXT ASSY
				LIST OF MATERIAL					APPLICATION	

DRILLED HOLE TOLERANCES	TOLERANCES EXCEPT AS NOTED			
.040 TO .1285 +.002, -.001	ANGLES ±1/2°	DECIMALS .XX = ±.05 .XXX = ±.010	DATE	
.136 TO .228 +.003, -.001	✓ SURFACE ROUGHNESS PER MIL-STD-10		DR BY	PEYOR
.234 TO 1/2 +.004, -.001			CHK BY	
33/64 TO 3/4 +.005, -.001	HEAT TREAT		APPD BY	
49/64 TO 1 +.007, -.001			APPD BY	
1-1/64 TO 2 +.010, -.001	FINISH			

MODEL ASSY-APOLLO FD-2 RE-ENTRY CONFIG (LANGLEY LLP-WT)

SCALE FULL WT

NORTH AMERICAN AVIATION, INC.

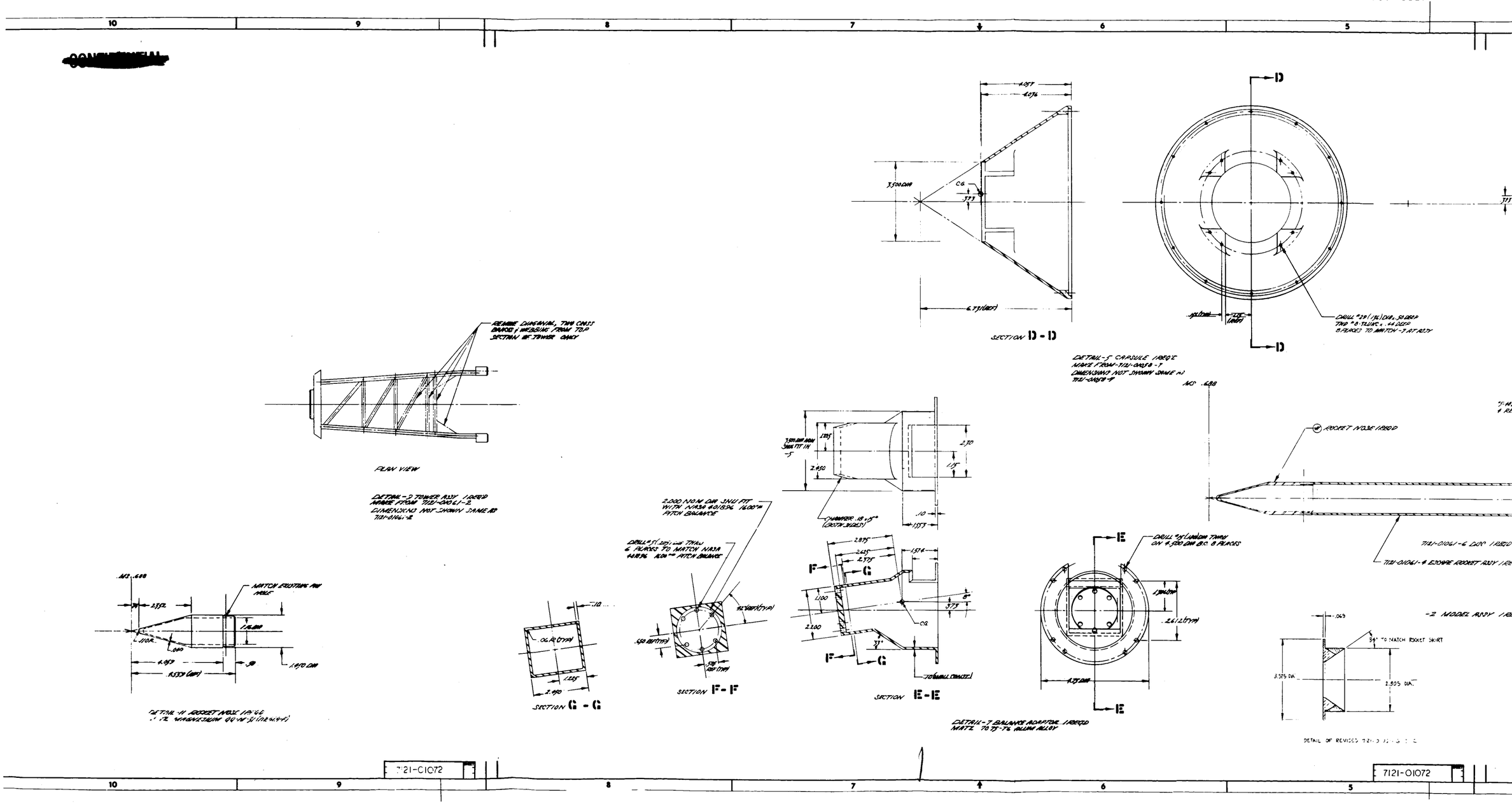
DWG SIZE 7121-01059

Figure 1

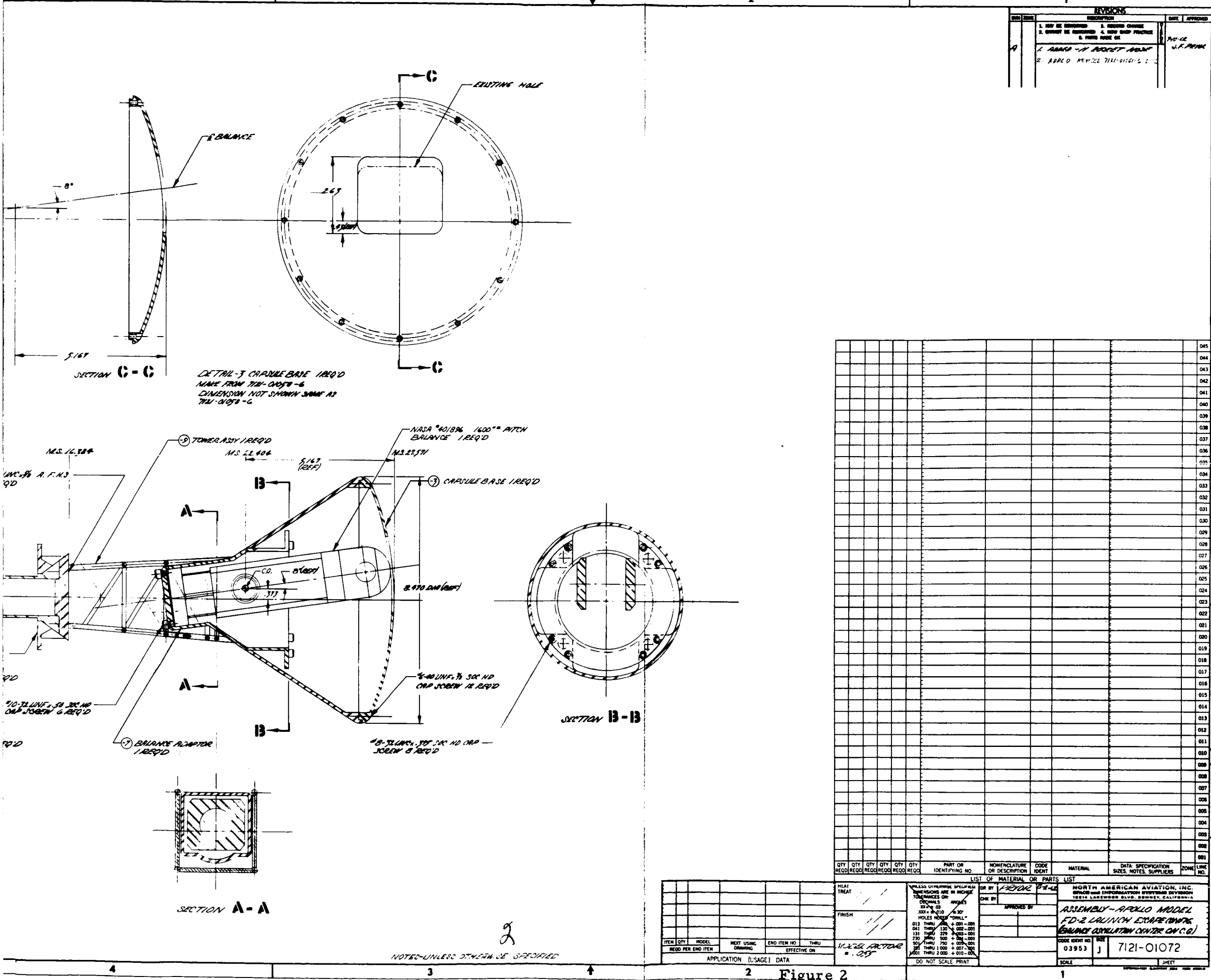
SID 63-96

4

[redacted]



SECTION D - D
DETAIL-5 CAPSULE 1 REQ'D
MAKE FROM 7121-01058-7
DIMENSIONS NOT SHOWN SAME AS 7121-01058-7
PLAN VIEW
DETAIL-9 TOWER ASSY 1 REQ'D
MAKE FROM 7121-01061-2
DIMENSIONS NOT SHOWN SAME AS 7121-01061-2
ROCKET NOSE 1 REQ'D
7121-01061-6 DISC 1 REQ'D
7121-01061-4 ESCAPE ROCKET ASSY 1 REQ'D
MATCH EXISTING PIN HOLE
DETAIL-11 ROCKET NOSE 1 REQ'D
SECTION G - G
SECTION F - F
SECTION E - E
DETAIL-7 BALANCE ADAPTOR 1 REQ'D
MAT'L 70 75-76 ALUM ALLOY
-2 MODEL ASSY 1 REQ'D
34° TO MATCH ROCKET SKIRT
7121-01072



REVISIONS
1. ADDED -11 ROCKET MODE
2. ADDED REVISED 7121-01061-6
EXISTING HOLE
℄ BALANCE
8°
2.63
5.167
SECTION C - C
DETAIL-3 CAPSULE BASE 1 REQ'D
MAKE FROM 7121-01058-6
DIMENSION NOT SHOWN SAME AS 7121-01058-6
NASA #401896 1600# PITCH BALANCE 1 REQ'D
-9 TOWER ASSY 1 REQ'D
M.S. 16.384
M.S. 22.404
M.S. 27.571
5.167 (REF)
-3 CAPSULE BASE 1 REQ'D
C.G.
8 (REF)
.373
8.470 DIA (REF)
#6-40 UNF x 3/8 SOC HD CAP SCREW 12 REQ'D
#10-32 UNF x .50 SOC HD CAP SCREW 6 REQ'D
-7 BALANCE ADAPTOR 1 REQ'D
#8-32 UNC x .375 SOC HD CAP SCREW 8 REQ'D
SECTION B - B
SECTION A - A
NOTES-UNLESS OTHERWISE SPECIFIED
LIST OF MATERIAL OR PARTS LIST
QTY REQD
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
CODE IDENT
MATERIAL
DATA: SPECIFICATION SIZES, NOTES, SUPPLIERS
ZONE
LINE NO.
HEAT TREAT
FINISH
MODEL FACTOR = .055
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .XX ± .03 .XXX ± .010 ANGLES ± 30' HOLES NOTED "DRILL" .013 THRU .040 + .001 - .001 .041 THRU .130 + .002 - .001 .131 THRU .229 + .003 - .001 .230 THRU .500 + .004 - .001 .501 THRU .750 + .005 - .001 .751 THRU 1.000 + .007 - .001 1.001 THRU 2.000 + .010 - .001
DO NOT SCALE PRINT
DR BY PRYOR
CHK BY
APPROVED BY
NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA
ASSEMBLY-APOLLO MODEL FD-2 LAUNCH ESCAPE CONFIG. (BALANCE OSCILLATION CENTER ON C.G.)
CODE IDENT NO. 03953
SIZE J
7121-01072
SCALE
SHEET
ITEM
QTY
MODEL
REQD PER END ITEM
NEXT USING DRAWING
END ITEM NO.
THRU
EFFECTIVE ON
APPLICATION (USAGE) DATA
7121-01072 A

Figure 2

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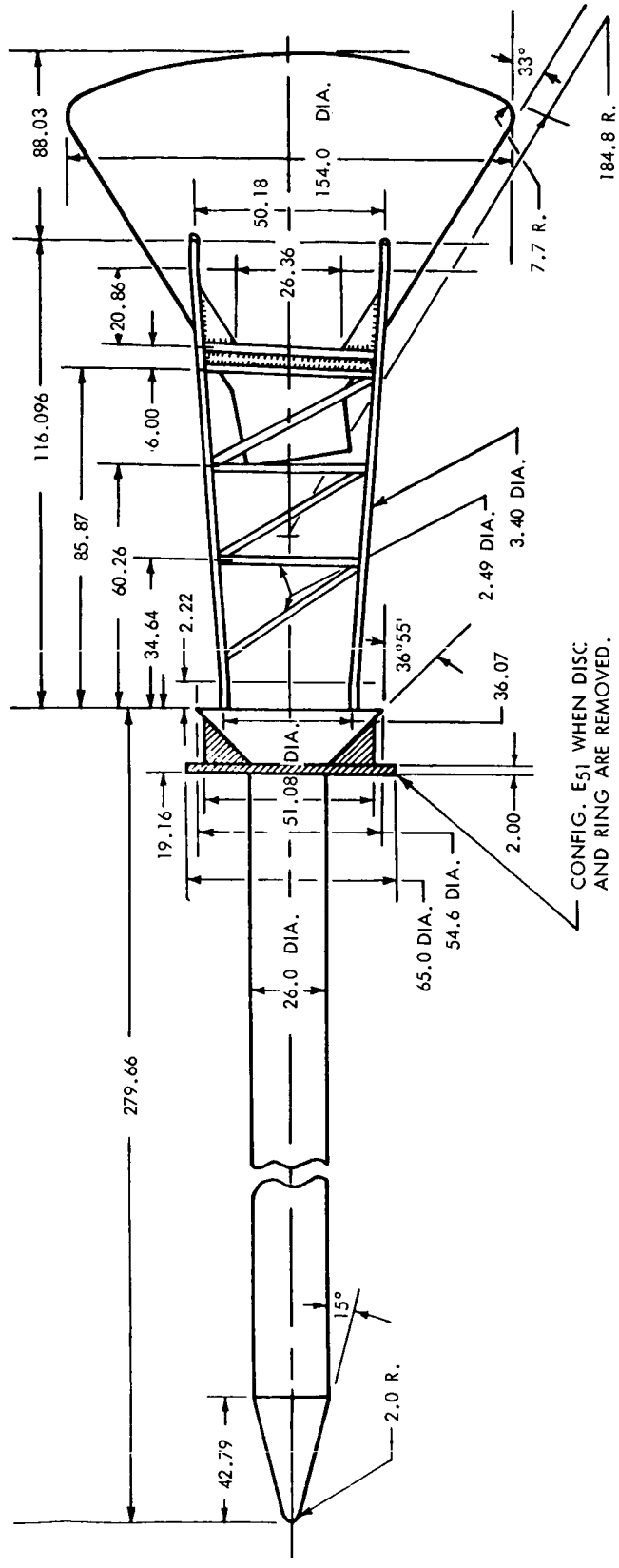

