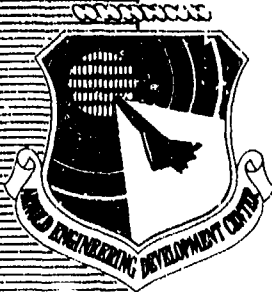


AD-A186 291



STATIC FORCE AND MOMENT TEST OF THE
HOLLOMAN NARROW-GAGE ROCKET SLED AT
MACH NUMBERS FROM 3.5 TO 5.5

C. L. Ratliff
Calspan Corporation

September 1987

Final Report for Period May 4 - May 7, 1987

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ARNOLD AIR FORCE BASE, TENNESSEE
AIR FORCE SYSTEMS COMMAND
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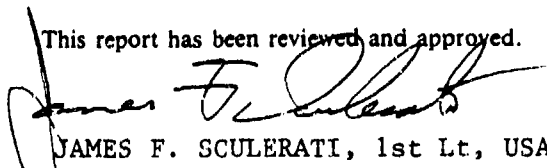
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FINAL TABULATED DATA



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NOMENCLATURE

A	Projected frontal area of model, 8.289 in. ²
AB	Cross-sectional area at the base, 7.514 in. ²
ALPHA	Model angle of attack, deg
ALPHA-GP	Ground plane angle of attack, deg
ALPI	Indicated sector pitch angle, deg
CA	Forebody axial-force coefficient, (CAT - CABT)
CABT	Base axial-force coefficient, - CPBA · AB/A
CAT	Total axial-force coefficient, total axial force/QA
CLL	Rolling-moment coefficient, rolling-moment/ QAℓ ₃
CLM	Pitching-moment coefficient, pitching-moment/ QAℓ ₁
CLN	Yawing-moment coefficient, yawing-moment/ QAℓ ₂
CN	Normal-force coefficient, normal-force/QA
CODE	Model configuration number (see Table 1)
CONFIG	Model configuration designation (see Table 1)
CPBA	Model base pressure coefficient, (PBA-P)/Q
CY	Side-force coefficient, side-force/QA
DS	Horizontal distance between the centerline of the front and rear slipper, 9.6 in.
FOUL	Indicates which slipper(s) contacted the rail
Hf	Average forward slipper height, in.
HR	Average rear slipper height, in.
hf _i	Front slipper height forward of the centerline of each slipper, i = 1, 2, 3, 4
hr _i	Rear slipper height aft of the centerline of each slipper, i = 1, 2, 3, 4
ℓ _i	Reference lengths to calculate the pitching-moment, yawing-moment and rolling-moment, in. i = 1, 2, 3

M	Free-stream Mach number
MRP	Model moment reference point (18.68 in. from the nose)
P	Free-stream static pressure, psia
PBA	Average base pressure, $(PB1 + PB2 + PB3 + PB4/4)$, psia
PB _i	Base pressure, psia, $i = 1, 2, 3, 4$
PHI	Aerodynamic roll angle, deg
PHII	Indicated sector roll angle, deg
PN	Data point number
PT	Tunnel stilling chamber pressure, psia
Q	Free-stream dynamic pressure, psia
RE	Free-stream unit Reynolds number, ft ⁻¹
RUN	Data set identification number
T	Free-stream static temperature, °R
TRIP	Identification of trip ball size, in.
TT	Tunnel stilling chamber temperature, °R
V	Free-stream velocity, fps

1.0 INTRODUCTION

The work reported herein was performed by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 921A71, Control Number 9A71, at the request of the 6585th Test Group/TKE, Holloman Air Force Base, New Mexico. The 6585th Test Group project manager was Mr. Jack Meyers. The results were obtained by Calspan Corporation/AEDC Division, operating contractor for the Aerospace Flight Dynamics testing effort at the AEDC, AFSC, Arnold Air Force Base, Tennessee. The test was performed in the von Karman Gas Dynamics Facility (VKF) Supersonic Wind Tunnel A during the period 4-7 May 1987, under AEDC Project Number CI62VA (Calspan Project Number V41A-37).

The primary objective of this test was to obtain aerodynamic loads data on a 1/12th scale model of a Holloman Narrow-Gage Rocket Sled with and without two top-mounted wedge configurations. The two wedge configuration angles were 4 and 16 deg. This test also used the Image Analyzer Data System (IADS), for the first time on a rocket sled test, to monitor the slipper clearances. This information was also used in calculating the angle of attack of the model with respect to the ground plane. In the past test, the model was assumed to be at an angle of attack of zero deg.

Inquiries to obtain copies of the test data should be directed to the 6585th Test Group/TKE, Holloman AFB, New Mexico 88330. A microfiche record of the tabulated data has been retained by the VKF at AEDC.

2.0 APPARATUS

2.1 TEST FACILITY

Tunnel A (Fig. 1) is a continuous, closed-circuit, variable density wind tunnel with an automatically driven flexible-plate-type nozzle and a 40- by 40-in. test section. The tunnel can be operated at Mach numbers from 1.5 to 5.5 at maximum stagnation pressures from 29 to 200 psia, respectively, and stagnation temperatures up to 750 OR at Mach number 5.5. Minimum operating pressures range from about one-tenth to one-twentieth of the maximum at each Mach number. The tunnel is equipped with a model injection system which allows removal of the model from the test section while the tunnel remains in operation. In this test the full inject/retract capability was not used. The model remained in the test section during tunnel startup and shutdown. A description of the tunnel airflow calibration information may be found in the Test Facilities Handbook (Ref. 1).

2.2 TEST ARTICLE

The Narrow-Gage Rocket Sled model and ground plane assembly, designed and fabricated by Systems Research Laboratories (SRL), is shown installed in Tunnel A in Fig. 2 and schematically in Fig. 3. The model, sting, and ground plane assembly are shown in Fig. 4 and details

of the model, rocket motors and wedges are shown in Figs. 5, 6, and 7, respectively. The baseline configuration is defined as the model without any wedges and is described in Table 1 along with the other two configurations. A trip band was used during the test on the nose of the model to promote early boundary layer transition. Three circular rows of 0.025 in. size balls were placed 0.082 in. apart with 14 balls per row and the middle row 1.0 in. axially from the nose tip (Fig. 8).

Before testing, two hardware problems had to be resolved. When the basic model was last run in 1974 (Ref. 2) an AEDC balance (4.04-Y-36-032) was used and had a rated normal force of thirty pounds. This particular balance had a tapered aft section. Since this balance no longer existed and the selected balance (4.00-Y-36-081) had an aft clutch face, the sting had to be altered by machining a matching clutch face. Next, the ground plane had to be reinforced on the sides. A tunnel blockage and stress analyses were performed and a weak section was found just ahead of the existing side plates. This area had to be strengthened to maintain a safety factor of 2 for a marginal block condition when starting and stopping the tunnel with the model in the test section. Extension braces were welded to the existing plates across the weakened area to give the needed support (Fig. 3).

The model could also be driven vertically and in pitch by remotely operated yokes attached to the sting support (Fig. 4). Fouling circuits were used to indicate when contact existed between the model slipper and the rails.

2.3 TEST INSTRUMENTATION

The measuring devices, recording devices, and calibration methods used for all measured parameters are listed in Table 2.

2.3.1 Model Force Instrumentation

Model forces and moments were measured with an internal six-component main balance which was supplied and calibrated by AEDC. Before each shift of the test, static loads were applied to the balance to simulate the range of loads anticipated for the test.

2.3.2 Model Positioning

The model, supported by a balance and sting, could be driven in pitch and height by motor-driven yokes attached to the sting. The roll motor was not used during the test (disconnected) at the users request.

2.3.3 Optical Instrumentation

Model/flow-field shadowgraph and color schlieren photographs were obtained on all three configurations. The photographs were obtained with a double-pass optical flow visualization system having a 35-in.-diam field of view.

The vertical distance from the top of a slipper to the top of the rail was measured with an Image Analyzer Data System (IADS). An IADS print (Fig. 9) shows the magnification and detail of slipper 2 as noted in Fig. 3. The slippers were also electrically isolated from the rails such, that if one or more of the slippers touched a rail, a foul light would turn on at the remote control unit and the drive-motors would stop. This condition indicated which slipper was fouled and was corrected by driving the model slipper to an unfouled position. An override button was interfaced with the remote control unit so that when a slipper fouled and the drive-motors turned off, the override button had to be pressed before the motors could be driven again. This prevented damaging a slipper and gave a moment to think about which motor to drive next to achieve an unfouled position.

During all test runs the distance between the top of the slippers (front and rear) and the top of the rail were measured with the IADS and recorded as shown in Table 3. The clearance between the inside top slipper and rail ranged from about 0.010 to 0.120-in. An example of calculating the model angle of attack is shown in Table 3.

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS

A summary of the nominal test conditions at each Mach number is given below:

M	PT	TT	Q	P	RE x 10 ⁻⁶	T	V
3.5	53	590	5.90	0.69	5.5	171	2244
4.0	69	590	5.00	0.45	5.5	140	2324
4.5	109	570	5.30	0.38	7.2	113	2345
5.0	143	660	4.70	0.27	6.0	110	2571
5.5	61	680	1.40	0.07	1.9	96	2642

The Tunnel A sidewall Mach number probe was used routinely to monitor deviations from the standard calibrated Mach numbers. When a deviation is measured, the free-stream conditions are corrected and the actual Mach number is printed on the data tabulations. At Mach numbers 5.0 and 5.5, higher total temperatures are required to maintain conditions above air liquefaction. An attempt was made at Mach 5.5 to run at the maximum Reynolds number of 4.5×10^6 (TT = 720, PT = 154), but the balance temperature exceeded the allowable temperature of 1800F and conditions had to be lowered.

A run summary showing all configurations tested and the variables for each is presented in Table 4.

3.2 TEST PROCEDURES

3.2.1 General

In the VKF continuous-flow Wind Tunnel A the model is mounted on a sting support mechanism in an installation tank directly underneath the

tunnel test section. The tank is separated from the tunnel by a pair of fairing doors and a safety door. When closed, the fairing doors, except for a slot for the pitch sector, cover the opening to the tank, and the safety door seals the tunnel from the tank area. After the model is prepared for a data run, the personnel access door to the installation tank is closed, the tank is vented to the tunnel flow, the safety and fairing doors are opened, the model is injected into the airstream, and the fairing doors are closed. After the data are obtained, the model is retracted into the tank, and the sequence is reversed with the tank being vented to atmosphere to allow access to the model in preparation for the next run. The sequence is repeated for each configuration change.

For this test, there was a potentially high risk of model damage due to deflection under airloads during the injection process and the above standard procedures were not used. For each model configuration, tunnel flow was started (at low pressure levels) with the model in the test section, and after data at all desired Mach numbers were obtained, the tunnel was shut-down (again at low pressure conditions). The model was then retracted for the next configuration change and the process repeated.

3.2.2 Data Acquisition

Data were recorded in the manual fixed point-pause mode of operation. The point-pause data were obtained for a value of ALPHA and YAW (zero) with a delay before the first data point to allow the base pressures to stabilize. Each data point for this mode of operation is the result of a Kaiser-Bessel digital filter utilizing 16 samples taken over a time span of 0.333 sec.

3.3 DATA REDUCTION

The Narrow-Gage Rocket Sled data were obtained utilizing the tunnel data acquisition system as described in Section 3.2.2. The force and moment measurements were reduced to coefficient form using the digitally filtered data points and correcting for first and second-order balance interaction effects. Tunnel stilling chamber pressure was also calculated from digitally filtered values. The same reference lengths and areas that were used for the baseline configuration were used for the other configurations.

3.4 MEASUREMENT UNCERTAINTIES

In general, instrumentation calibration and data uncertainty estimates were made using methods recognized by the National Bureau of Standards (NBS) presented in Ref. 3. Measurement uncertainty is a combination of bias and precision errors defined as:

$$U = \pm (B + t_{95}S)$$

where B is the bias limit, S is the sample standard deviation, and t_{95} is the 95th percentile point for the two-tailed Students "t"

distribution (95-percent confidence interval), which for sample sizes greater than 30 is taken equal to 2.

Estimates of the measured data uncertainties for this test are given in Table 2. With the exception of the force and moment balance, data uncertainties are determined from in-place calibrations through the data recording system and the data reduction program. Static load hangings on each balance simulate the range of loads and center-of-pressure locations anticipated during the test, and measurement errors are based on differences between applied loads and corresponding values calculated from the balance equations used in the data reduction. Load hangings to verify each balance calibration are made in-place on the assembled model.

Propagation of the bias and precision errors of measured data through the calculated data was made in accordance with Ref. 3 and the results are given in Table 2b. Uncertainties for the calculated data are presented for the maximum measured value of each parameter.

