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WIND TUNNEL TEST TO INVESTIGATE AERODYNAMIC HYSTERESIS PHENOMEN--ETC(U)
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AEDC-TSR-79-P27
May 15, 1979

LEVEL II

(2)



WIND TUNNEL TEST
TO INVESTIGATE AERODYNAMIC HYSTERESIS PHENOMENA
OF THE F-4 AND F-111 AIRCRAFT MODELS

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ARO, Inc., AEDC Division
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Wind tunnel tests were conducted to investigate aerodynamic hysteresis phenomena found in other investigations of the F-4 and F-111 aircraft models. A 1/20-scale model of the F-4C aircraft was used to obtain static force, moment and wing pressure data in pitch and sideslip over a Mach number range from 0.7 to 0.95. A 1/24-scale model of the F-111 aircraft was used to obtain static force and moment data for a Mach number range of 0.7 to 1.3. Data on the F-111 were obtained for wing sweep angles of 26 and 54 deg. In addition, tuft and oil flow visualization data were obtained for selected configurations.		

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NOMENCLATURE

A	Reference area; F-4, 1.325 ft ² , F-111, 0.91146 ft ²
AB	F-111 model base area, 0.03169 ft ²
ALFA, α	Model angle of attack measured between the relative wind vector and the reference waterline, deg
B	Wing span, F-4, 1.93 ft, F-111, 2.625 ft
BETA	Model sideslip angle, deg
BETA, β_M	Measured local wing surface flow angle in the yaw plane (Preston tube), deg
BL	Model buttline, in.
c	Local wing chord, in.
$\bar{c}$	Wing mean aerodynamic chord; F-4, 0.802 ft, F-111, 0.377 ft
C_L	Model centerline
CA	Total axial-force coefficient, total axial force/Q.A
CAB	Base axial-force coefficient, $-AB(PBA - P)/Q.A$
CLL	Rolling-moment coefficient, rolling moment/Q.A.B
CLM	Total pitching-moment coefficient, pitching moment/Q.A. $\bar{c}$
CLN	Yawing-moment coefficient, yawing moment/Q.A.B
CN	Normal-force coefficient, normal force/Q.A
CP	Pressure coefficient
CY	Side-force coefficient, side force/Q.A
FS	Fuselage station, in.
M	Free-stream Mach number
P	Free-stream static pressure, psfa
PART	Run (data set) identification number
PBA	Average base pressure, psfa
PHIA	Model roll angle, deg

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PT	Total pressure measured in the tunnel stilling chamber, psfa
PTi	Preston tube pressures, psfa (see Fig. 1c)
Q	Free-stream dynamic pressure, psf
WL	Model water line, in.
X/C	Fraction of wing chord measured from the leading edge
Y/C	Fraction of wing chord measured vertically from chord line
Λ	Wing leading-edge sweep, deg

1.0 INTRODUCTION

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Arnold Air Force Station, Tennessee, under Program Element 65807F. The Air Force project monitor was Mr. A. F. Money. The objective of the Flight Vehicle Motion Simulation project (P32F-30) is to provide a motion analysis and simulation capability at the AEDC and to stay abreast of and contribute to technology in three areas: (1) dynamic derivative estimation, (2) airframe flexibility effects, and (3) aerodynamic hysteresis. The wind tunnel test, reported on herein, was conducted in support of the hysteresis phase of the project under ARO Project No. P41C-A3 in the Aerodynamic Wind Tunnel (4T) from March 27 through April 5, 1979.

The test objectives were to obtain (1) force and wing pressure data on a 1/20-scale model of the F-4C aircraft and (2) force data on a 1/24-scale model of the F-111 aircraft with wing sweep angles of 26 and 54 deg in regions of aerodynamic hysteresis. The test was conducted in three phases: (1) wing pressure data for the F-4C model (the model was non-metric during this phase), (2) force data for the F-4C model (pressure lines were disconnected near the wing trailing edge), and (3) force data for the F-111 model. In addition, tuft and oil flow visualization data were obtained for selected configurations.

Requests data from these tests should be addressed to the Director of Test Engineering (AEDC/DOT), Arnold Air Force Station, Tennessee 37389. A copy of the final data is on file on microfilm at AEDC.