FULL-SCALE DIMENSIONS IN INCHES
DRAWING NOT TO SCALE

Figure 3. $E_{52}T_{21}C_{19}$ Launch Escape Vehicle Configuration

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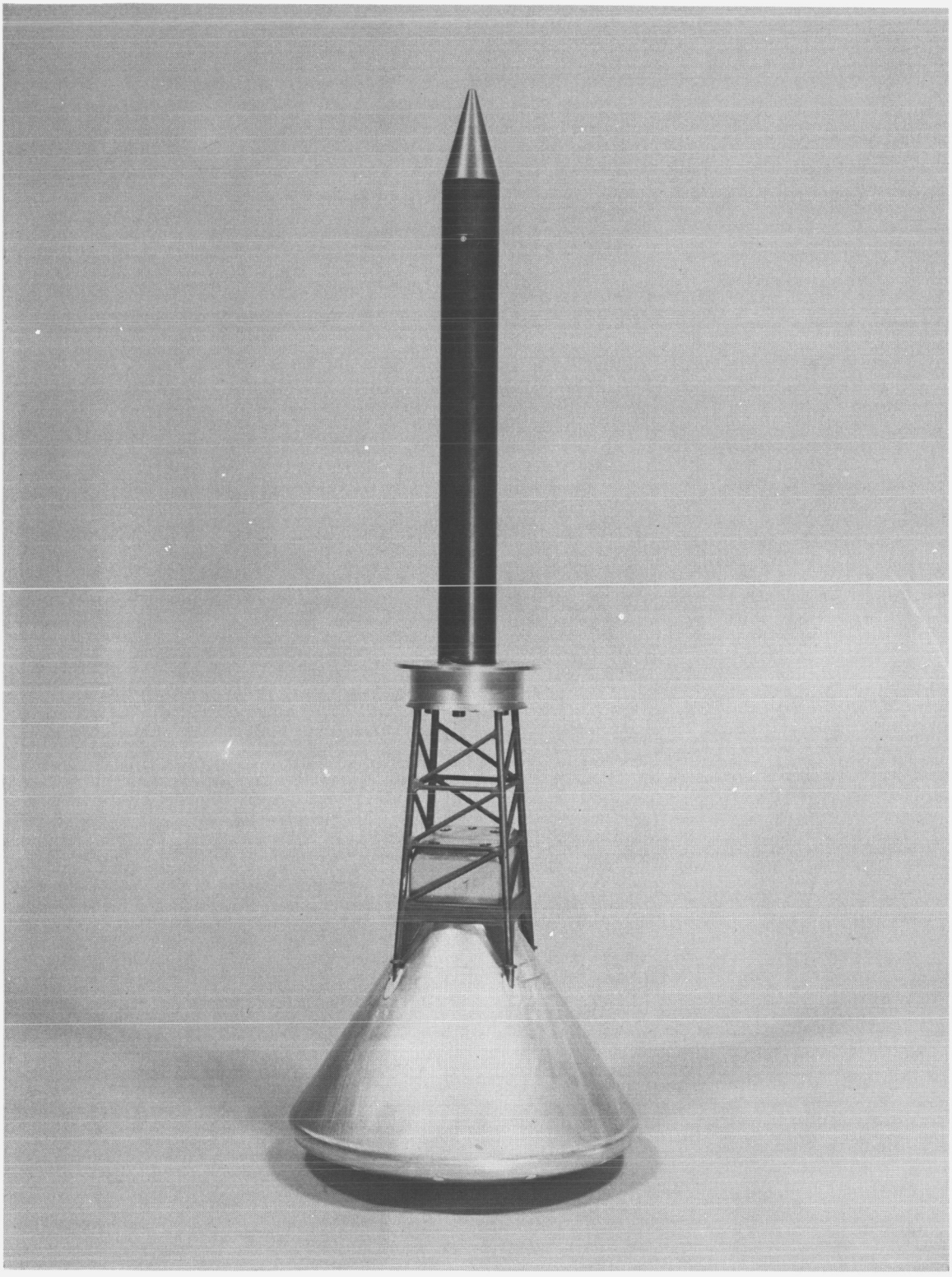

Figure 4. Launch Escape Vehicle Configuration With Flow Separator Disc

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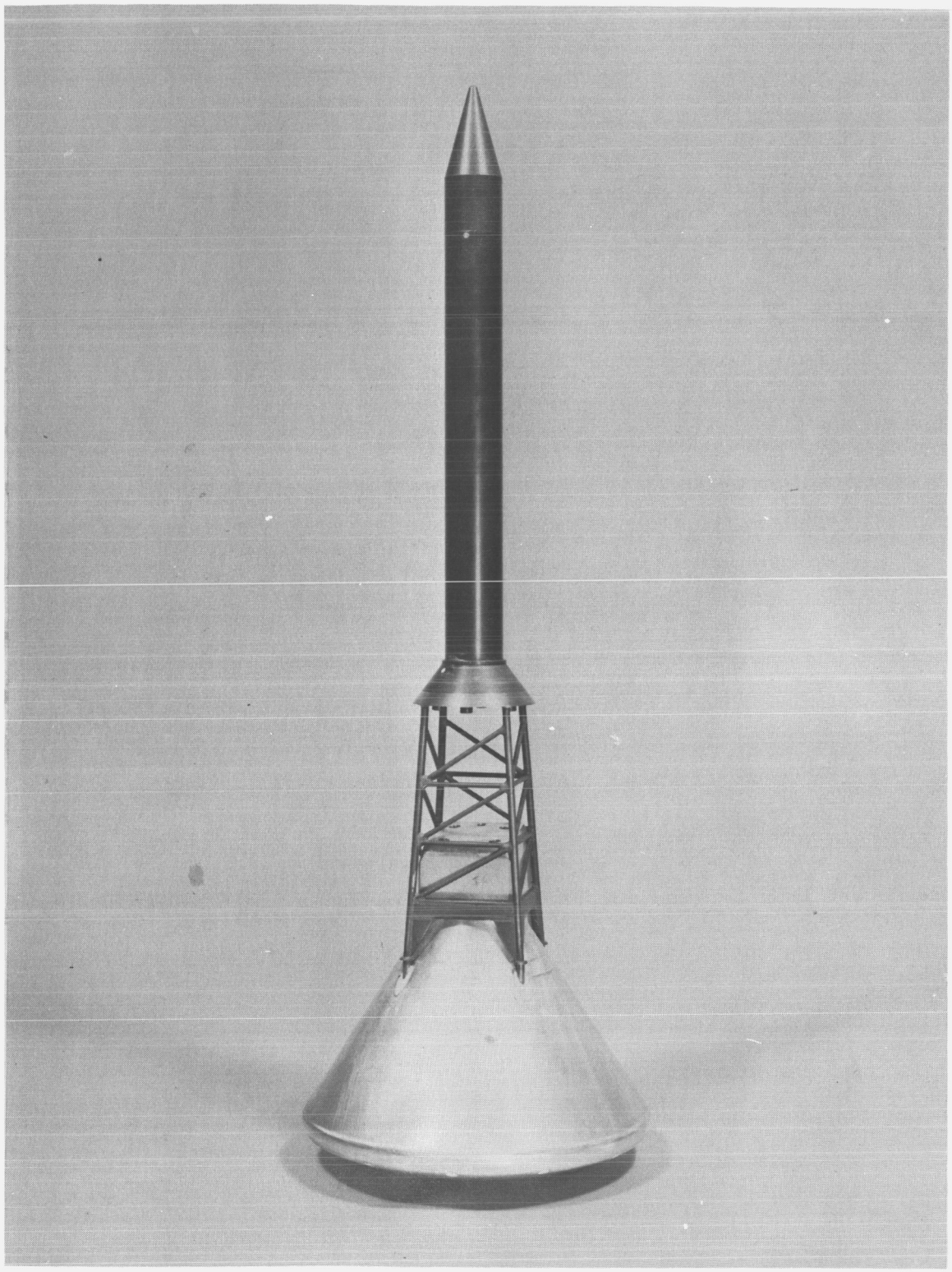

Figure 5. Launch Escape Vehicle Configuration Without Flow Separator Disc

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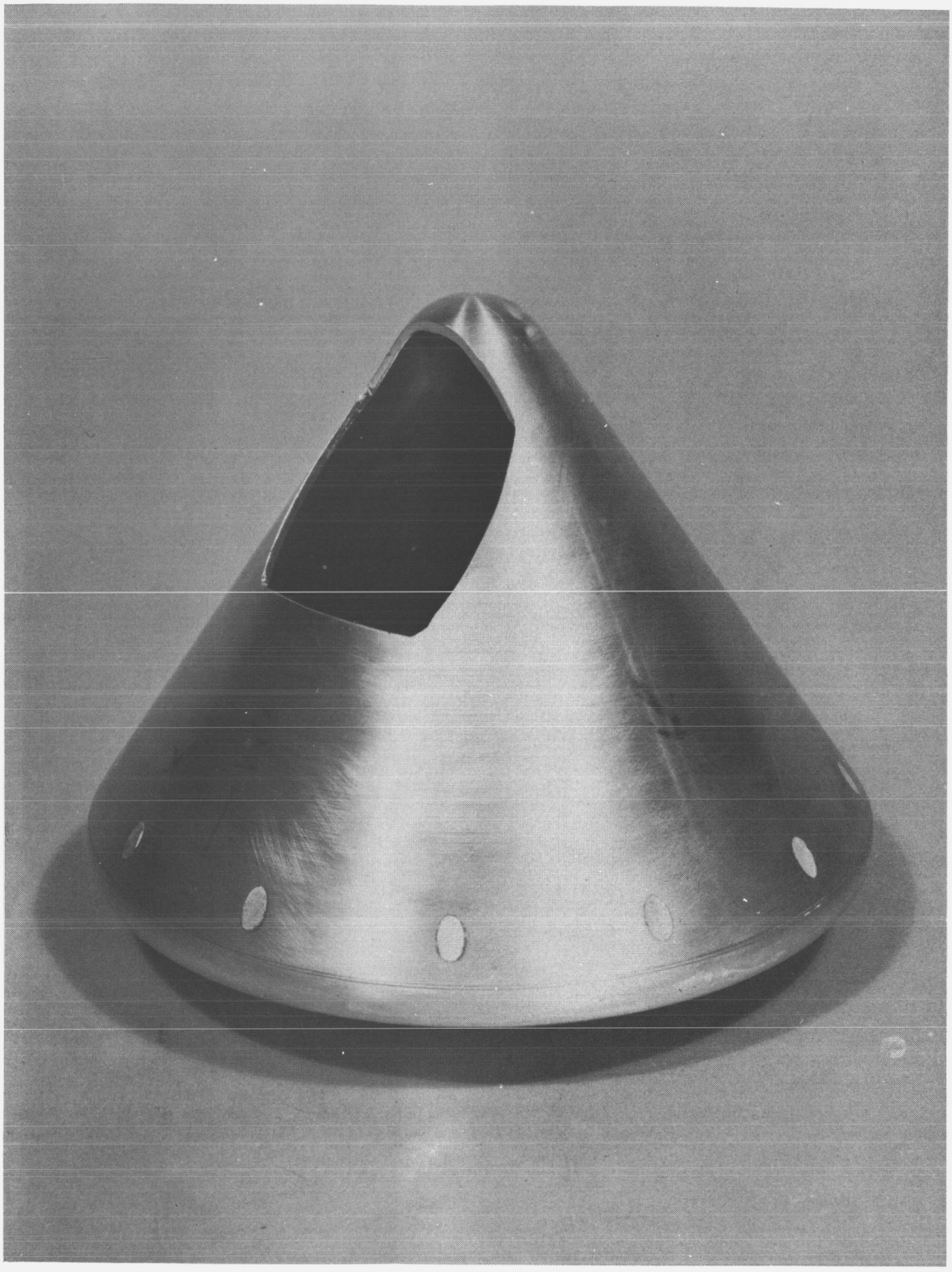

Figure 6. Command Module Reentry Configuration

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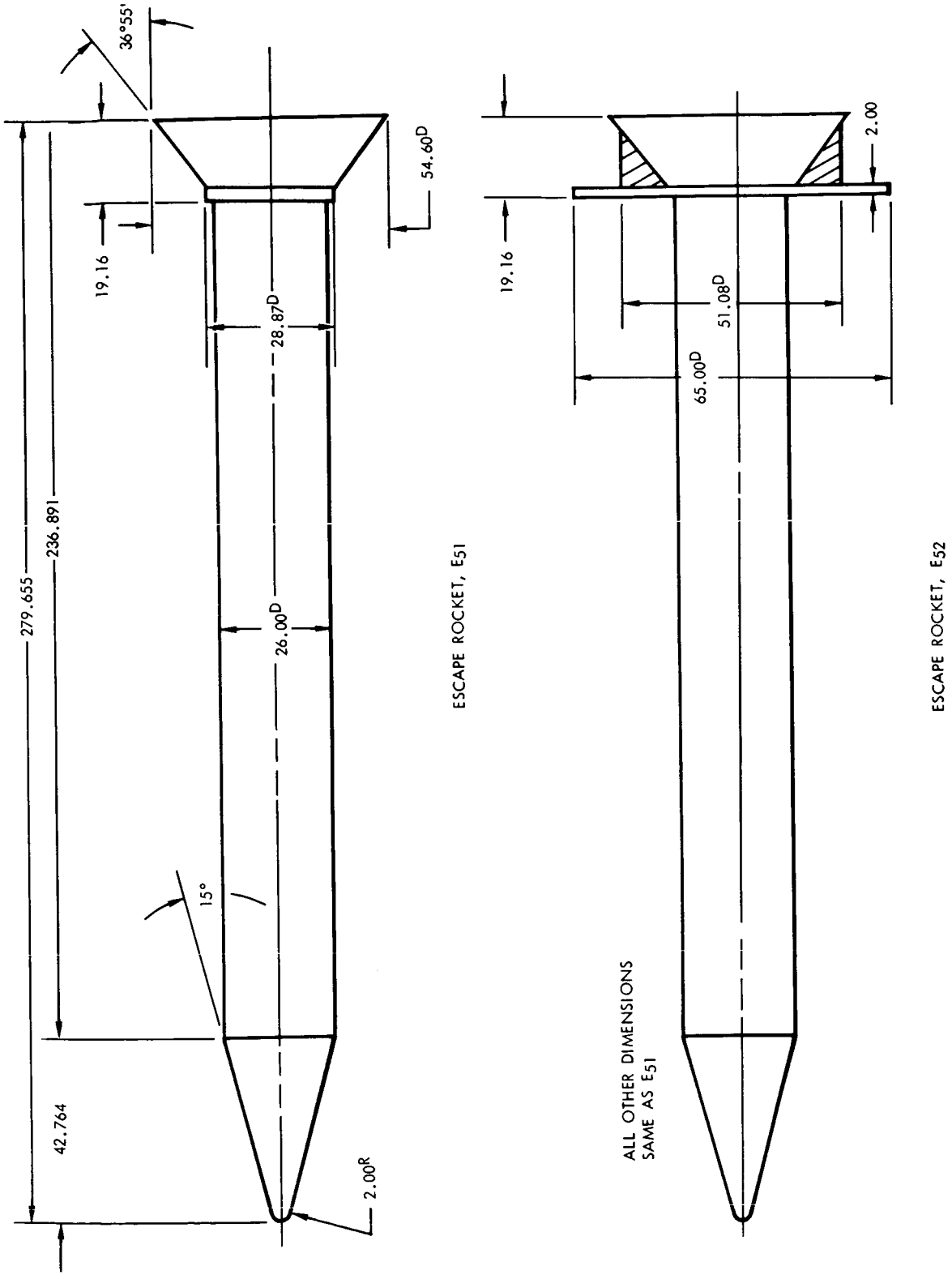