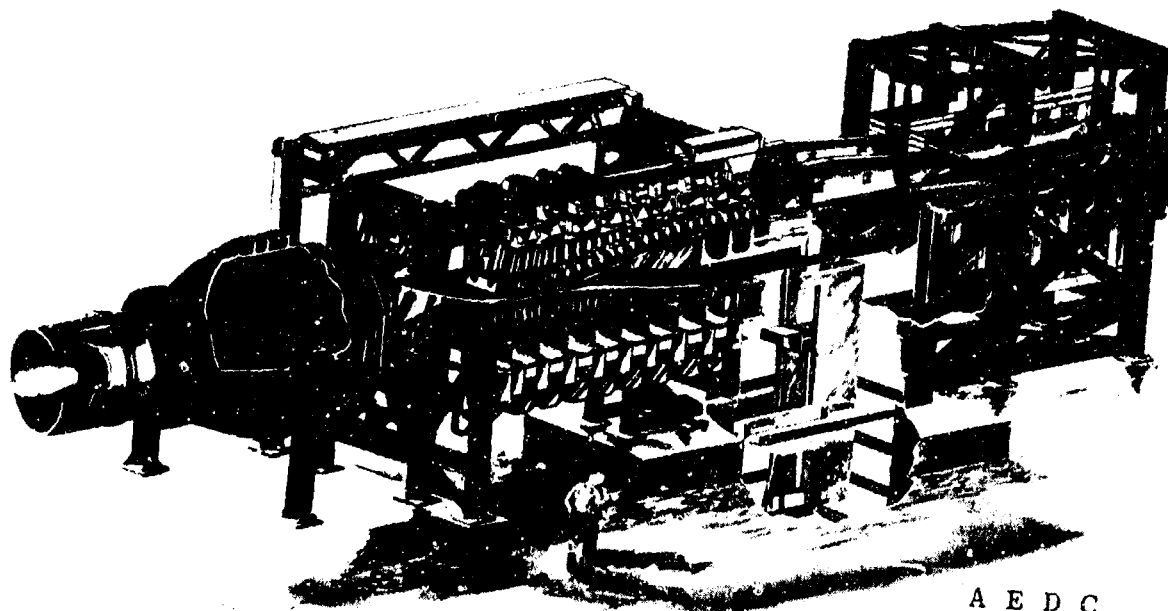
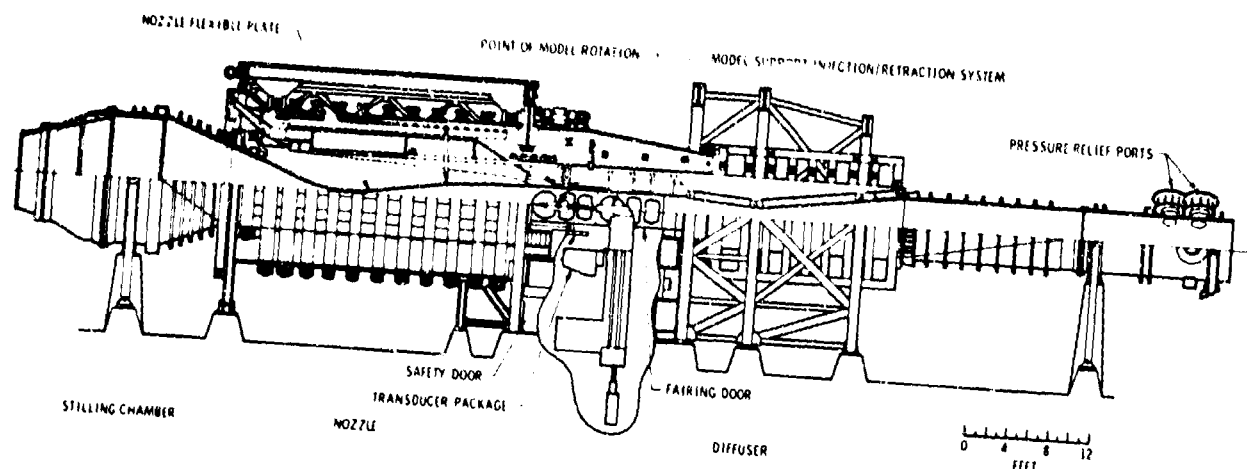
4.0 DATA PACKAGE PRESENTATION

The data package contains tabulated model aerodynamic force and moment data presented in the body axes system. Base pressure data are presented in the form of pressure ratios and coefficients. Final tabulated data obtained during the test are presented in the Appendix.

A complete set of test results in the form of tabulated data with detailed test logs and photographic data were transmitted to the 6585th Group/TKE, Holloman AFB. One printed copy and a microfiche record of this package were retained at AEDC.

REFERENCES

1. Test Facilities Handbook (Twelfth Edition), "von Karman Gas Dynamics Facility Vol. 3," Arnold Engineering Development Center, March 1984.
2. Rhudy, R. W. and Corce, J. D., "Static Force and Moment Tests of the Holloman Narrow-Gage Rocket Sled at Mach Numbers from 1.5 to 4.0." AEDC-TR-75-29, August 1975.
3. Abernethy, R. B. et. al. and Thompson, J. W., "Handbook Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5 (AD 755356), February 1973.



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Figure 1. Supersonic Wind Tunnel A

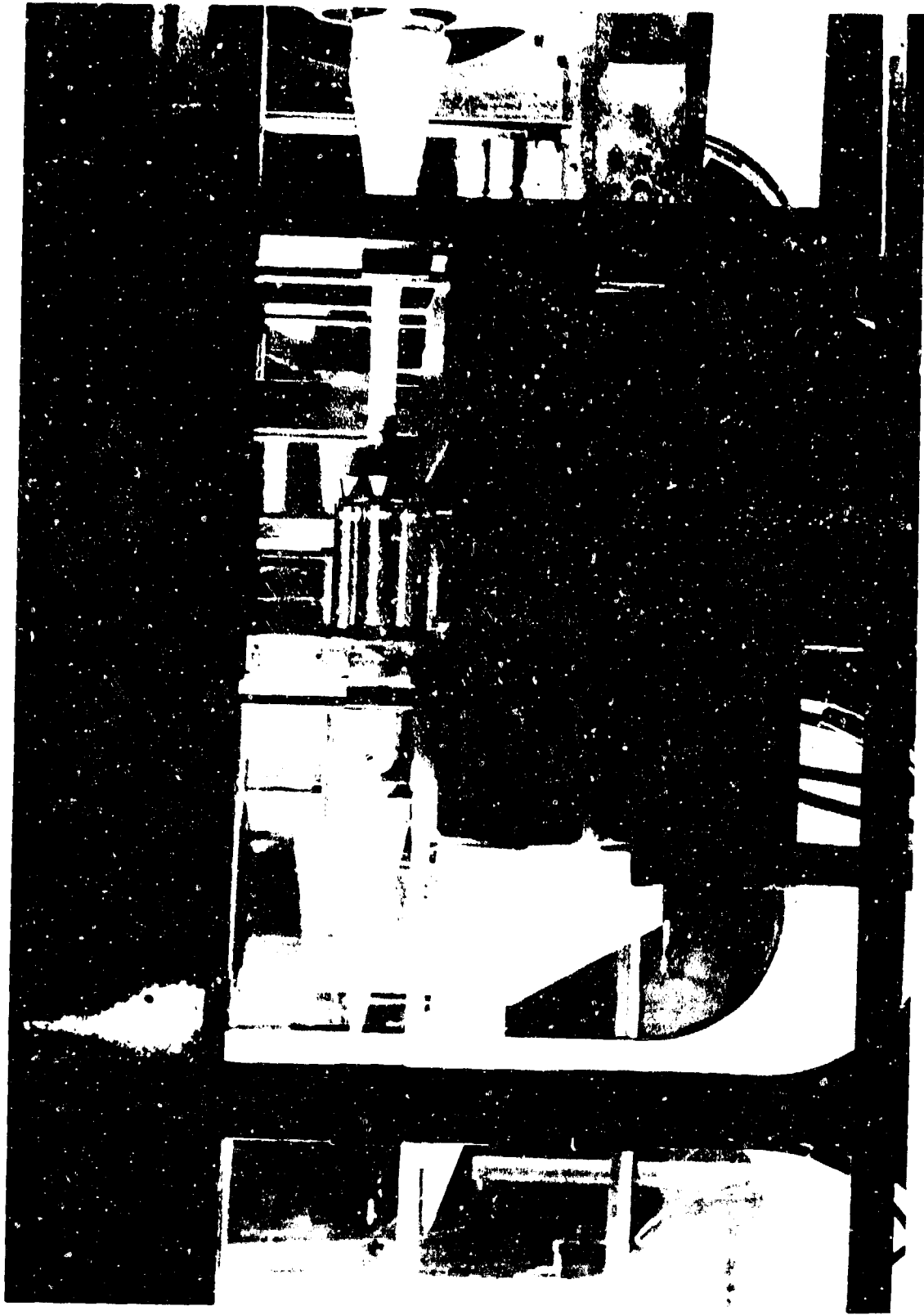
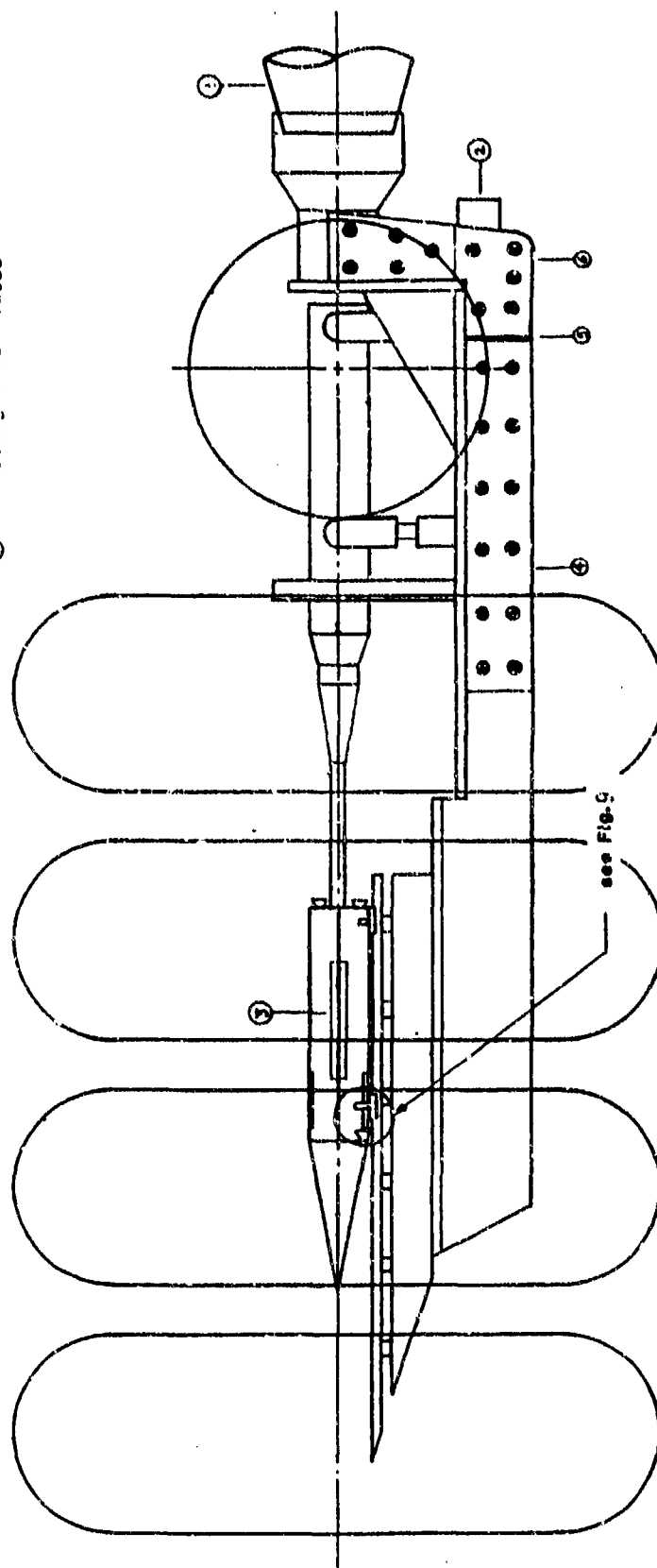


Figure 2. Narrow-Gage Rocket Sled Model Installed in Tunnel A

- ① Sector Hub
- ② Ground Plane Incl:nometer
- ③ 4.00-Y-36-081 Balance L=6.00 in.
- ④ Extension Braces
- ⑤ Welded Joint
- ⑥ Existing Side-Plates