2.0 APPARATUS

2.1 TEST FACILITY

The Aerodynamic Wind Tunnel (4T) is closed-loop continuous flow, variable-density tunnel in which the Mach number can be varied from 0.1 to 1.3 and can be set at discrete Mach numbers of 1.6 and 2.0 by placing nozzle inserts over the permanent sonic nozzle. At all Mach numbers, the stagnation pressure can be varied from 300 to 3,700 psfa. The test section is 4 ft square and 12.5 ft long with perforated variable-porosity (0.5- to 10-percent open) walls. It is completely enclosed in a plenum chamber from which the air

can be evacuated, allowing part of the tunnel airflow to be removed through the perforated walls of the test section. The model support system consists of a sector and sting attachment which has a pitch angle capability of -8 to 28 deg with respect to the tunnel centerline and a roll capability of -180 to 180 deg about the sting centerline. A more complete description of the tunnel may be found in the Test Facilities Handbook.¹

2.2 TEST ARTICLES

Details of the 1/20-scale F-4C model are presented in Figure 1a. The left wing of the model was constructed with 74 static pressure orifices located at two spanwise stations as shown in Fig. 1b. Figure 1c presents an identification key as used in the tabulated wing pressure data. Tabulated locations of the wing static pressure orifices are given in Table 1. A Preston tube was located on the left wing upper surface as shown in Fig. 1c and detailed in Fig. 1d. Various simulated leading-edge slats which were tested with the basic wing are shown in Fig. 1e. A configuration identification free laminar-to-turbulent boundary layer transition was allowed on all model components.

Details of the 1/24-scale F-111 model are presented in Fig. 2a. For limited testing, the boundary layer was tripped by applying No. 150 glass beads as shown in Fig. 2b. Both aircraft models were tested without pylons or external stores. The models installed in the tunnel are shown in Fig. 3.

2.3 INSTRUMENTATION

A six-component, internal strain-gage balance was used to measure the aerodynamic forces and moments for each of the models tested; however, the force and moment data

¹Test Facilities Handbook (Tenth Edition). "Propulsion Wind Tunnel Facility, Vol. 4." Arnold Engineering Development Center, May 1974

obtained during Phase 1 must be used with caution because the model was non-metric due to external wing pressure tubes. Base pressures, total pressure at the exit plane of the flow through ducts, and one cavity pressure for the F-111 model were measured using orifice tubes connected to differential pressure transducers of the PWT 4T pressure system. During Phase 1, the PWT 4T pressure system was used to measure the pressure sensed at the wing orifices of the F-4 model. A camera was installed in the top or side wall of the tunnel to provide flow visualization data.

Electrical signals from the balances, pressure transducers, and standard tunnel instrumentation were processed by the PWT data acquisition system for online data reduction. The balance outputs were also recorded on an oscillograph for monitoring model-balance dynamics. Selected coefficients were also graphically displayed on a cathode ray tube plotter during the test for online evaluation of data.

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS AND PROCEDURES

The nominal test conditions at which the test was conducted are listed in Table 3. Force and moment data were obtained while varying the model angle of attack or the sideslip angle at a constant Mach number and total stagnation pressure. All polars were run automatically (pitch-pause) utilizing online computer facilities which set the model pitch and roll angles to give the prescribed values of angle of attack and sideslip angle. Angle of attack was varied from -2 to 24 deg and angle of sideslip was varied from -12 to 12 deg. In addition to the force and moment data, selected configurations were examined using flow-visualization techniques. Fluorescent tufts were attached to the model or fluorescent oil was painted on the model surfaces, after which the test conditions were established and the model attitude was set. The model was then photographed using an ultraviolet flash. Two typical photographs obtained in this manner are presented in Fig. 4.

3.2 CORRECTIONS

The angle of attack and sideslip angle were corrected for sting and balance deflections caused by aerodynamic loads. Corrections for the components of model weight, normally termed static tares, were also applied to the data. Several of the model configurations were tested both upright and inverted to provide the data to correct for the tunnel flow angularity in the pitch plane.

3.3 DATA REDUCTION

The model aerodynamic forces and moments were reduced to coefficient form in the body and stability-axes systems. The model base pressure was measured and used to determine the base axial-force which was then used to determine the forebody coefficients for the F-111 model only. Moment reference points for the F-4 and F-111 models are given in Fig. 1a and 2a, respectively.