Figure 7. Escape Rocket Configurations

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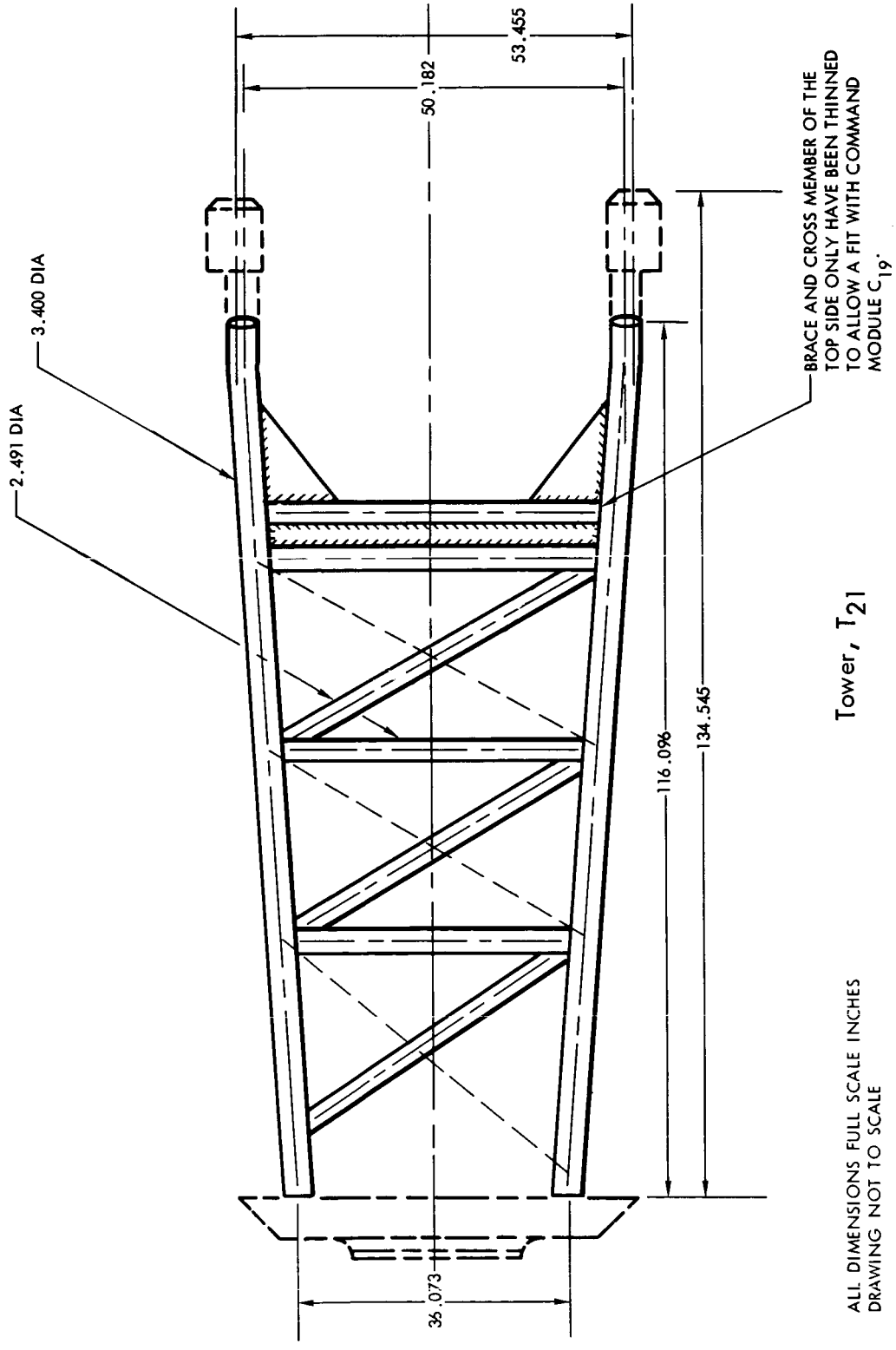

Figure 8. Tower Structure

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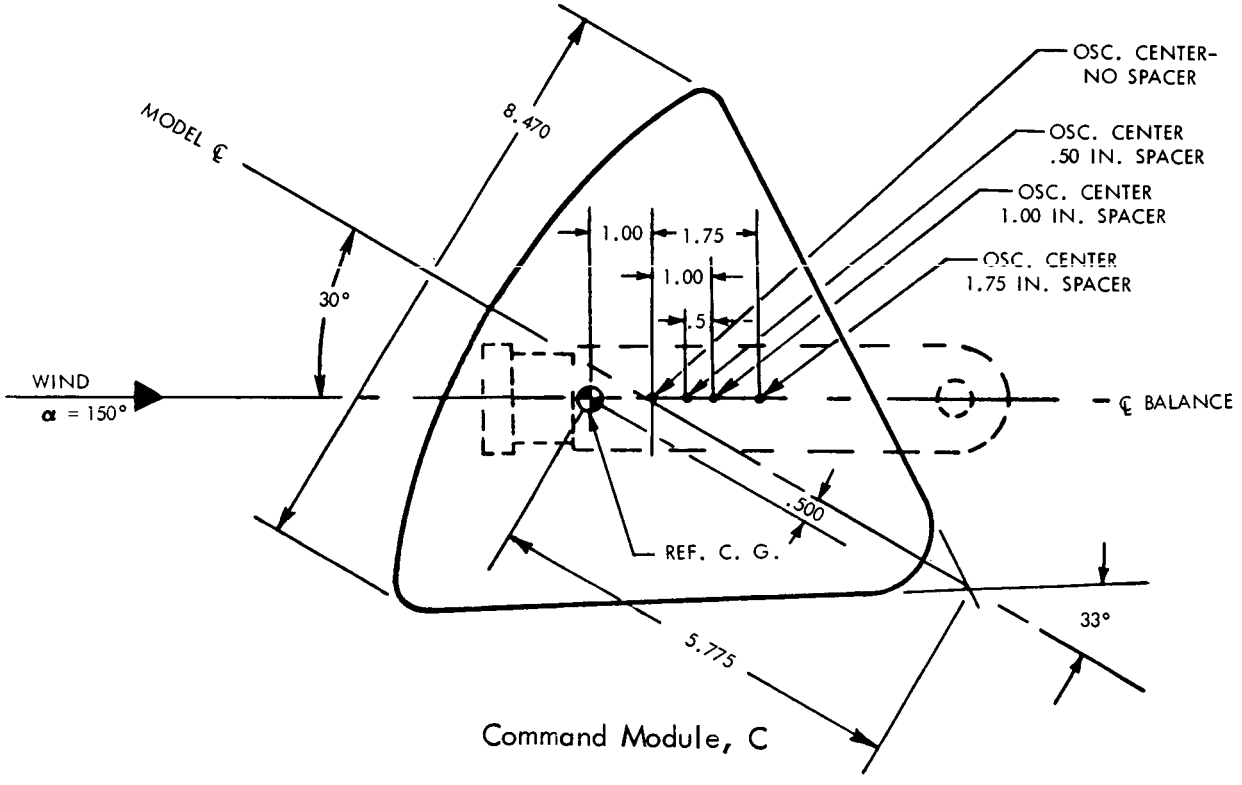

ALL DIMENSIONS MODEL SCALE INCHES
DRAWING NOT TO SCALE

Figure 9. Command Module Reentry Configuration Oscillation Center Location

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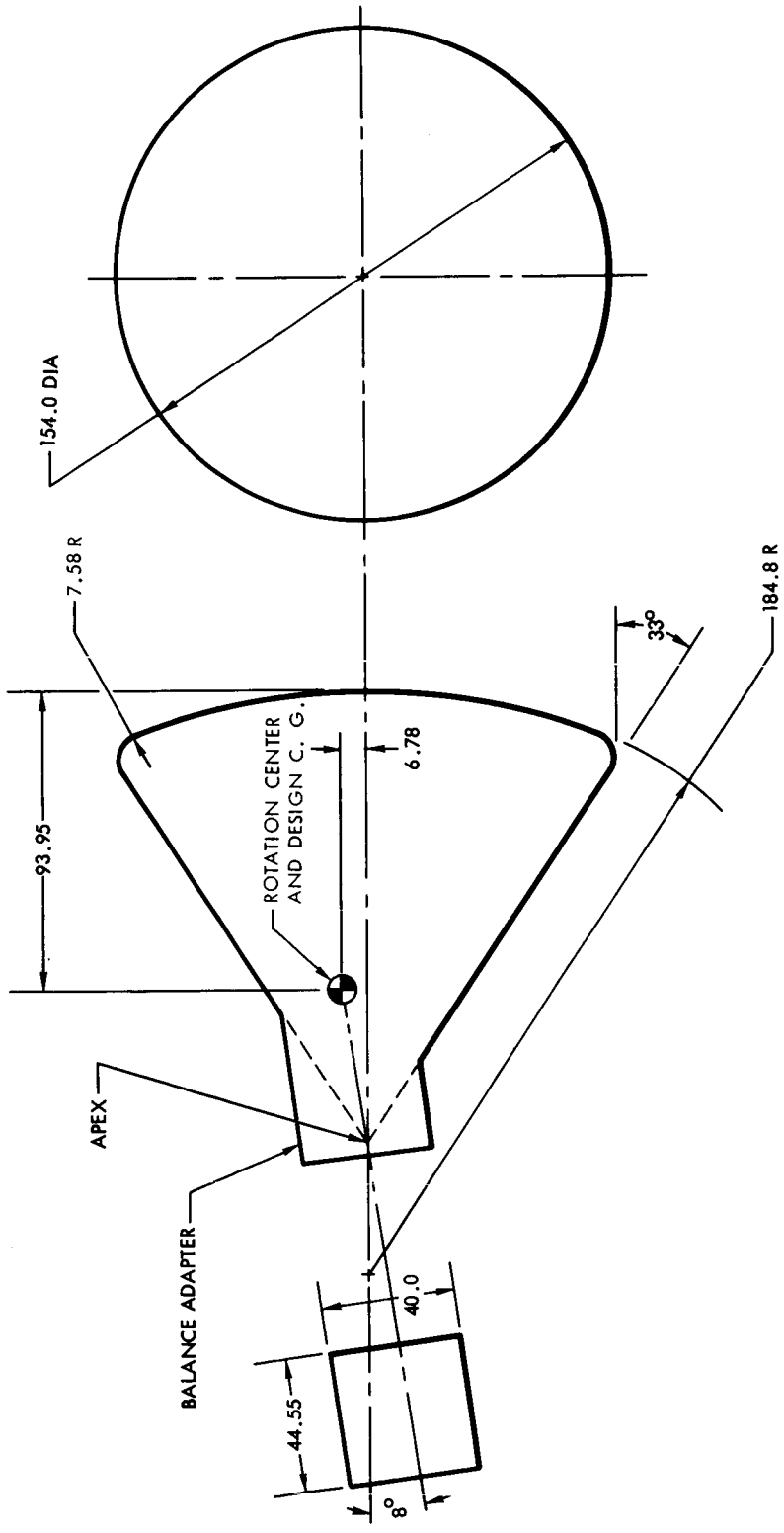

Command Module, C_{19}

ALL DIMENSIONS FULL SCALE INCHES
DRAWING NOT TO SCALE

Figure 10. Command Module for LEV Configuration

[redacted]

CO[redacted]

IV. TEST PROCEDURE

TEST NOMENCLATURE

A	Maximum cross-sectional area, ft^2, $\frac{\pi \ell^2}{4}$
ℓ	Maximum body diameter, ft
p	Free-stream static pressure, lb/ft^2
q_∞	Free-stream dynamic pressure, lb/ft^2
α	Angle of attack of model centerline, deg or radians
$\dot{\alpha}$	Rate of change of angle of attack, radians/sec
V	Free-stream velocity, ft/sec
M	Mach number
ω	Angular frequency of oscillation, radians/sec
k	Reduced frequency parameter, $\frac{\omega \ell}{V}$
R	Reynolds number based on ℓ
q	Angular velocity in pitch, radians/sec
$\dot{q}$	Rate of change of pitching angular velocity, $radians/sec^2$
I	Moment of inertia, $slug\text{-}ft^2$
C_m	Pitching moment coefficient, $\frac{\text{pitching moment}}{q_\infty A \ell}$
$C_{m_q} + C_{m_{\dot{\alpha}}}$	Damping-in-pitch parameter, per radian
$C_{m_\alpha} - k^2 C_{m_{\dot{q}}}$	Oscillatory longitudinal stability parameter, per radian

[redacted]

CO[redacted]

MODEL INSTALLATION

The FD-2 model was installed on the NASA 1600 in.-lb dynamic balance that was mounted on a straight sting containing the oscillating mechanism. The drive motor, clutch resolvers, and frequency generator were all contained in the downstream end of the sting, which was stiffened to provide a resonant frequency above the maximum oscillating frequency of the model. The oscillating mechanism was designed to provide maximum stiffness of all drive linkages so that the model responded only to the essentially sinusoidal forcing input of the crank and Scotch yoke.

The models were mounted so that the sting centerline and the command module axis of symmetry formed a 30-degree angle for the reentry configuration to allow testing through angles of attack of 138 to 162 degrees and an 8-degree angle for the launch escape configuration to allow testing through angles of attack of -18 to +4 degrees. The Unitary Plan Tunnel basic sting-type support system, which is mounted on a horizontal strut extending from wall to wall, was fitted with a special knuckle to allow pitching of the model in the vertical plane.

INSTRUMENTATION

The NASA 1600 in.-lb dynamic pitch balance was used to measure the moment and displacement functions as the model was mechanically forced to oscillate in a single degree of freedom.

In operation of the system, calibrated outputs of the moment and displacement strain gages are passed through coupled electrical sine-cosine resolvers that rotate at the frequency of oscillation. The resolvers transformed the outputs into orthogonal components from which the resultant applied moment and displacement and the phase angle between them were found. With the known oscillation frequency, the aerodynamic damping and oscillatory stability moments were computed.

All data were computed on a remotely located IBM 7090 computer.

FLOW VISUALIZATION STUDIES

A limited number of Schlieren photographs and motion pictures were made during this test. Motion pictures are available for both LEV configurations (flow separator disc on and off) at Mach numbers 1.80 and 2.50 in the angle-of-attack range of 0 to -8 degrees. Schlieren photographs of the LEV configurations taken at Mach numbers 1.80, 2.50 and 2.75 are presented in Figures 11, 12, and 13. Typical Schlieren photographs of the command module entry configuration at Mach number 1.60 are presented in Figure 14. These Schlieren photographs were taken at set angles of attack without model oscillation.

