

—SPACE SHUTTLE—

**SURFACE PRESSURE AND  
INVISCID FLOW FIELD PROPERTIES  
OF THE NORTH AMERICAN ROCKWELL  
DELTA-WING ORBITER FOR  
NOMINAL MACH NUMBER OF 8**

by

**R.K. Matthews, ARO, INC.  
W.R. Martindale, ARO, INC.  
J.D. Warmbrod, MSFC**

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INVISCID FLOW FIELD PROPERTIES OF THE NORTH  
AMERICAN ROCKWELL DELTA-WING ORBITER FOR  
NOMINAL MACH NUMBER R.K. Matthews, et al  
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Unclas  
25161

VK F 50-INCH  
HYPERSONIC TUNNEL B

**Arnold Engineering  
Development Center**

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SADSAC SPACE SHUTTLE  
AEROTHERMODYNAMIC  
DATA MANAGEMENT SYSTEM

CONTRACT NAS8-4016  
MARSHALL SPACE FLIGHT CENTER

SPACE DIVISION  **CHRYSLER  
CORPORATION**

This document should  
be referenced as  
NASA CR-120-046

62 p 80

CAT. 31

SADSAC/SPACE SHUTTLE

WIND TUNNEL TEST DATA REPORT

CONFIGURATION: North American Rockwell Delta Wing Orbiter

TEST PURPOSE: To Determine Surface Pressures and Inviscid Flow Field  
Properties at Mach Number 8

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TEST FACILITY: AEDC VKF 50-Inch Hypersonic Tunnel B

TESTING AGENCY: AEDC-MSFC

TEST NO. & DATE: VT 1162-7; September, 1971

FACILITY COORDINATOR: Mr. L. L. Trimmer, ARO, INC.

PROJECT ENGINEER(S): Mr. R. K. Matthews, ARO, INC.  
Mr. W. R. Martindale, ARO, INC.  
Mr. J. D. Warmbrod, NASA-MSFC

DATA MANAGEMENT SERVICES

LIAISON: J. E. Vaughn DATA OPERATIONS: J. R. Ziler  
for John E. Vaughn J. R. Ziler

RELEASE APPROVAL: J. E. Vaughn  
for N. D. Kemp, Supervisor  
 Aero Thermo Data Group

CONTRACT NAS 8-4016

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**FACILITY COORDINATOR:**

Mr. L. L. Trimmer, ARO, Inc.  
Arnold Engineering Development Center  
Arnold Air Force Station, Tennessee 37389

Phone: (615) 455-2611-X7377

**PROJECT ENGINEERS:**

Mr. R. K. Matthews ARO, Inc  
Arnold Engineering Development Center  
Arnold Air Force Station, Tennessee 37389

Phone: (615) 455-2611-X594

Mr. W. R. Martindale, ARO, Inc.  
Arnold Engineering Development Center  
Arnold Air Force Station, Tennessee 37389

Phone: (615) 455-2611-X575

Mr. J. D. Warmbrod  
S&E - AERO - AF  
Building 4610  
NASA-MSFC  
Huntsville, Alabama 35812

Phone: (205) 453-0170

**SADSAC LIAISON:**

Mr. John E. Vaughn  
Chrysler Corp. - Huntsville Division  
102 Wynn Drive, Department 4820  
Huntsville, Alabama 35805

Phone: (205) 895-1560

**SADSAC OPERATIONS:**

Mr. J. R. Ziler  
Chrysler Corp. Space Division  
P. O. Box 29200, Department 2780  
New Orleans, Louisiana 70129

Phone: (504) 255-2304

## FOREWORD

The work reported herein was sponsored by the Marshall Space Flight Center (MSFC), NASA. The results of tests presented were obtained by ARO, Inc. (a subsidiary of Sverdrup & Parcel and Associates, Inc.), contract operator of the Arnold Engineering Development Center (AEDC), AFSC, Arnold Air Force Station, Tennessee. Ascent and reentry conditions were simulated on shuttle models designed by McDonnell Douglas (MDAC), North American Rockwell (NAR) and General Dynamics Convair (GDC). In addition a limited amount of data were obtained on two research models provided by the Langley Research Center (LRC). Because of the broad scope of these tests the data will be presented in a series of SADSAC reports. This report presents the results of the surface pressure and flow field tests conducted at Mach 8 in Tunnel B on the North American Rockwell Delta Wing Orbiter.

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## NOMENCLATURE

ALPHA-MODEL ( $\alpha$ )	Model angle of attack, deg
ALPHA-PREBEND	Sting prebend angle, deg
ALPHA-SECTOR	Tunnel sector angle, deg
CP	Pressure coefficient, $(P_M - (P - INF))/Q - INF$
CP-MAX	Pressure coefficient based on P01, $(P01 - (P - INF))/Q - INF$
L	Model length (29.25 in.)
MACH NO.	Free-stream Mach number
ML	Local Mach number
MU-INF	Free-stream viscosity, lb-sec/ft <sup>2</sup>
MUL	Local viscosity, lb-sec/ft <sup>2</sup>
P-INF	Free-stream pressure, psia
PM	Model surface pressure, psia
PML	Local model surface pressure, psia
P0	Tunnel stilling chamber pressure, psia
P01	Stagnation pressure downstream of a normal shock, psia
PR	Rake probe stagnation pressure, psia
Q-INF	Free-stream dynamic pressure, psia
RE/FT	Free-stream unit Reynolds number, ft <sup>-1</sup>
REL	Local unit Reynolds number, ft <sup>-1</sup>
RHO-INF	Free-stream density, LBM/ft <sup>3</sup>
RHOL	Local density, LBM/ft <sup>3</sup>
RHOUL	Local density-velocity product, LBM/ft <sup>2</sup> -sec
ROLL-MODEL ( $\phi$ )	Model roll angle, deg
T-INF	Free-stream temperature, °R

TL	Local temperature, °R
TO	Tunnel stilling chamber temperature, °R
TTR	Total temperature measured by rake probes, °R
U-INF	Free-stream velocity, ft/sec
UL	Local velocity, ft/sec
X	Axial coordinate (see Fig. 1), in.
Y	Distance from model surface or probe height (see Figs. 1 and 3), in.
YAW	Model yaw angle, deg



## SECTION 1

### INTRODUCTION

This report presents the results of a wind tunnel test program to determine surface pressures and flow field properties on the North American Rockwell orbiter configuration. The tests were conducted at the Arnold Engineering Development Center (AEDC) in Tunnel B of the von Karman Gas Dynamics Facility (VKF). The tests were conducted in September 1971.

Data were obtained at a nominal Mach number of 8 and a free-stream unit Reynolds number of  $3.7 \times 10^6$  per foot. Angle of attack was varied from 10 to 50 deg in 10-deg increments.

## SECTION 2

### MODELS AND APPARATUS

#### 2.1 MODEL DESCRIPTION

Model drawings were provided ARO, Inc. by the North American Rockwell Corporation and fabrication of the Stycast model was subcontracted to the Grumman Aircraft Corporation. The model had a 1.0-in. long steel nose and 10 windward centerline pressure orifices. A sketch showing the overall model dimensions is presented in Fig. 1 and a photograph of the configuration is shown in Fig. 2. Table 1 provides additional configuration description details but it should be pointed out that the models were cast as one smooth surface without moveable control surfaces.

#### 2.2 FACILITY DESCRIPTION

Tunnel B is a continuous, closed-circuit, variable density wind tunnel with an axisymmetric contoured nozzle and a 50-in.-diam test section.

The tunnel can be operated at a nominal Mach number of 6 or 8 at stagnation pressures from 20 to 300 and 50 to 900 psia, respectively, and at stagnation temperatures up to 1350°R. The model may be injected into the tunnel for a test run and then retracted for model cooling or model changes without interrupting the tunnel flow.

### 2.3 INSTRUMENTATION

The model flow field was surveyed with pitot-pressure and single shield total temperature probe rakes. The rakes were mounted so that pressure and temperature measurements could be made simultaneously. The rakes, support mechanism, and spacing of the probes are shown in Fig. 3.

Static and pitot-probe pressures were measured with 15 psid transducers referenced to a near vacuum for pressures less than 15 psia and to atmospheric pressure for pressures greater than 15 psia. The atmospheric reference pressure was also measured with a 15 psid transducer.

## SECTION 3

### PROCEDURE

#### 3.1 TEST CONDITIONS

Nominal test conditions are presented in the data summary sheets (Table 2) and the specific test conditions for each run are provided at the top of the data tabulation sheet for that run.

#### 3.2 DATA REDUCTION

By assuming the flow-field static pressure equal to the wall static pressure, the local Mach number (ML) was calculated from the Rayleigh pitot formula,

$$\frac{PR}{PML} = \left( \frac{6ML^2}{5} \right)^{7/2} \left( \frac{6}{7ML^2 - 1} \right)^{5/2}, \text{ for } ML \geq 1$$

or from the compressible Bernoulli equation,

$$\frac{PR}{PML} = (1 + 0.2 ML^2)^{7/2}, \text{ for } ML < 1.$$

The assumption of constant static pressure becomes less valid as the distance from the model surface increases.

The equations for the other flow field parameters are:

<u>Parameter</u>	<u>Equation</u>	<u>Units</u>
TL	$TL = \frac{T_0}{(1 + 0.2 ML^2)}$	°R
UL	$UL = (49.02)(ML) \sqrt{TL}$	ft/sec
RHOL	$RHOL = \frac{(2.70)(PML)}{TL}$	LBM/ft <sup>3</sup>
MUL	$MUL = \frac{2.27 (TL)^{3/2}}{TL + 198.6} \times 10^{-8}$	lb-sec/ft <sup>2</sup>
REL	$REL = \frac{(RHOL)(UL)}{(32.17)(MUL)}$	ft <sup>-1</sup>

The quantities calculated using TL are not valid in the model boundary layer since TTR is less than T0 and, of course, none of the calculated parameters are meaningful outside the model shock layer.

### 3.3 DATA PRECISION

Estimated uncertainties of the primary measurements are given below:

<u>Parameter</u>	<u>Uncertainty</u>
PML	±0.015 psia
P0	±1.8 psia
P01	±0.021 psia
PR	±0.015 psia (for PR ≤ 15 psia) ±0.021 psia (for PR > 15 psia)
T0	±10°R
TTR	±25°R

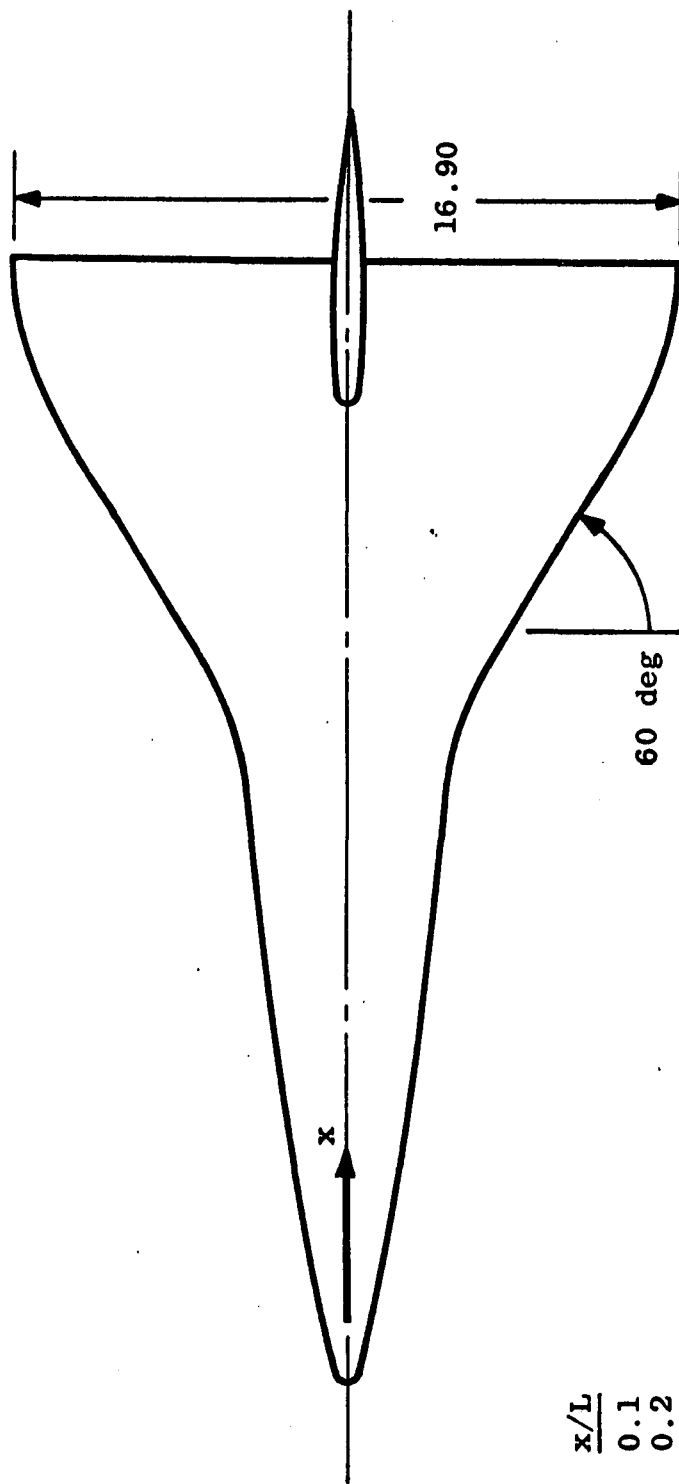
SECTION 4  
DATA PRESENTATION

The test data are presented in tabulated and plotted form in Appendixes A and B. The data are presented in the following order.

<u>Appendix</u>	<u>Type Data</u>	<u>α</u>	<u>X/L</u>
A	Surface Pressure	10	0.1 → 0.97
↓	↓	20	↓
		30	
		40	
		50	
B	Flow Field	10	0.3, 0.5, 0.7, 0.9
↓	↓	20	↓
		30	0.3, 0.7, 0.9
		40	0.7, 0.9

Table 3, Page 16, presents a summary of these data.

Pitot pressure and total temperature measurements were attempted at X/L stations of 0.7 and 0.9 at 50 degrees angle of attack; however, the rakes and support distorted the flow field as observed in shadowgraph photographs and therefore these measurements are not presented.



Pressure Orifice	x/L
1	0.1
2	0.2
3	0.3
4	0.4
5	0.5
6	0.6
7	0.7
8	0.8
9	0.9
10	0.97

All Dimensions in Inches  
 Model Scale ~ 0.013

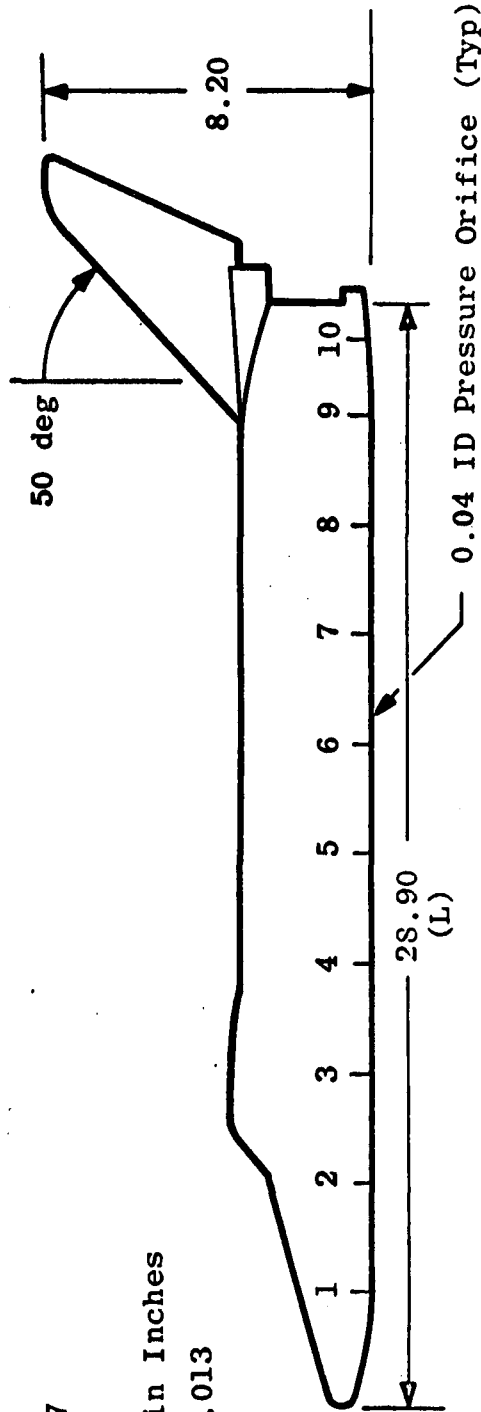
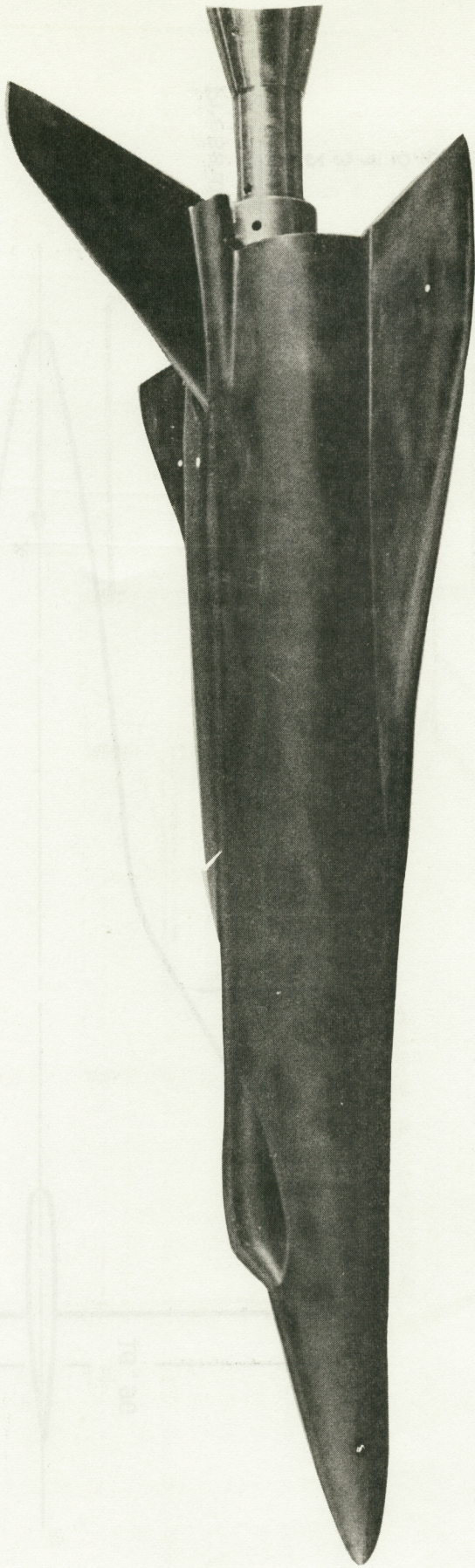