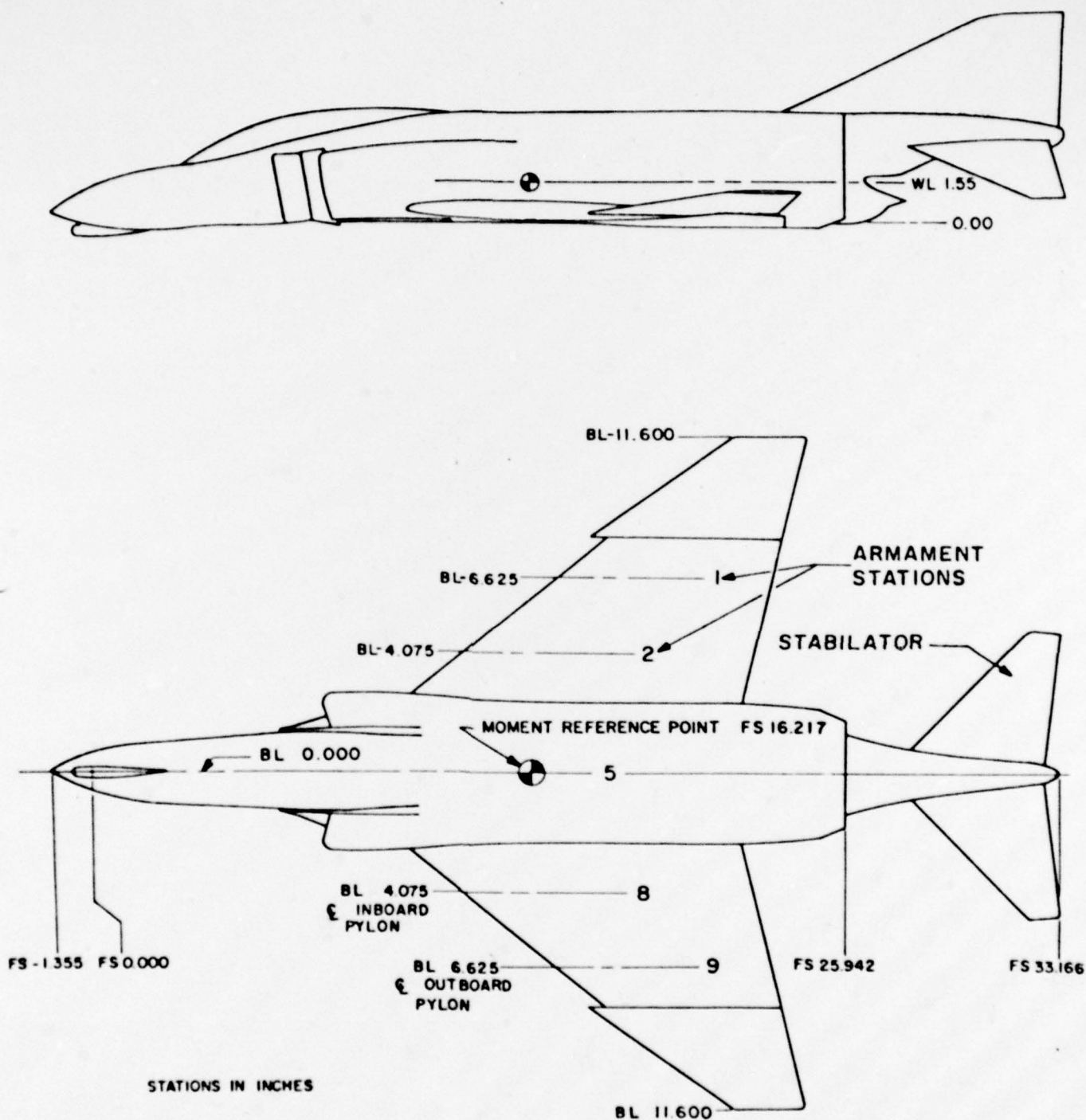
3.4 UNCERTAINTY/PRECISION OF MEASUREMENTS

The data uncertainties determined for a 95-percent confidence level are presented in Table 4. The aerodynamic coefficient uncertainties include the uncertainties of the Mach number and dynamic pressure along with the uncertainty contribution associated with the particular balance, transducers, and data acquisition system.