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DATA REDUCTION AND CONSTANTS

The equations used in reducing the data are as follows:

System damping moment in. -lb/rad/sec (C)

$C_{aero} = C_{run} - C_{tare}$, where C_{tare} = constant

System spring constant, in. -lb/rad (K)

$$(K - I\omega^2)_{aero} = (K - I\omega^2)_{run} - (K - I\omega^2)_{tare}$$

$$C_{m_q} + C_{m_{\dot{\alpha}}} = - \frac{VC_{aero}}{12\, q_\infty\, A\ell^2}$$

$$C_{m_\alpha} - k^2 C_{m_{\dot{q}}} = - \frac{(K - I\omega^2)_{aero}}{12\, q_\infty\, A\ell}$$

Where

$$k = \frac{\omega\ell}{V}$$

$$q_\infty = 0.7\, p\, M^2$$

$$p = \frac{\text{stagnation pressure}}{(1 + 0.2M^2)^{3.5}}$$

$$V = \frac{(49.0236)\sqrt{T_t}\, M}{(1 + 0.2M^2)^{1/2}}\ ;\ T_t = \text{tunnel total temperature, R}$$

$$\text{Reynolds number} = \frac{2\ell\, q_\infty}{\mu V}\ ;\ \mu = \text{viscosity, } \frac{\text{lb-sec}}{\text{ft}^2}$$

The following were constants for the test:

$$\ell = 0.7058 \text{ ft}$$

$$A = 0.3912 \text{ ft}^2$$

DATA ACCURACY

The estimated probable errors of the aerodynamic test conditions for this test are as follows:

k	±0.0001 radians
M	±0.005
R	±0.005 x 10^6
α	±0.2 degrees

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The ability of the forced oscillation equipment and instrumentation used in these tests to measure accurately the system damping and stability moments is discussed in Reference 4. These accuracies in measuring applied moments, based on repeatability in measuring the wind-off or tare moments of the model and mechanical system, give the following probable coefficient accuracies when translated to coefficient form using the dimensions of the 0.055-scale Apollo models.

$$C_{m_q} + C_{m_{\dot{\alpha}}} \quad \pm 0.06$$

$$C_{m_\alpha} + k^2 C_{m_{\dot{q}}} \quad \pm 0.03$$

All data in this report have been presented, as transmitted from NASA, in a form uncorrected for tunnel flow angularity. Angularity corrections for each Mach number are shown in Appendix B.

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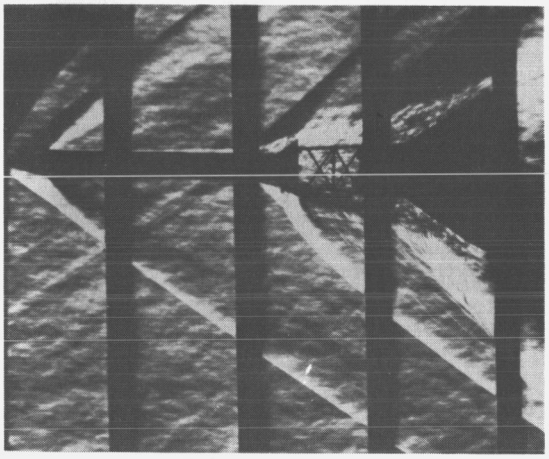
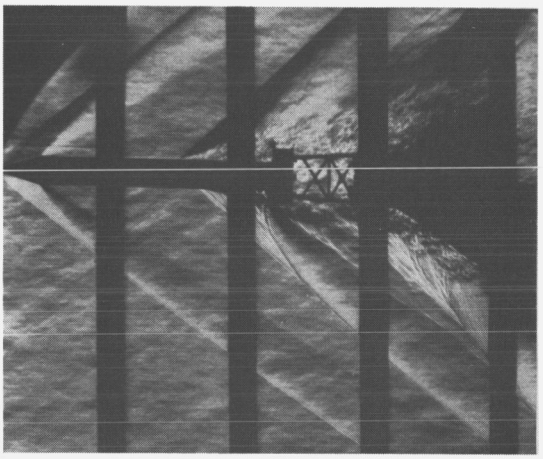
DISC OFF

DISC ON

α = -6 DEGREES

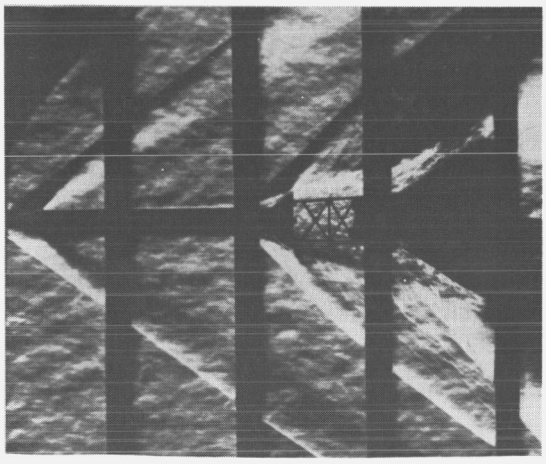


DISC OFF



DISC ON

α = +2 DEGREES



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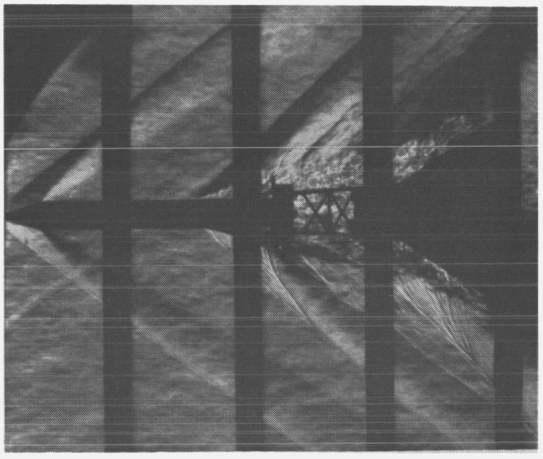

DISC ON

α = 0 DEGREES

Figure 13. Typical Schlieren Photographs of the LEV at $M = 1.80$ and $R = 3.76 \times 10^6$

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DISC OFF

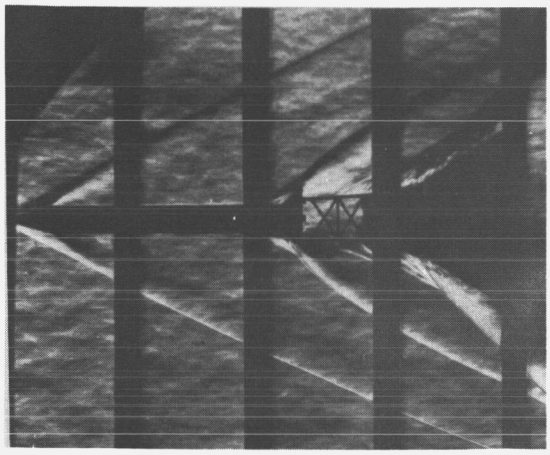
DISC ON

α = -6 DEGREES

DISC OFF

DISC ON

α = -2 DEGREES



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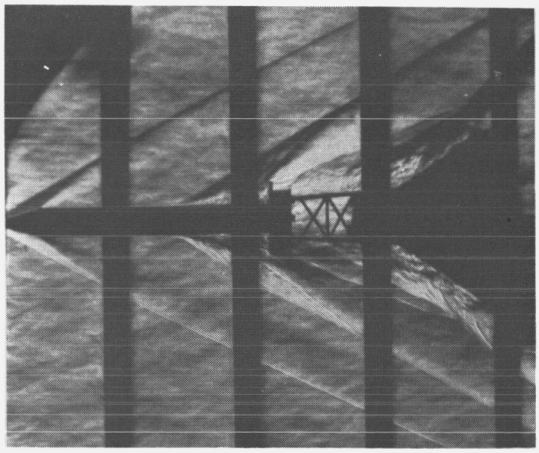

DISC ON

α = 0 DEGREES

Figure 12. Typical Schlieren Photographs of the LEV at M = 2.50 and R = 2.91×10^6

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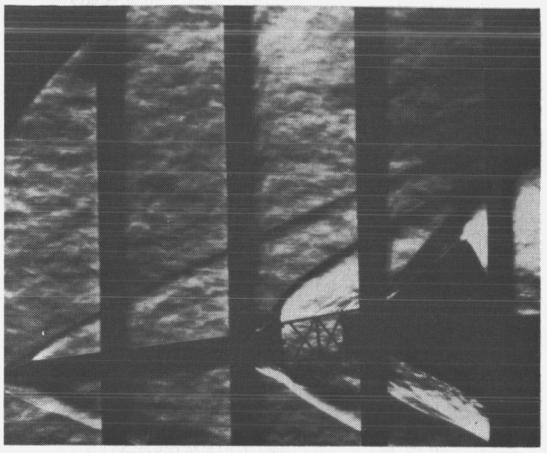

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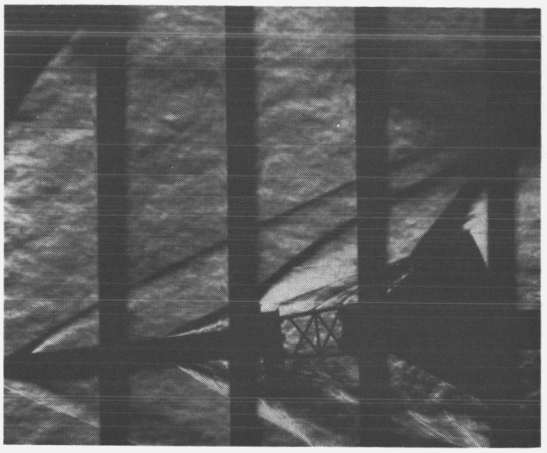
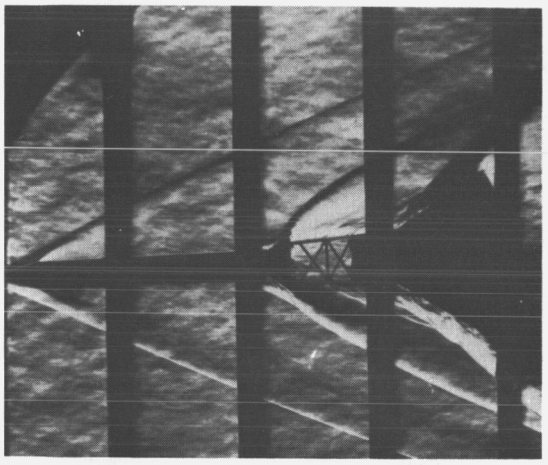


DISC ON

α = -6 DEGREES



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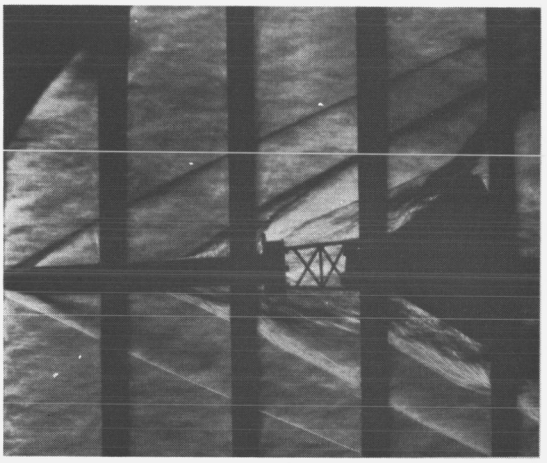
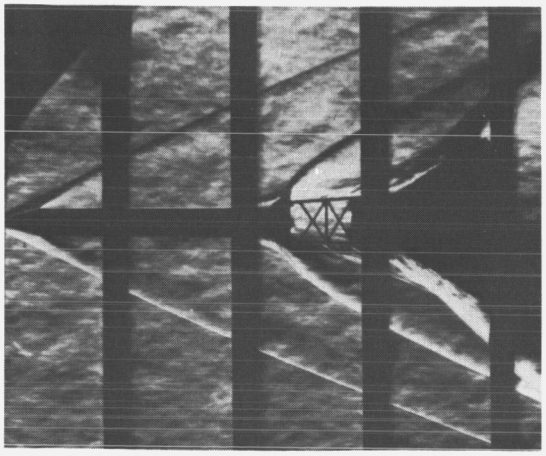


DISC ON

α = -2 DEGREES



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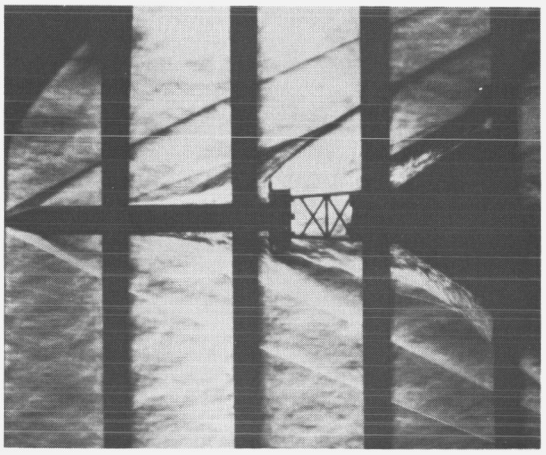