Fig. 1 North American Rockwell Delta Wing Orbiter Model Sketch (0.013 Scale)

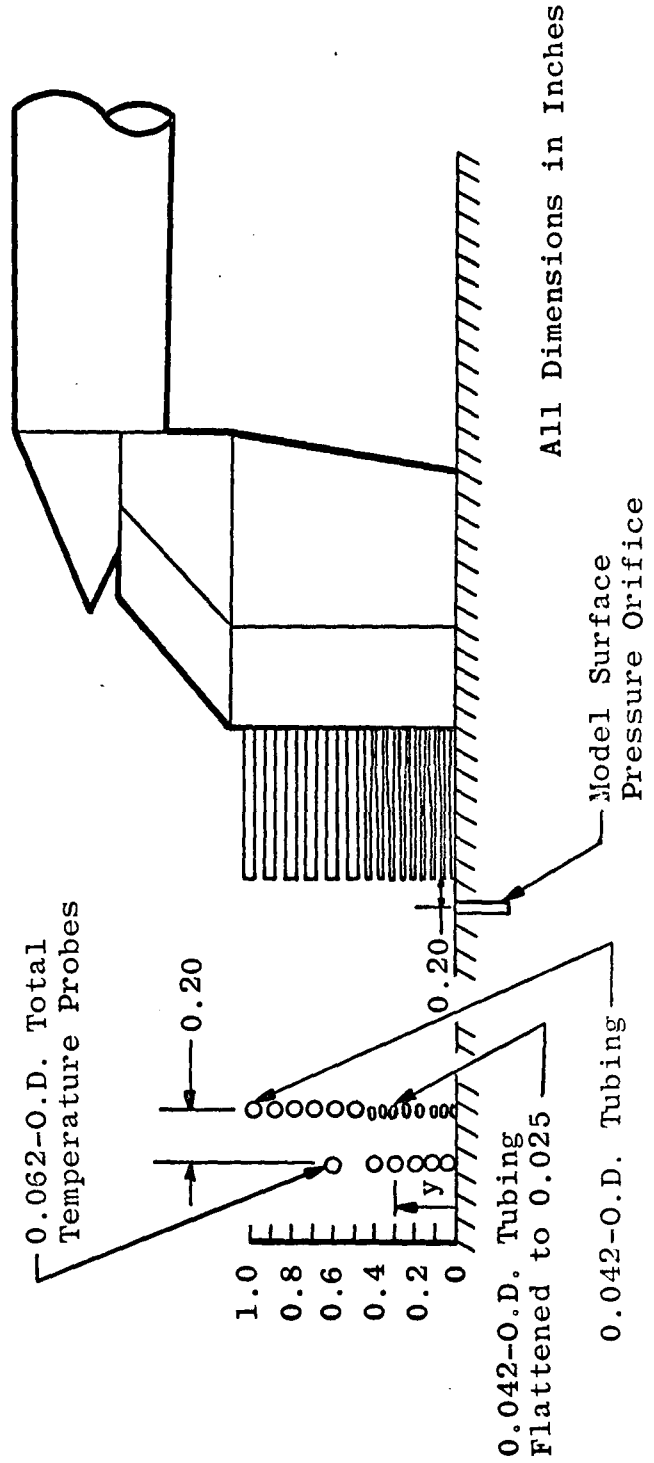
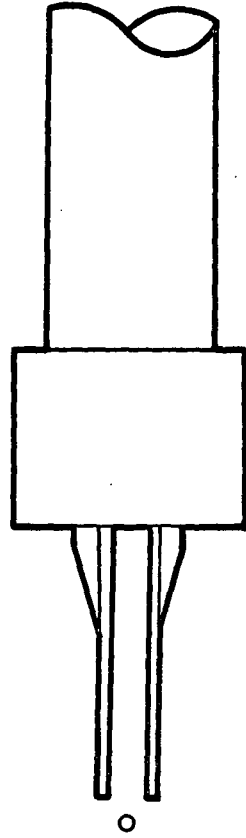


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Fig. 2 Model Photograph

Probe Height, Y, in.	
No.	Temperature Probes
1	0.014
2	0.066
3	0.112
4	0.163
5	0.216
6	0.258
7	0.313
8	0.365
9	0.415
10	0.499
11	0.606
12	0.702
13	0.802
14	0.892
15	0.981



All Dimensions in Inches

Fig. 3 Probe-Rakes and Support

TABLE 1  
CONFIGURATION DESCRIPTION DETAILS

MODEL COMPONENT: BODY - B6

GENERAL DESCRIPTION: Basic delta wing fuselage. Fuselage reference plane  
is located at water plane 400.00 in.

Model scale = 0.013

DRAWING NUMBER: NR 9992-161B

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length	<u>2223.00</u>	<u>28.899</u>
Max. Width	<u>495.80</u>	<u>6.445</u>
Max. Depth	<u>263.00</u>	<u>3.419</u>
Fineness Ratio	<u>6.019</u>	<u>6.019</u>
Area		
Max. Cross-Sectional	<u>743.95</u>	<u>.1257</u>
Planform	<u>DNA</u>	<u>DNA</u>
Wetted	<u>DNA</u>	<u>DNA</u>
Base	<u>DNA</u>	<u>DNA</u>



TABLE 1 - CONTINUED

MODEL COMPONENT: Wing - W<sub>21</sub>GENERAL DESCRIPTION: Delta wing with -5° twist and rounded wing tips. Wing  
blended into body. Used with body B6.

Model Scale = 0.013

DRAWING NUMBER: NR 9992-161B

DIMENSIONS: FULL-SCALE MODEL SCALE

TOTAL DATA

Area, ft <sup>2</sup>	6511.00	1.100
Planform	-	-
Wetted	-	-
Span (equivalent), in.	1272.38	16.541
Aspect Ratio	1.714	1.714
Rate of Taper	1.719	1.719
Taper Ratio	0.144	0.144
Diehedral Angle, degrees	7.000	7.000
Incidence Angle, degrees	0.000	0.000
Aerodynamic Twist, degrees	-5.000	-5.000
Incidence, Root (B.P. 247.90)	0.000	0.000
Incidence, Tip (B.P. 557.70)	-5.000	-5.000
Sweep Back Angles, degrees		
Leading Edge	59.808	59.808
Trailing Edge	0.000	0.000
0.25 Element Line	52.197	52.197
Chords:		
Root (Wing Sta. 0.0)	1287.70	16.740
Tip, (equivalent) (W.S. 640.97)	186.00	2.418
MAC, inches (W.S. 240.62)	874.10	11.363
Fus. Sta. of .25 MAC	1793.32	23.313
W.P. of .25 MAC	280.73	3.649
Airfoil Section		
Root	NACA 0009-64	
Tip	NACA 0012-64	

EXPOSED DATA

Area, ft <sup>2</sup>	3023.00	.5109
Span, (equivalent), in.	810.61	10.538
Aspect Ratio	1.498	1.498
Taper Ratio	0.209	0.209
Chords		
Root (Equiv.) (W.S. 232.62)	887.85	11.542
Tip (Equiv.) (W.S. 640.97)	186.00	2.418
MAC (W.S. 392.31)	613.38	7.974
Fus. Sta. of .25 MAC	1988.85	25.855
W.P. of .25 MAC	299.22	3.890



TABLE 1 - CONTINUED

MODEL COMPONENT: Elevon - E<sub>11</sub> (Data for one of two sides)

GENERAL DESCRIPTION: Constant chord elevon located on delta wing - W<sub>21</sub>

Model Scale = 0.013

DRAWING NUMBER: NR 9992-161B

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Area (true), ft <sup>2</sup>	<u>423.09</u>	<u>0.0715</u>
Span (equivalent), in.	<u>417.30</u>	<u>5.425</u>
Inb'd equivalent chord (W.S. 237.48)	<u>146.00</u>	<u>1.898</u>
Outb'd equivalent chord (W.S. 654.78)	<u>146.00</u>	<u>1.898</u>
Ratio Moveable Surface Chord/ Total Surface Chord		
At Inb'd equiv. chord	<u>0.166</u>	<u>0.166</u>
At Outb'd equiv. chord	<u>0.900</u>	<u>0.900</u>
Sweep Back Angles, degrees		
Leading Edge	<u>0.000</u>	<u>0.000</u>
Tailing Edge	<u>0.000</u>	<u>0.000</u>
Hingeline	<u>0.000</u>	<u>0.000</u>
Area Moment (Normal to hinge line), ft <sup>3</sup> (Product of area and mean chord)	<u>5144.00</u>	<u>0.01130</u>

TABLE 1 - CONTINUED

MODEL COMPONENT: Orbital Maneuvering System Shroud - Z<sub>2</sub>

GENERAL DESCRIPTION: Fairing over orbital maneuvering system. Located on aft upper fuselage mold line.

Model Scale = 0.013

DRAWING NUMBER: NR 9992-161B

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Length (along upper surface), in.	<u>359.31</u>	<u>4.671</u>
Sta. of Leading Edge, in.	<u>2163.33</u>	<u>          </u>
Sta. of Trailing Edge, in.	<u>2523.56</u>	<u>          </u>
Pitch Angle (T.E. Up), deg.	<u>3.181</u>	<u>3.181</u>
Area		
Max. Cross-Sectional	<u>          </u>	<u>          </u>
Planform	<u>          </u>	<u>          </u>
Wetted	<u>          </u>	<u>          </u>
Base	<u>          </u>	<u>          </u>

TABLE 1 - CONCLUDED

MODEL COMPONENT: Drag Brake - J4 (Data for one of two sides)

GENERAL DESCRIPTION: Drag Brake - J4 is the deflectable side panel of the vertical tail V27 hinged at 60% element line and extending to the trailing edge.

Model Scale = 0.013

DRAWING NUMBER: NR 9992-161B

(All dimensions are in the drag brake reference plane)

<u>DIMENSIONS:</u>	<u>FULL-SCALE</u>	<u>MODEL SCALE</u>
Area, ft <sup>2</sup>	<u>242.39</u>	<u>.0410</u>
Span (equivalent), in.	<u>355.61</u>	<u>4.623</u>
Inb'd equivalent chord, in. (W.P. 520.18)	<u>149.22</u>	<u>1.940</u>
Outb'd equivalent chord, in.	<u>47.08</u>	<u>.612</u>
Ratio Elevator chord/horizontal tail chord		
At Inb'd equiv. chord	<u>-</u>	<u>-</u>
At Outb'd equiv. chord	<u>-</u>	<u>-</u>
Sweep Back Angles, degrees		
Leading Edge	<u>37.273</u>	<u>37.273</u>
Tailing Edge	<u>25.352</u>	<u>25.352</u>
Hingeline	<u>37.273</u>	<u>37.273</u>
Area Moment (Normal to hinge line), ft <sup>3</sup> (Product of area and mean chord)	<u>1921.27</u>	<u>0.00422</u>

TABLE 2.

TEST DATA SUMMARY SHEETS

TEST TITLE: NAR-DWO Flow Field Tests

TEST NUMBER: VT1162

TEST FACILITY: AEDC Tunnel B

TEST DATE: September 1971

TEST ENGINEER: R. K. Matthews & W. R. Martindale

Run No.	Model Configuration Identification	Model Scale	Free Stream Mach Number	Total Pressure (psia)	Total Temp. (°R)	Re/ft × 10 <sup>-6</sup>	Flow Field Survey Station X/L	Type Data*	Model Position (degrees)		Remarks.
									α	φ	
320	NAR-DWO	0.013	8.0	860	1340	3.7	N/A	SP	10	0	180
321									20		
322									30		
323									40		
324									50		
316							0.3	FF	10		
312							0.5				
308							0.7				
303							0.9				
317							0.3			20	
315							0.5				
309							0.7				
306							0.9				

\*SP - Surface Pressure  
FF - Flow Field



TABLE 3  
SUMMARY DATA PLOT INDEX

TYPE OF DATA	PAGES	ANGLE OF ATTACK - DEGREES					FLOW FIELD SURVEY STATION (X/L)					
		10	20	30	40	50	0.3	0.5	0.7	0.9		
<u>SURFACE PRESSURE</u> ↑	19	X										
	21		X									
	23			X								
	25				X							
	27					X						
<u>FLOW FIELD</u> ↑	30	X										
	32	X										
	34	X										
	36	X										X
	38											
	40		X									
	42		X									
	44		X									
	46											
	48			X								
50			X								X	
52				X							X	
54				X							X	

SURFACE PRESSURE  
PM/POI vs. X/L

FLOW FIELD  
Y vs. PR/POI      Y vs. UL/U-INF  
Y vs. TTR/TO      Y vs. RHOUL/RHO  
Y vs. ML



APPENDIX A  
SURFACE PRESSURE

PAGE = 1

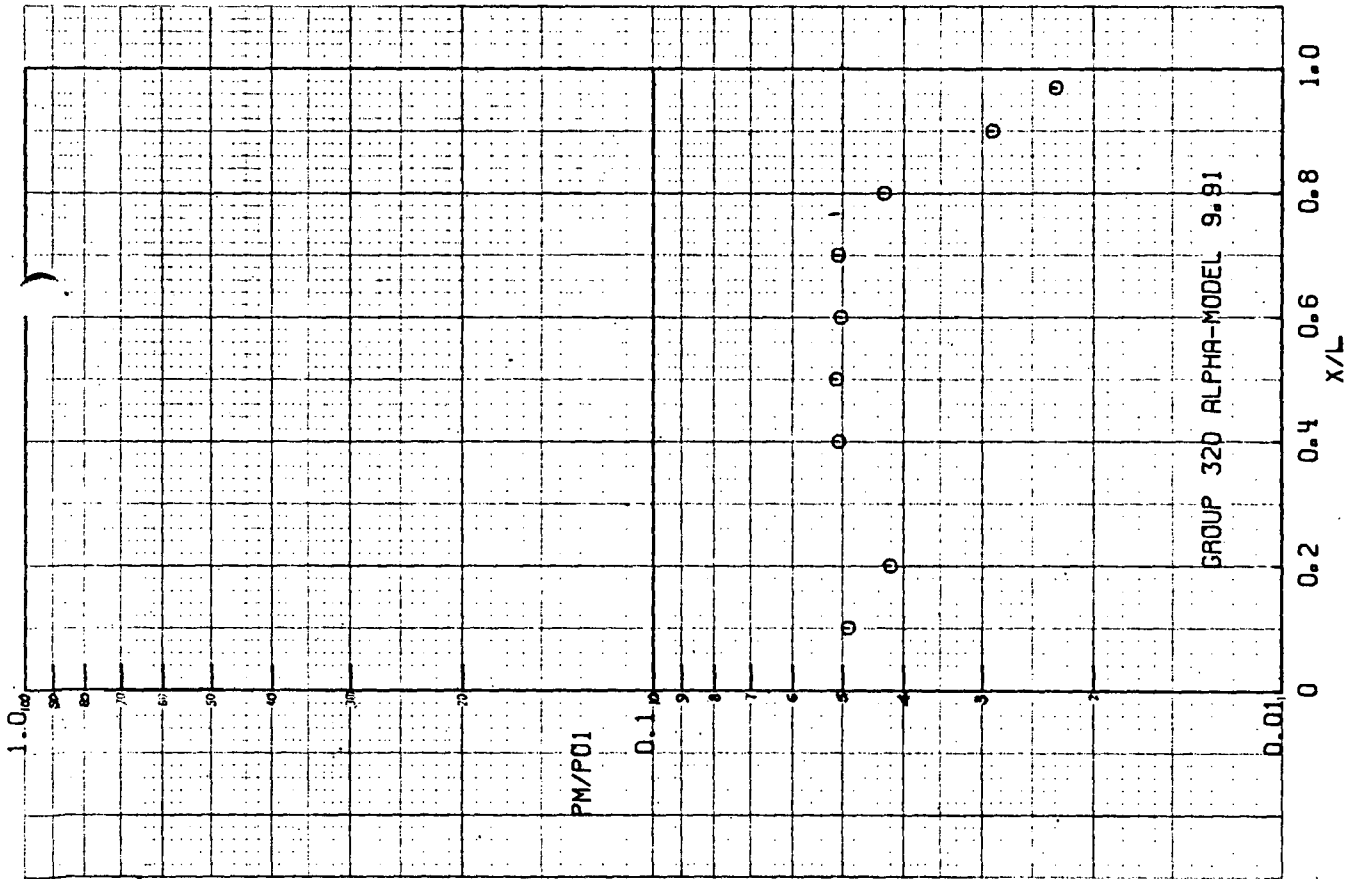
10/21/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
VON KARMAN GAS DYNAMICS FACILITY  
50 INCH HYPERSONIC TUNNEL B  
VT1162

GROUP 320 CONFIG 53 MACH NO. 8.00 PO PSIA 862.8 TO DEG R 1342 ALPHA-MODEL 9.91 ALPHA-SECTOR 13.09 ALPHA-PREBEND -23.00 ROLL-MODEL 180.00 YAW .0

T- INF (DEG R)	P- INF (PSIA)	M- INF (PSIA)	U- INF (FT/SEC)	RHO- INF (LB/FT <sup>3</sup> )	MU- INF (LB-SEC/FT <sup>2</sup> )	RE/FT (FT-1)	L (IN)
97	8.84E-02	7.323	3867	2.453E-03	7.829E-08	3.767E 06	28.90
CH POS TAP	PM (PSIA)	PM/PO	PM/P- INF	CP	CP/CP- MAX	X/L	
1 2 1	3.585E-01	4.155E-04	4.057E 00	6.823E-02	3.734E-02	.100	
2 2 2	3.077E-01	3.566E-04	3.481E 00	5.539E-02	3.031E-02	.200	
4 2 4	3.710E-01	4.300E-04	4.198E 00	7.139E-02	3.907E-02	.400	
5 2 5	3.750E-01	4.347E-04	4.243E 00	7.240E-02	3.962E-02	.500	
6 2 6	3.688E-01	4.274E-04	4.173E 00	7.083E-02	3.876E-02	.600	
7 2 7	3.719E-01	4.311E-04	4.209E 00	7.162E-02	3.919E-02	.700	
8 2 8	3.151E-01	3.652E-04	3.565E 00	5.726E-02	3.133E-02	.800	
9 2 9	2.115E-01	2.451E-04	2.393E 00	3.110E-02	1.702E-02	.900	
10 2 10	1.681E-01	1.948E-04	1.902E 00	2.013E-02	1.102E-02	.970	