Tunnel Wall



TUNNEL WALL

Figure 3. Installation Sketch

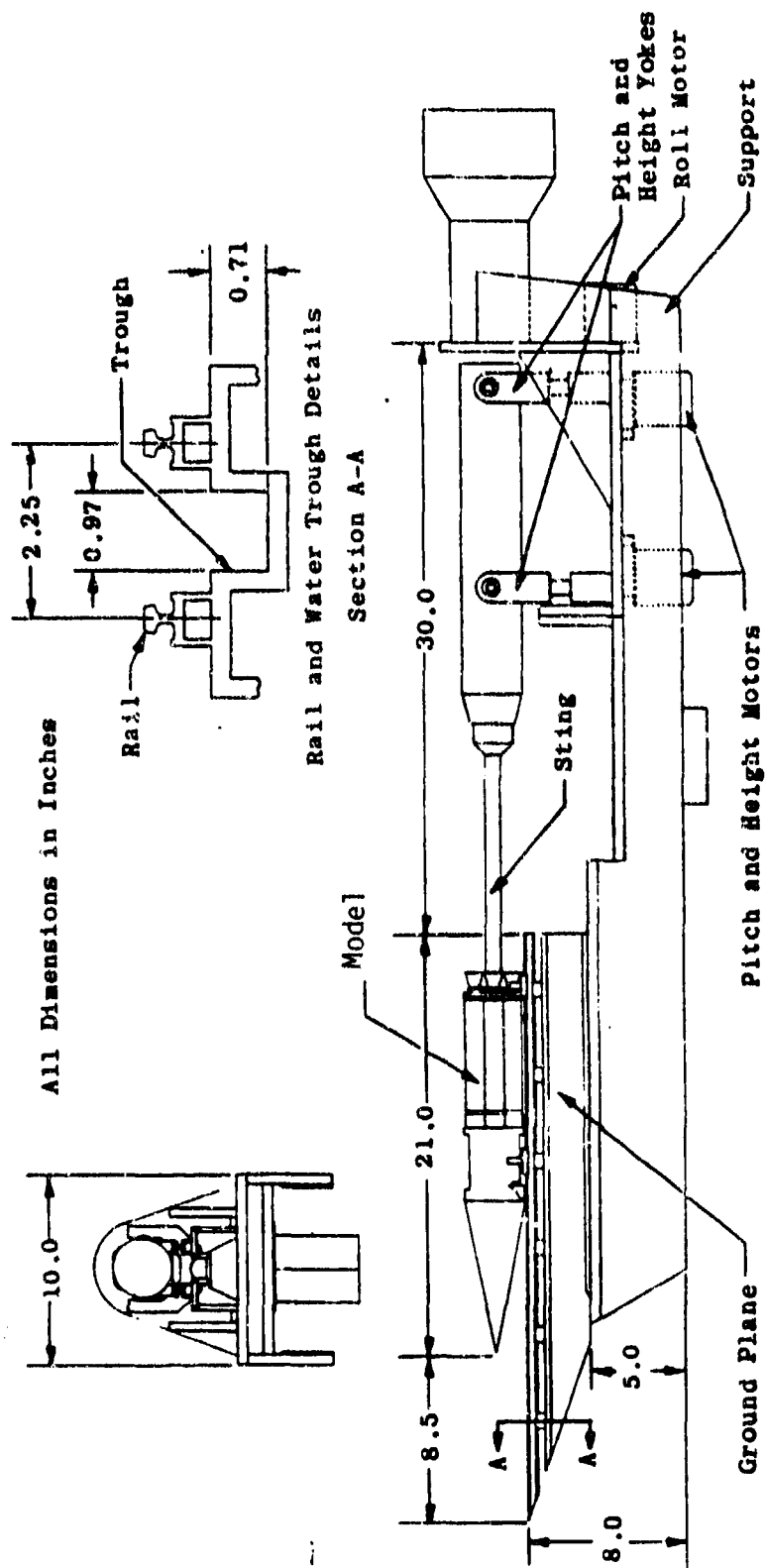


Figure 4. Model, sting, and ground plane assembly.