DISC ON

α = 0 DEGREES

Figure 11. Typical Schlieren Photographs of the LEV
M = 2.75 and R = 2.77×10^6

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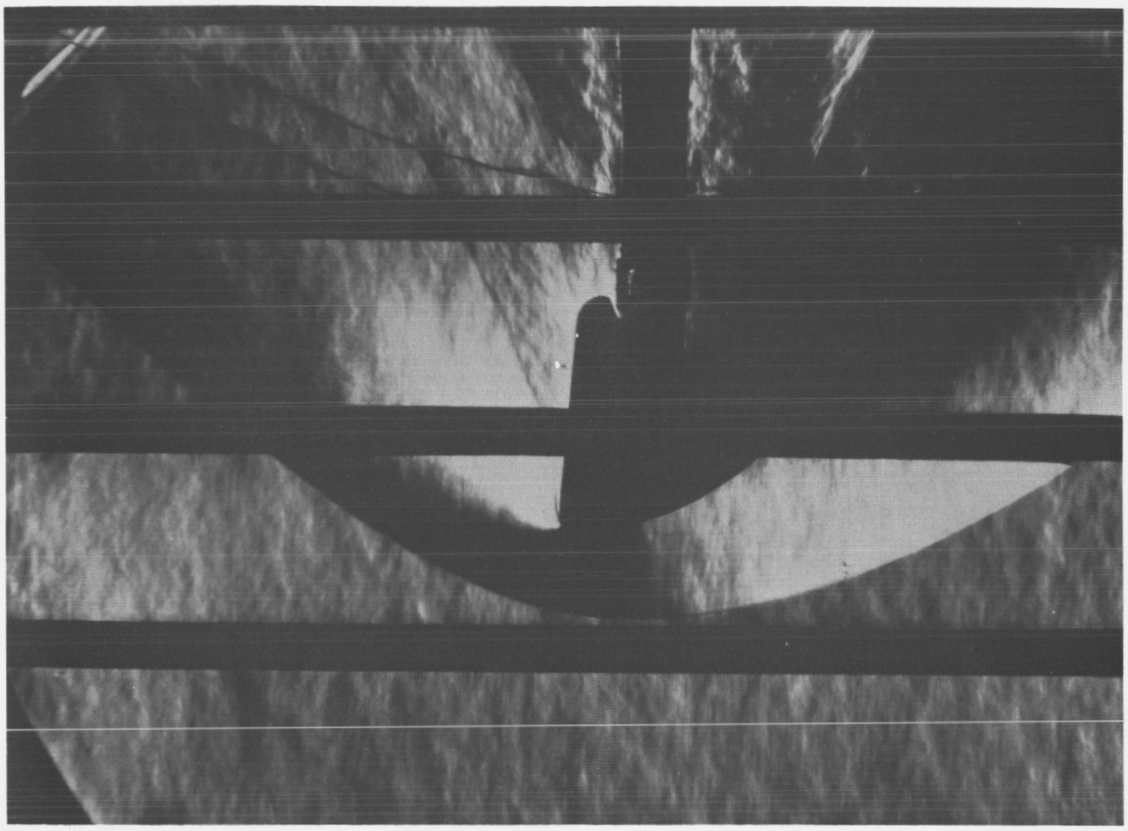
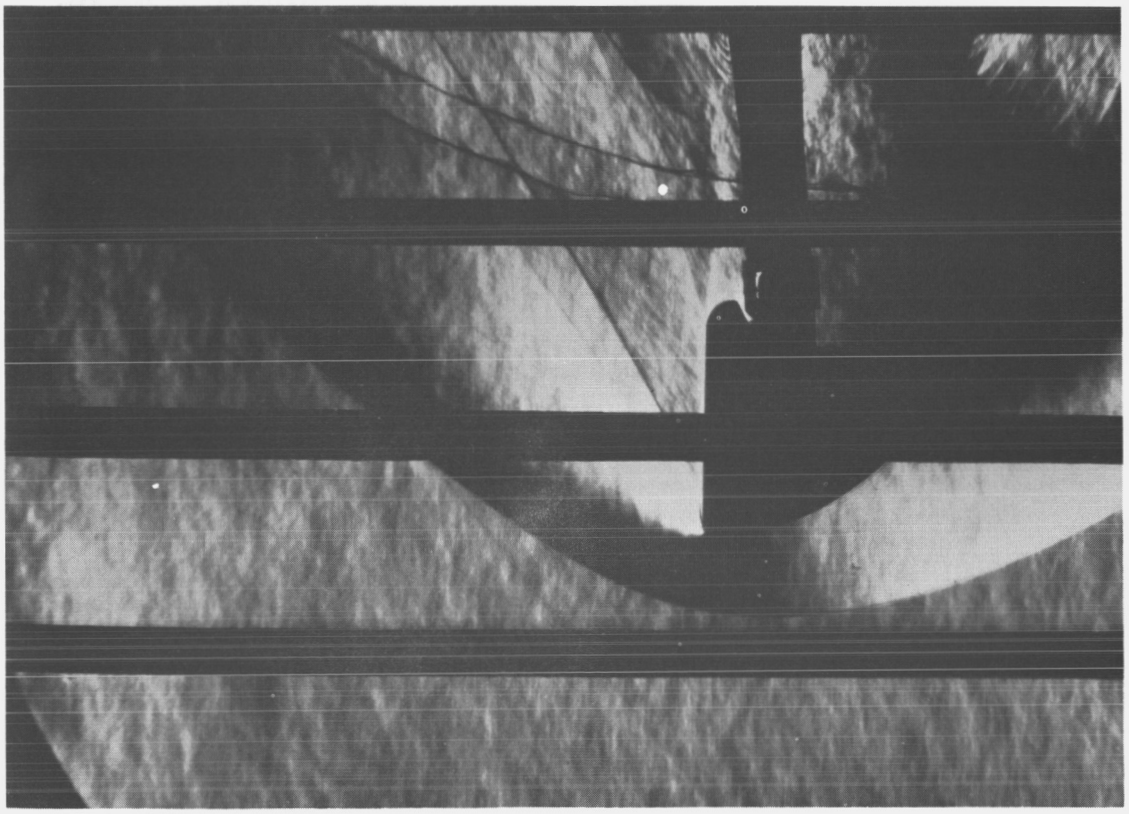


α = 152 DEGREES



α = 148 DEGREES

Figure 14. Typical Schlieren Photographs of the Command Module Reentry Configuration at M = 1.60 and R = 2.45 x 10^6 (Sheet 1 of 2)

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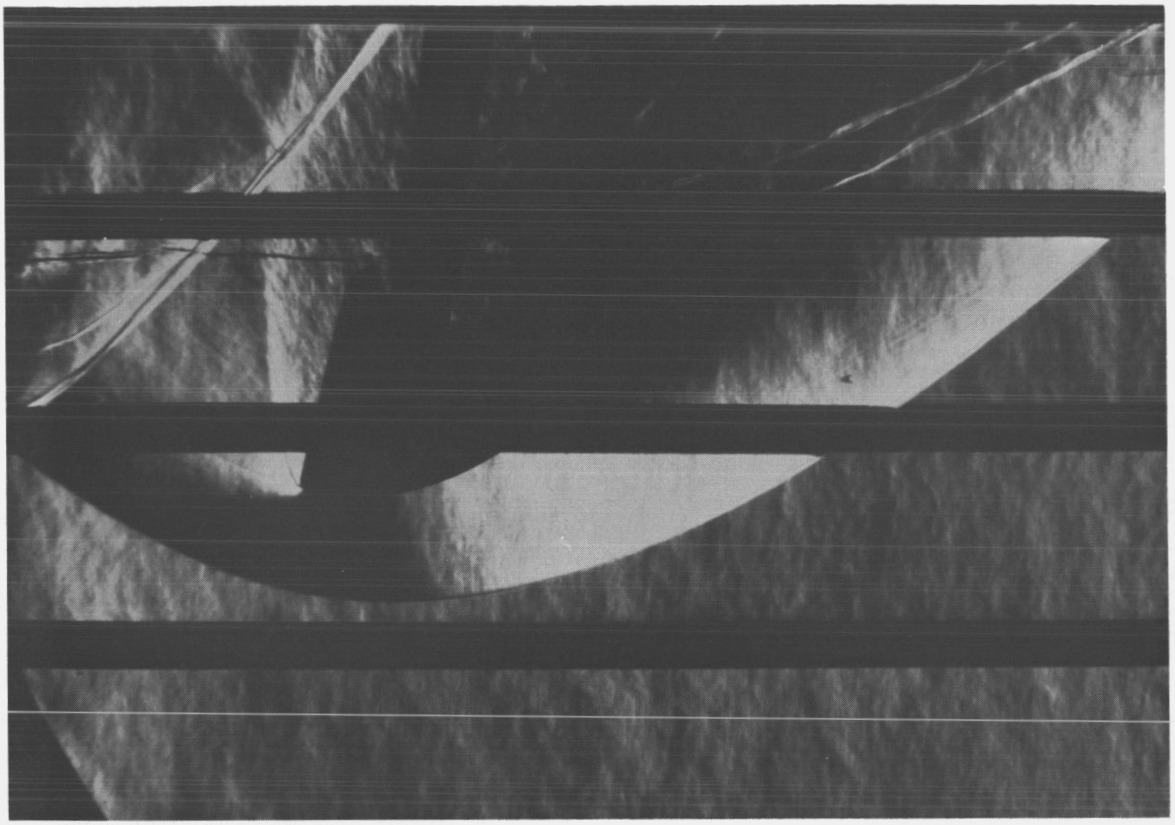
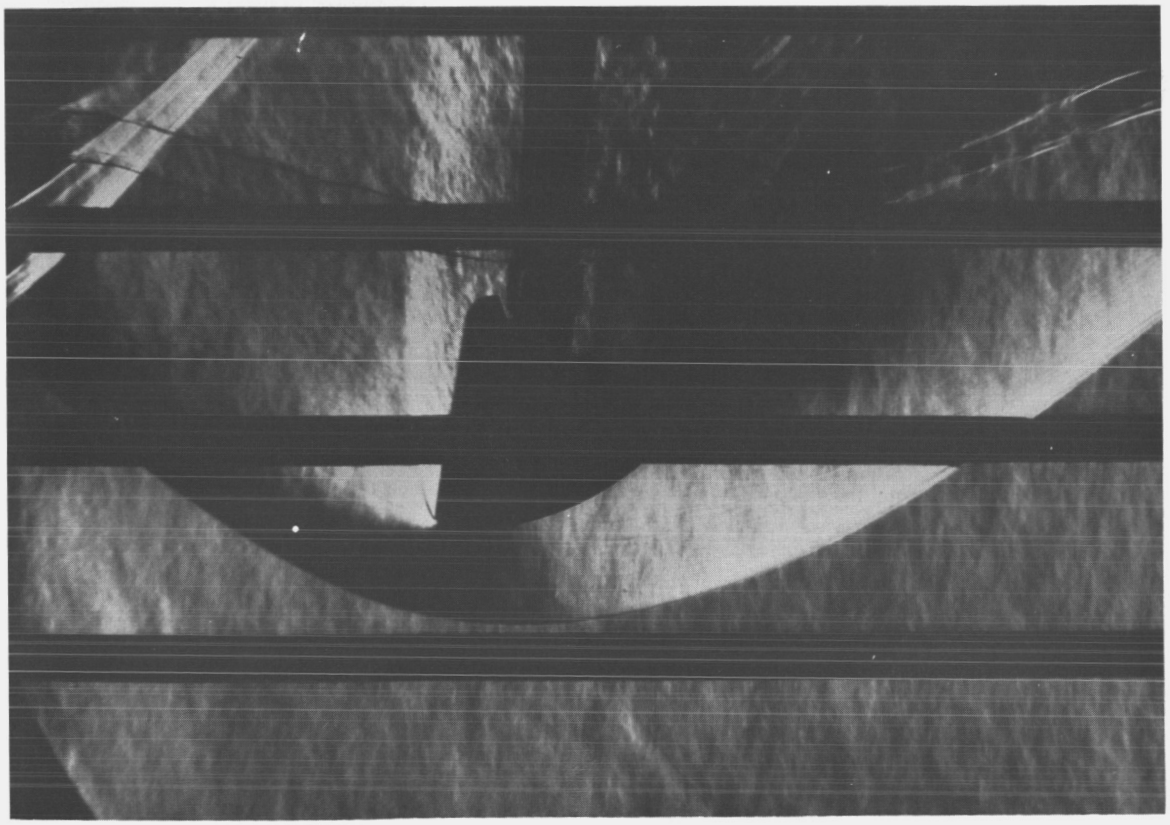


α = 160 DEGREES



α = 156 DEGREES

Figure 14. Typical Schlieren Photographs of the Command Module Reentry Configuration at M = 1.60 and R = 2.45 x 10^6 (Sheet 2 of 2)

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V. REFERENCES

1. Data Report for Langley Unitary Plan Wind Tunnel Tests (Project 374) of Apollo Model FD-2. NAA S&ID SID 62-1074 (24 August 1962).

2. Data Report for Langley Unitary Plan Wind Tunnel Tests (Project 349) of Apollo Model FD-2. NAA S&ID SID 62-536 (28 May 1962).

3. Data Report for Langley 8-Foot TPT Wind Tunnel Tests (Project 233) of Apollo Model FD-2. NAA S&ID SID 62-1065 (24 August 1962).

4. Dynamic Longitudinal and Directional Stability Derivatives for a 45-Degree Swept-Back Wing Airplane Model at Transonic Speeds. NASA TM X-39 (August 1959).

5. Structural Analysis of the 0.055-Scale Apollo Wind Tunnel Models. NAA S&ID SID 62-103 (16 February 1962).

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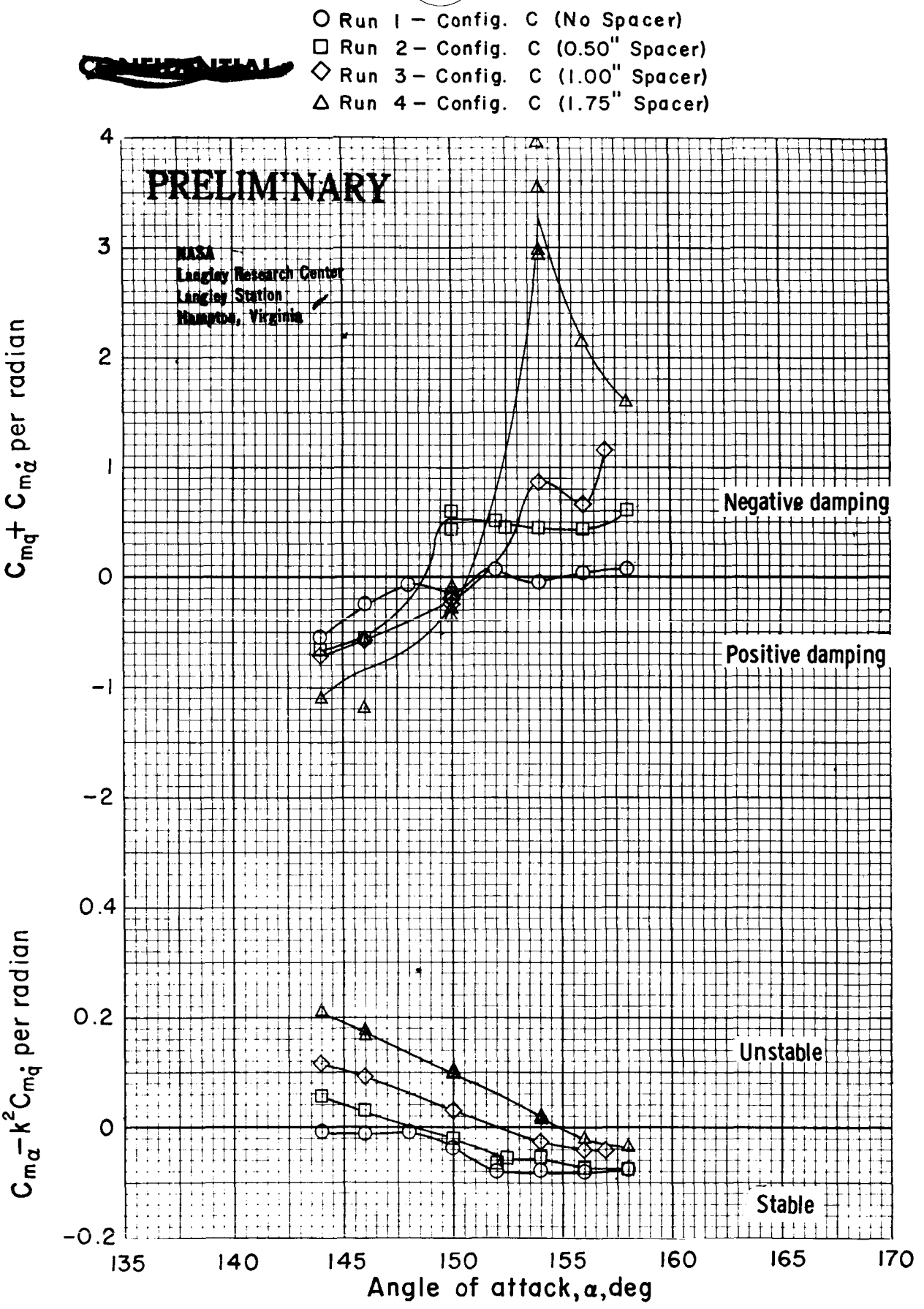
CO[redacted]