GROUP  
320



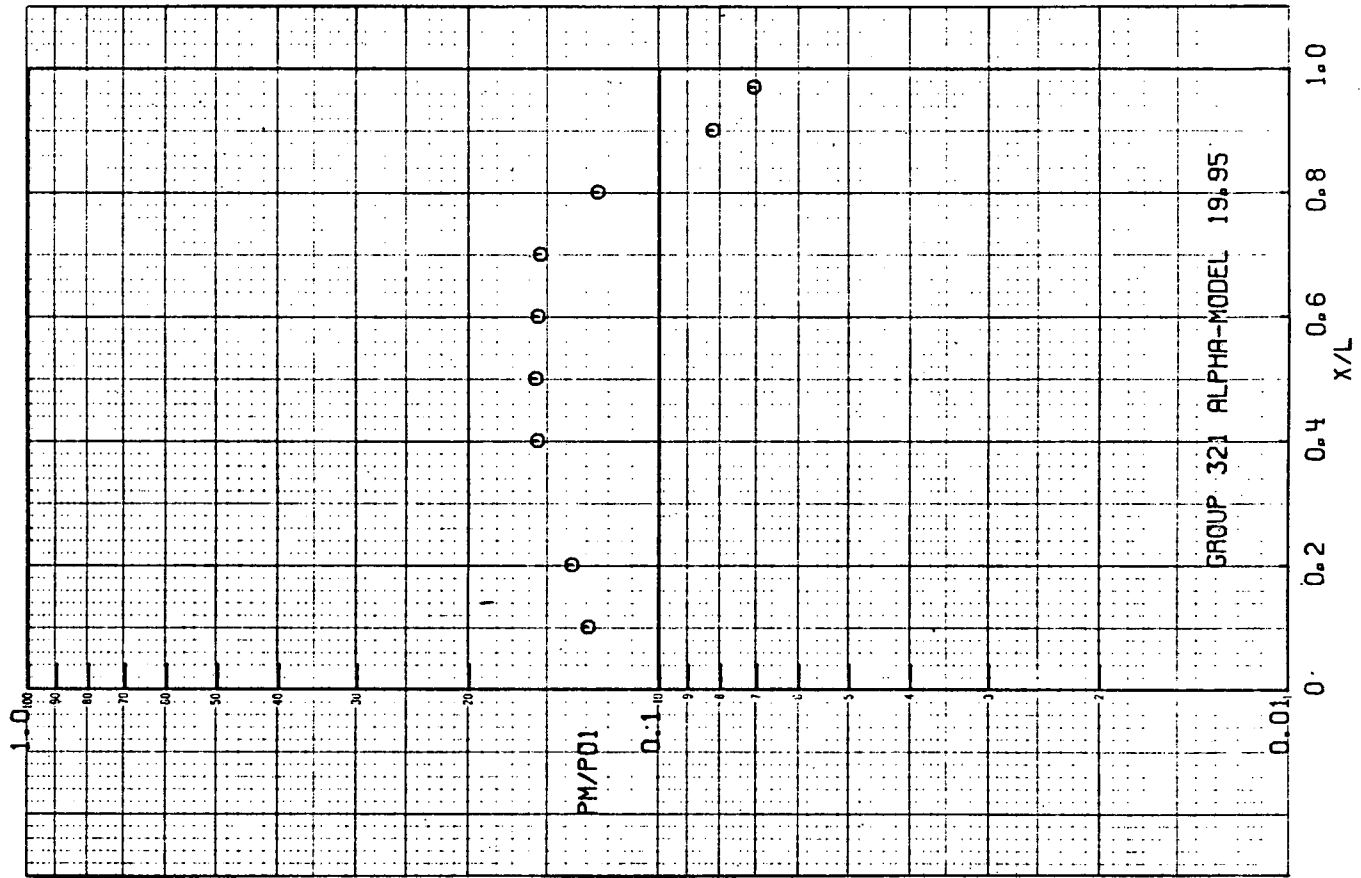
AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 VT1102

GROUP CONFIG MCDL MACH NO. PO PSIA TO DEG R ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW

321 53 NAR-DWO 8.00 862.3 1342 19.96 3.04 -23.00 180.00 .0

T-INF (DEG R) 97 P-INF (PSIA) 8.83E-02 P-INT (PSIA) 7.319 O-INF (PSIA) 3.957 U-INF (FT/SEC) 3867 RHO-INF (LBN/FT3) 2.451E-03 MU-INF (LB-SEC/FT2) 7.829E-08 RE/FT (FT-I) (IN) 28.90

CH	POS	TAP	PM (PSIA)	PM/PO	PM/POI	PH/P-INF	CP	CP/CP-MAX	X/L
1	2	1	9.480E-01	1.099E-03	1.295E-01	1.073E 01	2.173E-01	1.189E-01	.100
2	2	2	1.007E 00	1.168E-03	1.376E-01	1.140E 01	2.322E-01	1.271E-01	.200
4	2	4	1.141E 00	1.323E-03	1.559E-01	1.292E 01	2.660E-01	1.456E-01	.400
5	2	5	1.149E 00	1.333E-03	1.570E-01	1.301E 01	2.681E-01	1.467E-01	.500
6	2	6	1.139E 00	1.321E-03	1.575E-01	1.290E 01	2.654E-01	1.454E-01	.600
7	2	7	1.129E 00	1.310E-03	1.543E-01	1.279E 01	2.631E-01	1.440E-01	.700
8	2	8	9.167E-01	1.063E-03	1.253E-01	1.038E 01	2.094E-01	1.140E-01	.800
9	2	9	6.030E-01	6.993E-04	8.239E-02	6.827E 00	1.301E-01	7.119E-02	.900
10	2	10	5.177E-01	6.004E-04	7.074E-02	5.862E 00	1.085E-01	5.939E-02	.970

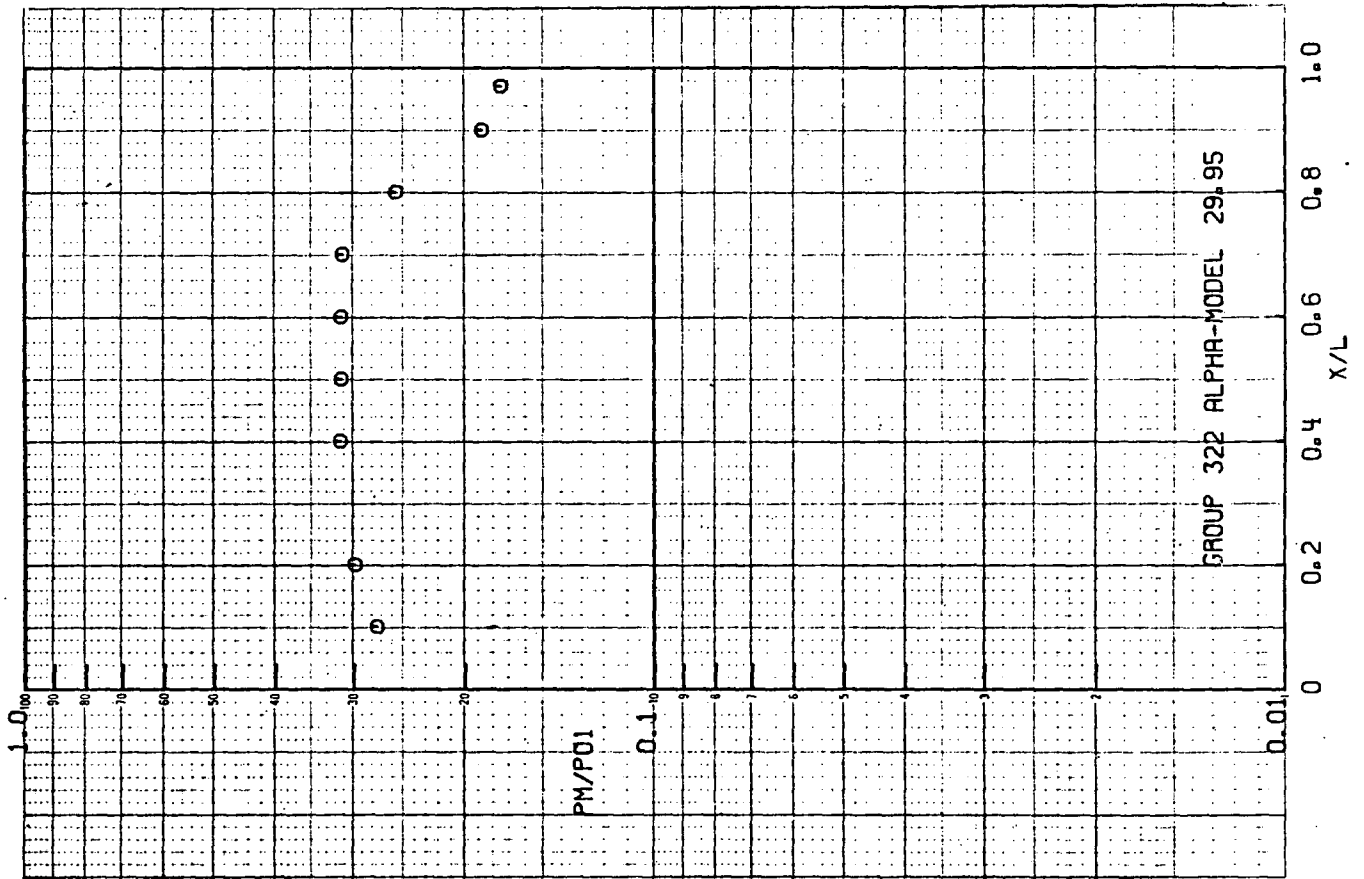


AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 VT1162

GROUP 322 CONFIG 53 MODEL NAR-DWO MACH NO. 8.00 PO PSIA 861.7 TO DEG R 1342 ALPHA-MODEL 29.95 ALPHA-SECTOR -6.95 ALPHA-PREBEND -23.00 ROLL-MODEL 180.00 YAW .0

T-INF (DEG R) 97 P-INF (PSIA) 8.83E-02 P01 (PSIA) 7.314 O-INF (PSIA) 3.954 U-INF (FT/SEC) 3867 RHO-INF (LBM/FT3) 2.850E-03 MU-INF (LB-SEC/FT2) 7.829E-08 RE/FT (FT-1) 3.762E 06 L (IN) 28.90

CH	POS	TAP	PH (PSIA)	PM/PO	PM/PO1	PH/P-P-INF	CP	CP/CP-MAX	X/L
1	2	1	2.013E 00	2.336E-03	2.752E-01	2.281E 01	4.868E-01	2.664E-01	.100
2	2	2	2.182E 00	2.532E-03	2.984E-01	2.572E 01	5.296E-01	2.898E-01	.200
4	2	4	2.298E 00	2.667E-03	3.142E-01	2.604E 01	5.589E-01	3.058E-01	.400
5	2	5	2.292E 00	2.660E-03	3.134E-01	2.597E 01	5.573E-01	3.050E-01	.500
6	2	6	2.294E 00	2.662E-03	3.136E-01	2.599E 01	5.578E-01	3.052E-01	.600
7	2	7	2.280E 00	2.646E-03	3.117E-01	2.583E 01	5.542E-01	3.033E-01	.700
8	2	8	1.878E 00	2.180E-03	2.568E-01	2.128E 01	4.527E-01	2.478E-01	.800
9	2	9	1.375E 00	1.596E-03	1.881E-01	1.558E 01	3.254E-01	1.782E-01	.900
10	2	10	1.283E 00	1.489E-03	1.754E-01	1.454E 01	3.022E-01	1.654E-01	.970



10/21/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 VII162

GROUP CONFIG MODEL MACH NO. PO PSIA TO DEG R ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW

323 53 NAR-DWO 8.00 861.4 1341 39.59 10.92 50.00 180.00 .0

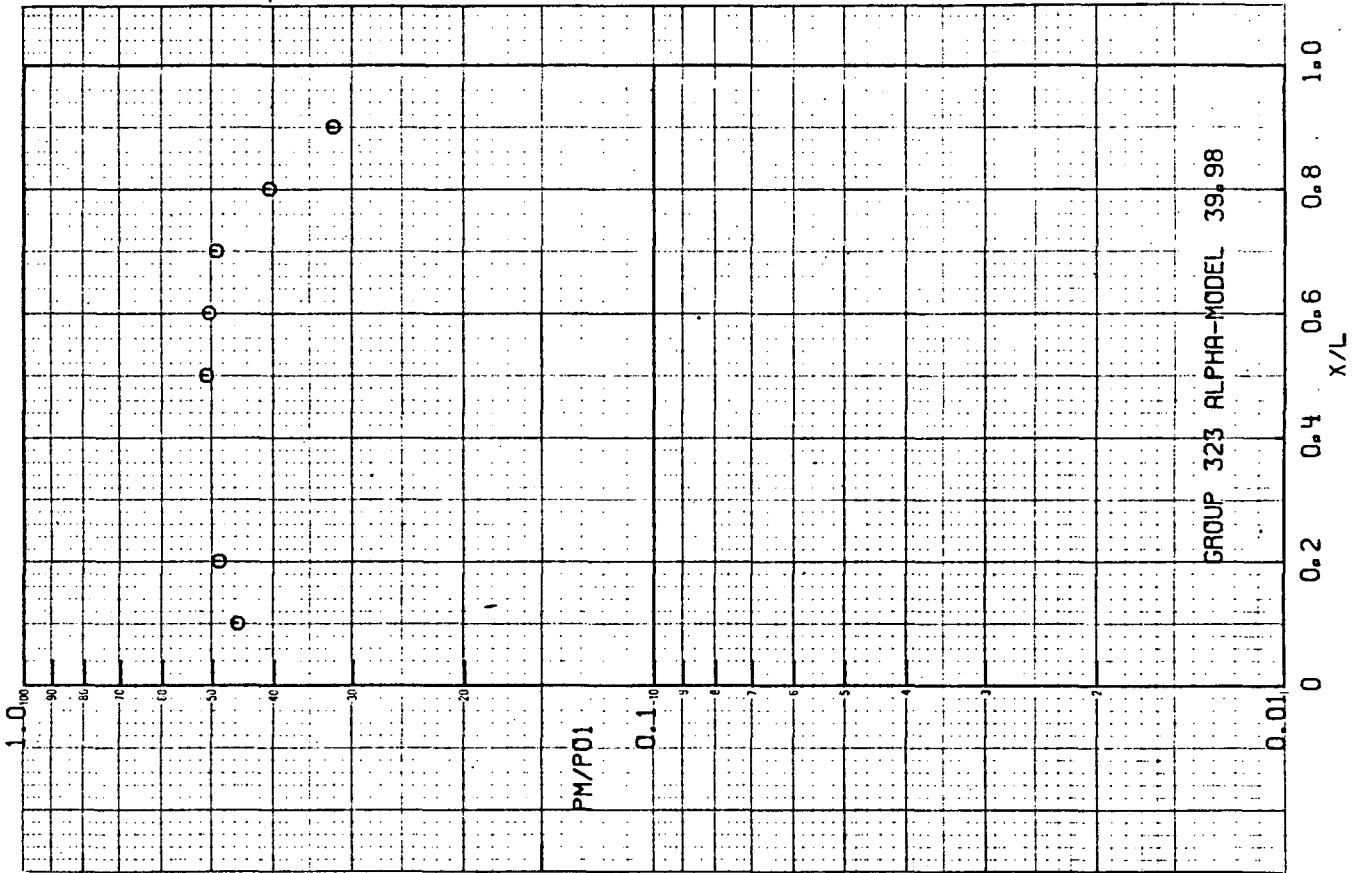
T-INF P-INF Q-INF RHO-INF MU-INF RE/FT L  
 (DEG R) (PSIA) (PSIA) (LB/FT<sup>3</sup>) (LB-SEC/FT<sup>2</sup>) (FT-1) (IN)

97 8.82E-02 7.311 3.953 2.451E-03 7.823E-08 3.765E 06 28.90

CH POS TAP PM PM/PO PM/PO1 PM/P-INF CP CP/CP-MAX X/L

1	2	1	3.334E 00	3.871E-03	4.561E-01	3.779E 01	8.213E-01	4.494E-01	.100
2	2	2	3.570E 00	4.145E-03	4.893E-01	4.047E 01	8.810E-01	4.821E-01	.200
5	2	5	3.733E 00	4.334E-03	5.107E-01	4.232E 01	9.222E-01	5.047E-01	.500
6	2	6	3.692E 00	4.287E-03	5.050E-01	4.185E 01	9.118E-01	4.990E-01	.600
7	2	7	3.598E 00	4.177E-03	4.921E-01	4.078E 01	8.879E-01	4.859E-01	.700
8	2	8	2.968E 00	3.445E-03	4.059E-01	3.364E 01	7.285E-01	3.986E-01	.800
9	2	9	2.347E 00	2.725E-03	3.211E-01	2.661E 01	5.716E-01	3.128E-01	.900





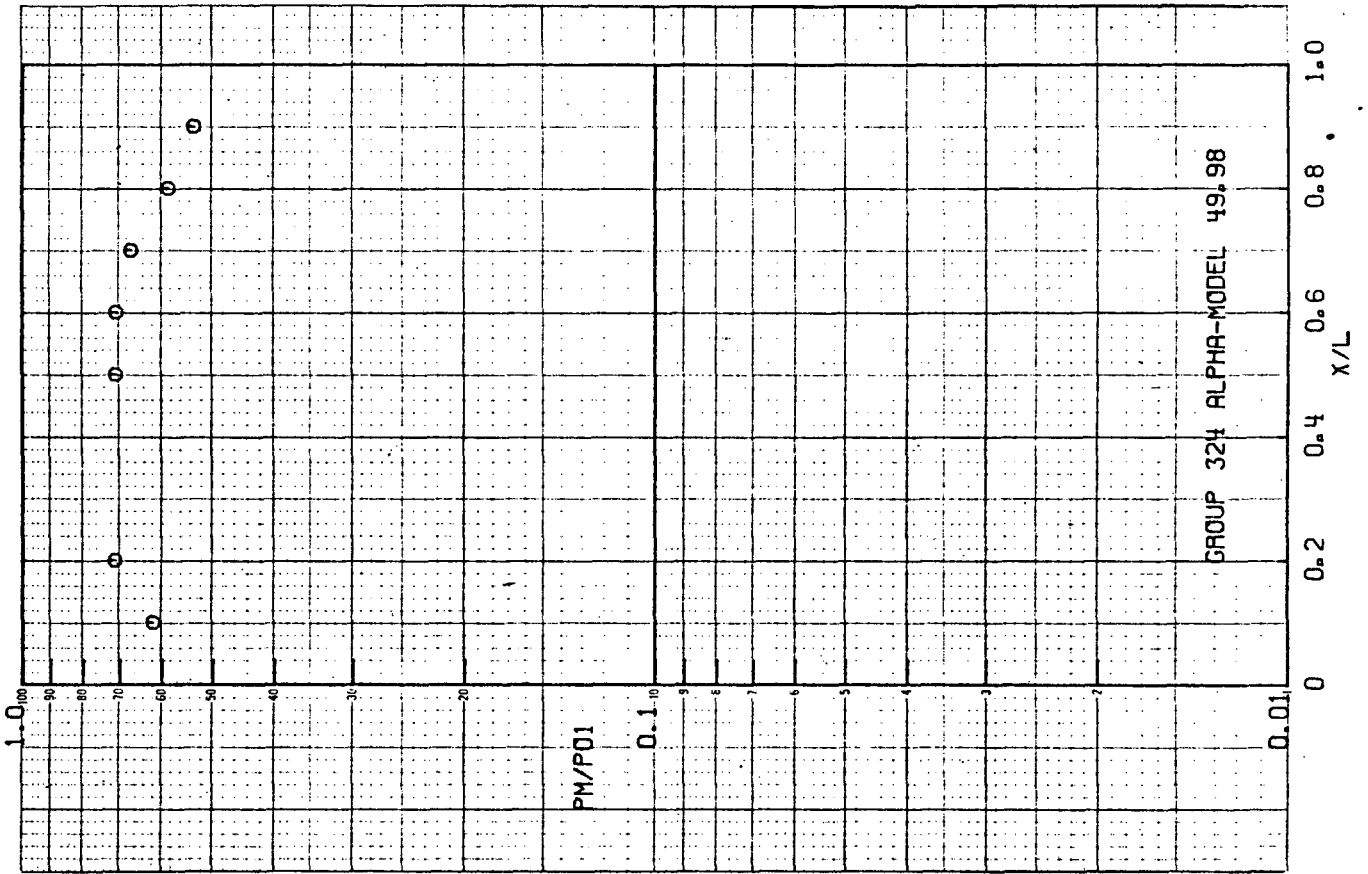
AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 VT1162