All Dimensions in Inches

Slipper Height	Dimension A
Short	1.508

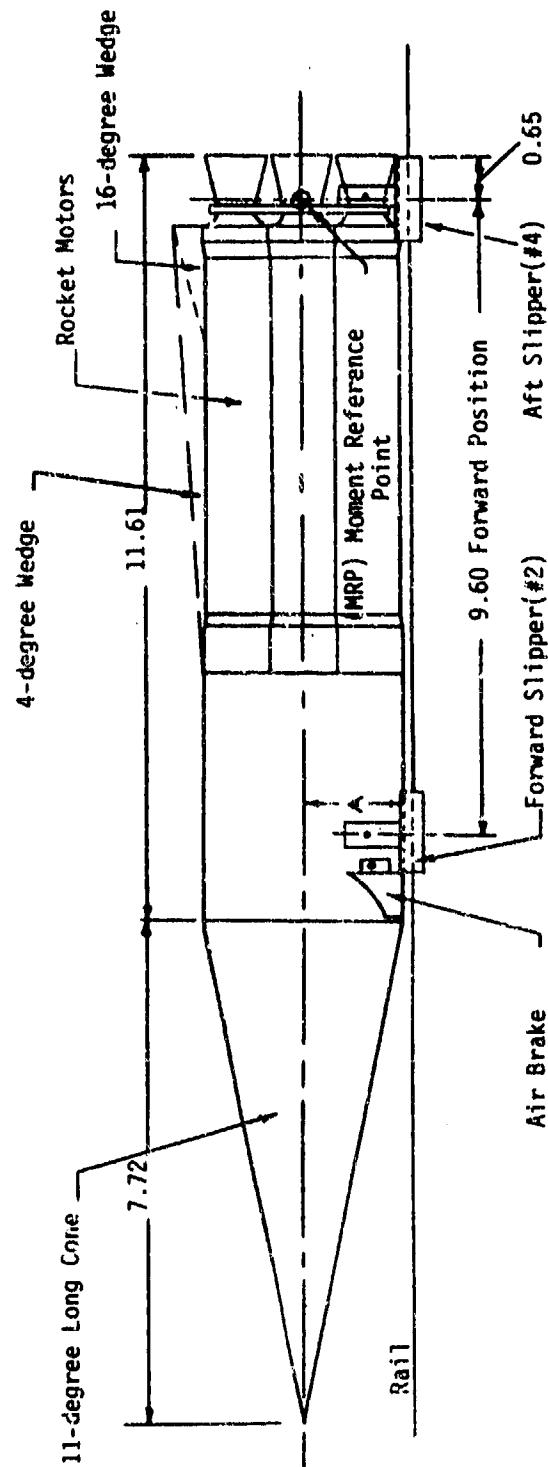


Figure 5. Model Details

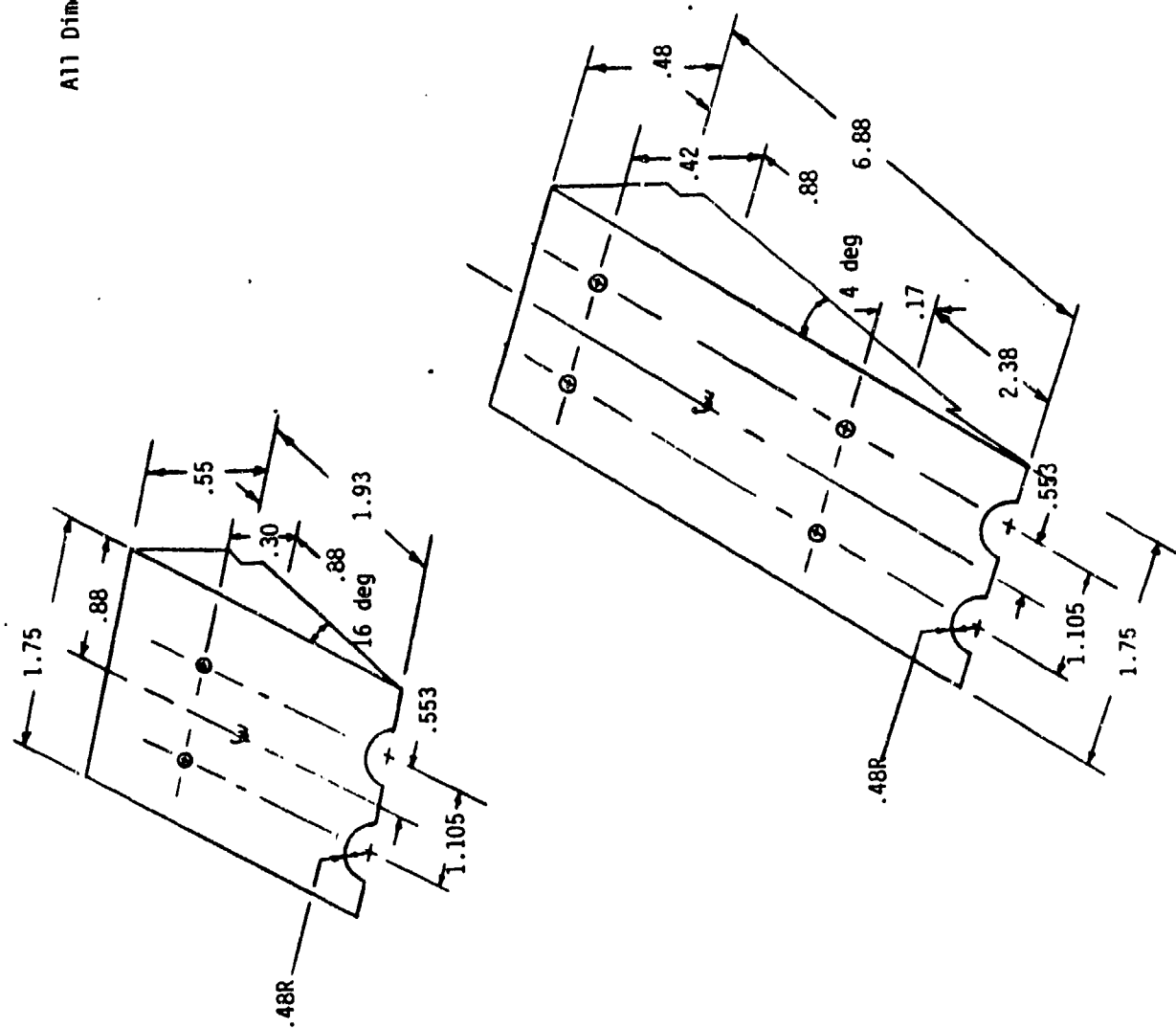


Figure 7. Wedge Details

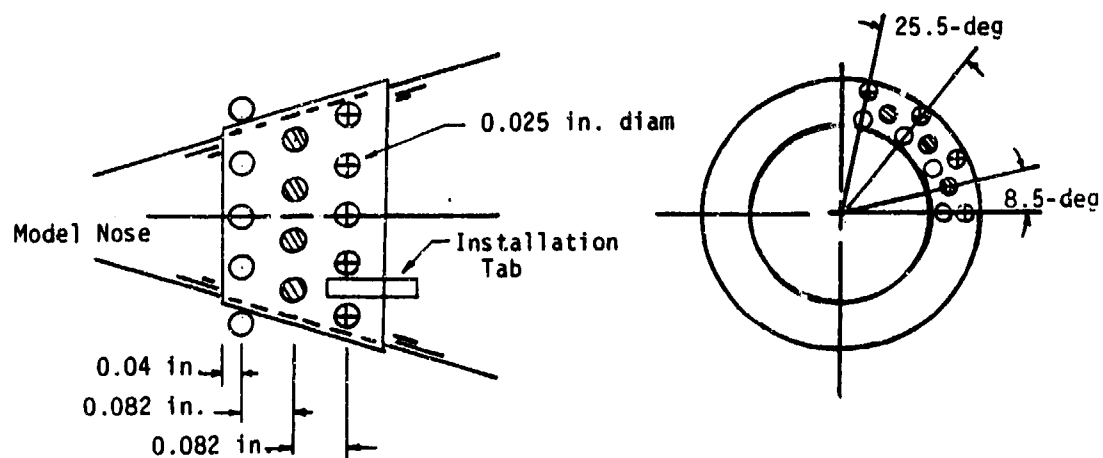
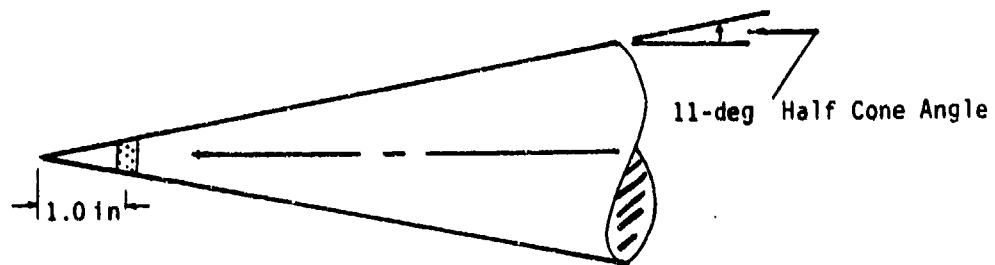
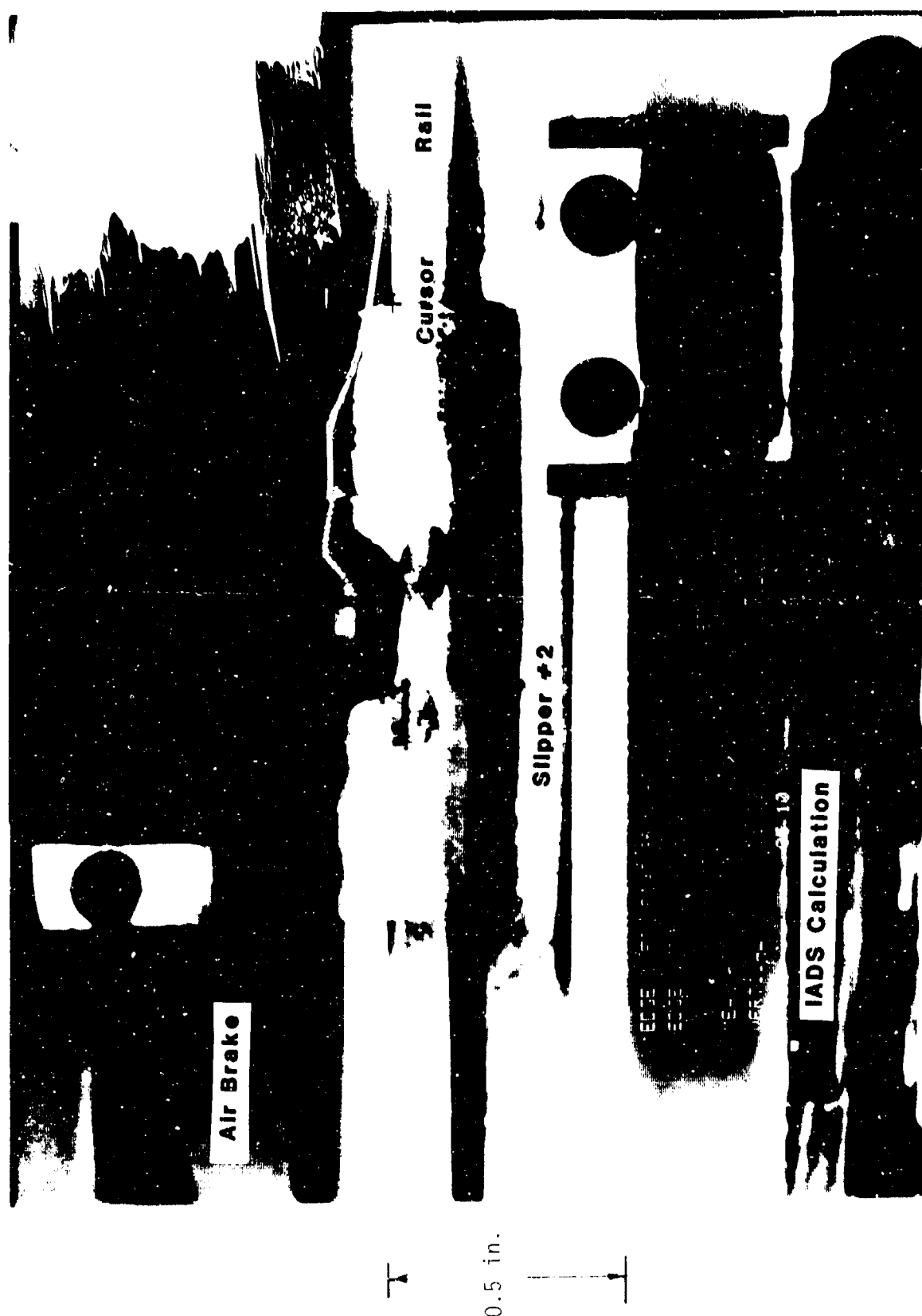


Figure 8. Trip Band



a. Print

Figure 9. Image Analyzer Data System (IADS)

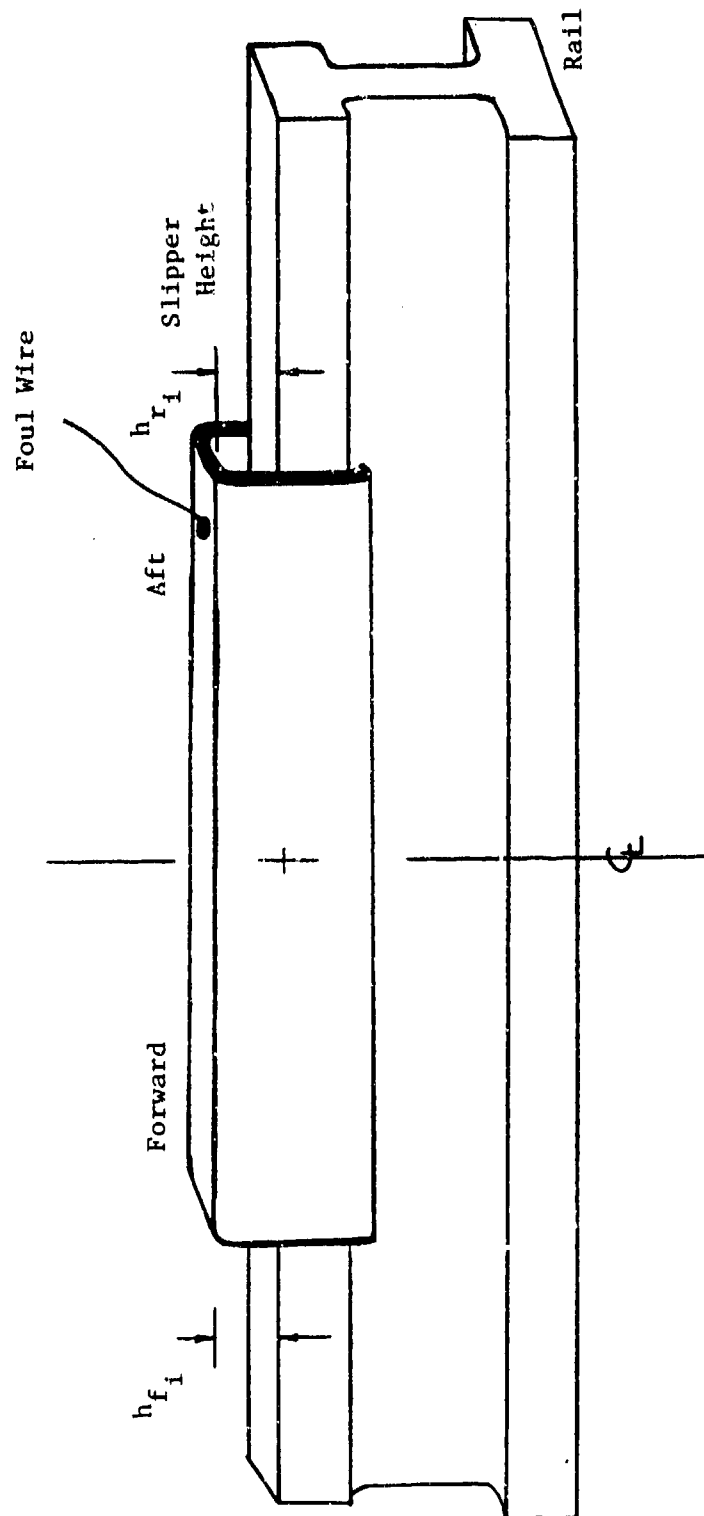


TABLE 1. CONFIGURATION DESIGNATIONS

CODE	CONFIGURATION
1	1.3.2.2.2 (AB = 7.514, A = 8.289)
2	1.3.2.2.2W4
3	1.3.2.2.2W16

COMPONENT	DESCRIPTION
1.X.X.X.X.WXX	Slipper Height (measured from centerline of model to inside top of slipper. 1. Short - 1.508 in.
X.3.X.X.X.WXX	Forward Slipper Location (measured from center of aft slipper to center of forward slipper) 3. Forward - 9.60 in.
X.X.2.X.X.WXX	Bleed Area 2. Closed
X.X.X.2.X.WXX	Nose Shape 2. 11-degree Long Cone
X.X.X.X.2.WXX	Water Brake 2. Off
X.X.X.X.X.W4	4-degree Long Wedge Length = 6.88" Height = 0.48"
X.X.X.X.X.W16	16-degree Short Wedge Length = 1.93" Height = 0.55"

Table 2. Estimated Uncertainties
a. Measured Parameters

Parameter Designation	Steady-State Estimated Measurements ¹							Range	Type of Measuring Device	Type of Recording Device	Method of System Calibration
	Precision Index (S)			Bias (B)		Uncertainty $\pm(B + 1.95S)$					
	Percent of Reading	Unit of Measurement	Degree of Freedom	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement				
PT, psia		0.007 0.017	> 30 > 30		0.011 0.011		0.025 0.045	15-50 50-150	Bell & Howell force balance pressure transducer	Digital data acquisition system analog-to-digital converter	In-place application of multiple pressure levels measured with a pressure measuring device calibrated in the standards laboratory
TT, °F		1.0	> 30		2.0		4.0	0-300	Chromalox 10-A1 type 10 thermocouple	Digital thermometer and microprocessor averaging	Thermocouple verification of NBS conformity by voltage substitution calibration
Normal Force, lbs		0.059	96		0.008		0.125	± 50	Six-component strain gage balance; (4.00-Y-36-081)	Digital data acquisition system	Static loading
Pitching Moment, in-lbs		0.218	96		0.027		0.463	± 185			
Side Force, lbs		0.059	96		0.027		0.125	± 50			
Yawing Moments, in-lbs		0.207	96		0.048		0.463	± 185			
Rolling Moments, in-lbs		0.058	96		0.009		0.125	± 50			
Axial Force, lbs		0.040	96		0.063		0.143	± 30			
ALPHA-GP, deg		0.02	8		0.02		0.07	± 2	Servo-actuator (water-cooled)	Digital data acquisition system	In-place calibration of multiple angles measured with a measuring device calibrated in standards laboratory
P01, P02, P03, P04, psia		0.0015	> 30		0.0015		0.005	0-15	Bell & Howell variable capacitance pressure transducer	Digital data acquisition system	Same as PT

*Reference: Abernethy, R.B. et al and Thompson, J. W. "Handbook Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5, February 1973.

Table 2. Continued
b. Calculated Parameters

Parameter Designation	Steady-State Estimated Measurement*							Nominal Mach Number	Nominal Value
	Precision Index (S)		Bias (B)		Uncertainty				
					± (B + 195S)				
					Percent of Reading	Unit of Measurement			
M	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement			
		0.006				0.012	3.5	3.5	
		0.009				0.018	4.0	4.0	
		0.011				0.022	4.5	4.5	
		0.013				0.026	5.0	5.0	
P		0.008				0.016	5.5	5.5	
		0.006			0.001	0.013	3.5	3.5	
		0.006			0.001	0.013	4.0	4.0	
		0.006			0.001	0.013	4.5	4.5	
		0.004			0.001	0.009	5.0	5.0	
Q		0.001			0.001	0.002	5.5	5.5	
		0.030			0.012	0.072	3.5	3.5	
		0.038			0.010	0.086	4.0	4.0	
		0.048			0.011	0.107	4.5	4.5	
		0.047			0.010	0.104	5.0	5.0	
RE x 10-6		0.008			0.003	0.019	5.5	5.5	
	0.40		0.54			1.34	3.5	3.5	
	0.53		0.54			1.60	4.0	4.0	
	0.60		0.55			1.75	4.5	4.5	
	0.65		0.50			1.80	5.0	5.0	
CN	0.42		0.48			1.32	5.5	5.5	
		0.0016			0.0006	0.0038	3.5	3.5	
		0.0025			0.0007	0.0057	4.0	4.0	
		0.0035			0.0008	0.0084	4.5	4.5	
		0.0038			0.0008	0.0084	5.0	5.0	
CLM		0.0028			0.0010	0.0066	5.5	5.5	
		0.0039			0.0015	0.0093	3.5	3.5	
		0.0059			0.0016	0.0134	4.0	4.0	
		0.0080			0.0019	0.0179	4.5	4.5	
		0.0086			0.0018	0.0190	5.0	5.0	
	0.0063			0.0023	0.0149	5.5	5.5		

*Reference: Abernethy, R.B. et al and Thompson, J. W. "Handbook Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5, February 1973.