APPENDIX A

PLOTTED DATA

[redacted]

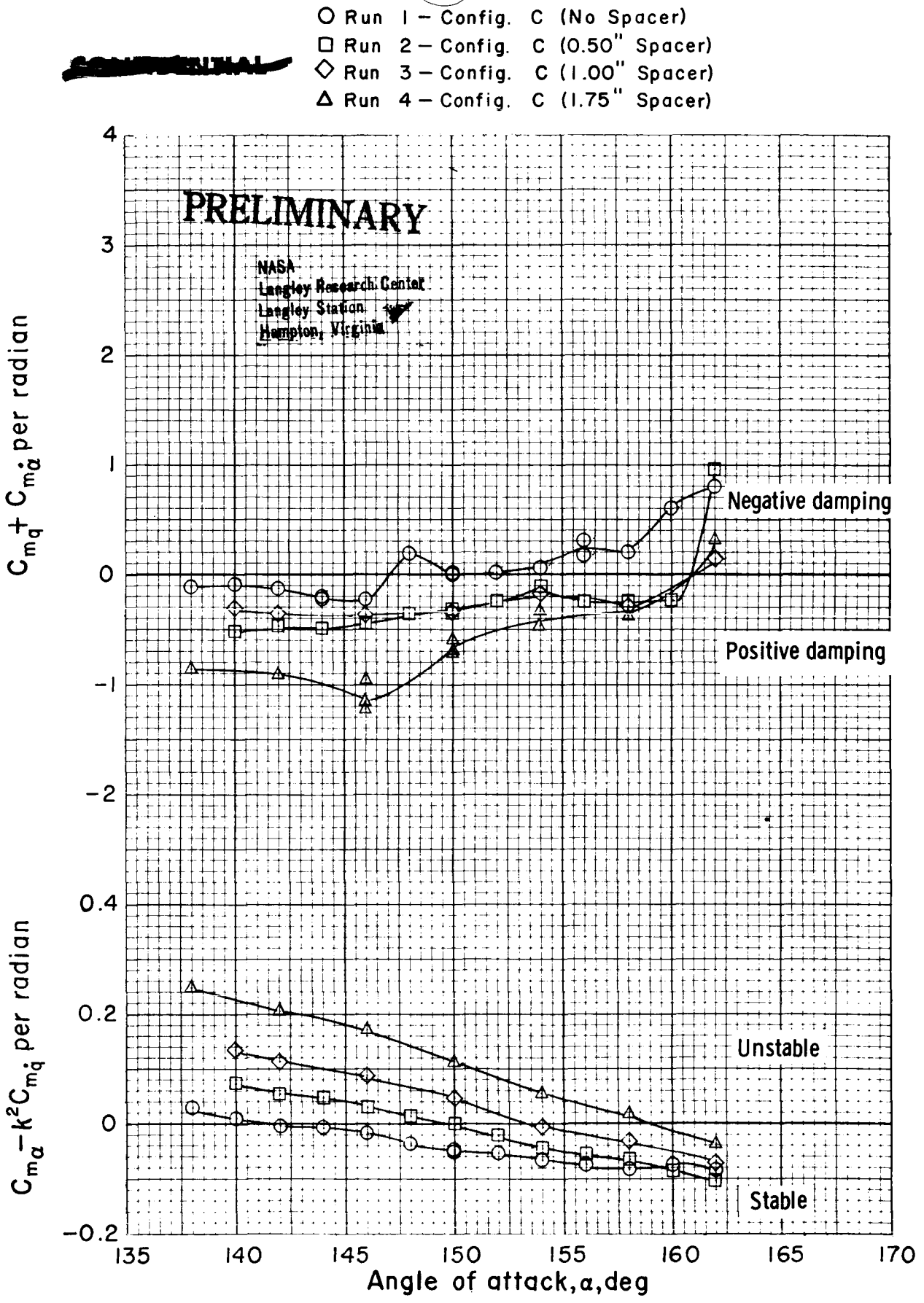
[redacted]



Effect of Oscillation Center Location on Dynamic Stability Characteristics
Command Module Entry Configuration, M=1.60 R=2.45 x 10^6

[redacted]

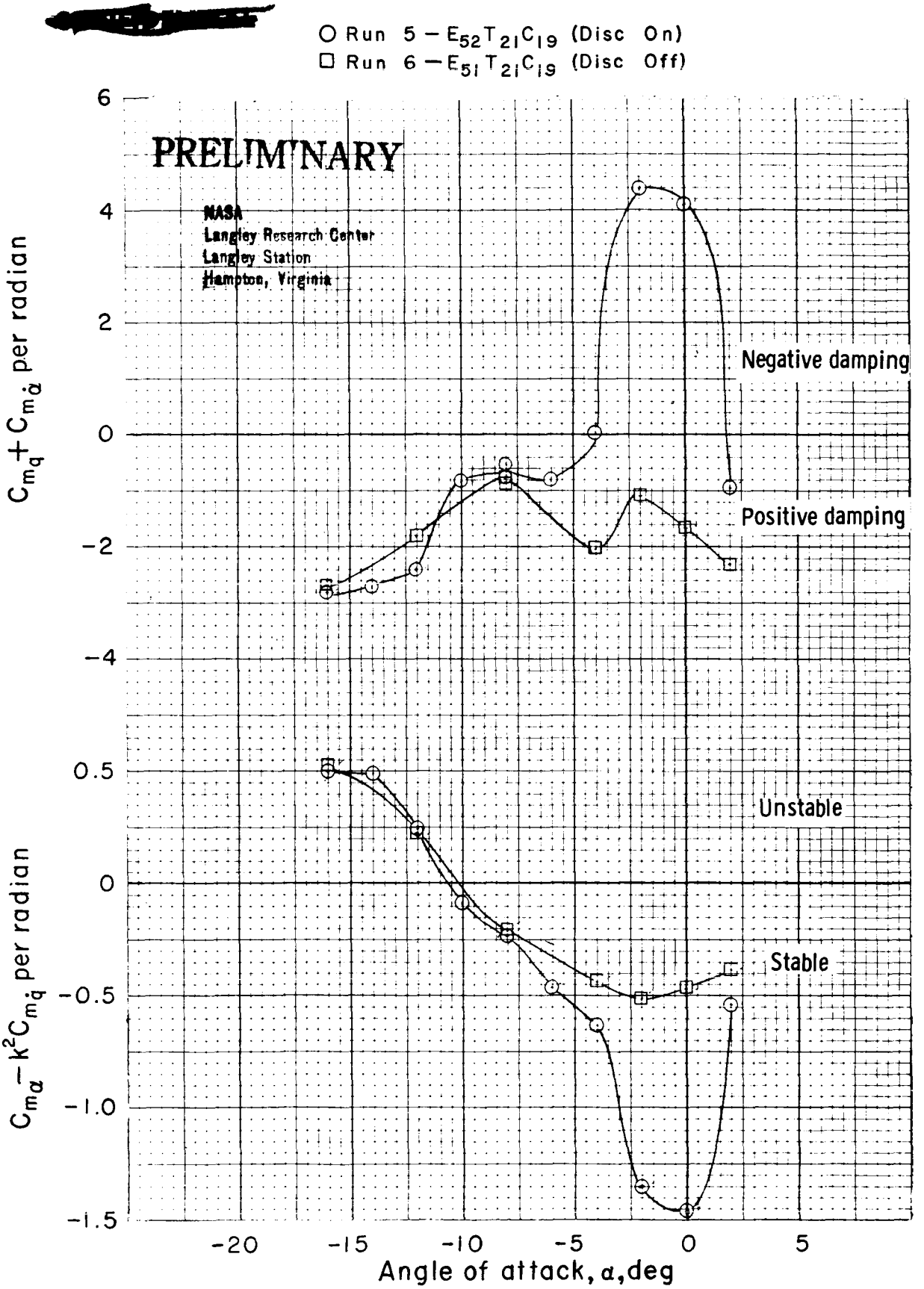
[redacted]



Effect of Oscillation Center Location on Dynamic Stability Characteristics
Command Module Entry Configuration, M = 2.16 R = 2.53 x 10^6

[redacted]

[redacted]



Effect of Flow Separator Disc on Dynamic Stability Characteristics
Launch Escape Configuration, M=1.80 R=3.67 x 10^6

[redacted]

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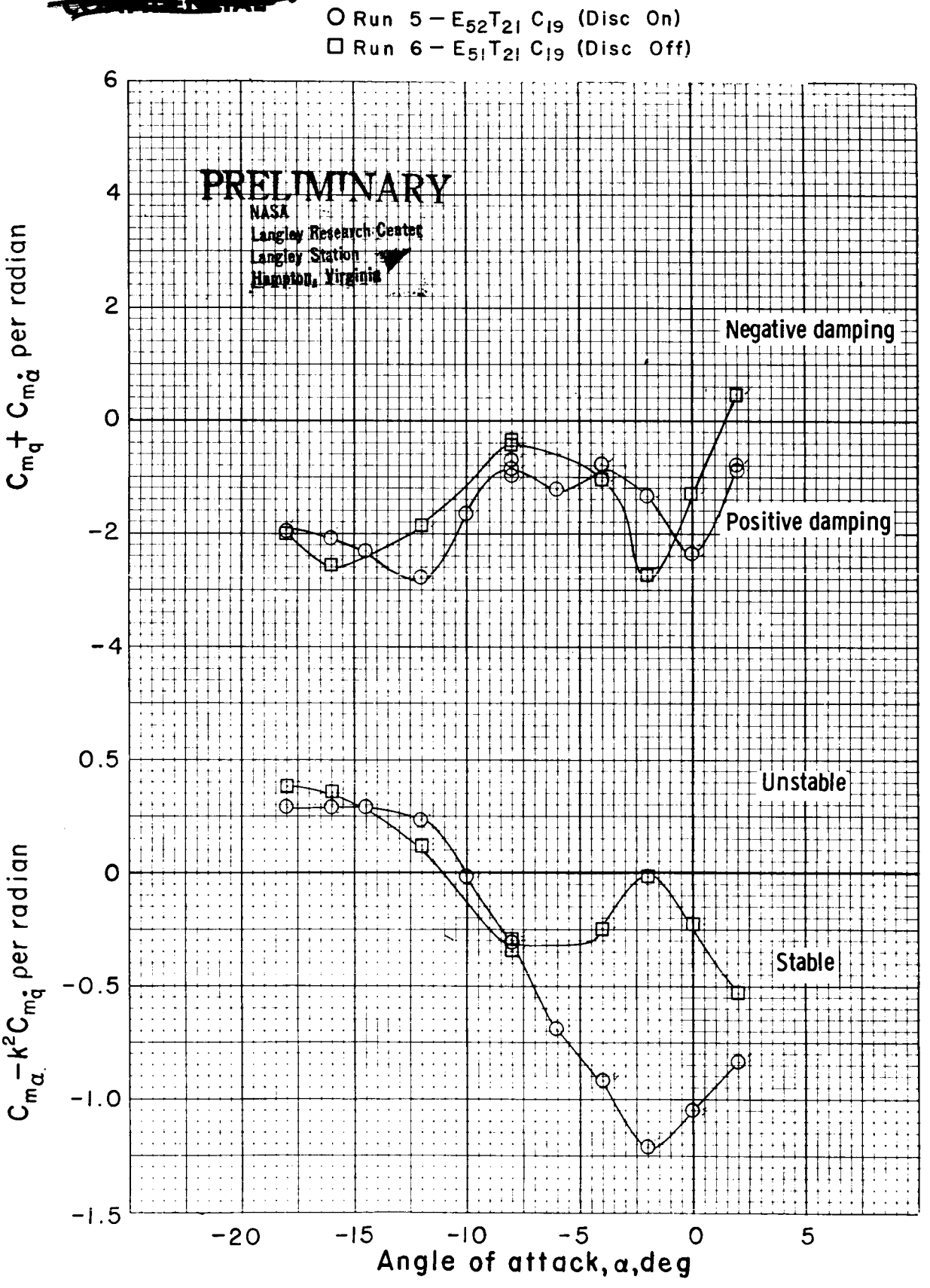

Effect of Flow Separator Disc on Dynamic Stability Characteristics
Launch Escape Configuration, M=2.16 R=3.39 x 10^6