GROUP 324 CONFIG MODEL MACH NO. PO PSTA TO DEG R ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW

53 NAR-DWO 8.00 859.8 134.0 49.99 .01 -50.00 180.00 .0

T-INF (DEG R) 97 P-INF (PSIA) 8.81E-02 POI (PSIA) 7.297 O-INF (PSIA) 3.945 U-INF (FT/SEC) 3864 RHO-INF (LBX/FT3) 2.448E-03 MU-INF (LB-SEC/FT2) 7.818E-08 RE/FT (FT-1) (IN) 28.90 L

CH	POS	TAP	PM (PSIA)	PM/PO	PM/PO1	PM/P-INF	CP	CP/CP-MAX	X/L
1	2	1	4.529E 00	5.267E-03	6.206E-01	5.142E 01	1.126E 00	6.159E-01	.100
2	2	2	5.211E 00	6.061E-03	7.140E-01	5.917E 01	1.298E 00	7.105E-01	.200
5	2	5	5.188E 00	6.035E-03	7.110E-01	5.892E 01	1.298E 00	7.075E-01	.500
6	2	6	5.191E 00	6.038E-03	7.114E-01	5.895E 01	1.294E 00	7.079E-01	.600
7	2	7	4.918E 00	5.720E-03	6.739E-01	5.585E 01	1.224E 00	6.699E-01	.700
8	2	8	4.289E 00	4.889E-03	5.878E-01	4.871E 01	1.065E 00	5.828E-01	.800
9	2	9	3.910E 00	4.548E-03	5.359E-01	4.441E 01	9.689E-01	5.302E-01	.900

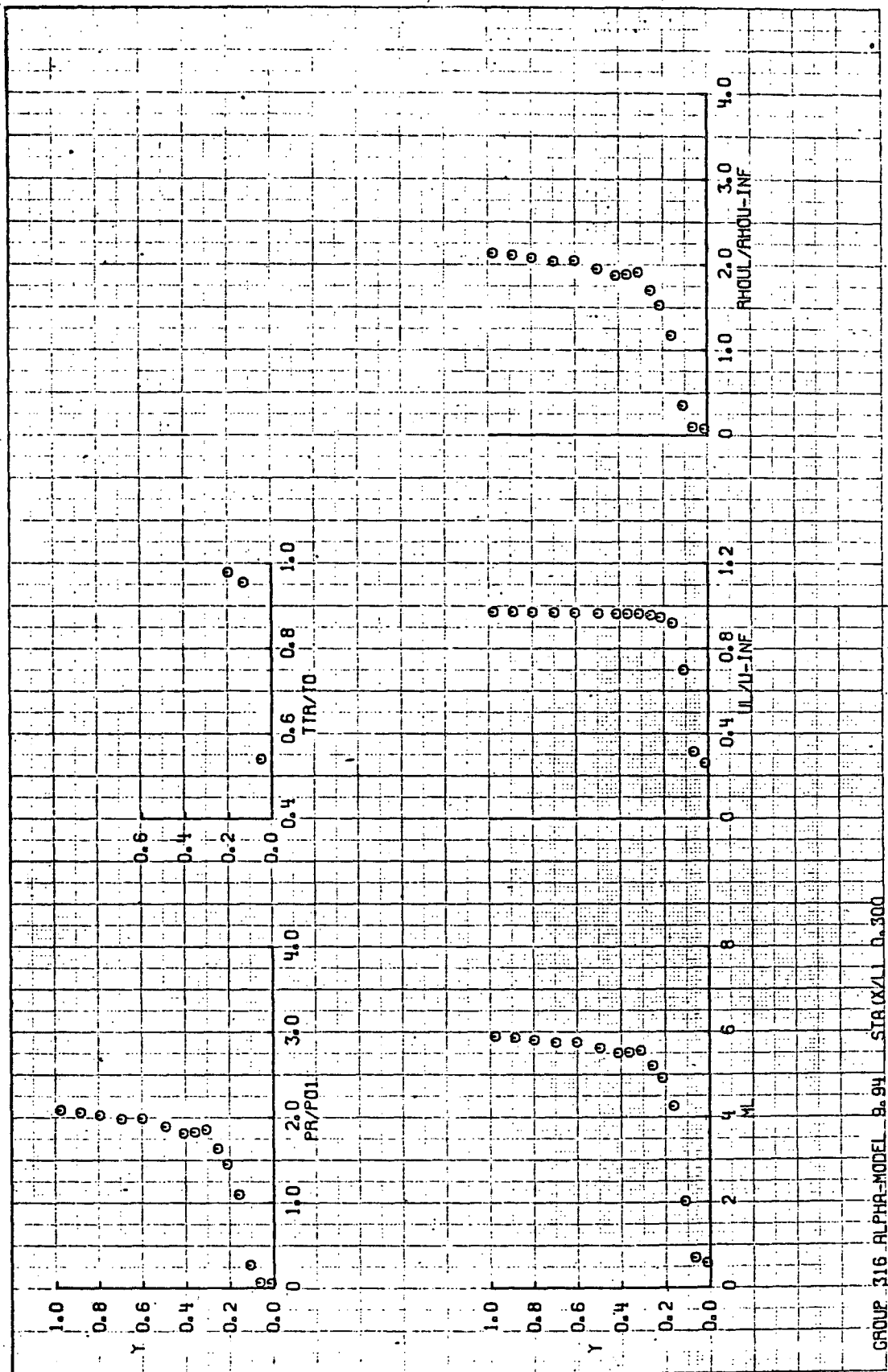


APPENDIX B  
FLOW FIELD DATA

AEVC (AFC) INC., ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL H  
 V11162

GROUP	CONFIG	MODEL	MACH NO.	PO PSIA	10 DEG H	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW				
316	53	NAR-DWO	8.00	862.4	1342	9.95	13.05	-23.00	180.00	.0				
T-INF	(DEG R)	P-INF	(PSIA)	P01	(PSIA)	U-INF	(FT/SEC)	RHO-INF	(LBM/FT3)	MU-INF	(LB-SEC/FT2)	RE/FT	MODEL STA	L
97		8.83E-02	7.320		3.957	3867		2.452E-03	7.829E-08	3.765E-06			(X/L)	(IN)
CH	POS	TAP	PH	PR/P01	Y(IN)	PML/PR	ML	RFL	TL/T-INF	UL/U-INF	RHOL/RHO-INF	RHOUL/RHOU-INF	MUL/MU-INF	
1	3	1	4.230E-01	5.779E-02	.014	7.960E-01	.580	3.262E-04	12.929	.261	.2948	.0769	8.878	
2	3	2	4.647E-01	6.418E-02	.066	7.168E-01	.706	4.108E-04	12.548	.313	.3038	.0950	8.710	
3	3	3	1.253E-00	2.668E-01	.112	1.728E-01	2.030	2.139E-05	7.564	.698	.5039	.3518	6.192	
4	3	4	8.020E-00	1.096E-00	.163	4.198E-02	4.259	1.510E-06	2.982	.919	1.2782	1.1752	2.931	
5	3	5	1.063E-01	1.453E-00	.216	3.168E-02	4.917	2.431E-06	2.365	.945	1.6118	1.5236	2.359	
6	3	6	1.194E-01	1.632E-00	.258	2.819E-02	5.214	2.980E-06	2.144	.954	1.7780	1.6968	2.144	
7	3	7	1.358E-01	1.855E-00	.313	2.479E-02	5.565	3.759E-06	1.918	.964	1.9873	1.9149	1.918	
8	3	8	1.337E-01	1.826E-00	.365	2.519E-02	5.521	3.651E-06	1.945	.962	1.9598	1.8863	1.945	
9	3	9	1.326E-01	1.812E-00	.415	2.538E-02	5.499	3.600E-06	1.958	.962	1.9867	1.8727	1.958	
10	3	10	1.347E-01	1.895E-00	.459	2.428E-02	5.624	3.905E-06	1.884	.965	2.0235	1.9526	1.883	
11	3	11	1.455E-01	1.948E-00	.506	2.314E-02	5.761	4.267E-06	1.806	.968	2.1107	2.0435	1.803	
12	3	12	1.450E-01	1.941E-00	.502	2.322E-02	5.751	4.235E-06	1.812	.968	2.1033	2.0357	1.810	
13	3	13	1.482E-01	2.024E-00	.502	2.273E-02	5.815	4.412E-06	1.777	.969	2.1445	2.0786	1.774	
14	3	14	1.508E-01	2.054E-00	.492	2.236E-02	5.864	4.550E-06	1.752	.970	2.1760	2.1114	1.747	
15	3	15	1.524E-01	2.083E-00	.481	2.209E-02	5.899	4.651E-06	1.734	.971	2.1988	2.1351	1.728	

CH	TC	TTR	TTR/TC	Y(IN)	PML/P01
1	1	724	.5395	.051	4.600E-02
2	2	1240	.9538	.131	
3	3	1313	.9784	.202	



GROUP 316 ALPHA-MODEL B.94 STR (X/1) 0.300

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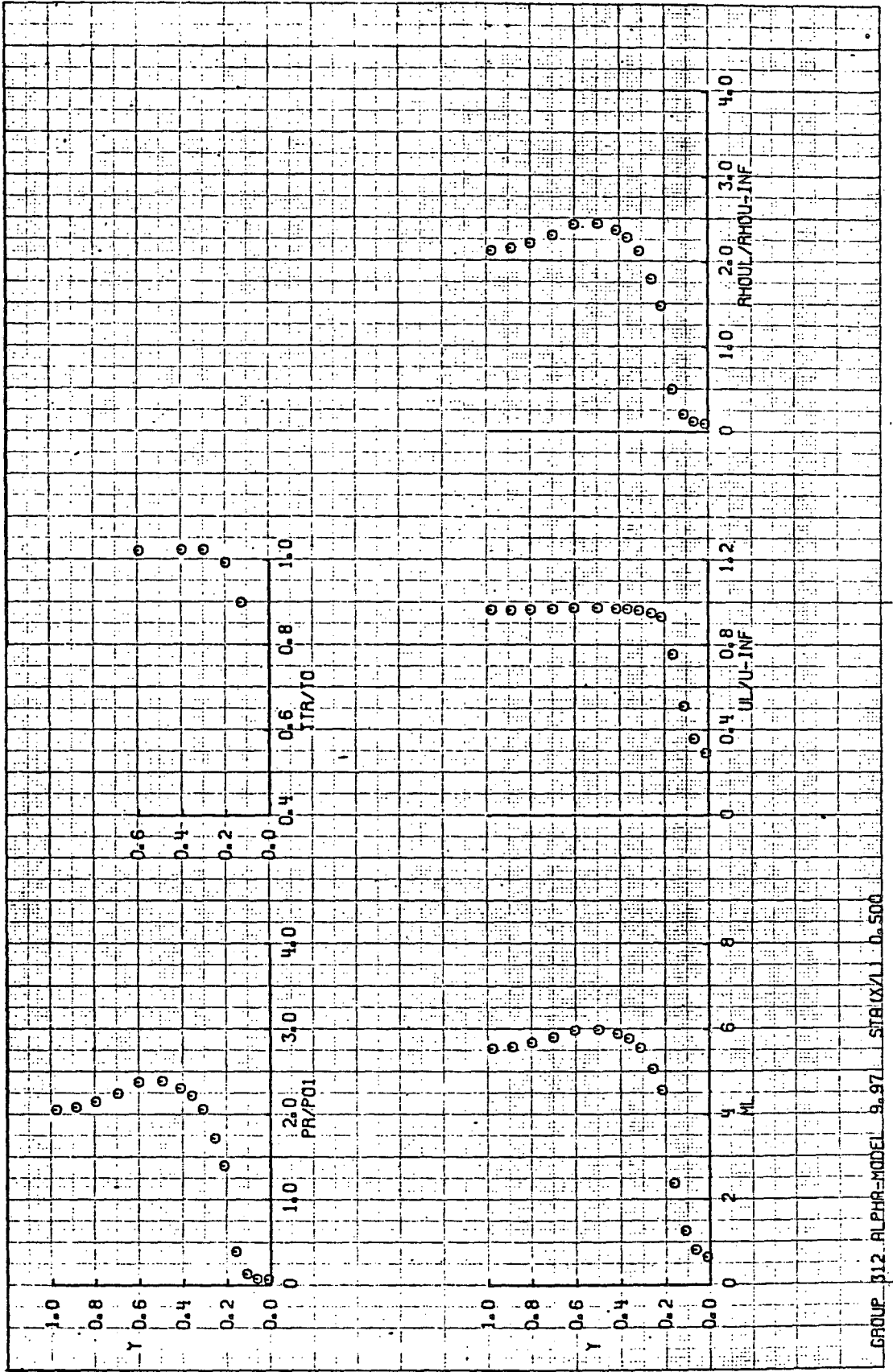
AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 Y11162

GROUP 312 CONFIG 53 MODEL NAR-DWO MACH NO. 8.00 PO1 (PSIA) 7.320 U-INF (FT/SEC) 3865 RHO-INF (LBM/FT3) 2.454E-03 ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW  
 862.4 1341 9.97 13.93 -23.00 180.00

CH	POS	TAP	PH (PSIA)	PR/PO1	Y (IN)	PML/PH	ML (FT-1)	REL	TL/T-INF	UL/U-INF	RHOL/RHO-INF	RHOU/RHO-INF	MU-INF (LB-SEC/FT2)	RE/FT (FT-1)	MODEL STA (X/L)	L (IN)
1	3	1	5.010E-01	6.845E-02	.014	7.480E-01	.658	4.201E-04	12.701	.293	.3340	.0979	.3497	.1263	8.781	
2	3	2	5.883E-01	8.037E-02	.066	6.370E-01	.829	5.582E-04	12.132	.361	.4067	.1263	.2086	.2086	8.526	
3	3	3	9.829E-01	1.342E-01	.112	3.815E-01	1.271	1.018E-05	10.432	.513	.4987	.2086	.6580	.4987	7.725	
4	3	4	2.931E 00	4.004E-01	.163	1.279E-01	2.388	3.409E-05	6.448	.758	1.5923	1.4854	1.7959	1.4854	5.515	
5	3	5	1.026E 01	1.401E 00	.216	3.854E-02	4.571	2.119E-06	2.664	.933	1.8900	2.4374	2.3604	2.4374	2.642	
6	3	6	1.200E 01	1.721E 00	.258	2.975E-02	5.073	3.018E-06	2.245	.950	2.2133	2.4374	2.3604	2.4374	2.642	
7	3	7	1.513E 01	2.067E 00	.313	2.477E-02	5.567	4.194E-06	1.917	.964	2.2133	2.4374	2.3604	2.4374	2.642	
8	3	8	1.629E 01	2.225E 00	.365	2.301E-02	5.778	4.802E-06	1.736	.968	2.2133	2.4374	2.3604	2.4374	2.642	
9	3	9	1.695E 01	2.315E 00	.415	2.211E-02	5.896	5.170E-06	1.686	.971	2.2133	2.4374	2.3604	2.4374	2.642	
10	3	10	1.751E 01	2.392E 00	.499	2.141E-02	5.993	5.495E-06	1.693	.973	2.2133	2.4374	2.3604	2.4374	2.642	
11	3	11	1.743E 01	2.381E 00	.506	2.150E-02	5.979	5.448E-06	1.693	.973	2.2133	2.4374	2.3604	2.4374	2.642	
12	3	12	1.646E 01	2.248E 00	.702	2.277E-02	5.810	4.898E-06	1.781	.964	2.2133	2.4374	2.3604	2.4374	2.642	
13	3	13	1.577E 01	2.154E 00	.802	2.377E-02	5.685	4.524E-06	1.849	.966	2.2133	2.4374	2.3604	2.4374	2.642	
14	3	14	1.525E 01	2.083E 00	.892	2.458E-02	5.589	4.253E-06	1.904	.964	2.2133	2.4374	2.3604	2.4374	2.642	
15	3	15	1.509E 01	2.057E 00	.981	2.489E-02	5.554	4.157E-06	1.925	.963	2.2133	2.4374	2.3604	2.4374	2.642	

CH	TC	TTR (DEG R)	TTR/TC (DEG R)	Y (IN)	PML/PO1
2	2	1206	.8993	.131	5.120E-02
3	2	1310	.9916	.202	
4	4	1372	1.0231	.303	
5	5	1372	1.0231	.402	
6	6	1369	1.0209	.599	