Table 2. Concluded

b. Concluded

Parameter Designation	Steady-State Estimated Measurement*						Nominal Mach Number	Nominal Value
	Precision Index (S)		Bias (B)		Uncertainty $\pm (B + 195S)$			
	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement	Percent of Reading	Unit of Measurement		
CY		0.0003		0.0001		0.0007	3.5	0.02
		0.0003		0.0002		0.0008	4.0	0.02
		0.0004		0.0002		0.0010	4.5	0.01
		0.0004		0.0002		0.0010	5.0	0.02
		0.0011		0.0006		0.0028	5.5	0.02
CLN		0.0010		0.0006		0.0026	3.5	0.09
		0.0012		0.0007		0.0031	4.0	0.07
		0.0012		0.0007		0.0031	4.5	0.01
		0.0013		0.0008		0.0034	5.0	0.08
		0.0036		0.0026		0.0098	5.5	0.07
CLL		0.0004		0.0001		0.0009	3.5	-0.003
		0.0004		0.0001		0.0009	4.0	-0.005
		0.0005		0.0001		0.0011	4.5	-0.003
		0.0005		0.0001		0.0011	5.0	-0.001
		0.0009		0.0004		0.0022	5.5	-0.001
CA		0.0028		0.0016		0.0072	3.5	0.34
		0.0037		0.0017		0.0091	4.0	0.33
		0.0040		0.0016		0.0096	4.5	0.33
		0.0044		0.0018		0.0106	5.0	0.35
		0.0044		0.0055		0.0143	5.5	0.37
CAT		0.0022		0.0015		0.0059	3.5	0.39
		0.0030		0.0017		0.0077	4.0	0.37
		0.0034		0.0016		0.0084	4.5	0.35
		0.0038		0.0018		0.0094	5.0	0.36
		0.0041		0.0055		0.0137	5.5	0.38

*Reference: Abernethy, R.B. et al and Thompson, J. W. "Handbook Uncertainty in Gas Turbine Measurements." AEDC-TR-73-5, February 1973

Table 3. Image Analyzer Slipper Height Measurements

Run	Slipper #1		Slipper #2		Slipper #3		Slipper #4		Alpha
	Front	Rear	Front	Rear	Front	Rear	Front	Rear	
	h_{f1}	h_{r1}	h_{f2}	h_{r2}	h_{f3}	h_{r3}	h_{f4}	h_{r4}	
1	0.132	0.140	0.140	0.123	0.148	0.123	0.091	0.140	0.05
3	0.153	0.148	0.169	0.132	0.090	0.074	0.090	0.070	0.41
4	0.099	0.107	0.091	0.103	0.140	0.132	0.111	0.149	-0.20
5	0.173	0.161	0.157	0.161	0.186	0.169	0.157	0.186	-0.07
6	0.074	0.083	0.066	0.070	0.156	0.144	0.132	0.169	-0.46
7	0.145	0.140	0.140	0.156	0.182	0.182	0.161	0.189	-0.20
8	0.157	0.144	0.095	0.144	0.148	0.136	0.161	0.156	-0.09
9	0.161	0.157	0.153	0.161	0.149	0.128	0.136	0.153	0.10
10	0.119	0.140	0.128	0.132	0.169	0.161	0.153	0.165	-0.20
12	0.165	0.149	0.161	0.140	0.078	0.062	0.078	0.086	0.46
13	0.149	0.153	0.145	0.153	0.145	0.149	0.124	0.157	0.04
14	0.145	0.149	0.149	0.145	0.136	0.128	0.107	0.144	0.11
15	0.157	0.145	0.169	0.148	0.140	0.144	0.099	0.148	0.13
16	0.141	0.137	0.140	0.140	0.132	0.140	0.132	0.152	0.00
17	0.182	0.173	0.153	0.157	0.157	0.157	0.165	0.173	0.02
18	0.161	0.165	0.157	0.161	0.153	0.153	0.140	0.165	0.05
19	0.120	0.130	0.124	0.127	0.120	0.111	0.100	0.123	0.07
20	0.124	0.116	0.116	0.107	0.116	0.103	0.103	0.120	0.03

Table 3. Concluded

MODEL ANGLE OF ATTACK CALCULATION

A. Equations

$$\bar{H}_F = [(h_{f_1} + h_{r_1}) + (h_{f_2} + h_{r_2})]/4$$

$$\bar{H}_R = [(h_{f_3} + h_{r_3}) + (h_{f_4} + h_{r_4})]/4$$

$$\alpha \quad (\text{deg}) = \text{TAN}^{-1} \frac{\bar{H}_F - \bar{H}_R}{D_s}, \text{ where } D_s = 9.6$$

B. Sample Calculation of Run #3

$$\bar{H}_F = [(0.153 + 0.148) + (0.169 + 0.132)]/4$$

$$\bar{H}_F = 0.1505$$

$$\bar{H}_R = [(0.090 + 0.074) + (0.090 + 0.070)]/4$$

$$\bar{H}_R = 0.0810$$

$$\alpha = \text{TAN}^{-1} \frac{0.1505 - 0.0810}{9.60}$$

$$\alpha = 0.41$$

TABLE 4. RUN SUMMARY

Mach No.	Q	CONFIGURATIONS		
		1.3.2.2.2	1.3.2.2.2.W4	1.3.2.2.2.W16
3.5	5.9	15	18	19
4.0	5.0	16	17	20
4.5	5.3	1, 3	8	12, 13
5.0	4.7	4, 5	9	14
5.5	1.4	6, 7	10	

APPENDIX

DATE COMPUTED 9-JUN-87
 TIME COMPUTED 10:09:18
 DATE RECORDED 5-MAY-87
 TIME RECORDED 0:45:0
 PROJECT NUMBER V--A-37

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HUN CODE M PT TT Q P T PE A RLF LENGTHS(CLM,CLM,CLL)
 1 1 4.52 108.01 571.7 5.206 0.364 112.4 0.705E+07 6.289 3.000 2.200 2.200

CONFIG
 1.3.2.2.2.

PKIP
 0.025

---TUNNEL CONDITIONS, BASF PRESSURES---

PN	ALPI	PHI1	PT	TT	Q	P	CPBA	CABT	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	-0.01	-0.01	108.01	571.7	5.206	0.364	-0.0235	0.0213	0.6636	0.6864	0.4054	1.1755	0.3859
2	-0.01	-0.01	108.07	571.7	5.209	0.364	-0.0234	0.0212	0.6654	0.6878	0.4079	1.1804	0.3856
3	-0.01	-0.01	108.05	571.7	5.208	0.364	-0.0234	0.0212	0.6656	0.6880	0.4080	1.1807	0.3857
4	-0.01	-0.01	107.98	571.7	5.204	0.364	-0.0233	0.0211	0.6674	0.6884	0.4083	1.1870	0.3860
5	-0.01	-0.01	107.99	571.7	5.205	0.364	-0.0234	0.0212	0.6659	0.6865	0.4082	1.1831	0.3859

--- BODY AXES ---

PN	ALPHA	PHI	CM	CLM	CY	CLIN	CLL	CAT	CA	ACP/LM	YCP/LM	FOUL
1	0.05	-0.02	0.3572	0.7994	0.0078	0.0174	-0.0044	0.3494	0.3281	0.6191	0.7131	
2	0.05	-0.02	0.3571	0.7988	0.0081	0.0178	-0.0045	0.3495	0.3283	0.6192	0.7159	
3	0.05	-0.02	0.3572	0.7990	0.0081	0.0177	-0.0046	0.3496	0.3284	0.6192	0.7177	
4	0.05	-0.02	0.3570	0.7988	0.0077	0.0170	-0.0044	0.3493	0.3282	0.6191	0.7139	
5	0.05	-0.02	0.3571	0.7984	0.0083	0.0174	-0.0046	0.3496	0.3284	0.6194	0.7268	

DATE COMPUTED 9-JUN-67
 TIME COMPUTED 10:15:50
 DATE RECORDED 5-MAY-67
 TIME RECORDED 2:45:51
 PROJECT NUMBER V--A-37

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RUN	CODE	M	PI	IT	Q	P	T	RE	A	REF LENGTHS(CLM,CLN,CLL)
3	J	4.52	108.63	571.7	5.236	0.366	112.4	0.710E+07	0.289	3.000 2.200 2.200

CONFIG
 1.3.2.2.2.

IRIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI	PI	IT	Q	P	CPHA	CABT	PBA/P	PBI/P	PB2/P	PB3/P	PB4/P
1	-0.00	0.00	108.63	571.7	5.236	0.366	-0.0231	0.0210	0.6689	0.6474	0.4093	1.2161	0.4029
2	-0.00	0.00	108.66	571.7	5.237	0.366	-0.0231	0.0209	0.6696	0.6489	0.4092	1.2175	0.4028
3	-0.00	0.00	108.75	571.7	5.241	0.367	-0.0232	0.0210	0.6686	0.6484	0.4089	1.2147	0.4025
4	-0.00	-0.00	108.94	571.7	5.251	0.367	-0.0231	0.0210	0.6693	0.6473	0.4082	1.2200	0.4018
5	-0.00	0.00	108.89	571.7	5.248	0.367	-0.0231	0.0209	0.6696	0.6476	0.4084	1.2187	0.4038

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CUL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.41	0.00	0.3941	0.9008	0.0050	0.0066	-0.0006	0.3511	0.3302	0.6116		
2	0.41	0.00	0.3941	0.9009	0.0052	0.0073	-0.0007	0.3514	0.3305	0.6116		
3	0.41	0.00	0.3943	0.9015	0.0049	0.0065	-0.0006	0.3512	0.3302	0.6116		
4	0.41	-0.00	0.3943	0.9013	0.0050	0.0069	-0.0006	0.3512	0.3302	0.6116		
5	0.41	0.00	0.3941	0.9011	0.0051	0.0072	-0.0007	0.3512	0.3302	0.6115		

DATE COMPUTED 9-JUN-87
 TIME COMPUTED 10116111
 DATE RECORDED 6-MAY-87
 TIME RECORDED 0151151
 PROJECT NUMBER V--A-37

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RUN	CODE	M	PI	TT	Q	P	T	RE	A	REL LENGTHS(CLM,CLN,CLL)
4	1	5.06	143.34	660.7	4.528	0.253	107.9	0.583E+07	8.289	3.000 2.200 2.200

CONFIG
 1.3.2.2.2.

IKIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPHA	PHI	PF	TT	U	P	CPBA	CABT	PRA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	0.04	0.01	143.34	660.7	4.528	0.253	-0.0137	0.0124	0.7549	0.6692	0.4217	1.4855	0.4431
2	0.04	0.01	143.42	661.7	4.531	0.253	-0.0137	0.0125	0.7538	0.6688	0.4215	1.4820	0.4429
3	0.05	0.01	143.46	661.7	4.532	0.253	-0.0137	0.0124	0.7543	0.6687	0.4214	1.4843	0.4428
4	0.05	0.01	143.51	660.7	4.534	0.253	-0.0138	0.0125	0.7533	0.6684	0.4212	1.4811	0.4426
5	0.05	0.01	143.55	661.7	4.535	0.253	-0.0138	0.0125	0.7531	0.6682	0.4211	1.4807	0.4425
6	0.05	0.01	143.56	661.7	4.535	0.253	-0.0137	0.0125	0.7538	0.6682	0.4211	1.4833	0.4424

--- BODY AXES ---

PN	ALPHA	PHI	CA	CLM	CY	CLN	CLL	CAT	CA	MCP/LM	YCP/LM	FOUL
1	-0.20	-0.01	0.3565	0.8051	-0.0079	-0.0263	-0.0093	0.3536	0.3413	0.6158	0.5869	1
2	-0.20	-0.01	0.3564	0.8044	-0.0074	-0.0238	-0.0096	0.3535	0.3411	0.6161	0.6021	
3	-0.20	-0.01	0.3559	0.8038	-0.0078	-0.0256	-0.0094	0.3536	0.3412	0.6159	0.5918	
4	-0.20	-0.01	0.3559	0.8041	-0.0078	-0.0256	-0.0097	0.3536	0.3411	0.6158	0.5921	1
5	-0.20	-0.01	0.3562	0.8056	-0.0080	-0.0268	-0.0094	0.3534	0.3409	0.6156	0.5833	
6	-0.20	-0.01	0.3562	0.8045	-0.0078	-0.0260	-0.0094	0.3533	0.3408	0.6158	0.5856	

CALSPAN CORPORATION

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VON KARMAN GAS DYNAMICS FACILITY
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TIME COMPUTED 10:16:43
DATE RECORDED 6-MAY-67
TIME RECORDED 2:41:31
PROJECT NUMBER V--A-37

RUN CODE	M	PT	TT	Q	P	T	RE	A	REF LENGTHS(CLM,CLM,CLL)
5	1	5.06	143.42	656.7	4.531	0.253	107.3	0.588e+07	8.289 3.000 2.200 2.206

CONFIG
1.3.2.2.2.

TRIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI1	PT	TT	Q	P	CPBA	CABT	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	-0.01	-0.00	143.42	656.7	4.531	0.253	-0.0137	0.0124	0.7552	0.6845	0.4109	1.5195	0.4057
2	-0.01	-0.00	143.30	658.7	4.527	0.253	-0.0136	0.0124	0.7557	0.6877	0.4112	1.5180	0.4060
3	-0.01	-0.00	143.60	657.7	4.537	0.253	-0.0138	0.0125	0.7522	0.6837	0.4104	1.5095	0.4052
4	-0.01	-0.00	143.44	656.7	4.532	0.253	-0.0137	0.0124	0.7544	0.6871	0.4135	1.5086	0.4083
5	-0.00	-0.00	143.18	657.7	4.524	0.252	-0.0139	0.0126	0.7517	0.6857	0.4116	1.5032	0.4064
6	-0.00	-0.00	143.01	657.7	4.518	0.252	-0.0138	0.0125	0.7519	0.6865	0.4121	1.5023	0.4069

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLM	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	-0.07	-0.01	0.3799	0.8505	0.0179	0.0662	-0.0064	0.3643	0.3519	0.6190	0.5442	
2	-0.07	-0.01	0.3801	0.8516	0.0179	0.0668	-0.0063	0.3644	0.3521	0.6187	0.5425	
3	-0.07	-0.01	0.3808	0.8535	0.0179	0.0659	-0.0064	0.3644	0.3519	0.6185	0.5471	
4	-0.07	-0.01	0.3798	0.8506	0.0181	0.0671	-0.0062	0.3641	0.3517	0.6188	0.5448	
5	-0.07	-0.01	0.3799	0.8511	0.0183	0.0676	-0.0063	0.3644	0.3518	0.6186	0.5459	
6	-0.07	-0.01	0.3793	0.8511	0.0182	0.0669	-0.0063	0.3643	0.3517	0.6187	0.5470	

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DATE COMPUT 9-JUN-67
 TIME COMPUTED 1:11:56
 DATE RECORDED 6-MAY-67
 TIME RECORDED 4:15:15
 PROJECT NUMBER V--A-37

RUN CODE M PT TT U P T RE A REL LENGTHS(CLM,CLM,CLL)
 6 1 5.50 59.79 677.7 1.361 0.004 96.1 0.192E+07 0.289 3.000 2.200 2.200

IRIP
 0.025

CONFIG
 1.3.2.2.2.

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI1	PT	TT	U	P	CPBA	CART	PBA/P	PH1/P	PB2/P	PB3/P	PB4/P
1	0.02	0.01	59.79	677.7	1.361	0.064	-0.0130	0.0118	0.7237	0.7570	0.4568	1.2210	0.4599
2	0.02	0.00	59.78	677.7	1.361	0.054	-0.0130	0.0118	0.7238	0.7571	0.4569	1.2212	0.4600
3	0.02	0.01	59.74	677.7	1.360	0.064	-0.0130	0.0118	0.7244	0.7577	0.4573	1.2222	0.4603
4	0.02	0.00	59.74	677.7	1.360	0.064	-0.0130	0.0118	0.7243	0.7577	0.4573	1.2221	0.4603
5	0.02	0.01	59.76	677.7	1.360	0.064	-0.0130	0.0118	0.7240	0.7573	0.4570	1.2216	0.4601
6	0.02	0.00	59.78	677.7	1.361	0.064	-0.0130	0.0118	0.7238	0.7571	0.4569	1.2212	0.4600

---BODY AXES---

PN	ALPHA	PHI	CM	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	-0.40	-0.01	0.3352	0.7269	0.0229	0.1077	-0.0227	0.3836	0.3717	0.6298	0.4311	
2	-0.40	-0.01	0.3352	0.7270	0.0229	0.1078	-0.0227	0.3838	0.3719	0.6298	0.4316	
3	-0.40	-0.00	0.3352	0.7271	0.0230	0.1080	-0.0227	0.3835	0.3717	0.6298	0.4309	
4	-0.40	-0.01	0.3353	0.7270	0.0230	0.1080	-0.0227	0.3841	0.3723	0.6298	0.4322	
5	-0.40	-0.01	0.3352	0.7272	0.0228	0.1076	-0.0228	0.3840	0.3722	0.6297	0.4300	
6	-0.40	-0.01	0.3353	0.7272	0.0229	0.1078	-0.0228	0.3839	0.3721	0.6297	0.4311	

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DATE COMPUTED 9-JUN-67
TIME COMPUTED 10:17:00
DATE RECORDED 6-MAY-67
TIME RECORDED 4:28:37
PROJECT NUMBER V--A-37

RUN	CODE	M	P1	TT	U	P	T	RE	A	REL LENGTHS(CLN,CLN,CLL)
7	1	5.50	59.78	677.7	1.360	0.064	96.1	0.192E+07	8.289	3.000 2.200 2.200

CONFIG
1.3.2.2.2.

TRIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALP1	PHI1	PT	TT	U	P	CPBA	CABT	PRA/P	PA/P	PB2/P	PB3/P	PB4/P
1	0.02	0.01	59.78	677.7	1.360	0.064	-0.0086	0.0078	0.8185	0.7675	0.4569	1.6209	0.4287
2	0.02	0.01	59.76	677.7	1.360	0.064	-0.0086	0.0078	0.8188	0.7678	0.4571	1.6215	0.4289
3	0.02	0.01	59.75	677.7	1.360	0.064	-0.0086	0.0078	0.8189	0.7679	0.4571	1.6217	0.4289
4	0.02	0.00	59.80	677.7	1.361	0.064	-0.0086	0.0078	0.8182	0.7672	0.4567	1.6203	0.4285
5	0.02	0.00	59.87	677.7	1.363	0.064	-0.0086	0.0078	0.8172	0.7663	0.4562	1.6183	0.4280
6	0.02	0.00	59.94	677.7	1.364	0.064	-0.0087	0.0079	0.8162	0.7654	0.4556	1.6164	0.4275

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CX	CLN	CLL	CAT	CA	WCP/LM	YCP/LM	FOUL
1	-0.20	0.00	0.3749	0.8338	0.0167	0.0577	-0.0061	0.3891	0.3813	0.6212		
2	-0.20	0.00	0.3751	0.8342	0.0167	0.0579	-0.0060	0.3887	0.3810	0.6212		
3	-0.20	0.01	0.3749	0.8338	0.0165	0.0570	-0.0061	0.3890	0.3813	0.6212		
4	-0.20	-0.00	0.3751	0.8338	0.0166	0.0575	-0.0060	0.3892	0.3815	0.6214		
5	-0.20	-0.00	0.3749	0.8336	0.0166	0.0573	-0.0061	0.3895	0.3816	0.6213		
6	-0.20	-0.00	0.3748	0.8333	0.0167	0.0576	-0.0060	0.3891	0.3813	0.6213		

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DATE COMPUTE 9-JUN-67
TIME COMPUTED 10:17:19
DATE RECORDED 6-MAY-67
TIME RECORDED 5:19:29
PROJECT NUMBER V--A-37

RUN	CODE	M	PT	TT	Q	P	T	RE	A	REF LENGTHS(CLM,CLM,CLL)
8	2	4.52	108.74	579.7	5.241	0.366	114.0	0.696E+07	8.289	3.000 2.200 2.200

CONFIG
1.3.2.2.2.M4

TRIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PM	ALPI	PHII	PT	TT	Q	P	CPBA	CABT	PBA/P	PBI/P	PB2/P	PB3/P	PB4/P
1	-0.04	-0.01	108.74	579.7	5.241	0.366	-0.0278	0.0252	0.6017	0.5756	0.4159	1.0278	0.3876
2	-0.04	-0.01	106.40	579.7	5.225	0.365	-0.0278	0.0252	0.6027	0.5756	0.4172	1.0310	0.3870
3	-0.04	-0.01	108.22	579.7	5.216	0.365	-0.0278	0.0252	0.6023	0.5747	0.4161	1.0309	0.3877
4	-0.04	-0.01	108.47	578.7	5.228	0.366	-0.0278	0.0252	0.6028	0.5753	0.4170	1.0323	0.3868
5	-0.04	-0.01	108.52	578.7	5.230	0.366	-0.0278	0.0252	0.6021	0.5750	0.4168	1.0299	0.3866

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--- BODY AXES ---

PM	ALPHA	PHI	CM	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	-0.09	-0.02	0.3282	0.7202	0.0202	0.0732	-0.0049	0.3542	0.3290	0.6258	0.5532	
2	-0.09	-0.02	0.3284	0.7205	0.0199	0.0722	-0.0049	0.3544	0.3292	0.6258	0.5531	
3	-0.09	-0.02	0.3284	0.7204	0.0200	0.0726	-0.0049	0.3545	0.3292	0.6259	0.5525	
4	-0.09	-0.02	0.3283	0.7206	0.0199	0.0722	-0.0050	0.3544	0.3292	0.6258	0.5537	
5	-0.09	-0.02	0.3284	0.7203	0.0201	0.0726	-0.0050	0.3545	0.3293	0.6259	0.5557	

DATE COMPUT. 9-JUN-87
TIME: COMPUTED 10:17:56
DATE RECORDED 6-MAY-87
TIME RECORDED 5:46:19
PROJECT NUMBER V--A-37

CALSPAN CORPORATION
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PAGE 1

RUN CODE	M	PT	TT	G	P	T	RE	A	REF LENGTHS(CLN,CLN,CLL)
9	2	5.06	143.83	656.7	4.544	0.254	108.9	0.577E+07	0.289 3.000 2.200 2.200

CONFIG
1.3.2.2.2.W4

TRIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHII	PT	TT	G	P	CPBA	CABT	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	-0.04	-0.01	143.83	666.7	4.544	0.254	-0.0108	0.0170	0.6634	0.6221	0.4542	1.1703	0.4071
2	-0.04	-0.01	143.85	667.7	4.545	0.254	-0.0183	0.0171	0.6620	0.6221	0.4542	1.1648	0.4070
3	-0.04	-0.00	143.77	667.7	4.542	0.253	-0.0188	0.0170	0.6637	0.6224	0.4544	1.1708	0.4073
4	-0.04	-0.01	143.65	668.7	4.538	0.253	-0.0188	0.0170	0.6636	0.6203	0.4575	1.1691	0.4076
5	-0.04	-0.01	143.60	668.7	4.537	0.253	-0.0188	0.0170	0.6638	0.6205	0.4576	1.1695	0.4078
6	-0.04	-0.01	143.51	669.7	4.534	0.253	-0.0187	0.0169	0.6650	0.6209	0.4579	1.1730	0.4080
7	-0.04	-0.01	143.54	669.7	4.535	0.253	-0.0187	0.0170	0.6641	0.6208	0.4578	1.1700	0.4079
8	-0.04	-0.01	143.47	669.7	4.533	0.253	-0.0187	0.0170	0.6645	0.6211	0.4580	1.1706	0.4081

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLN	CY	CU	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.10	-0.02	0.3699	0.8314	0.0257	0.0950	-0.0071	0.3668	0.3497	0.6176	0.5451
2	0.10	-0.02	0.3702	0.8323	0.0260	0.0963	-0.0070	0.3670	0.3500	0.6175	0.5446
3	0.10	-0.02	0.3703	0.8324	0.0257	0.0950	-0.0070	0.3671	0.3501	0.6175	0.5450
4	0.10	-0.02	0.3703	0.8341	0.0265	0.0981	-0.0071	0.3669	0.3499	0.6168	0.5447
5	0.10	-0.02	0.3704	0.8347	0.0261	0.0961	-0.0072	0.3671	0.3501	0.6166	0.5472
6	0.10	-0.02	0.3704	0.8347	0.0253	0.0975	-0.0072	0.3672	0.3503	0.6166	0.5442
7	0.10	-0.02	0.3703	0.8348	0.0259	0.0954	-0.0072	0.3672	0.3502	0.6165	0.5470
8	0.10	-0.02	0.3703	0.8348	0.0260	0.0963	-0.0072	0.3671	0.3502	0.6165	0.5455

DATE COMPUT. 9-JUN-87
 TIME COMPUTED 10118:16
 DATE RECORDED 6-MAY-87
 TIME RECORDED 0120:57
 PROJECT NUMBER V--A-37

CALSPAN REPARATION
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 VON KARMAN GAS DYNAMICS FACILITY
 ARNOLD AIR FORCE STATION, TENNESSEE
 HOLLOWAN ROCKET SLEE
 PAGE 1

RUN	CODE	M	PI	TT	Q	P	T	KE	A	REF LENGTHS(CLM,CLN,CLL)
10	2	5.50	61.02	681.7	1.389	0.066	96.7	0.194E+07	8.289	3.000 2.200 2.200