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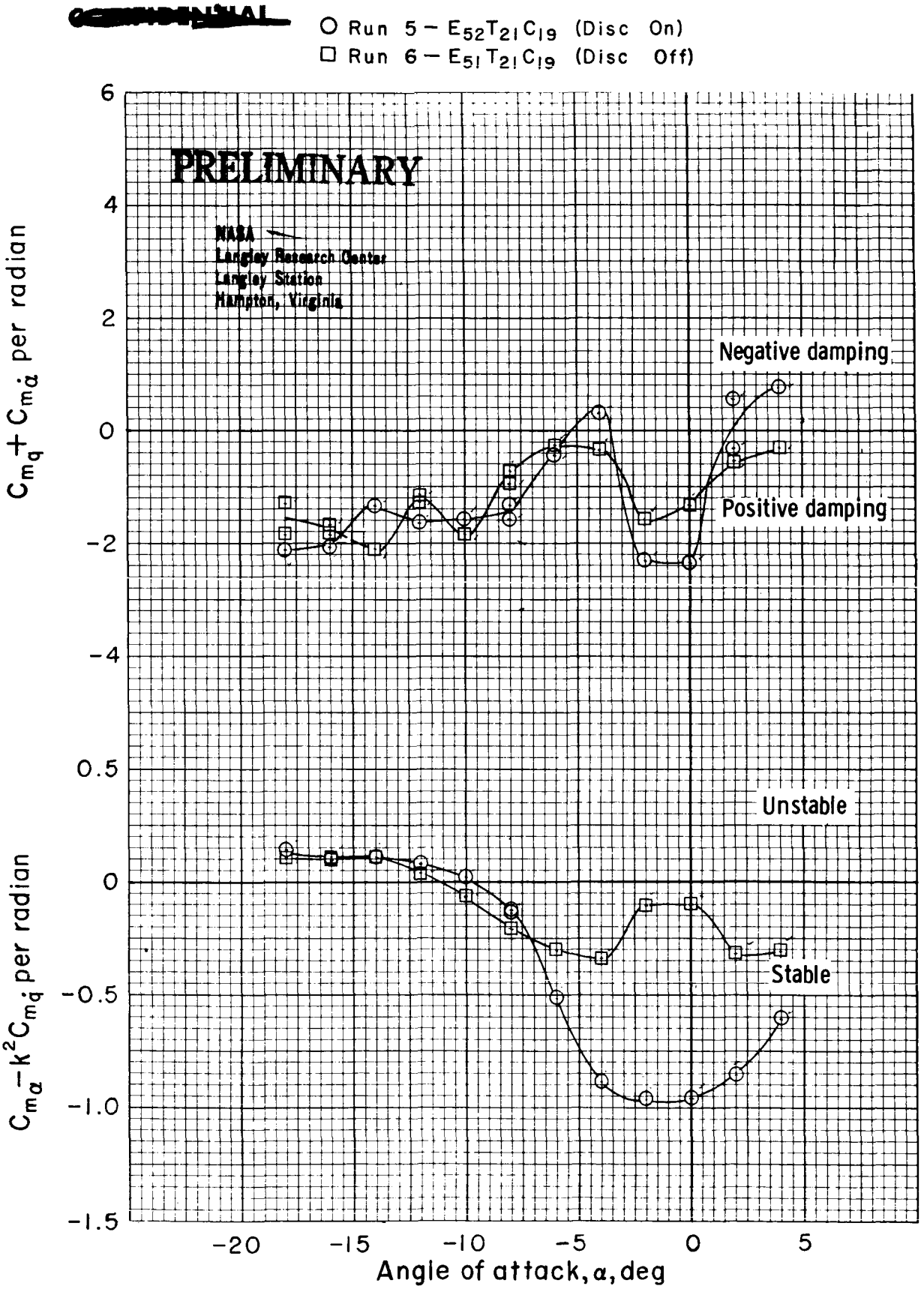
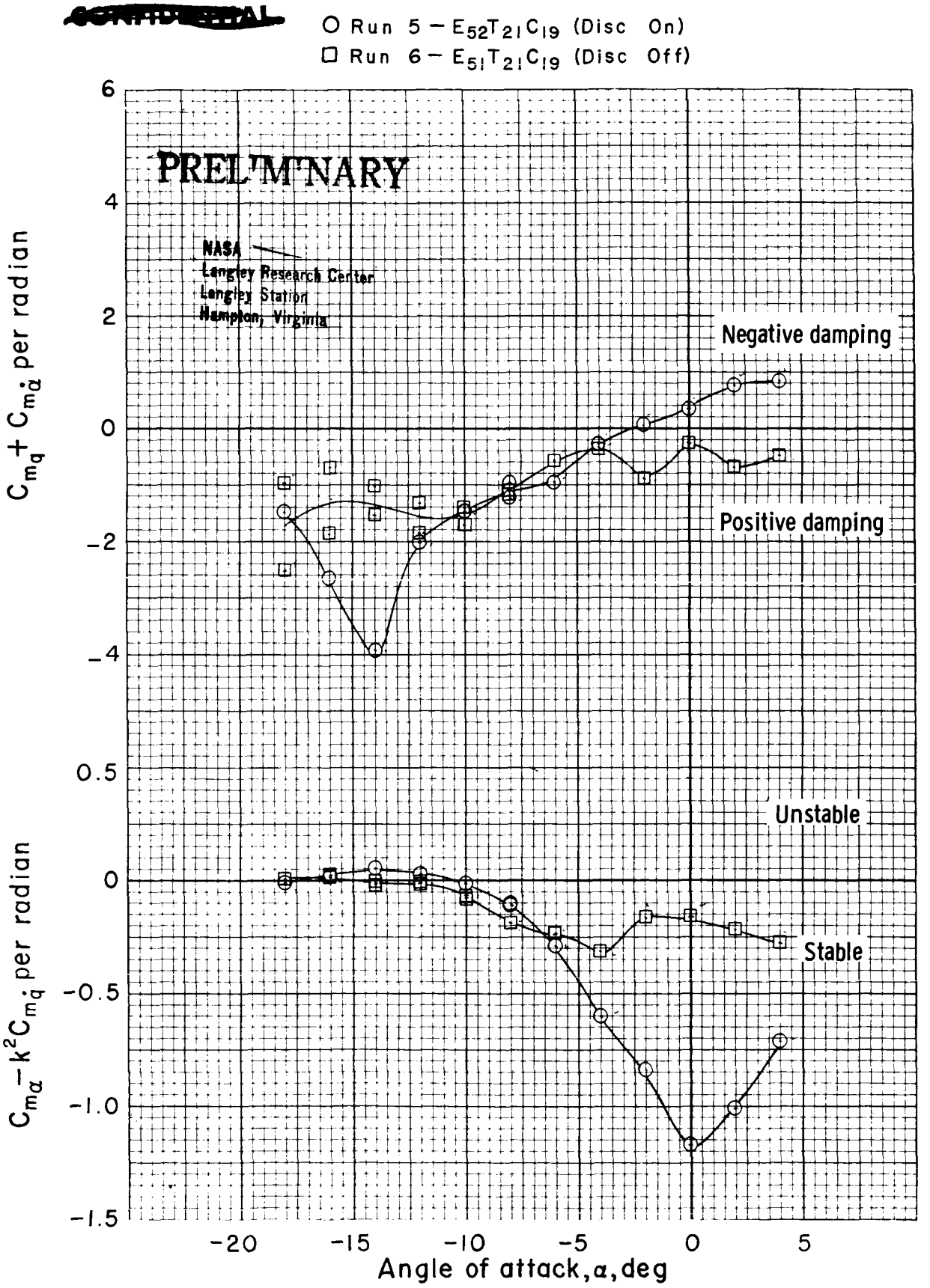
[redacted]



Effect of Flow Separator Disc on Dynamic Stability Characteristics
Launch Escape Configuration, M = 2.50 R = 2.91 x 10^6

[redacted]

[redacted]



Effect of Flow Separator Disc on Dynamic Stability Characteristics
Launch Escape Configuration, M = 2.75 R = 2.77 x 10^6

[redacted]

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APPENDIX B

TABULATED DATA

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[redacted]

Run Index

Run No.	Configuration	Mach No.	Angle Range (deg)	R x 10^{-6}	Page
1	C-Reentry (Command Module, no spacer)	1.60	159 to 142	2.45	B-5
		2.16	162 to 138	2.53	B-5
2	C-Reentry (Command Module, 0.50-inch spacer)	1.60	158 to 142	2.45	B-6
		2.16	162 to 140	2.53	B-6
3	C-Reentry (Command Module, 1.00-inch spacer)	1.60	157 to 144	2.45	B-7
		2.16	162 to 140	2.53	B-7
4	C-Reentry (Command Module, 1.75-inch spacer)	1.60	158 to 142	2.45	B-8
		2.16	162 to 138	2.53	B-8
5	$E_{52}T_{21}C_{19}$ (Launch Escape Vehicle, disc on)	1.80	+2 to -16	3.67	B-9
		2.16	+2 to -18	3.39	B-9
		2.50	+4 to -18	2.91	B-10
		2.75	+4 to -18	2.77	B-10
6	$E_{51}T_{21}C_{19}$ (Launch Escape Vehicle, disc off)	1.80	+2 to -16	3.67	B-11
		2.16	+2 to -18	3.39	B-11
		2.50	+4 to -18	2.91	B-12
		2.75	+4 to -18	2.77	B-13

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Data Format

Item or Column Heading	Definition
Config	Configuration No. 90002 - C, no spacer 90003 - C, 0.50-inch spacer 90004 - C, 1.00-inch spacer 90005 - C, 1.75-inch spacer 90010 - $E_{51}T_{21}C_{19}$ 90011 - $E_{52}T_{21}C_{19}$
Velocity	Free-stream velocity, ft/sec
Q	Free-stream dynamic pressure, lb/ft^2
R	Reynolds number x 10^{-6} based on a reference length of 0.706 ft
Theta	Phase angle between driving torque and model displacement, deg
Disp	Amplitude of oscillation, radians
Beta	Angle of sideslip, deg
Alpha	Angle of attack, deg
k	Reduced frequency parameter, $\frac{\omega \ell}{V}$
CMQ	Damping-in-pitch parameter per radian, $C_{m_q} + C_{m_{\dot{\alpha}}}$
CMA	Oscillatory longitudinal stability parameter per radian, $C_{m_\alpha} - k^2 C_{m_{\dot{q}}}$

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To expedite transmittal, the data have not been corrected for flow angularity in the tunnel test section. The flow angularity, θ_F, as determined from measurements on symmetrical bodies located in the center of the test section is as follows:

Mach No.	θ_F (deg)
1.60	+0.47
1.80	+0.63
2.16	+1.48
2.50	+1.09
2.75	+0.31

The correction should be added algebraically to the tabulated and plotted value of angle of attack.

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TEST 398 AT UPWT TS1 CONFIG 90002 REFERENCE LENGTH .706 FT.
RUN 1 09-24-62 MACH NO. 1.600 REFERENCE AREA .391 SQ.FT.
VELOCITY 1542.8 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
38	790.1	2.450	103.73	.0354	.00	150.05	.0378	.198-	.039-
39	790.2	2.451	215.19	.0354	.00	152.00	.0412	.058	.080-
40	790.7	2.452	121.77	.0354	.00	154.05	.0411	.049-	.079-
41	790.0	2.450	163.00	.0354	.00	156.05	.0412	.026	.081-
42	789.7	2.449	199.96	.0354	.00	158.00	.0411	.074	.076-
45	789.8	2.450	119.09	.0353	.00	150.05	.0378	.148-	.037-
46	790.0	2.450	150.15	.0353	.00-	148.00	.0353	.068-	.006-
47	790.0	2.450	71.95	.0354	.00-	146.05	.0347	.248-	.010-
48	790.0	2.450	84.03	.0353	.00-	144.00	.0347	.559-	.009-
51	789.9	2.450	85.97	.0354	.00-	144.00	.0351	.552-	.011-
52	789.8	2.449	101.30	.0354	.00	150.00	.0378	.147-	.039-

TEST 398 AT UPWT TS1 CONFIG 90002 REFERENCE LENGTH .706 FT.
RUN 1 09-24-62 MACH NO. 2.160 REFERENCE AREA .391 SQ.FT.
VELOCITY 1842.0 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
20	786.7	2.529	175.60	.0354	.00	150.05	.0322	.036	.047-
21	786.3	2.527	139.62	.0354	.00	152.00	.0326	.004	.054-
22	786.4	2.528	185.91	.0354	.00	154.05	.0334	.047	.064-
23	786.2	2.527	254.66	.0354	.00	156.00	.0341	.173	.076-
24	786.3	2.528	244.70	.0354	.00	158.05	.0345	.200	.081-
25	785.6	2.525	272.83	.0354	.00	160.00	.0340	.605	.077-
26	785.5	2.525	269.48	.0354	.00	162.00	.0344	.809	.082-
27	785.5	2.525	263.35	.0354	.00	156.05	.0340	.295	.075-
28	785.2	2.524	137.47	.0355	.00	150.00	.0324	.004-	.050-
29	785.3	2.524	264.16	.0355	.00-	148.00	.0314	.192	.037-
30	785.3	2.525	97.99	.0355	.00-	146.05	.0301	.225-	.019-
31	786.1	2.527	102.24	.0355	.00-	144.00	.0291	.202-	.006-
32	785.2	2.524	121.06	.0356	.00-	142.05	.0290	.116-	.003-
33	785.4	2.525	84.98	.0356	.00-	140.00	.0276	.089-	.011
34	785.6	2.525	100.00	.0356	.00-	138.05	.0263	.120-	.027
35	785.6	2.525	74.18	.0356	.00-	144.05	.0289	.221-	.006-

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TEST 398 AT UPWT TS1 CONFIG 90003 REFERENCE LENGTH .706 FT.
RUN 2 09-24-62 MACH NO. 1.600 REFERENCE AREA .391 SQ.FT.
VELOCITY 1542.8 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
9	789.7	2.449	263.61	.0364	.00	150.00	.0328	.587	.020-
10	789.7	2.449	265.90	.0364	.00	154.00	.0355	.436	.057-
11	789.3	2.448	264.52	.0364	.00	158.05	.0369	.619	.075-
12	789.9	2.450	265.45	.0365	.00	152.00	.0360	.510	.063-
13	788.4	2.445	266.16	.0365	.00	152.50	.0356	.462	.058-
14	788.9	2.446	256.72	.0365	.00	156.00	.0371	.444	.076-
15	788.9	2.447	99.51	.0364	.00-	146.00	.0282	.563-	.032
17	789.0	2.447	95.80	.0365	.00-	144.00	.0259	.662-	.054
18	789.2	2.447	268.64	.0365	.00	150.05	.0325	.423	.019-

TEST 398 AT UPWT TS1 CONFIG 90003 REFERENCE LENGTH .706 FT.
RUN 2 09-24-62 MACH NO. 2.160 REFERENCE AREA .391 SQ.FT.
VELOCITY 1842.0 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
22	785.7	2.526	94.20	.0363	.00	150.00	.0259	.341-	.000-
23	785.9	2.526	92.59	.0363	.00	152.05	.0275	.256-	.022-
24	786.0	2.527	87.84	.0362	.00	154.05	.0291	.107-	.048-
25	785.7	2.526	93.66	.0365	.00	156.00	.0296	.239-	.055-
26	785.9	2.526	26.21	.0365	.00	158.05	.0292	.238-	.066-
27	785.8	2.526	88.85	.0365	.00	160.05	.0313	.218-	.084-
28	785.9	2.526	265.47	.0365	.00	162.00	.0325	.972	.102-
29	785.7	2.526	93.05	.0365	.00	150.00	.0260	.369-	.001-
30	786.1	2.527	91.64	.0365	.00-	148.05	.0248	.372-	.014
31	786.0	2.527	89.16	.0365	.00-	146.05	.0235	.442-	.030
32	785.8	2.526	97.29	.0365	.00-	144.05	.0222	.490-	.048
33	785.9	2.526	96.67	.0365	.00-	142.05	.0217	.460-	.054
34	785.8	2.526	94.17	.0366	.00-	140.05	.0199	.516-	.073

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TEST 398 AT UPWT TS1 CONFIG 90004 REFERENCE LENGTH .706 FT.
RLN 3 09-25-62 MACH NO. 1.600 REFERENCE AREA .391 SQ.FT.
VELOCITY 1542.8 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
18	790.2	2.451	115.35	.0359	.00	150.05	.0256	.251-	.030
19	790.5	2.451	266.75	.0359	.00	154.05	.0298	.868	.025-
20	790.5	2.452	291.86	.0359	.00	157.05	.0299	1.154	.041-
21	790.6	2.452	279.40	.0359	.00	156.05	.0305	.644	.040-
22	790.5	2.452	134.93	.0359	.00	150.05	.0257	.188-	.031
23	790.7	2.452	85.41	.0360	.00-	146.05	.0194	.578-	.090
24	790.8	2.452	100.57	.0360	.00-	144.00	.0167	.707-	.116
25	790.9	2.453	82.68	.0360	.00	150.00	.0251	.206-	.032

TEST 398 AT UPWT TS1 CONFIG 90004 REFERENCE LENGTH .706 FT.
RLN 3 09-25-62 MACH NO. 2.160 REFERENCE AREA .391 SQ.FT.
VELOCITY 1842.0 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
28	786.3	2.528	106.50	.0354	.00	150.00	.0202	.354-	.046
29	784.9	2.523	109.07	.0354	.00	154.00	.0237	.165-	.005-
30	785.3	2.524	104.27	.0354	.00	158.00	.0254	.293-	.031-
31	785.5	2.525	316.33	.0354	.00	162.05	.0274	.125	.072-
32	784.9	2.523	96.91	.0351	.00	154.00	.0235	.182-	.003-
33	785.1	2.524	115.60	.0350	.00	150.00	.0202	.336-	.047
34	785.2	2.524	117.92	.0355	.00-	146.00	.0168	.366-	.089
35	785.1	2.524	81.93	.0355	.00-	142.05	.0139	.349-	.114
36	785.0	2.523	118.27	.0355	.00-	140.00	.0117	.309-	.137
37	784.9	2.523	116.30	.0355	.00-	146.05	.0165	.373-	.092
38	785.1	2.524	98.71	.0355	.00	150.00	.0200	.334-	.048