GROUP 312



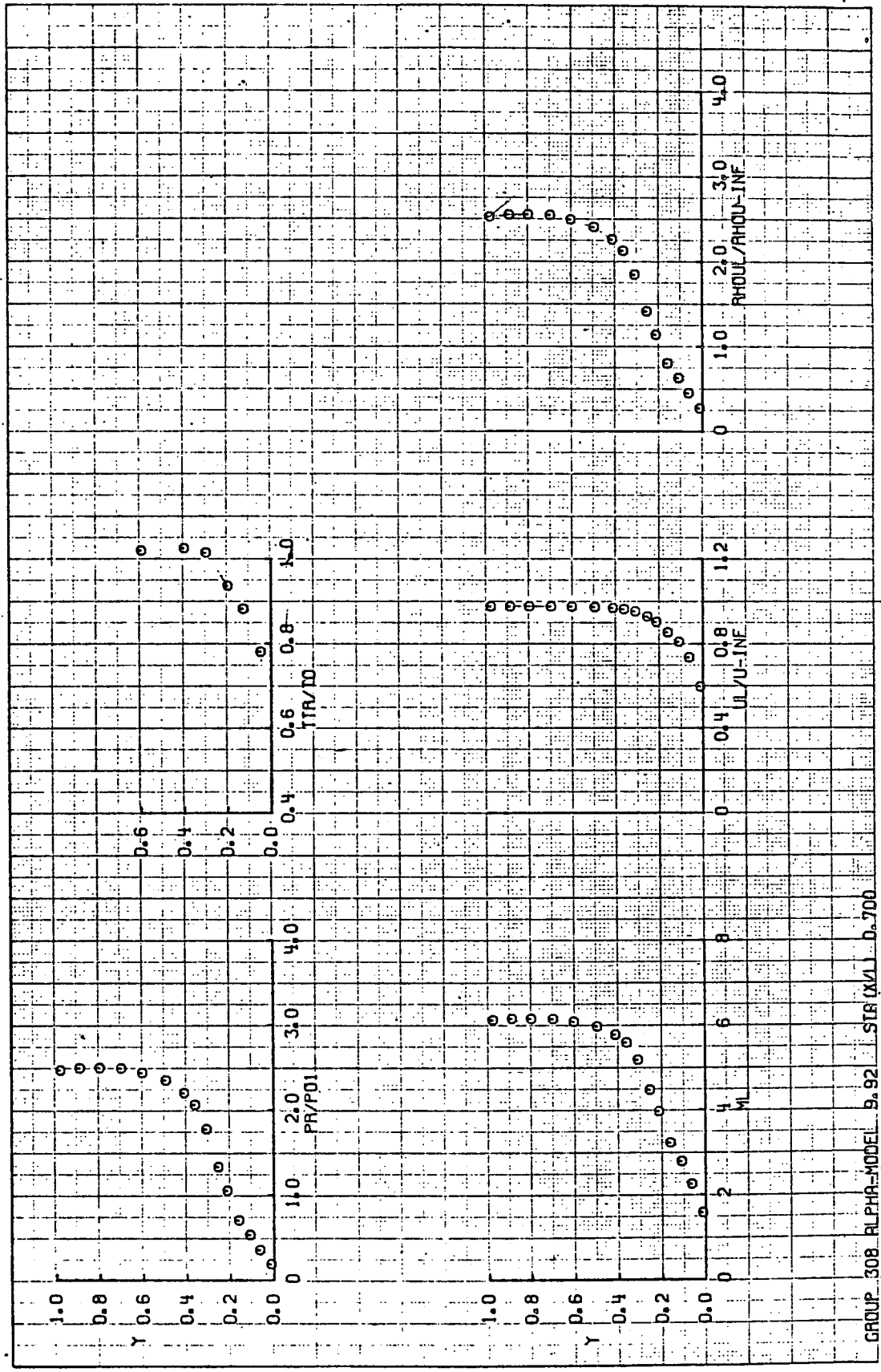
GROUP 012 ALPHA-MODEL 9.97L STEELX/1 0.500



AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 Y11162

GROUP	CONFIG	MODEL	MACH NO.	PO PSIA	TO DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PRBEND	ROLL-MODEL	YAW	
308	53	NAR-DWO	8.00	860.2	1336	9.92	13.08	-21.00	180.00	0.0	
T-INF (DEG H)	P-INF (PSIA)	P-INF (PSIA)	POI (PSIA)	O-INF (PSIA)	U-INF (FT/SEC)	RHO-INF (LB/FT3)	MU-INF (LB-SEC/FT2)	RE/FT (FT-1)	MODEL SIA (X/L)	L (IN)	
97	8.81E-02	7.301	3.947	3.947	3658	2.456E-03	7.794E-08	3.781E-06	.700	28.90	
CH POS	TAP	PH (PSIA)	PR/POI	Y(IN)	PML/PR	ML	REL (FT-1)	UL/U-INF	RHOL/RHO-INF	MUL/MU-INF	
1	3	1.377E 00	1.884E-01	.014	2.693E-01	1.577	1.453E 05	9.215	.599	.2734	7.115
2	3	2.596E 00	3.556E-01	.066	1.429E-01	2.249	2.957E 05	6.860	.736	.4519	5.778
3	3	3.476E 00	5.308E-01	.112	9.570E-02	2.784	4.927E 05	5.411	.810	.6299	4.833
4	3	4.5139E 00	7.039E-01	.163	7.217E-02	3.224	7.278E 05	4.483	.853	.9390	4.162
5	3	7.657E 00	1.040E 00	.216	4.843E-02	3.958	1.329E 06	1.330	.904	1.2608	3.243
6	3	9.709E 00	1.330E 00	.258	3.820E-02	4.468	1.955E 06	2.764	.929	1.5228	2.735
7	3	1.295E 01	1.774E 00	.313	2.843E-02	5.178	2.214E 06	2.173	.953	1.9375	2.173
8	3	1.506E 01	2.062E 00	.365	2.463E-02	5.583	4.217E 06	1.908	.904	2.2066	1.907
9	3	1.607E 01	2.201E 00	.415	2.308E-02	5.771	4.756E 06	1.802	.968	2.3365	1.798
10	3	1.716E 01	2.351E 00	.499	2.161E-02	5.966	5.377E 06	1.700	.972	2.4763	1.693
11	3	1.783E 01	2.438E 00	.506	2.043E-02	6.077	5.761E 06	1.649	.975	2.5581	1.636
12	3	1.820E 01	2.492E 00	.702	2.034E-02	6.144	6.000E 06	1.614	.976	2.6076	1.603
13	3	1.824E 01	2.494E 00	.802	2.034E-02	6.149	6.022E 06	1.612	.976	2.6120	1.600
14	3	1.822E 01	2.495E 00	.892	2.036E-02	6.147	6.015E 06	1.612	.976	2.6106	1.601
15	3	1.809E 01	2.449E 00	.981	2.057E-02	6.114	5.894E 06	1.628	.975	2.5857	1.618

CH	TC	TTP (DEG H)	TTR/TC (DEG H)	Y(IN)	PML/POI
1	1	1044	.7814	.051	5.080E-02
2	2	1179	.4825	.131	
3	3	1251	.9364	.202	
4	4	1355	1.0142	.303	
5	5	1369	1.0247	.402	
6	6	1342	1.0195	.599	



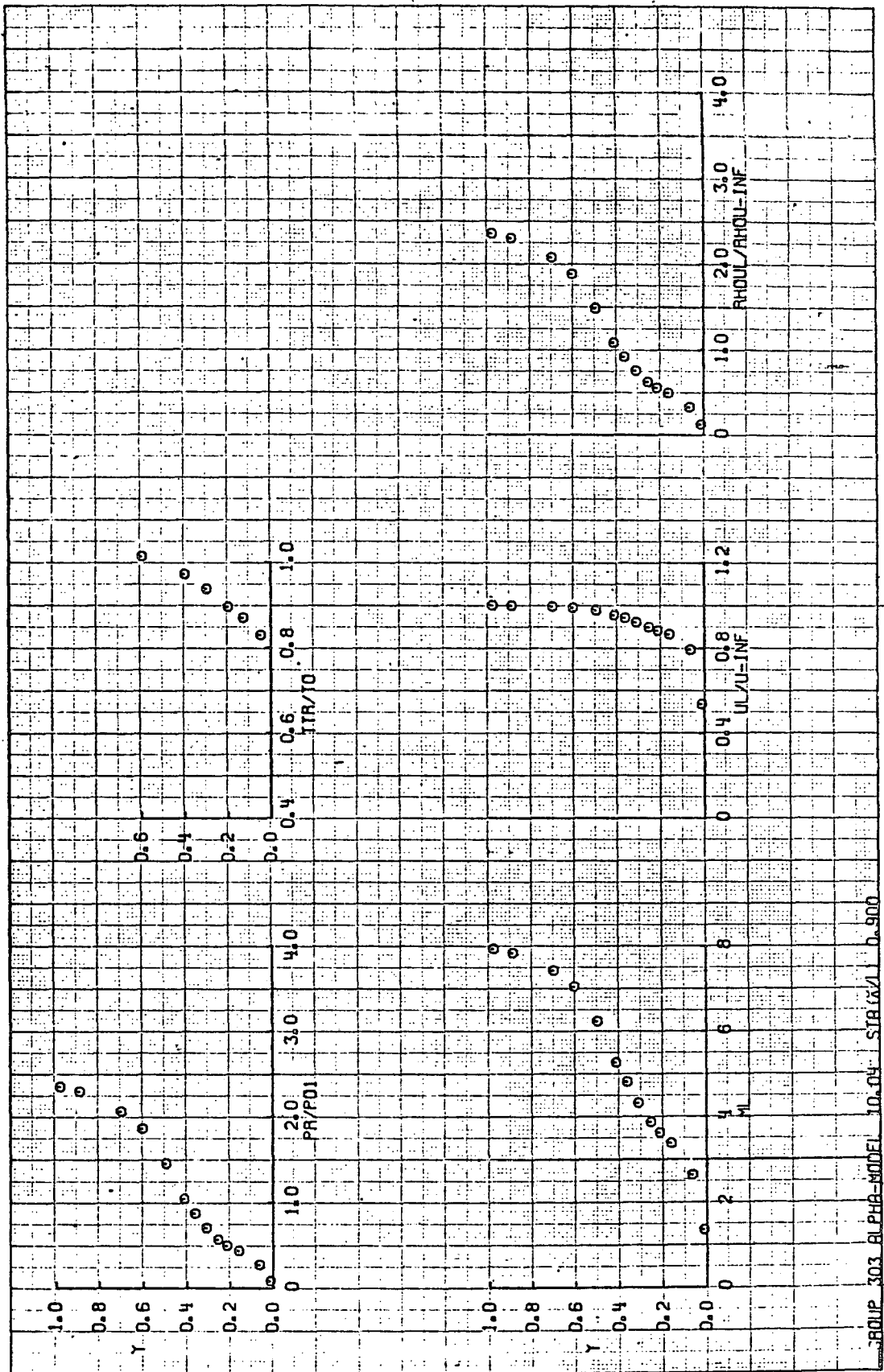
GROUP 308 ALPHA=MODEL 9.92 STR (XVI) 0.700

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 VII162

GROUP	CURFIG	MODEL	MACH NO.	PO	PSIA	TO DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PRBEND	ROLL-MODEL	YAW		
303	53	NAR-DWO	8.00	852.9	1326	10.04	12.96	-23.00	180.00	0.0			
Y-1NF	(DEG R)	P-1NF	(PSIA)	Q-1NF	U-1NF	RHO-1NF	MU-1NF	RE/FT	MODEL STA	L			
95	8.21E-02	7.298	3.946	3844	2.474E-03	7.736E-08	3.822E-06	.900	28.90				
CH	POS	TAP	PK	PR/PO1	Y(IN)	PML/PK	ML	REL	TL/T-1NF	UL/U-1NF	RHOL/RHO-1NF	RHOUL/RHO-1NF	MUL/MU-1NF
1	3	1	6.120E-01	8.386E-02	.014	3.446E-01	1.356	6.446E-04	10.088	.539	.2374	.1279	7.582
2	3	2	2.002E-00	2.743E-01	.066	1.054E-01	2.646	2.488E-05	5.751	.793	.4164	.3303	5.074
4	3	4	3.188E-00	4.367E-01	.163	6.617E-02	3.372	4.744E-05	4.215	.865	.5682	.4917	3.962
5	3	5	3.664E-00	5.021E-01	.216	5.756E-02	3.624	5.847E-05	3.805	.894	.6294	.5562	3.636
6	3	6	4.168E-00	5.708E-01	.258	5.063E-02	3.870	7.125E-05	3.454	.899	.6934	.6234	3.344
7	3	7	5.160E-00	7.071E-01	.313	4.087E-02	4.317	1.005E-06	2.919	.922	.8205	.7566	2.877
8	3	8	6.387E-00	8.751E-01	.365	3.302E-02	4.812	1.440E-06	2.451	.942	.9770	.9201	2.443
9	3	9	7.638E-00	1.047E-00	.415	2.761E-02	5.269	1.972E-06	2.106	.956	1.1369	1.0868	2.107
10	3	10	1.065E-01	1.459E-00	.499	1.981E-02	6.233	3.647E-06	1.573	.977	1.5221	1.4878	1.559
11	3	11	1.361E-01	1.865E-00	.606	1.450E-02	7.054	5.879E-06	1.260	.990	1.9004	1.8812	1.223
12	3	12	1.509E-01	2.068E-00	.702	1.397E-02	7.431	7.233E-06	1.146	.994	2.0899	2.0782	1.098
14	3	14	1.677E-01	2.298E-00	.821	1.258E-02	7.837	8.972E-06	1.039	.999	2.3051	2.3019	.981
15	3	15	1.719E-01	2.355E-00	.881	1.227E-02	7.933	9.428E-06	1.016	.999	2.3575	2.3563	.955

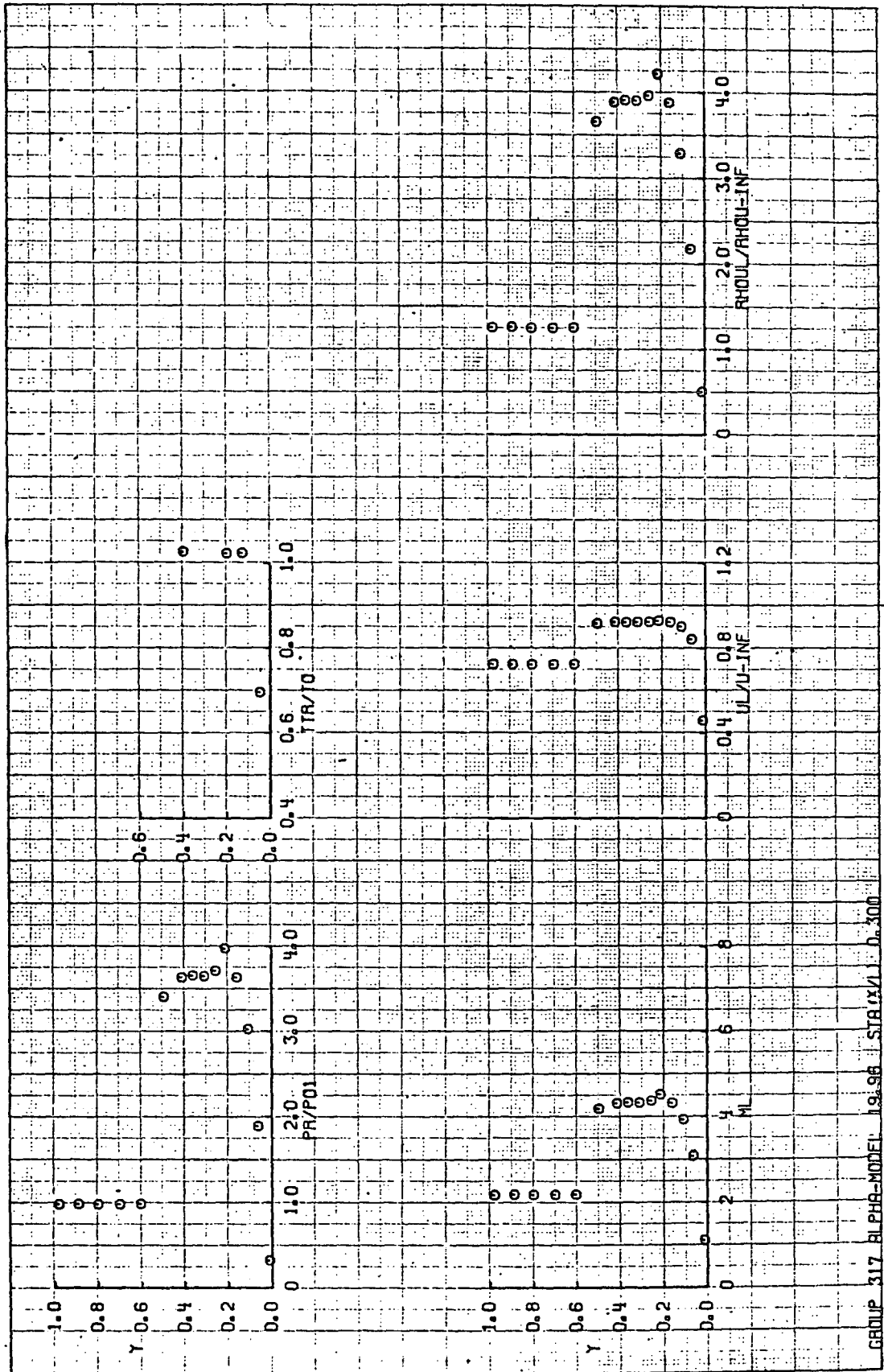
CH	TC	TTR	TTR/TC	Y(IN)	PML/PO1
1	1	1102	.8311	.051	2.890E-02
2	2	1155	.8710	.131	
3	3	1188	.8959	.202	
4	4	1245	.9389	.303	
5	5	1290	.9729	.402	
6	6	1346	1.0151	.599	

GROUP  
303



GROUP 303 ALPHA-MODEL 10.04 STR (X) 0.900





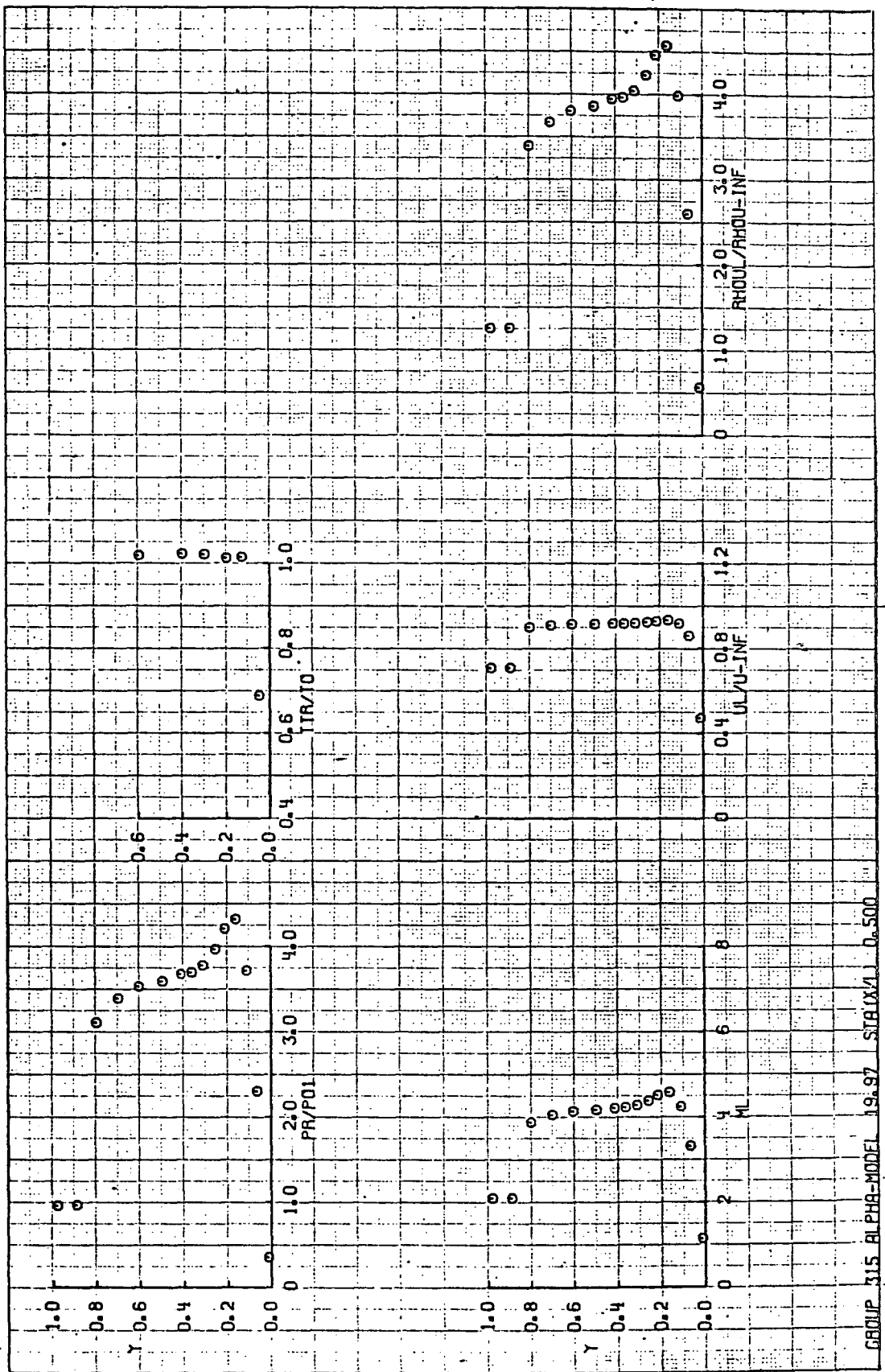
GROUP 317 BLP88-MODEL 19.96 STR (X) 1 0.300