TRIP
 0.025

CONFIG
 1.3.2.2.2.04

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALP1	PH1	PI	TT	Q	P	CPBA	CABT	PBA/P	PD1/P	PB2/P	PB3/P	PB4/P
1	-0.02	-0.00	61.02	681.7	1.389	0.066	-0.0111	0.0100	0.7659	0.6403	0.5084	1.4642	0.4505
2	-0.02	-0.00	61.11	681.7	1.391	0.066	-0.0111	0.0101	0.7646	0.6392	0.5076	1.4619	0.4498
3	-0.02	-0.00	61.11	681.7	1.391	0.066	-0.0110	0.0100	0.7672	0.6393	0.5076	1.4723	0.4498
4	-0.02	0.00	61.10	681.7	1.391	0.066	-0.0110	0.0100	0.7674	0.6394	0.5077	1.4725	0.4499
5	-0.02	-0.01	61.06	681.7	1.390	0.066	-0.0111	0.0100	0.7653	0.6398	0.5080	1.4631	0.4502
6	-0.02	-0.00	61.05	681.7	1.389	0.066	-0.0111	0.0100	0.7654	0.6399	0.5081	1.4634	0.4503
7	-0.02	-0.01	61.05	681.7	1.389	0.066	-0.0111	0.0100	0.7655	0.6399	0.5081	1.4635	0.4503

--- BODY AXES ---

PN	ALPHA	PH1	CN	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	-0.20	-0.01	0.3497	0.7948	0.0243	0.0915	-0.0061	0.3624	0.3523	0.6137	0.5373	
2	-0.20	-0.01	0.3500	0.7954	0.0242	0.0916	-0.0060	0.3627	0.3526	0.6137	0.5360	
3	-0.20	-0.00	0.3499	0.7951	0.0245	0.0923	-0.0061	0.3621	0.3521	0.6137	0.5370	
4	-0.20	-0.00	0.3498	0.7948	0.0243	0.0917	-0.0060	0.3625	0.3526	0.6137	0.5364	
5	-0.20	-0.01	0.3503	0.7957	0.0245	0.0919	-0.0061	0.3629	0.3528	0.6138	0.5387	
6	-0.20	-0.01	0.3503	0.7958	0.0243	0.0918	-0.0060	0.3631	0.3531	0.6138	0.5368	
7	-0.20	-0.01	0.3499	0.7947	0.0243	0.0913	-0.0061	0.3625	0.3525	0.6138	0.5382	

CALSPAN CORPORATION
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VON KARMAN GAS DYNAMICS FACILITY
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HOLLOWAY ROCKET SLED
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DATE COMPUTED 9-JUN-87
TIME COMPUTED 10:20:21
DATE RECORDED 6-MAY-87
TIME RECORDED 22:44:23
PROJECT NUMBER V--A-37

RUN CODE M P₁ TT P U P T RE A REF LENGTHS(CLM,CLM,CLL)
12 J 4.52 111.61 573.7 5.379 0.376 112.8 0.725E+07 0.289 3.000 2.200 2.200

CONFIG
1.3.2.2.2.M16

TRIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALP1	PH1	PI	TT	Q	P	CPBA	CABT	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	0.02	-0.01	111.61	573.7	5.379	0.376	-0.0249	0.0226	0.6432	0.6074	0.4341	1.1389	0.3925
2	0.02	-0.01	111.42	573.7	5.370	0.375	-0.0250	0.0226	0.6429	0.6066	0.4346	1.1372	0.3931
3	0.02	-0.01	111.28	573.7	5.364	0.375	-0.0249	0.0226	0.6441	0.6073	0.4353	1.1403	0.3936
4	0.01	-0.00	111.10	574.7	5.355	0.374	-0.0248	0.0225	0.6457	0.6066	0.4360	1.1477	0.3925
5	0.01	-0.01	111.07	574.7	5.353	0.374	-0.0249	0.0226	0.6441	0.6067	0.4344	1.1426	0.3926

--- BODY AXES ---

PN	ALPHA	PH1	CN	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.46	-0.02	0.3542	0.8491	0.0229	0.0805	-0.0061	0.3667	0.3441	0.5943	0.5664	
2	0.46	-0.02	0.3546	0.8497	0.0225	0.0793	-0.0061	0.3667	0.3440	0.5945	0.5655	
3	0.46	-0.02	0.3547	0.8500	0.0223	0.0792	-0.0061	0.3666	0.3440	0.5944	0.5623	
4	0.46	-0.02	0.3546	0.8502	0.0225	0.0796	-0.0061	0.3666	0.3441	0.5942	0.5630	
5	0.46	-0.02	0.3546	0.8504	0.0227	0.0805	-0.0061	0.3666	0.3441	0.5941	0.5635	

DATE COMPUTED 9-JUN-87
 TIME COMPUTED 10120133
 DATE RECORDED 6-MAY-87
 TIME RECORDED 231 2814
 PROJECT NUMBER V--A-37

CALSPAN CORPORATION
 AEC DIVISION
 VON KARMAN GAS DYNAMICS FACILITY
 ARNOLD AIR FORCE STATION, TENNESSEE
 HOLLOWAY ROCKET SLED
 PAGE 1

RUN CODE	M	PT	TT	O	P	T	RE	A	REF LENGTHS(CLM,CLM,CLL)
13	3	4.52	108.92	572.7	5.250	0.367	112.6	0.710E+07	8.289 3.000 2.200 2.200

IRIP
0.925

CONFIG
1.3.2.2.2.W16

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPT	PHI	PT	TT	O	P	CPBA	CABT	PBA/P	PBI/P	PB2/P	PB3/P	PB4/P
1	0.01	-0.01	108.92	572.7	5.250	0.367	-0.0265	0.0241	0.6205	0.5896	0.4138	1.1132	0.3655
2	0.01	-0.01	108.91	572.7	5.249	0.367	-0.0266	0.0241	0.6197	0.5897	0.4139	1.1079	0.3674
3	0.01	-0.01	108.90	572.7	5.249	0.367	-0.0265	0.0240	0.6211	0.5897	0.4139	1.1117	0.3692
4	0.01	-0.01	108.90	572.7	5.249	0.367	-0.0265	0.0240	0.6206	0.5897	0.4139	1.1116	0.3674
5	0.02	-0.01	108.98	572.7	5.253	0.367	-0.0266	0.0241	0.6197	0.5893	0.4136	1.1071	0.3690
6	0.02	-0.01	108.98	572.7	5.253	0.367	-0.0266	0.0241	0.6197	0.5893	0.4136	1.1071	0.3690

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CLL	CAT	CA	MCP/LM	YCP/LM	FOUL
1	0.04	-0.02	0.3132	0.7468	0.0219	0.0767	-0.0057	0.3623	0.3382	0.5963	0.5677	
2	0.04	-0.02	0.3134	0.7486	0.0218	0.0757	-0.0056	0.3624	0.3383	0.5956	0.5707	
3	0.04	-0.02	0.3129	0.7474	0.0218	0.0757	-0.0056	0.3622	0.3382	0.5957	0.5716	
4	0.04	-0.02	0.3129	0.7475	0.0219	0.0757	-0.0056	0.3622	0.3382	0.5956	0.5724	
5	0.04	-0.02	0.3130	0.7477	0.0218	0.0756	-0.0056	0.3622	0.3381	0.5957	0.5722	
6	0.04	-0.02	0.3130	0.7479	0.0219	0.0756	-0.0056	0.3623	0.3382	0.5956	0.5725	

DATE COMPUT. 9-JUN-87
 TIME COMPUTED 10:20:47
 DATE RECORDED 6-MAY-87
 TIME RECORDED 23:27:49
 PROJECT NUMBER V--A-37

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 AEC DIVISION
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RUN CODE	A	PT	TT	Q	P	T	RE	A	REF LENGTHS(CLM,CLM,CLL)
14	3	5.06	142.57	671.7	4.507	0.251	109.7	0.566E+07	8.289 3.000 2.200 2.200

CONFIG
 1.3.2.2.2.W16
 IMIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PM	ALPI	PHII	PT	TT	Q	P	CPBA	CABT	PBA/P	PBI/P	IBZ/P	PB3/P	PB4/P
1	0.03	0.00	142.57	671.7	4.507	0.251	-0.0156	0.0142	0.7198	0.6356	0.4689	1.3903	0.3842
2	0.03	0.01	141.00	668.7	4.455	0.249	-0.0155	0.0141	0.7222	0.6377	0.4718	1.3931	0.3860
3	0.03	0.01	142.34	664.7	4.497	0.251	-0.0153	0.0139	0.7255	0.6370	0.4727	1.4097	0.3824
4	0.03	0.00	142.11	659.7	4.509	0.252	-0.0151	0.0137	0.7296	0.6380	0.4767	1.4223	0.3814
5	0.03	0.00	142.97	655.7	4.517	0.252	-0.0151	0.0137	0.7296	0.6369	0.4759	1.4251	0.3807

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLIN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.11	-0.01	0.3609	0.8618	0.0242	0.0855	-0.0055	0.3710	0.3568	0.5958	0.5648	
2	0.11	-0.00	0.3603	0.8616	0.0242	0.0858	-0.0066	0.3701	0.3561	0.5952	0.5624	
3	0.11	-0.01	0.3598	0.8597	0.0243	0.0855	-0.0066	0.3695	0.3557	0.5955	0.5650	
4	0.11	-0.01	0.3590	0.8572	0.0244	0.0862	-0.0066	0.3691	0.3554	0.5958	0.5644	
5	0.11	-0.01	0.3581	0.8552	0.0246	0.0874	-0.0067	0.3687	0.3550	0.5958	0.5625	

DATE COMPUT. 9-JUN-67
TIME COMPUTED 10:21:10
DATE RECORDED 7-MAY-67
TIME RECORDED 01:46:48
PROJECT NUMBER V--A-37

CALSPAN CORPORATION
AEC DIVISION
VON KARMAN GAS DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
HULLMAN ROCKET SLED
PAGE 1

RUN	CODE	M	PT	TT	U	P	T	RE	A	RZF LENGTHS(CLM,CLM,CLL)
15	1	3.51	53.19	592.7	5.930	0.688	1/1.1	0.551	4.289	3.000 2.200 2.200

CONFIG
1.3.2.2.2.

FWIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI	PT	TT	U	P	CPBA	CART	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	-0.00	0.01	53.19	592.7	5.930	0.688	-0.0484	0.0434	0.5630	0.6071	0.4162	0.8722	0.4366
2	-0.00	0.01	53.02	592.7	5.911	0.685	-0.0482	0.0437	0.5846	0.6100	0.4166	0.8740	0.4379
3	0.00	0.01	52.96	593.7	5.904	0.685	-0.0483	0.0438	0.5836	0.6068	0.4161	0.8711	0.4365
4	-0.00	0.01	52.85	593.7	5.892	0.683	-0.0483	0.0438	0.5930	0.6080	0.4170	0.8688	0.4384
5	-0.00	0.01	52.85	593.7	5.892	0.683	-0.0485	0.0440	0.5818	0.6060	0.4160	0.8669	0.4364
6	0.00	0.01	52.91	593.7	5.898	0.684	-0.0483	0.0438	0.5836	0.6083	0.4165	0.8709	0.4384

--- HOLY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.13	0.01	0.3031	0.7226	0.0136	0.0685	-0.0017	0.3771	0.3333	0.5964	0.3913	
2	0.13	0.01	0.3029	0.7220	0.0136	0.0689	-0.0016	0.3772	0.3335	0.5964	0.3902	
3	0.13	0.01	0.3026	0.7217	0.0135	0.0687	-0.0017	0.3771	0.3333	0.5962	0.3884	
4	0.13	0.01	0.3029	0.7224	0.0134	0.0682	-0.0017	0.3772	0.3334	0.5963	0.3867	
5	0.13	0.01	0.3028	0.7221	0.0135	0.0688	-0.0017	0.3770	0.3330	0.5963	0.3856	
6	0.13	0.01	0.3029	0.7224	0.0137	0.0693	-0.0017	0.3772	0.3334	0.5962	0.3845	

DATE COMPUT 9-JUN-87
 TIME COMPUTED 10:21:29
 DATE RECORDED 7-MAY-87
 TIME RECORDED 1: 3:17
 PROJECT NUMBER V--A-37

CALSPAN CORPORATION
 AEDC DIVISION
 YUN KARMAN GAS DYNAMICS FACILITY
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 HOLLOWMAN ROCKET SLED
 PAGE 1

RUN CUDE M PT TT Q P T RE A REF LENGTHS(CLM,CLM,CLL)
 16 : 4.02 69.07 592.7 5.011 0.443 140.0 0.549E+07 4.284 3.000 2.200 2.200