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TEST 398 AT UPWT TS1 CONFIG 90005
RUN 4 09-25-62 MACH NO. 1.600
VELOCITY 1542.8

REFERENCE LENGTH .706 FT.
REFERENCE AREA .391 SQ.FT.
TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
7	787.5	2.442	122.68	.0353	.00	150.05	.0153	.285-	.098
8	790.1	2.450	268.90	.0354	.00	154.00	.0217	3.948	.013
9	790.0	2.450	268.74	.0354	.00	154.00	.0216	2.966	.013
10	790.3	2.451	269.29	.0354	.00	156.00	.0238	2.126	.022-
11	790.6	2.452	269.29	.0354	.00	158.00	.0246	1.586	.036-
12	791.4	2.454	255.29	.0354	.00	154.00	.0223	2.927	.019
13	791.5	2.455	264.17	.0354	.00	154.05	.0223	3.541	.010
14	791.4	2.454	168.55	.0354	.00	150.05	.0155	.093-	.103
15	791.0	2.453	157.02	.0355	.00-	146.00	.0118	1.198-	.164
16	790.9	2.453	170.60	.0355	.00-	144.00	.0119	1.094-	.210
18	791.1	2.454	158.82	.0357	.00-	146.05	.0102	1.198-	.174
19	790.1	2.450	177.00	.0356	.00-	146.00	.0313	.546-	.176
20	790.0	2.450	96.60	.0354	.00	150.05	.0151	.351-	.098

TEST 398 AT UPWT TS1 CONFIG 90005
RUN 4 09-25-62 MACH NO. 2.160
VELOCITY 1842.0

REFERENCE LENGTH .706 FT.
REFERENCE AREA .391 SQ.FT.
TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
23	785.6	2.525	103.34	.0352	.00	150.00	.0116	.603-	.112
24	785.1	2.524	106.31	.0353	.00	154.00	.0157	.333-	.055
25	786.2	2.527	82.07	.0353	.00	158.05	.0178	.380-	.016
26	786.0	2.527	253.37	.0353	.00	162.00	.0208	.306	.039-
27	786.3	2.527	93.44	.0353	.00	154.05	.0157	.469-	.055
28	786.0	2.527	96.59	.0353	.00	150.00	.0117	.699-	.111
29	785.7	2.526	164.10	.0355	.00-	146.05	.0096	1.157-	.173
30	786.0	2.527	166.38	.0355	.00-	146.00	.0096	.946-	.172
31	786.0	2.527	172.87	.0354	.00-	142.00	.0098	.908-	.206
32	785.8	2.526	175.72	.0355	.00-	138.05	.0098	.857-	.249
33	785.9	2.526	163.65	.0355	.00-	146.05	.0097	1.208-	.173
34	786.1	2.527	83.09	.0353	.00	150.00	.0115	.708-	.111

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TEST 398 AT UPWT TS1 CONFIG 90011 REFERENCE LENGTH .706 FT.
RUN 5 09-25-62 MACH NO. 1.800 REFERENCE AREA .391 SQ.FT.
VELOCITY 1662.5 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
32	1184.4	3.667	107.02	.0355	.00	8.00-	.0254	.518-	.228-
33	1184.2	3.667	85.15	.0356	.00	6.00-	.0325	.799-	.460-
34	1184.3	3.667	359.99	.0356	.00	4.00-	.0305	.024	.634-
35	1184.2	3.667	352.03	.0353	.00	2.00-	.0306	4.395	1.352-
36	1184.4	3.667	353.06	.0351	.00	.00	.0312	4.104	1.461-
37	1184.0	3.666	9.55	.0355	.00	2.00	.0299	.945-	.542-
38	1184.2	3.667	85.93	.0355	.00	7.95-	.0254	.775-	.234-
39	1184.2	3.667	90.06	.0355	.00-	9.95-	.0194	.819-	.087-
41	1184.4	3.667	171.61	.0354	.00-	12.00-	.0150	2.403-	.244
42	1184.4	3.667	175.03	.0355	.00-	14.00-	.0160	2.743-	.489
43	1183.8	3.666	175.01	.0355	.00-	16.00-	.0160	2.809-	.500

TEST 398 AT UPWT TS1 CONFIG 90011 REFERENCE LENGTH .706 FT.
RUN 5 09-25-62 MACH NO. 2.160 REFERENCE AREA .391 SQ.FT.
VELOCITY 1842.0 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
12	1053.9	3.388	97.20	.0356	.00	8.00-	.0242	.865-	.306-
13	1053.9	3.388	91.94	.0357	.00	5.95-	.0331	1.224-	.693-
14	1053.7	3.387	4.36	.0356	.00	3.95-	.0290	1.063-	.917-
15	1053.8	3.388	3.17	.0355	.00	2.00-	.0290	1.337-	1.215-
16	1053.6	3.387	7.16	.0355	.00	.00	.0290	2.340-	1.049-
17	1054.0	3.388	4.13	.0357	.00	2.05	.0290	.796-	.834-
18	1054.5	3.390	98.86	.0357	.00	7.95-	.0245	1.003-	.313-
19	1054.2	3.389	3.18	.0356	.00	4.00-	.0291	.779-	.930-
20	1054.0	3.388	7.50	.0354	.00	.00	.0291	2.363-	1.036-
21	1054.4	3.390	4.63	.0356	.00	2.00	.0291	.895-	.839-
22	1054.6	3.390	98.43	.0356	.00	7.95-	.0243	.695-	.307-
23	1054.3	3.389	94.12	.0354	.00-	10.00-	.0139	1.662-	.010-
24	1054.5	3.390	171.11	.0354	.00-	11.95-	.0140	2.785-	.239
25	1054.3	3.389	173.90	.0355	.00-	14.00-	.0139	2.306-	.293
26	1054.6	3.390	174.27	.0355	.00-	16.00-	.0140	2.091-	.283
27	1054.2	3.389	174.63	.0355	.00-	18.00-	.0140	1.959-	.284
28	1053.7	3.387	95.03	.0356	.00	8.00-	.0242	.698-	.306-

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TEST 398 AT UPWT TS1 CONFIG 90011 REFERENCE LENGTH .706 FT.
RUN 5 09-25-62 MACH NO. 2.500 REFERENCE AREA .391 SQ.FT.
VELOCITY 2017.9 TOTAL TEMPERATURE 150 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
46	897.3	2.910	94.70	.0354	.00	7.95-	.0164	1.338-	.126-
47	897.0	2.909	98.79	.0355	.00	6.00-	.0253	.417-	.523-
48	896.6	2.908	359.16	.0355	.00	4.00-	.0241	.298	.891-
49	897.3	2.910	6.43	.0355	.00	2.00-	.0241	2.302-	.964-
50	896.6	2.908	6.63	.0354	.00	.00	.0241	2.344-	.958-
51	897.5	2.910	359.11	.0351	.00	2.00	.0189	.556	.859-
52	896.6	2.908	.65	.0351	.00	2.00	.0189	.338-	.856-
53	897.5	2.911	358.03	.0353	.00	4.05	.0189	.741	.612-
54	896.9	2.909	90.00	.0354	.00	7.95-	.0169	1.602-	.146-
55	897.0	2.909	95.94	.0353	.00-	10.00-	.0113	1.609-	.022
56	897.3	2.910	172.12	.0354	.00-	12.00-	.0162	1.667-	.077
57	896.8	2.908	174.44	.0354	.00-	14.00-	.0163	1.344-	.107
58	897.3	2.910	171.33	.0354	.00-	16.00-	.0163	2.062-	.100
59	896.6	2.908	172.51	.0354	.00-	18.00-	.0163	2.108-	.140

TEST 398 AT UPWT TS1 CONFIG 90011 REFERENCE LENGTH .706 FT.
RUN 5 09-25-62 MACH NO. 2.750 REFERENCE AREA .391 SQ.FT.
VELOCITY 2100.6 TOTAL TEMPERATURE 150 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
62	800.3	2.765	95.27	.0353	.00	8.00-	.0150	.971-	.113-
63	800.8	2.766	88.74	.0354	.00	5.95-	.0191	.936-	.296-
64	800.9	2.767	1.33	.0354	.00	4.00-	.0198	.276-	.605-
65	800.4	2.765	359.95	.0354	.00	2.00-	.0199	.064	.844-
67	800.6	2.766	359.55	.0354	.00	.05	.0199	.377	1.183-
68	800.4	2.765	358.76	.0351	.00	2.05	.0199	.772	1.010-
69	800.4	2.765	357.61	.0354	.00	4.00	.0199	.818	.704-
70	800.2	2.764	92.14	.0354	.00	8.00-	.0148	1.226-	.104-
71	800.3	2.765	166.45	.0354	.00-	9.95-	.0148	1.489-	.011-
72	800.4	2.765	166.80	.0354	.00-	11.95-	.0148	2.015-	.024
73	800.3	2.765	159.94	.0354	.00-	14.00-	.0148	3.941-	.055
74	800.6	2.766	162.64	.0354	.00-	15.95-	.0148	2.665-	.022
75	800.3	2.765	166.15	.0354	.00-	18.00-	.0148	1.482-	.016-

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TEST 398 AT UPWT TS1 CONFIG 90010 REFERENCE LENGTH .706 FT.
RLN 6 09-25-62 MACH NO. 1.800 REFERENCE AREA .391 SQ.FT.
VELOCITY 1662.5 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
46	1186.3	3.673	87.74	.0355	.00	8.00-	.0258	.738-	.206-
47	1186.7	3.675	93.74	.0355	.00	4.00-	.0339	2.041-	.438-
48	1185.9	3.672	13.87	.0355	.00	.05	.0283	1.662-	.468-
49	1186.6	3.674	30.64	.0356	.00	2.00	.0283	2.303-	.384-
50	1186.6	3.674	7.64	.0355	.00	2.00-	.0283	1.103-	.511-
51	1186.3	3.673	84.35	.0355	.00	7.95-	.0262	.825-	.218-
52	1186.6	3.674	173.91	.0357	.00-	12.00-	.0262	1.792-	.230
53	1186.9	3.675	174.62	.0358	.00-	15.95-	.0263	2.673-	.535

TEST 398 AT UPWT TS1 CONFIG 90010 REFERENCE LENGTH .706 FT.
RLN 6 09-25-62 MACH NO. 2.160 REFERENCE AREA .391 SQ.FT.
VELOCITY 1842.0 TOTAL TEMPERATURE 125 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
56	1053.6	3.387	96.15	.0355	.00	8.00-	.0250	.352-	.288-
57	1054.0	3.388	83.93	.0355	.00	4.00-	.0237	1.037-	.247-
58	1054.1	3.389	81.57	.0355	.00	1.95-	.0141	2.775-	.006-
59	1053.9	3.388	92.42	.0356	.00	.05	.0231	1.297-	.224-
60	1053.7	3.387	358.13	.0356	.00	2.00	.0231	.457	.529-
61	1053.5	3.387	88.68	.0356	.00	7.95-	.0252	.474-	.297-
62	1053.4	3.386	170.78	.0357	.00-	11.95-	.0186	1.859-	.116
63	1053.5	3.387	173.95	.0357	.00-	16.00-	.0184	2.592-	.362
64	1052.9	3.385	175.44	.0357	.00-	18.00-	.0185	1.997-	.374

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TEST 398 AT UPWT TS1 CONFIG 90010 REFERENCE LENGTH .706 FT.
RUN 6 C9-25-62 MACH NO. 2.500 REFERENCE AREA .391 SQ.FT.
VELOCITY 2017.9 TOTAL TEMPERATURE 150 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
8	897.7	2.911	90.40	.0354	.00	8.00-	.0198	.931-	.215-
9	897.4	2.910	104.34	.0355	.00	6.00-	.0220	.236-	.303-
10	897.5	2.911	95.44	.0355	.00	4.00-	.0229	.377-	.340-
11	897.6	2.911	86.72	.0355	.00	2.00-	.0164	1.592-	.102-
12	897.6	2.911	94.76	.0355	.00	.05	.0165	1.322-	.101-
13	897.5	2.911	96.13	.0355	.00	2.05	.0225	.576-	.323-
14	896.8	2.908	97.60	.0355	.00	4.05	.0224	.312-	.319-
15	897.3	2.910	94.70	.0355	.00	7.95-	.0198	.719-	.214-
16	897.8	2.912	91.29	.0355	.00-	10.00-	.0155	1.840-	.070-
17	897.4	2.910	92.74	.0353	.00-	12.00-	.0112	1.284-	.039
18	897.4	2.910	165.85	.0353	.00-	14.00-	.0127	2.106-	.111
19	898.0	2.912	171.14	.0354	.00-	16.00-	.0169	1.851-	.089
20	897.4	2.910	172.37	.0354	.00-	15.95-	.0169	1.687-	.103
21	897.8	2.912	171.92	.0354	.00-	17.95-	.0169	1.837-	.108
22	898.5	2.914	174.21	.0354	.00-	17.95-	.0169	1.305-	.108
23	898.0	2.912	172.61	.0355	.00-	11.95-	.0169	1.124-	.035

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TEST 398 AT UPWT TS1
RUN 6 09-25-62

CONFIG 90010
MACH NO. 2.750
VELOCITY 2100.6

REFERENCE LENGTH .706 FT.
REFERENCE AREA .391 SQ.FT.
TOTAL TEMPERATURE 150 DEG.F.

POINT	Q	R	THETA	DISP.	BETA	ALPHA	K	CMQ	CMA
26	800.4	2.765	89.53	.0354	.00	8.00-	.0177	1.192-	.186-
27	800.2	2.764	91.67	.0354	.00	6.00-	.0189	.589-	.236-
28	800.4	2.765	95.50	.0355	.00	4.00-	.0204	.320-	.307-
29	800.0	2.764	93.44	.0355	.00	2.00-	.0174	.893-	.172-
30	800.4	2.765	98.40	.0355	.00	.05	.0174	.241-	.172-
31	800.4	2.765	90.97	.0355	.00	2.05	.0186	.685-	.222-
32	800.2	2.764	93.77	.0355	.00	4.00	.0199	.488-	.282-
33	800.2	2.764	91.49	.0355	.00	8.00-	.0178	1.136-	.189-
34	800.4	2.765	96.76	.0354	.00-	9.95-	.0146	1.411-	.068-
35	800.4	2.765	82.07	.0354	.00-	9.95-	.0146	1.724-	.074-
36	799.9	2.763	81.66	.0354	.00-	11.95-	.0127	1.368-	.012-
37	800.4	2.765	80.47	.0354	.00-	11.95-	.0127	1.869-	.014-
38	800.5	2.765	88.11	.0354	.00-	14.00-	.0129	1.013-	.015-
39	800.6	2.766	82.64	.0354	.00-	14.00-	.0129	1.543-	.017-
40	800.6	2.766	54.09	.0353	.00-	15.95-	.0116	.683-	.015
41	800.3	2.765	92.21	.0353	.00-	16.00-	.0116	1.879-	.022
42	800.5	2.765	96.99	.0353	.00-	17.95-	.0121	.990-	.009
43	800.5	2.765	90.70	.0353	.00-	17.95-	.0120	2.541-	.009

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