AEDC (AEDC, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 Y11162

GROUP 315 CONTIG MODEL MACH NO. PO PSIA TO DEG R ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW  
 53 NAR-DW0 8.00 860.5 1341 19.97 3.03 -23.00 180.00

CH	POS	TAP	P-INF (PSIA)	P-INF (PSIA)	P-INF (PSIA)	U-INF (FT/SEC)	RHO-INF (LBM/FT3)	MU-INF (LB-SEC/FT2)	RE/FT (FT-1)	MODEL STA (X/L)	MUL/MU-INF		
1	3	1	2.589E 00	3.545E-01	0.14	4.429E-01	1.147	2.667E-05	10.923	.474	1.1910	.5647	7.961
2	3	2	1.689E 01	2.307E 00	.066	6.806E-02	3.323	2.438E 06	4.301	.862	3.0250	2.6063	4.021
3	3	3	2.717E 01	3.720E 00	.112	4.221E-02	4.247	5.102E 06	2.995	.914	4.3436	3.9913	2.942
4	3	4	3.157E 01	4.323E 00	.163	3.632E-02	4.585	6.548E 06	2.652	.933	4.9063	4.5794	2.630
5	3	5	3.074E 01	4.209E 00	.216	3.731E-02	4.522	6.257E 06	2.711	.931	4.7990	4.4673	2.685
6	3	6	2.899E 01	3.969E 00	.258	3.955E-02	4.390	5.675E 06	2.843	.925	4.5758	4.2341	2.806
7	3	7	2.760E 01	3.779E 00	.313	4.155E-02	4.282	5.239E 06	2.957	.921	4.4002	4.0504	2.908
8	3	8	2.701E 01	3.698E 00	.365	4.246E-02	4.233	5.049E 06	3.010	.918	4.3218	3.9684	2.956
9	3	9	2.685E 01	3.676E 00	.415	4.271E-02	4.222	5.005E 06	3.023	.918	4.3031	3.9488	2.967
10	3	10	2.629E 01	3.502E 00	.499	4.371E-02	4.173	4.823E 06	3.079	.915	4.2258	3.8680	3.016
11	3	11	2.577E 01	3.528E 00	.606	4.500E-02	4.134	4.682E 06	3.124	.913	4.1646	3.8039	3.056
12	3	12	2.479E 01	3.395E 00	.702	4.625E-02	4.054	4.402E 06	3.219	.909	4.0410	3.6744	3.139
13	3	13	2.270E 01	3.108E 00	.802	5.052E-02	3.874	3.826E 06	3.449	.899	3.7724	3.3929	3.335
14	3	14	7.038E 00	9.637E-01	.892	1.629E-01	2.095	7.790E 05	7.350	.710	1.7700	1.2566	6.067
15	3	15	6.997E 00	9.581E-01	.981	1.639E-01	2.089	7.743E 05	7.369	.709	1.7654	1.2515	6.079

CH	TC	TTR/TC (DEG R)	Y(IN)	PML/POI
1	1	.6883	.051	1.570E-01
2	2	1.0142	.131	
3	3	1.0119	.202	
4	4	1.0209	.303	
5	5	1.0216	.402	
6	6	1.0179	.599	



GROUP 315 ALPHA-MODEL 19.97 STR(X)1 0.500

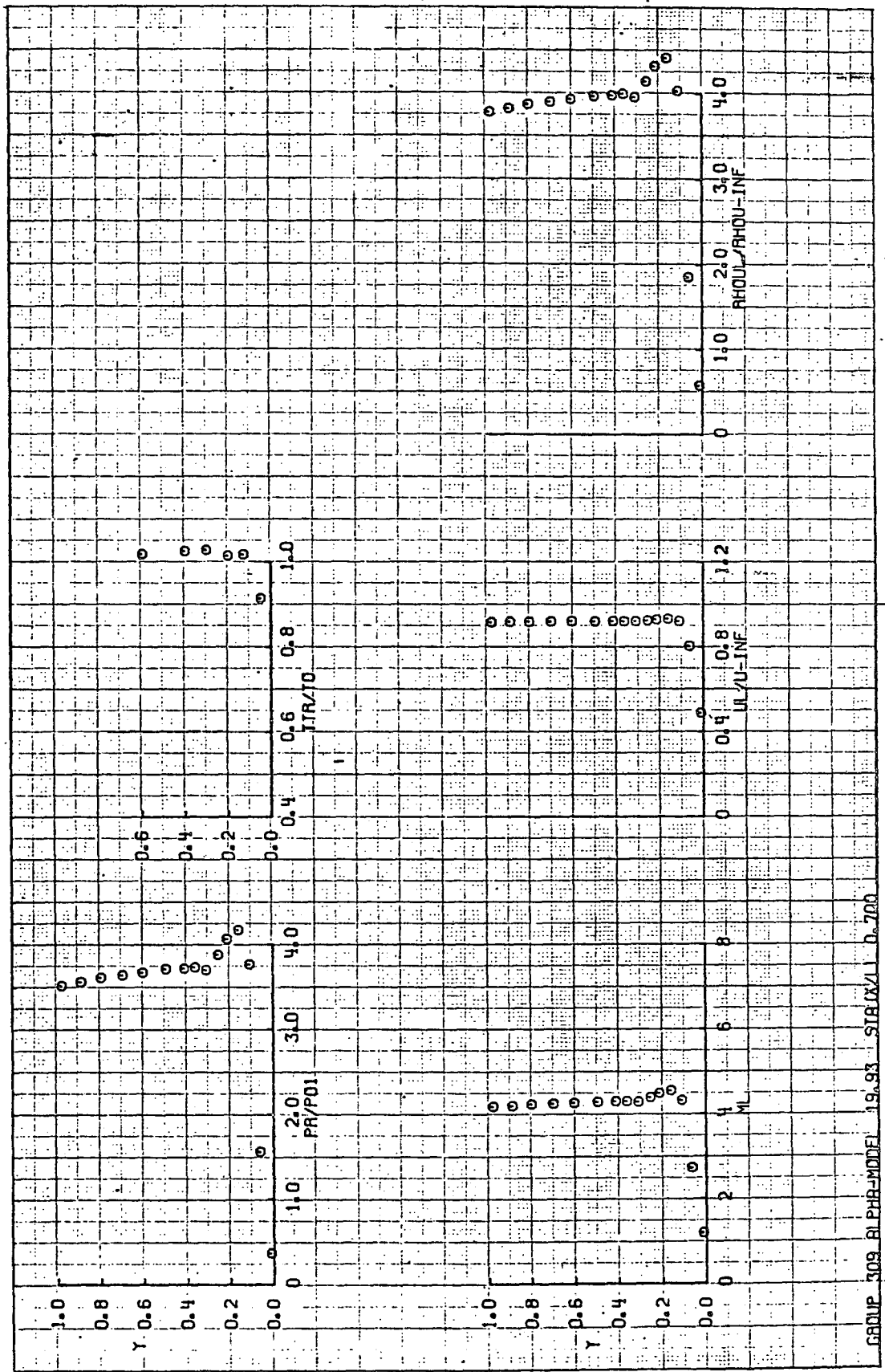


10/20/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 VILL62

GROUP	CONFIG	MODEL	MACH NO.	PO PSIA	10 DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW		
309	53	NAR-DWO	8.00	850-5	1337	19.93	3.07	-23.00	180.00	0.0		
Y-INF (DEG R)	P-INF (PSIA)	P01 (PSIA)	U-INF (FT/SEC)	RHO-INF (LB/FT3)	MU-INF (LB-SEC/FT2)	RE/FT (FT-1)	MODEL STA (A/L)	L (IN)				
97	8.81E-02	7.304	3860	2.456E-03	7.800E-08	3.778E-06	.700	28.90				
CM POS	TAP	PR (PSIA)	PR/PO1	Y(IN)	PML/PR	ML	HFL (FT-1)	UL/U-INF	RHOL/RHO-INF	RHOUL/RHOU-INF	MUL/MU-INF	
1	3	2.682E-00	3.672E-01	.014	4.194E-01	1.192	2.781E-05	1.0745	.689	1.1877	.5803	7.885
2	3	1.136E 01	1.556E 00	.066	9.899E-02	2.733	1.425E 06	5.533	.804	2.3065	1.8539	4.916
3	3	2.752E 01	3.764E 00	.112	4.087E-02	4.317	5.298E 06	2.919	.922	4.3720	4.0315	2.875
4	3	3.045E 01	4.169E 00	.163	3.694E-02	4.546	6.271E 06	2.688	.932	4.7466	4.4230	2.665
5	3	2.968E 01	4.063E 00	.216	3.790E-02	4.487	6.008E 06	2.745	.929	4.6487	4.3207	2.717
6	3	2.834E 01	3.840E 00	.258	3.970E-02	4.382	5.559E 06	2.851	.925	4.4757	4.1399	2.814
7	3	2.700E 01	3.696E 00	.313	4.157E-02	4.274	5.131E 06	2.965	.920	4.3037	3.9601	2.916
8	3	2.726E 01	3.732E 00	.365	4.127E-02	4.296	5.214E 06	2.942	.921	4.3378	3.9957	2.896
9	3	2.715E 01	3.717E 00	.415	4.143E-02	4.288	5.183E 06	2.950	.921	4.3254	3.9827	2.903
10	3	2.707E 01	3.706E 00	.499	4.156E-02	4.280	5.153E 06	2.959	.920	4.3130	3.9698	2.911
11	3	2.679E 01	3.658E 00	.506	4.198E-02	4.259	5.071E 06	2.982	.919	4.2791	3.9343	2.932
12	3	2.657E 01	3.638E 00	.702	4.234E-02	4.241	5.004E 06	3.002	.919	4.2514	3.9054	2.949
13	3	2.637E 01	3.611E 00	.802	4.265E-02	4.224	4.938E 06	3.021	.918	4.2239	3.8766	2.966
14	3	2.596E 01	3.554E 00	.892	4.333E-02	4.190	4.815E 06	3.059	.916	4.1722	3.8225	2.999
15	3	2.506E 01	3.513E 00	.981	4.384E-02	4.165	4.723E 06	3.088	.915	4.1330	3.7814	3.025

CM	TC	TTR (DEG R)	TTR/TC (DEG R)	Y(IN)	PML/PO1
1	1	1.222	.9140	.051	1.540E-01
2	2	1.360	1.0172	.131	
3	3	1.356	1.0142	.202	
4	4	1.374	1.0277	.303	
5	5	1.371	1.0254	.402	
6	6	1.361	1.0180	.599	



GROUP 309 B1 PHB-MODEL 19.93 STR(X)/1 0.700

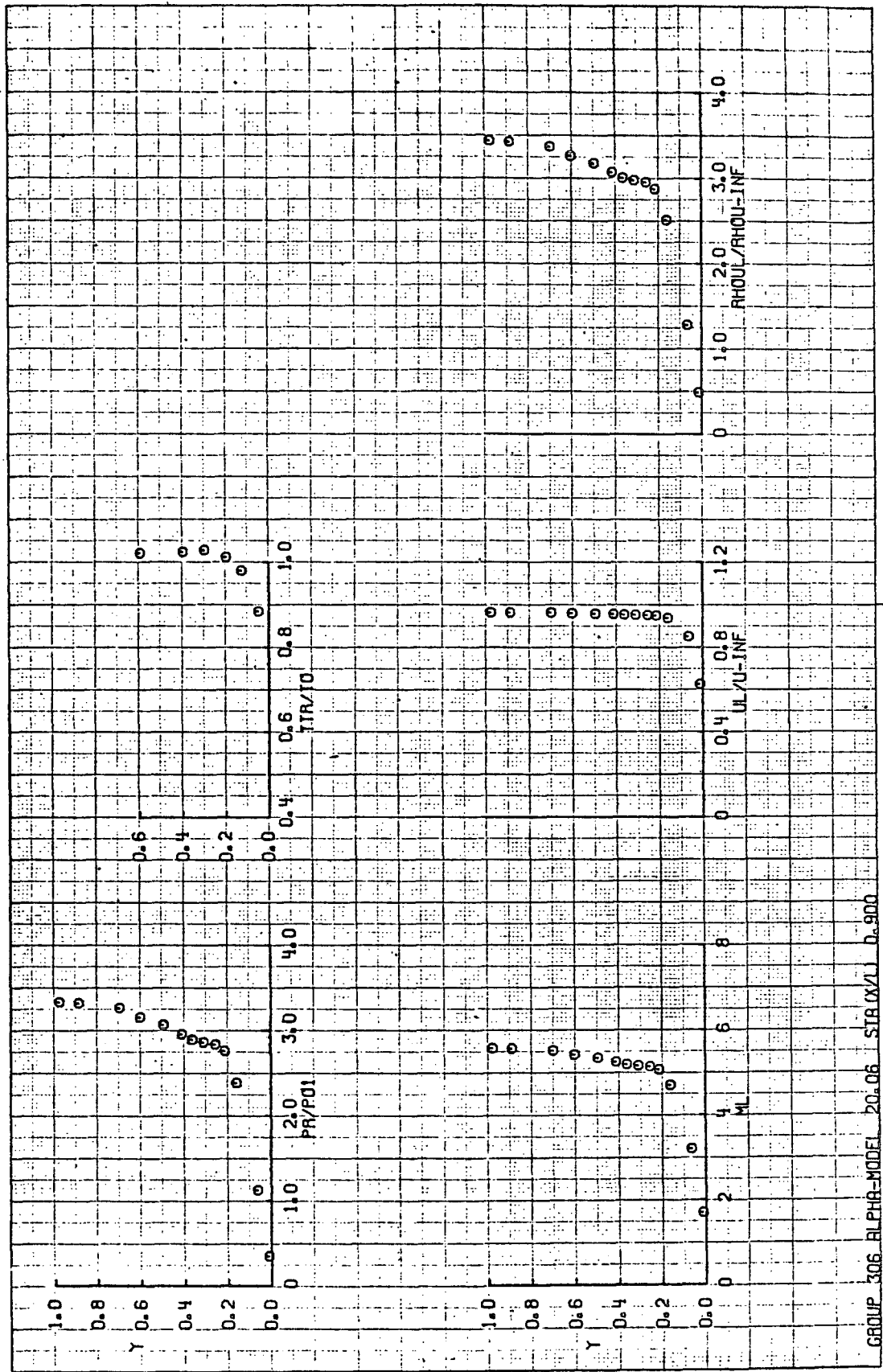
PAGE = 1 10/20/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL B  
 V111162

GROUP	CONFIG	MCDL	MACH NO.	PO	PSIA	TO	DEG	H	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW
306	53	NAR-DWO	8.00	860.3	1334	20.06			2.94		-23.00	180.00	.0
T-INF (DEG H)	P-INF (PSIA)	P01 (PSIA)	U-INF (FT/SEC)	RHO-INF (LB/FT <sup>3</sup> )	MU-INF (LB-SEC/FT <sup>2</sup> )	RE/FT (FT-1)	MODEL STA (X/L)	L (IN)					
97	8.81E-02	7.302	3855	2.460E-03	7.783E-08	3.790E 06	.900	28.90					
CH	POS	TAP	PR	PR/P01	Y (IN)	PML/PH	ML	HFL (FT-1)	TL/T-INF	UL/U-INF	RHOL/RHO-INF	RHOUL/RHOU-INF	MUL/MU-INF
1	3	1	2.530E 00	3.466E-01	.114	2.378E-01	1.696	2.697E 05	8.759	.628	.7795	.4892	6.875
2	3	2	8.197E 00	1.123E 00	.166	7.340E-02	3.196	1.155E 06	4.535	.851	1.5057	1.2812	4.203
4	3	4	1.741E 01	2.384E 00	.163	3.456E-02	4.702	3.766E 06	2.545	.938	2.6827	2.5159	2.532
5	3	5	2.014E 01	2.759E 00	.216	2.987E-02	5.063	4.858E 06	2.252	.950	3.0319	2.8801	2.250
6	3	6	2.072E 01	2.834E 00	.258	2.904E-02	5.138	5.102E 06	2.198	.952	3.1068	2.9582	2.197
7	3	7	2.092E 01	2.862E 00	.313	2.879E-02	5.159	5.177E 06	2.182	.953	3.1287	2.9811	2.182
8	3	8	2.112E 01	2.897E 00	.365	2.869E-02	5.187	5.274E 06	2.163	.954	3.1567	3.0102	2.163
9	3	9	2.159E 01	2.957E 00	.415	2.786E-02	5.245	5.487E 06	2.122	.955	3.2172	3.0733	2.123
10	3	10	2.234E 01	3.067E 00	.499	2.697E-02	5.343	5.857E 06	2.057	.958	3.3195	3.1799	2.058
11	3	11	2.303E 01	3.154E 00	.606	2.613E-02	5.419	6.180E 06	2.008	.960	3.4006	3.2644	2.008
12	3	12	2.384E 01	3.264E 00	.702	2.524E-02	5.515	6.559E 06	1.949	.962	3.5042	3.3722	1.949
14	3	14	2.425E 01	3.321E 00	.892	2.481E-02	5.562	6.762E 06	1.920	.963	3.5556	3.4257	1.920
15	3	15	2.492E 01	3.331E 00	.981	2.474E-02	5.571	6.805E 06	1.915	.964	3.5863	3.4369	1.915

CH	TC	TR	TR/TC	Y (IN)	PML/PO1
1	1	1180	.8846	.051	8.240E-02
2	2	1307	.9798	.131	
3	3	1349	1.0112	.202	
4	4	1372	1.0285	.303	
5	5	1366	1.0240	.402	
6	6	1362	1.0210	.599	