CONFIG
 1.3.2.2.2.
 TRIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI1	PI	TT	Q	P	CP8A	CABT	PDA/P	PS1/P	PS2/P	PS3/P	PS4/P
1	-0.00	-0.01	69.07	592.7	5.011	0.443	-0.0332	0.0301	0.6250	0.6370	0.4208	1.0034	0.4387
2	-0.00	-0.01	69.11	592.7	5.013	0.443	-0.0331	0.0300	0.6258	0.6367	0.4220	1.0060	0.4385
3	-0.00	-0.01	69.07	592.7	5.011	0.443	-0.0331	0.0300	0.6257	0.6370	0.4207	1.0054	0.4387
4	-0.00	-0.01	69.06	591.7	5.010	0.443	-0.0331	0.0300	0.6255	0.6371	0.4209	1.0051	0.4386
5	-0.00	-0.01	69.01	591.7	5.006	0.443	-0.0330	0.0299	0.6267	0.6376	0.4211	1.0089	0.4391
6	-0.00	-0.01	69.14	591.7	5.016	0.443	-0.0331	0.0300	0.6259	0.6364	0.4219	1.0071	0.4383

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CUL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.00	-0.02	0.3261	0.7466	0.0146	0.0656	-0.0038	0.3503	0.3303	0.6110	0.4555	
2	0.00	-0.02	0.3261	0.7467	0.0146	0.0657	-0.0038	0.3502	0.3303	0.6110	0.4546	
3	0.00	-0.02	0.3261	0.7466	0.0145	0.0654	-0.0038	0.3503	0.3303	0.6111	0.4544	
4	0.00	-0.02	0.3262	0.7468	0.0146	0.0657	-0.0038	0.3503	0.3303	0.6110	0.4547	
5	0.00	-0.02	0.3262	0.7468	0.0145	0.0651	-0.0038	0.3501	0.3302	0.6110	0.4541	
6	0.00	-0.02	0.3262	0.7469	0.0145	0.0652	-0.0037	0.3503	0.3303	0.6110	0.4539	

CALSPAN REPUTATION

AEDC DIVISION
VON KARMAN GAS DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
HULLOMAN ROCKET SLED
PAGE 1

DATE COMPUTED 9-JUN-67
TIME COMPUTED 10:21:45
DATE RECORDED 7-MAY-67
TIME RECORDED 11:45:22
PROJECT NUMBER V--A-37

RUN	CUDE	M	PT	TT	Q	P	T	RE	A	REF LENGTHS(CLM/CLM,CLL)
17	2	4.02	68.71	584.7	4.984	0.441	138.2	0.557E-07	8.289	3.000 2.200 2.200

CONFIG
1.3.2.2.2.44

FWIP
0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI	PT	TT	Q	P	CPWA	CABT	PBA/P	PA1/P	PA2/P	PA3/P	PA4/P
1	0.01	0.01	68.71	584.7	4.984	0.441	-0.0390	0.0354	0.5587	0.5302	0.4004	0.9042	0.4091
2	0.01	0.00	68.87	584.7	4.996	0.442	-0.0391	0.0354	0.5578	0.5290	0.3994	0.9036	0.3991
3	0.01	0.00	69.10	584.7	5.013	0.443	-0.0391	0.0355	0.5575	0.5287	0.3996	0.9022	0.3993
4	0.01	0.00	69.20	584.7	5.020	0.444	-0.0391	0.0354	0.5582	0.5295	0.4006	0.9039	0.3987
5	0.01	0.00	69.22	584.7	5.022	0.444	-0.0390	0.0354	0.5583	0.5293	0.4004	0.9036	0.4001
6	0.01	0.00	69.13	585.7	5.015	0.443	-0.0390	0.0353	0.5591	0.5300	0.4010	0.9048	0.4006
7	0.01	0.00	69.07	585.7	5.011	0.443	-0.0391	0.0355	0.5573	0.5289	0.3998	0.9010	0.3994

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CLL	CAT	CA	NCP/IM	YCP/LM
1	0.02	-0.00	0.3040	0.6673	0.0170	0.0724	-0.0049	0.3668	0.3314	0.6257	0.4828
2	0.02	-0.01	0.3039	0.6673	0.0171	0.0723	-0.0050	0.3665	0.3310	0.6256	0.4841
3	0.02	-0.01	0.3040	0.6675	0.0172	0.0727	-0.0050	0.3665	0.3311	0.6257	0.4845
4	0.02	-0.01	0.3043	0.6679	0.0172	0.0726	-0.0051	0.3663	0.3309	0.6257	0.4843
5	0.02	-0.01	0.3041	0.6676	0.0172	0.0728	-0.0051	0.3664	0.3310	0.6256	0.4853
6	0.02	-0.01	0.3039	0.6672	0.0171	0.0725	-0.0051	0.3663	0.3310	0.6257	0.4839
7	0.02	-0.01	0.3039	0.6671	0.0172	0.0726	-0.0050	0.3664	0.3309	0.6256	0.4846

FOUL

DATE COMPUTE 9-JUN-87
 TIME COMPUTED 10:22:07
 DATE RECORDED 7-MAY-87
 TIME RECORDED 4: 4:31
 PROJECT NUMBER V--A-37

CALSPAN APURATION
 AEDC DIVISION
 VON KARMAN GAS DYNAMICS FACILITY
 ARNOLD AIR FORCE STATION, TENNESSEE
 HOLLOWMAN NOCKET SLED
 PAGE 1

RUN CODE M PI TT U P T RE A REF LENGTHS(CLM,CLM,CLL)
 18 2 3.51 52.89 593.7 5.896 0.684 171.4 0.547E+07 8.289 3.000 2.200 2.200

CONFIG
 1.3.2.2.2.W4

IRIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPH	PHI	PI	IT	U	P	CPBA	CART	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	0.02	-0.00	52.89	593.7	5.896	0.684	-0.0545	0.0494	0.5296	0.5076	0.4263	0.7730	0.4116
2	0.02	-0.00	53.00	593.7	5.908	0.685	-0.0545	0.0494	0.5301	0.5076	0.4265	0.7745	0.4117
3	0.02	-0.00	52.98	593.7	5.906	0.685	-0.0545	0.0494	0.5302	0.5077	0.4266	0.7747	0.4119
4	0.02	-0.00	52.91	593.7	5.898	0.684	-0.0546	0.0495	0.5295	0.5064	0.4262	0.7738	0.4114
5	0.02	-0.00	52.97	593.7	5.905	0.685	-0.0547	0.0496	0.5281	0.5068	0.4257	0.7679	0.4119

--- BODY AXES ---

PN	ALPHA	PHI	CM	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM
1	0.05	-0.01	0.2804	0.6511	0.0185	0.0857	-0.0025	0.3854	0.3359	0.6059	0.4397
2	0.05	-0.01	0.2802	0.6508	0.0185	0.0860	-0.0025	0.3855	0.3361	0.6059	0.4386
3	0.05	-0.01	0.2800	0.6504	0.0187	0.0862	-0.0024	0.3853	0.3360	0.6059	0.4406
4	0.05	-0.01	0.2803	0.6514	0.0187	0.0865	-0.0025	0.3854	0.3360	0.6057	0.4397
5	0.05	-0.01	0.2803	0.6513	0.0188	0.0867	-0.0025	0.3854	0.3357	0.6058	0.4411

FOUL

CALSPAN CORPORATION
 AEDC DIVISION
 VON KARMAN GAS DYNAMICS FACILITY
 ARNOLD AIR FORCE STATION, TENNESSEE
 HULLMAN ROCKET SLED
 PAGE 1

DATE COMPUTED 9-JUN-67
 TIME COMPUTED 10:22:24
 DATE RECORDED 7-MAY-87
 TIME RECORDED 2:17:0
 PROJECT NUMBER V-A-37

RUN CODE M PI TT Q P T RE A REF LENGTHS(CLM,CLM,CLL)
 19 J 3.51 52.97 591.7 5.905 0.685 170.8 0.550E+07 0.289 3.000 2.200 2.200
 CONFIG
 1.3.2.2.2.w16
 TWIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPI	PHI	PI	TT	Q	P	CPBA	CART	PBA/P	PB1/P	PR2/P	PB3/P	PB4/P
1	0.01	0.00	52.97	591.7	5.905	0.685	-0.0551	0.0500	0.5245	0.5284	0.3927	0.7708	0.4080
2	0.01	0.00	53.03	591.7	5.912	0.680	-0.0552	0.0500	0.5243	0.5258	0.3932	0.7709	0.4075
3	0.01	0.01	53.01	591.7	5.909	0.685	-0.0550	0.0498	0.5258	0.5260	0.3934	0.7763	0.4077
4	0.01	0.00	53.11	591.7	5.921	0.687	-0.0550	0.0499	0.5255	0.5250	0.3936	0.7757	0.4079
5	0.01	0.01	53.04	591.7	5.913	0.686	-0.0549	0.0498	0.5265	0.5276	0.3941	0.7757	0.4084
6	0.01	0.00	52.92	592.7	5.900	0.684	-0.0548	0.0497	0.5274	0.5269	0.3940	0.7805	0.4084

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CX	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.01	0.00	0.2695	0.7354	0.0176	0.0733	-0.0007	0.4021	0.3522	0.5429	0.4918	
2	0.01	0.00	0.2698	0.7360	0.0176	0.0731	-0.0006	0.4022	0.3522	0.5430	0.4938	
3	0.01	0.01	0.2698	0.7364	0.0176	0.0737	-0.0008	0.4023	0.3524	0.5428	0.4895	
4	0.01	0.00	0.2696	0.7354	0.0177	0.0737	-0.0007	0.4021	0.3523	0.5430	0.4924	
5	0.01	0.01	0.2700	0.7361	0.0177	0.0740	-0.0009	0.4025	0.3527	0.5432	0.4895	
6	0.01	0.00	0.2694	0.7361	0.0176	0.0736	-0.0007	0.4026	0.3529	0.5429	0.4941	

DATE COMPUT. 9-JUN-87
 TIME COMPUTED 10:22:39
 DATE RECORDED 7-MAY-87
 TIME RECORDED 3: 7: 2
 PROJECT NUMBER V-A-37

CALSPAN CORPORATION
 AEDC DIVISION
 VON KARMAN GAS DYNAMICS FACILITY
 ARNOLD AIR FORCE STATION, TENNESSEE
 HOLLOWAY ROCKET SLED
 PAGE 1

RUN CODE M PT TT Q P T RE A REF LENGTHS(CLM,CLM,CLL)
 20 3 4.02 69.11 590.7 5.014 0.443 139.6 0.552E+07 8.289 3.090 2.200 2.200

CONFIG
 1.3.2.2.2.M16

INIP
 0.025

---TUNNEL CONDITIONS, BASE PRESSURES---

PN	ALPH	PHI	PT	TT	Q	P	CPHA	CABT	PBA/P	PB1/P	PB2/P	PB3/P	PB4/P
1	0.01	0.01	69.11	590.7	5.014	0.443	-0.0390	0.0354	0.5587	0.5376	0.4085	0.8927	0.3961
2	0.01	0.01	69.20	590.7	5.020	0.444	-0.0391	0.0354	0.5580	0.5383	0.4079	0.8885	0.3971
3	0.01	0.00	69.18	590.7	5.019	0.444	-0.0390	0.0353	0.5589	0.5385	0.4061	0.8918	0.3972
4	0.01	0.01	69.24	590.7	5.023	0.444	-0.0390	0.0354	0.5584	0.5380	0.4077	0.8910	0.3969
5	0.01	0.01	69.92	590.7	5.000	0.442	-0.0390	0.0353	0.5591	0.5391	0.4081	0.8922	0.3972
6	0.01	0.01	69.87	590.7	4.996	0.442	-0.0390	0.0353	0.5591	0.5379	0.4084	0.8927	0.3975

--- BODY AXES ---

PN	ALPHA	PHI	CN	CLM	CY	CLN	CLL	CAT	CA	NCP/LM	YCP/LM	FOUL
1	0.03	0.01	0.3094	0.7797	0.0142	0.0600	-0.0024	0.3847	0.3493	0.5753	0.4871	
2	0.03	0.00	0.3093	0.7793	0.0143	0.0602	-0.0023	0.3846	0.3491	0.5753	0.4857	
3	0.03	0.00	0.3094	0.7794	0.0143	0.0603	-0.0023	0.3845	0.3491	0.5753	0.4855	
4	0.03	0.00	0.3095	0.7797	0.0143	0.0602	-0.0023	0.3845	0.3491	0.5754	0.4863	
5	0.03	0.01	0.3092	0.7794	0.0141	0.0593	-0.0023	0.3847	0.3494	0.5757	0.4862	
6	0.03	0.00	0.3093	0.7806	0.0143	0.0601	-0.0023	0.3837	0.3484	0.5746	0.4888	