GROUP  
306



GROUP 306 ALPHA-MODEL 20.06 STA(X)/L D.900

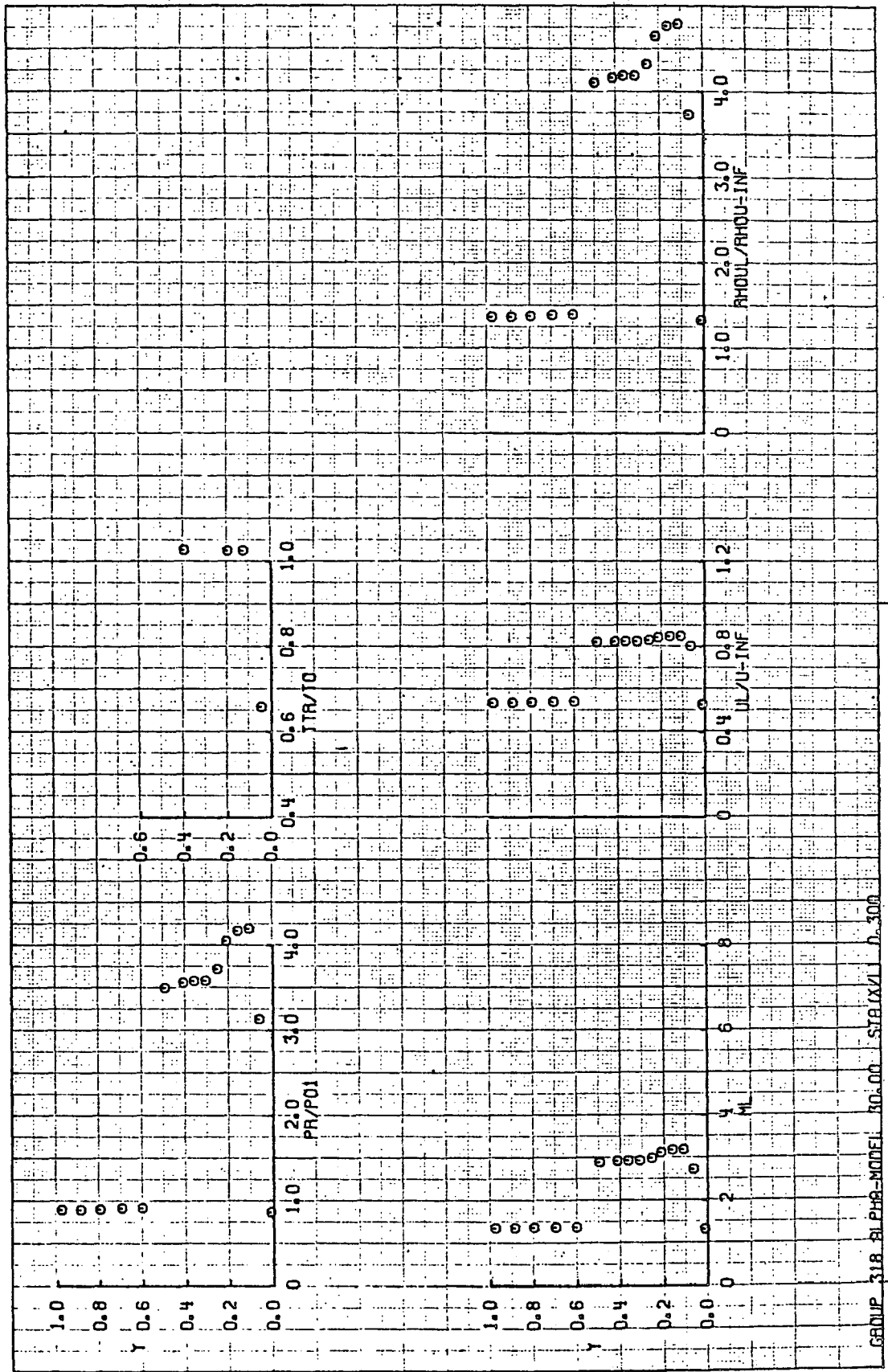
10/20/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 Y11162

GROUP CONFIG MDEL MACH NO. PO PSIA TO DEG R ALPHA-MODEL ALPHA-SECTOR ALPHA-PREBEND ROLL-MODEL YAW  
 31A 53 8.20E-02 8.00 852.3 1341 30.00 -7.00 -23.00 180.00 0.0

CH	POS	TAP	PR	PR/PO1	Y(IN)	PML/PR	ML	REF	TL/T-INF	UL/U-INF	RHOL/RHO-INF	RE/FT	MODEL STA	MUL/MU-INF
			(PSIA)				(FT-1)					(FT-1)	(X/L)	(IN)
1	3	1	6.316E-01	84661E-01	.014	3.579E-01	1.325	6.567E-05	10.213	.529	2.5152	1.3317	7.616	
2	3	2	2.287E-01	34136E-00	.066	9.885E-02	2.735	2.858E-06	5.528	.804	4.6469	3.7361	4.910	
3	3	3	3.063E-01	44200E-00	.112	7.990E-02	3.187	4.276E-06	4.553	.850	5.6416	4.7956	4.212	
4	3	4	3.045E-01	44175E-00	.163	7.425E-02	3.177	4.240E-06	4.572	.849	5.6185	4.7711	4.227	
5	3	5	2.956E-01	44053E-00	.216	7.648E-02	3.128	4.064E-06	4.667	.845	5.5039	4.6496	4.297	
6	3	6	2.710E-01	3727E-00	.258	8.317E-02	2.995	3.615E-06	4.939	.832	5.2011	4.3280	4.496	
7	3	7	2.617E-01	34588E-00	.313	8.639E-02	2.937	3.431E-06	5.065	.826	5.0717	4.1902	4.586	
8	3	8	2.618E-01	34584E-00	.365	8.649E-02	2.935	3.425E-06	5.069	.826	5.0675	4.1857	4.589	
9	3	9	2.592E-01	34533E-00	.415	8.699E-02	2.925	3.395E-06	5.091	.825	5.0462	4.1630	4.605	
10	3	10	2.555E-01	34503E-00	.499	8.849E-02	2.899	3.319E-06	5.147	.822	4.9911	4.1042	4.645	
11	3	11	2.670E-01	44145E-01	.606	3.390E-01	1.372	6.448E-05	10.025	.543	2.5623	1.3316	7.523	
12	3	12	6.660E-00	94132E-01	.702	3.995E-01	1.370	6.931E-05	10.033	.543	2.5623	1.3316	7.527	
13	3	13	6.564E-00	94000E-01	.802	3.444E-01	1.358	6.835E-05	10.080	.539	2.5484	1.3740	7.550	
14	3	14	6.521E-00	8941E-01	.892	3.467E-01	1.353	6.787E-05	10.103	.537	2.5425	1.3665	7.562	
15	3	15	6.514E-00	8937E-01	.981	3.4669E-01	1.351	6.771E-05	10.111	.537	2.5405	1.3640	7.566	

CH	TC	TIR	TIR/TC	Y(IN)	PML/PO1
		(DEG R)	(DEG R)		
1	1	894	.6592	.051	3.100E-01
2	2	1376	1.0261	.131	
3	3	1375	1.0254	.202	
5	5	1378	1.0276	.402	



GROUP 318 ALPHA-MODEL 30.00 STAR (XVI) 0.300

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AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
VON KARMAN GAS DYNAMICS FACILITY  
50 INCH HYPERSONIC TUNNEL R  
Y11162

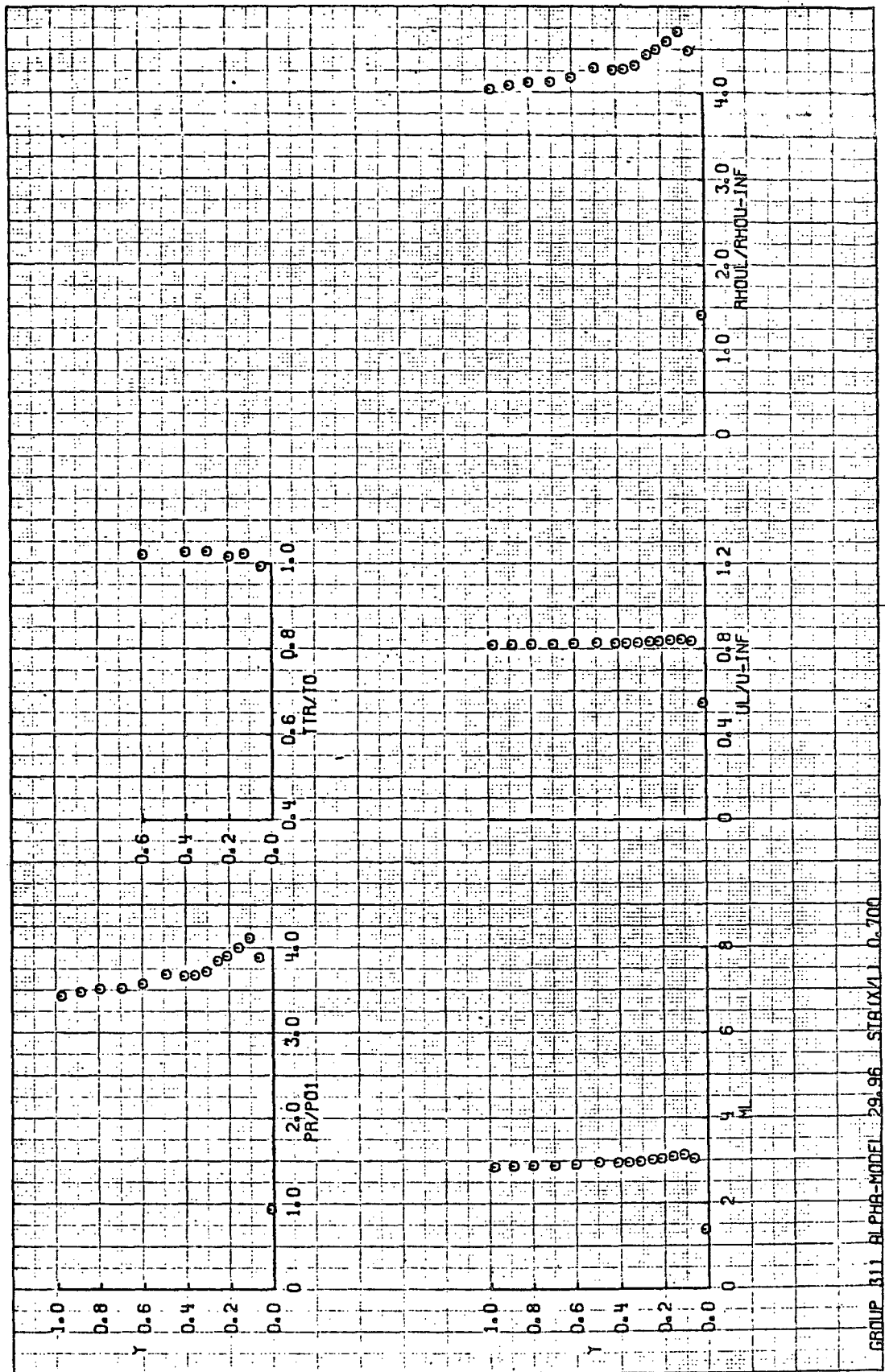
GROUP 311  
CONFIG 53  
MCDL WACH NO. 8.00  
MACH NO. 862.3  
1341  
ALPHA-MODEL 29.97  
ALPHA-SECTOR ALPHA-PRBEND -6.97  
ROLL-MODEL 180.00  
YAW 0.0

T-INF (DEG H) 97  
P-INF (PSIA) 8.83E-02  
Q-INF (PSIA) 3.957  
U-INF (FT/SEC) 3865  
RHO-INF (LB/FT3) 2.453E-03  
MU-INF (LB-SEC/FT2) 7.823E-08  
RE/FT (FT-1) 3.769E-06  
MODEL STA (X/L) .700  
L (IN) 28.90

CM	POS	TAP	PR (PSIA)	PR/PO1	Y (IN)	PML/PR	ML	REL (FT-1)	UL/U-INF	RHOL/RHO-INF	UL/U-INF	RHOL/RHO-INF	MU-INF	RE/FT	MODEL STA	L
1	3	1	6.829E-00	9.332E-01	.014	3.343E-01	1.384	7.116E-05	9.978	.546	2.5909	4.2724	5.1562	4.2955	4.1807	4.811
2	3	2	2.740E-01	3.888E-00	.066	8.024E-02	3.052	3.839E-06	4.821	.838	5.3630	4.4450	5.1779	4.2955	4.1807	4.811
3	3	3	3.012E-01	4.116E-00	.112	7.560E-02	3.144	4.160E-06	4.636	.849	5.5761	4.4450	5.1779	4.2955	4.1807	4.811
4	3	4	2.928E-01	4.000E-00	.163	7.799E-02	3.097	3.994E-06	4.729	.842	5.4665	4.4450	5.1779	4.2955	4.1807	4.811
5	3	5	2.956E-01	3.902E-00	.216	7.996E-02	3.058	3.859E-06	4.809	.838	5.3764	4.4450	5.1779	4.2955	4.1807	4.811
6	3	6	2.811E-01	3.841E-00	.258	8.122E-02	3.032	3.773E-06	4.861	.836	5.3185	4.4450	5.1779	4.2955	4.1807	4.811
7	3	7	2.725E-01	3.723E-00	.313	8.340E-02	2.983	3.614E-06	4.964	.831	5.2084	4.4450	5.1779	4.2955	4.1807	4.811
8	3	8	2.699E-01	3.676E-00	.365	8.488E-02	2.964	3.551E-06	5.006	.829	5.1649	4.4450	5.1779	4.2955	4.1807	4.811
9	3	9	2.689E-01	3.669E-00	.419	8.503E-02	2.960	3.539E-06	5.014	.829	5.1562	4.4450	5.1779	4.2955	4.1807	4.811
10	3	10	2.700E-01	3.689E-00	.499	8.458E-02	2.970	3.570E-06	4.993	.830	5.1779	4.4450	5.1779	4.2955	4.1807	4.811
11	3	11	2.619E-01	3.577E-00	.606	8.722E-02	2.921	3.417E-06	5.099	.825	5.0702	4.4450	5.1779	4.2955	4.1807	4.811
12	3	12	2.581E-01	3.527E-00	.702	8.846E-02	2.899	3.352E-06	5.147	.822	5.0233	4.4450	5.1779	4.2955	4.1807	4.811
13	3	13	2.574E-01	3.517E-00	.802	8.871E-02	2.896	3.340E-06	5.155	.822	5.0148	4.4450	5.1779	4.2955	4.1807	4.811
14	3	14	2.550E-01	3.484E-00	.892	8.955E-02	2.882	3.299E-06	5.186	.820	4.9852	4.4450	5.1779	4.2955	4.1807	4.811
15	3	15	2.574E-01	3.435E-00	.981	9.082E-02	2.860	3.236E-06	5.235	.818	4.9390	4.4450	5.1779	4.2955	4.1807	4.811

CH	TC	TR/TC (DEG R)	Y (IN)	FML/PO1
1	1	1332	.933	.051
2	2	1372	1.0231	.131
3	3	1362	1.0157	.202
4	4	1379	1.0283	.303
5	5	1377	1.0268	.402
6	6	1368	1.0291	.599

GROUP 311



GROUP 311 ALPHA-MODEL 29.96 STR(X/V) 0.700

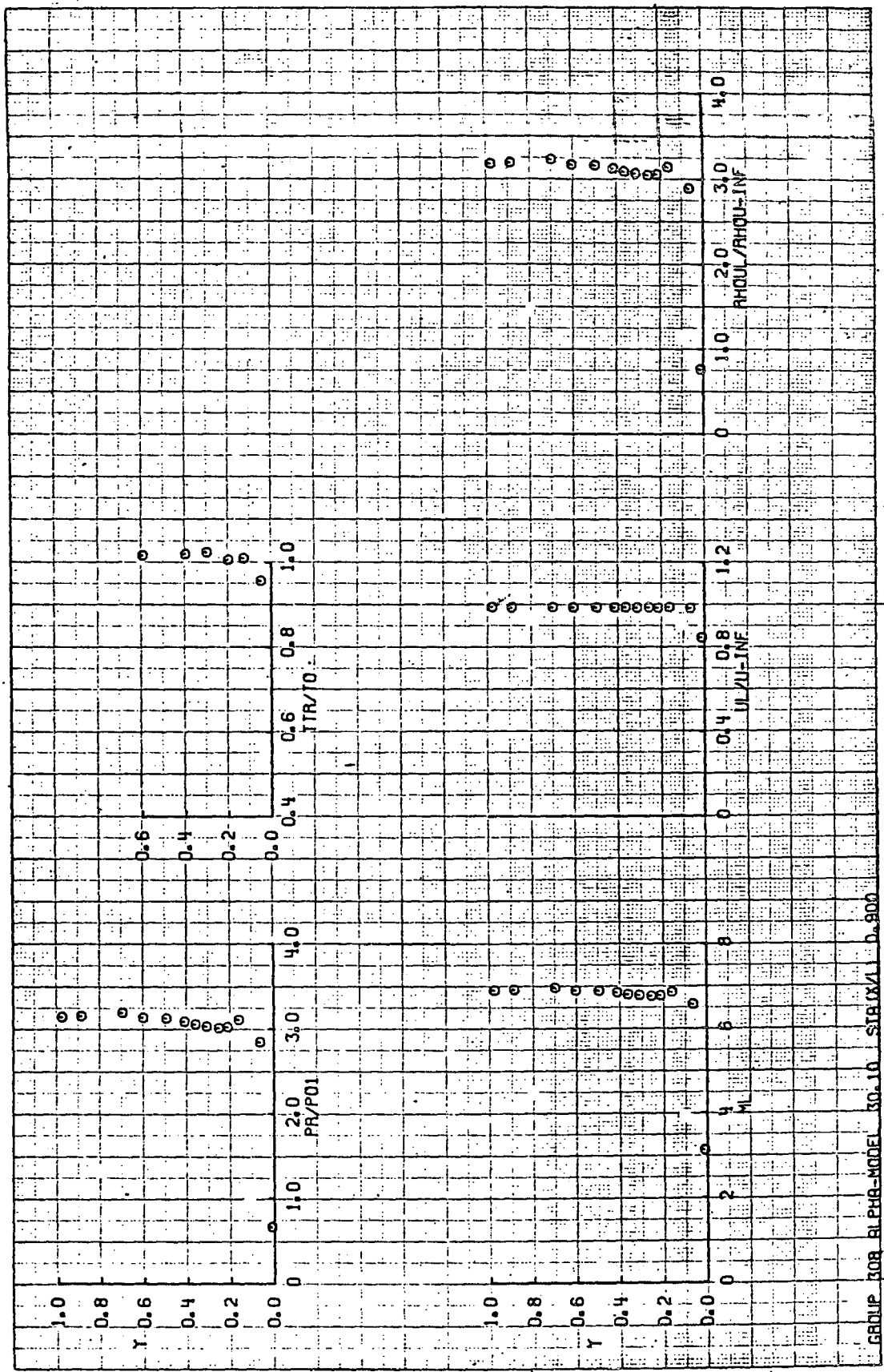


10/20/71

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 Y11162

GROUP	CONFIG	MODEL	MACH NO.	PO	PSIA	TO DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW		
30A	53	NAR-DWO	8.00	860.7	1336	30.10	30.10	-7.10	-23.00	180.00	.0		
T-INF (DEG R)	P-INF (PSIA)	U-INF (FT/SEC)	RHO-INF (LB/SEC/FT <sup>3</sup> )	RE/FT (X/L)	MODEL STA (IN)	MU-INF (LB-SEC/FT <sup>2</sup> )	RE/FT (X/L)	MODEL STA (IN)	MU-INF (LB-SEC/FT <sup>2</sup> )	RE/FT (X/L)	MODEL STA (IN)		
97	8.92E-02	3.949	3.45E-03	7.94E-08	3.783E .06	.980	.980	28.90	.980	.980	28.90		
CH	POS	TAP	PR (PSIA)	PR/POI	Y (IN)	PML/PH	ML	REL (FT-1)	TL/T-INF	UL/U-INF	RHO/RHO-INF	RHOUL/RHOU-INF	MUL/MU-INF
1	3	1	4.851E .00	6.641E-01	.014	7.950E-02	3.12R	6.702E .05	4.667	.845	.9019	.7619	4.201
2	3	2	2.082E 01	2.849E .00	.066	1.783E-02	6.573	7.763E .06	1.431	.983	2.9410	2.8914	1.409
3	3	3	7.537E .00	1.032E .00	.112	4.924E-02	3.925	1.295E .06	3.382	.902	1.2948	1.1232	3.280
4	3	4	2.270E 01	3.108E .00	.163	1.035E-02	6.866	9.194E .06	1.323	.987	3.1812	3.1411	1.293
5	3	5	2.219E 01	3.025E .00	.216	1.679E-02	6.774	8.724E .06	1.356	.986	3.1048	3.0617	1.328
6	3	6	2.149E 01	3.011E .00	.258	1.647E-02	6.759	8.644E .06	1.361	.986	3.0919	3.0483	1.334
7	3	7	2.219E 01	3.032E .00	.313	1.676E-02	6.782	8.763E .06	1.353	.986	3.1113	3.0684	1.325
8	3	8	2.232E 01	3.055E .00	.365	1.663E-02	6.808	8.891E .06	1.344	.987	3.1323	3.0903	1.315
9	3	9	2.257E 01	3.090E .00	.415	1.644E-02	6.847	8.992E .06	1.330	.987	3.1649	3.1282	1.300
10	3	10	2.285E 01	3.129E .00	.499	1.624E-02	6.890	9.217E .06	1.315	.988	3.2009	3.1616	1.284
11	3	11	2.292E 01	3.138E .00	.506	1.619E-02	6.899	9.369E .06	1.312	.988	3.2091	3.1701	1.280
12	3	12	2.336E 01	3.198E .00	.702	1.588E-02	6.966	9.727E .06	1.289	.989	3.2653	3.2285	1.256
13	3	13	2.474E 01	1.352E .00	.402	3.758E-02	6.507	2.013E .06	2.726	.930	1.5442	1.4365	2.700
14	3	14	2.430E 01	3.159E .00	.492	1.608E-02	6.925	9.504E .06	1.303	.988	3.2305	3.1924	1.271
15	3	15	2.298E 01	3.146E .00	.481	1.615E-02	6.909	9.421E .06	1.308	.988	3.2173	3.1787	1.276

CH	TC	TTR (DEG R)	TTR/TC (DEG R)	Y (IN)	PML/POI
1	1	1278	.4566	.051	5.080E-02
2	2	1349	1.0097	.131	
3	3	1344	1.0060	.202	
4	4	1347	1.0232	.303	
5	5	1362	1.0195	.407	
6	6	1357	1.0157	.599	



GROUP 308 ALPHA-MODEL 30.10 STR IX/1 0.900

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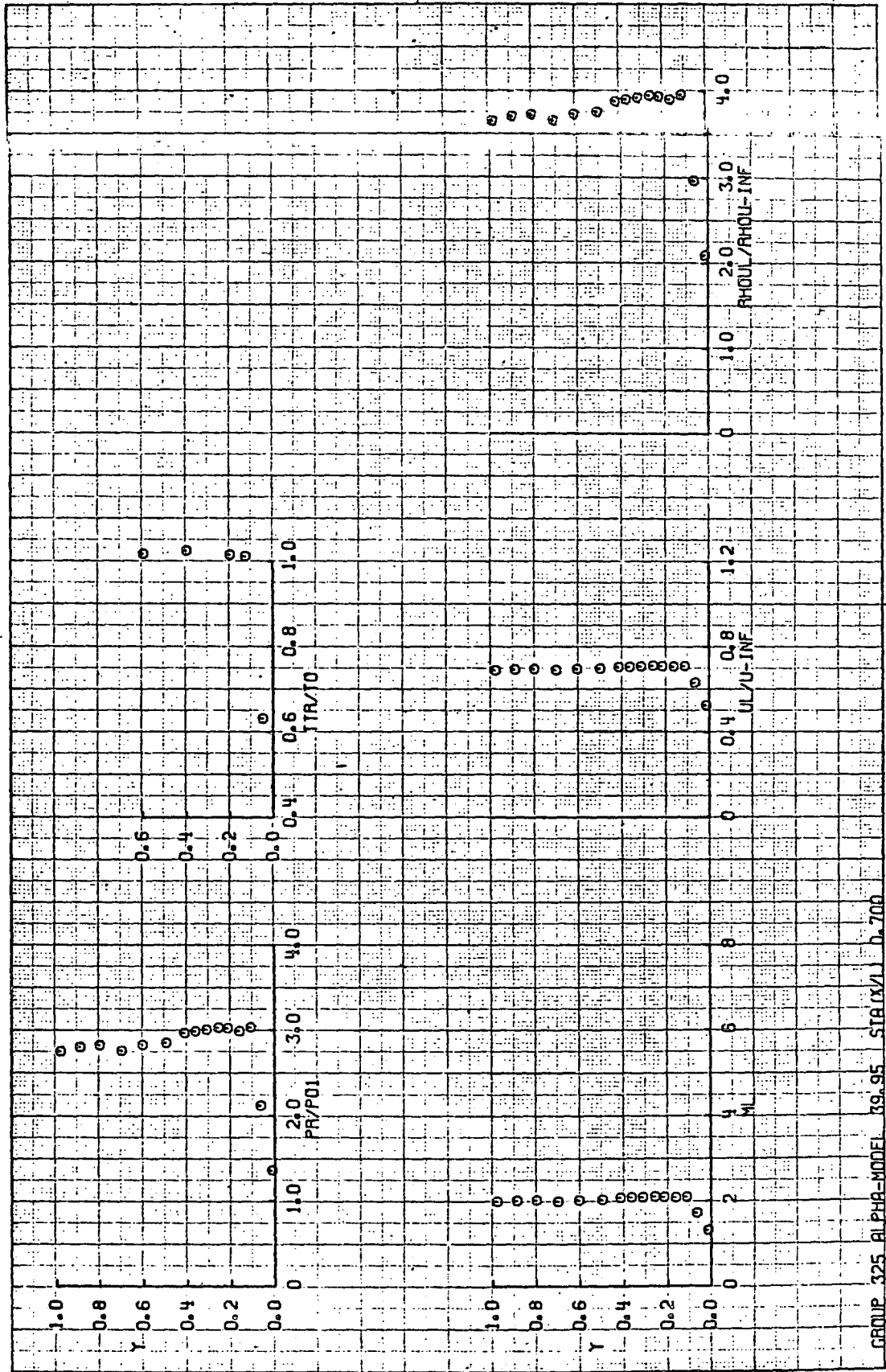
10/20/77

AEDC (ARO, INC.) ARNOLD AFS, TENNESSEE  
JOHN KARMAN GAS DYNAMICS FACILITY  
50 INCH HYPERSONIC TUNNEL R  
VII162

GROUP	CONFIG	MODEL	MACH NO.	PO	PSIA	10 DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW		
325	53	NAR-DRO	8.00	861.1	1339	39.95	10.05	-50.00	180.00	0.00	0.00		
T-INF (DEG R)	P-INF (PSIA)	P0I (PSIA)	U-INF (FT/SEC)	RHO-INF (LBM/FT3)	MU-INF (LB-SEC/FT2)	RE/FT (FT-1)	MODEL STA (X/L)	L (IN)					
97	8.82E-02	7.30A	3862	2.453E-03	7.812E-08	3.772E-06	.700	28.290					
CH	POS	TAP	PR	PR/POI	Y(IN)	PML/PH	ML	REL (FT-1)	TL/T-INF	UL/U-INF	RHOUL/RHO-INF	MUL/MU-INF	
1	3	1	9.934E-00	1.359E-00	.014	3.619E-01	1.315	1.034E-06	10.252	.527	3.9767	2.0939	7.540
2	3	2	1.548E-01	2.118E-00	.066	2.323E-01	1.718	1.643E-06	8.678	.633	4.6977	2.9719	6.823
3	3	3	2.216E-01	3.033E-00	.112	1.622E-01	2.101	2.462E-06	7.331	.711	5.5614	3.9542	6.058
4	3	4	2.182E-01	2.985E-00	.163	1.648E-01	2.081	2.413E-06	7.395	.707	5.5131	3.9004	6.096
5	3	5	2.208E-01	3.021E-00	.216	1.629E-01	2.095	2.347E-06	7.350	.710	5.5469	3.9380	6.070
6	3	6	2.211E-01	3.025E-00	.258	1.626E-01	2.097	2.452E-06	7.343	.710	5.5517	3.9434	6.066
7	3	7	2.196E-01	3.005E-00	.313	1.637E-01	2.089	2.333E-06	7.369	.709	5.5324	3.9219	6.081
8	3	8	2.180E-01	2.983E-00	.365	1.649E-01	2.081	2.413E-06	7.395	.706	5.5131	3.9004	6.096
9	3	9	2.166E-01	2.964E-00	.415	1.660E-01	2.073	2.394E-06	7.421	.706	5.4940	3.8790	6.112
10	3	10	2.162E-01	2.948E-00	.499	1.777E-01	2.028	2.286E-06	7.571	.698	5.3851	3.7572	6.200
11	3	11	2.092E-01	2.821E-00	.506	1.744E-01	2.019	2.263E-06	7.604	.696	5.3618	3.7310	6.219
12	3	12	2.013E-01	2.755E-00	.702	1.766E-01	1.991	2.200E-06	7.697	.691	5.2970	3.6581	6.273
13	3	13	2.060E-01	2.818E-00	.602	1.746E-01	2.017	2.258E-06	7.610	.695	5.3571	3.7257	6.223
14	3	14	2.044E-01	2.797E-00	.92	1.759E-01	2.009	2.240E-06	7.637	.694	5.3385	3.7048	6.238
15	3	15	2.008E-01	2.748E-00	.981	1.790E-01	1.989	2.195E-06	7.703	.690	5.2924	3.6529	6.277

CH	TC	TTR	TTR/TC	Y(IN)	PML/POI
1	1	846	.6318	.051	4.920E-01
2	2	1355	1.0119	.131	
3	3	1359	1.0149	.202	
5	5	1371	1.0235	.402	
6	6	1362	1.0172	.599	

GROUP  
325

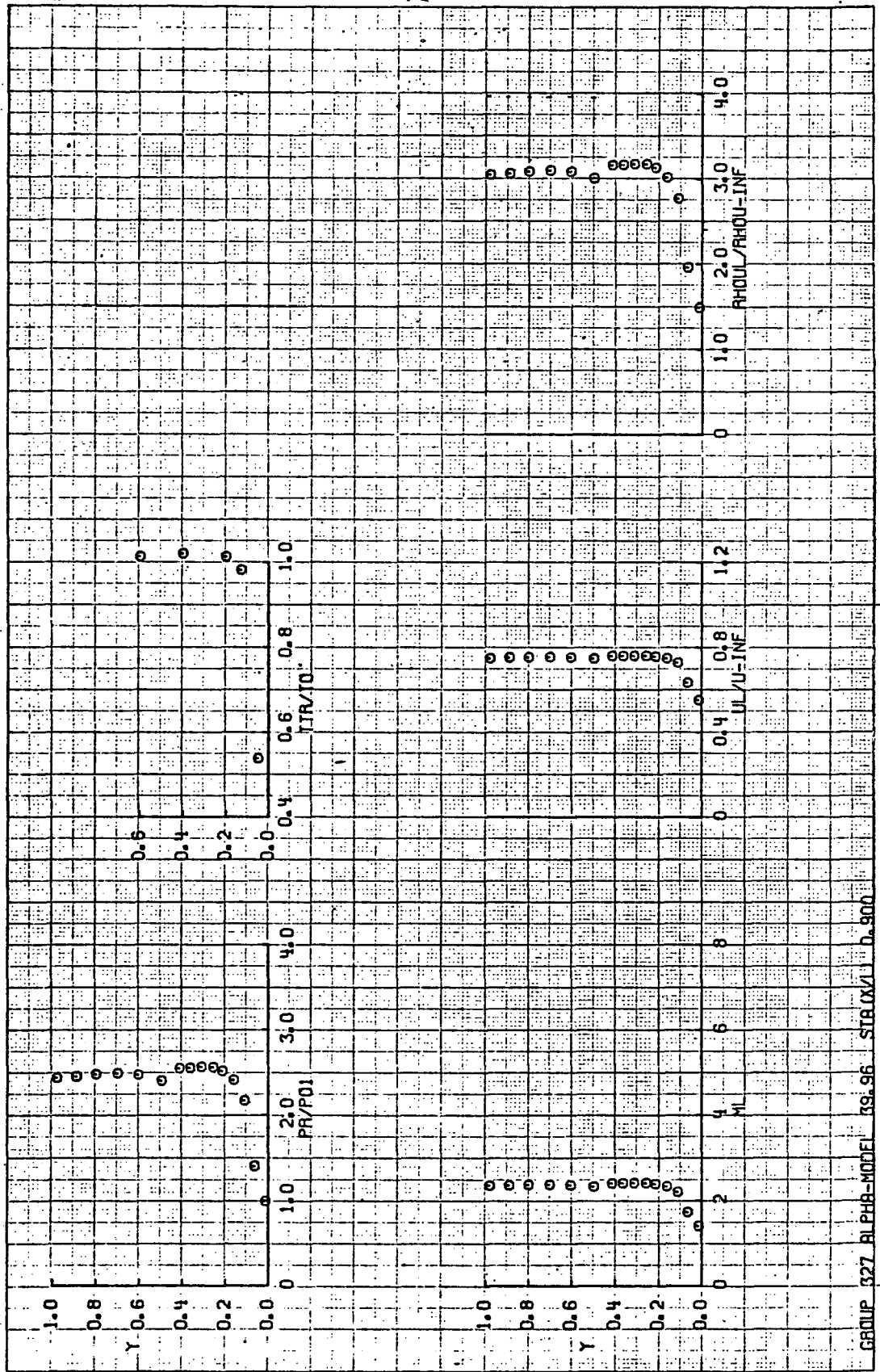


GROUP 325 ALPHA-MODEL 39.95 STA(X)/1 0.700

AEDC (AOC, INC.) ARNOLD AFS, TENNESSEE  
 VON KARMAN GAS DYNAMICS FACILITY  
 50 INCH HYPERSONIC TUNNEL R  
 VII162

GROUP	CONFIG	MODEL	MACH NO.	PO	PSIA	TO DEG R	ALPHA-MODEL	ALPHA-SECTOR	ALPHA-PREBEND	ROLL-MODEL	YAW		
327	53	NAR-DWO	8.00	863.7	13.0	39.96	10.94	-50.00	180.00	180.00	0.0		
T-INF	P-INF	P01	U-INF	RHO-INF	MU-INF	RE/FT	MODEL STA	L					
(DEG R)	(PSIA)	(PSIA)	(FT/SEC)	(LBF/FT3)	(LB-SEC/FT2)	(FT-1)	(X/L)	(IN)					
97	8.85E-02	7.331	3864	2.459E-03	7.818E-08	3.779E-06	.900	28.90					
CH	POS	TAP	PR	PR/PO1	Y(IN)	PML/PR	ML	HEL	TL/T-INF	UL/U-INF	RHOL/RHO-INF	RHOUL/RHOU-INF	MUL/MU-INF
			(PSIA)		(FT-1)			(FT-1)					
1	3	1	7.273E 00	9.922E-01	.014	3.235E-01	1.411	7.581E 05	9.869	.554	2.6951	1.4937	7.446
2	3	2	1.027E 01	1.401E 00	.066	2.291E-01	1.733	1.093E 06	8.620	.636	3.0858	1.9633	6.790
3	3	3	1.588E 01	2.167E 00	.112	1.482E-01	2.206	1.791E 06	6.993	.729	3.8036	2.7740	5.854
4	3	4	1.766E 01	2.409E 00	.163	1.333E-01	2.335	2.035E 06	6.602	.750	4.0292	3.0219	5.613
5	3	5	1.649E 01	2.518E 00	.216	1.275E-01	2.392	2.150E 06	6.437	.759	4.1324	3.1346	5.509
6	3	6	1.877E 01	2.560E 00	.258	1.254E-01	2.413	2.196E 06	6.375	.762	4.1722	3.1780	5.470
7	3	7	1.877E 01	2.561E 00	.313	1.253E-01	2.410	2.196E 06	6.375	.762	4.1722	3.1780	5.470
8	3	8	1.869E 01	2.549E 00	.365	1.259E-01	2.407	2.183E 06	6.392	.761	4.1613	3.1661	5.480
9	3	9	1.865E 01	2.544E 00	.415	1.262E-01	2.405	2.179E 06	6.398	.761	4.1577	3.1622	5.484
10	3	10	1.759E 01	2.398E 00	.499	1.338E-01	2.329	2.033E 06	6.619	.749	4.0187	3.0104	5.555
11	3	11	1.809E 01	2.448E 00	.606	1.301E-01	2.366	2.098E 06	6.510	.755	4.0852	3.0838	5.541
12	3	12	1.822E 01	2.446E 00	.702	1.291E-01	2.374	2.114E 06	6.487	.756	4.1001	3.0994	5.552
13	3	13	1.813E 01	2.474E 00	.802	1.298E-01	2.368	2.102E 06	6.504	.755	4.0894	3.0877	5.573
14	3	14	1.795E 01	2.449E 00	.892	1.311E-01	2.356	2.078E 06	6.539	.753	4.0681	3.0644	5.588
15	3	15	1.789E 01	2.435E 00	.981	1.318E-01	2.349	2.092E 06	6.561	.752	4.0939	3.0489	5.588

CH	TC	TTR	TTR/TC	Y(IN)	PML/PO1
		(DEG R)	(DEG R)		
1	1	720	.5372	.051	3.210E-01
2	2	1316	.9821	.131	
3	3	1357	1.0127	.202	
5	5	1367	1.0201	.402	
6	6	1358	1.0134	.599	



GROUP 327 ALPHA-MODEL 99.96 STR(X)/1 0.900