The precision in setting and maintaining a specific Mach number was ± 0.005 . The Mach number variation in the test section occupied by the model was no greater than ± 0.005 for Mach numbers up to 0.95 and ± 0.01 for Mach numbers greater than 1.0. The uncertainty in the model angle of attack and roll angle was 0.1 deg and ± 0.30 deg, respectively.

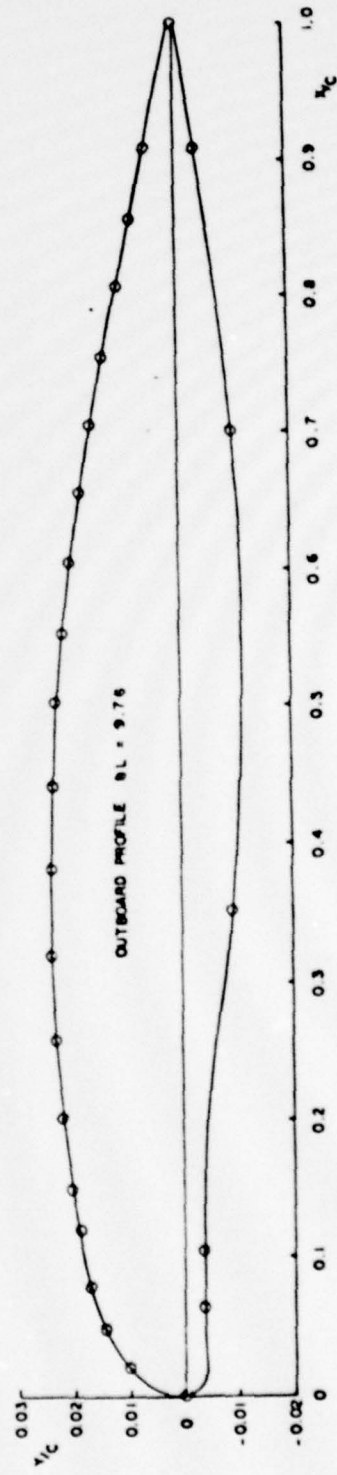
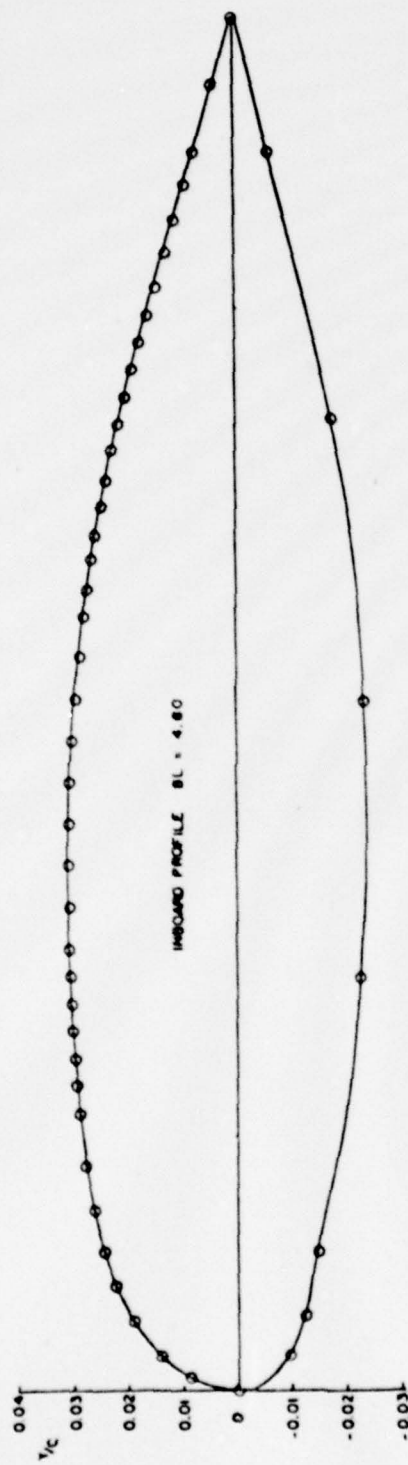
4.0 DATA PACKAGE PRESENTATION

The final data package contained tabulated data, flow visualization photographs, and installation photographs. A part number summary of the data is presented in Table 5. A sample of the point-by-point test data for Phase I is shown in Table 6a. An example of the summary test data is shown in Table 6b. All data parameters used herein are defined in the nomenclature of this report. The nomenclature for the parameters appearing in the tabulated data is presented in Table 7.



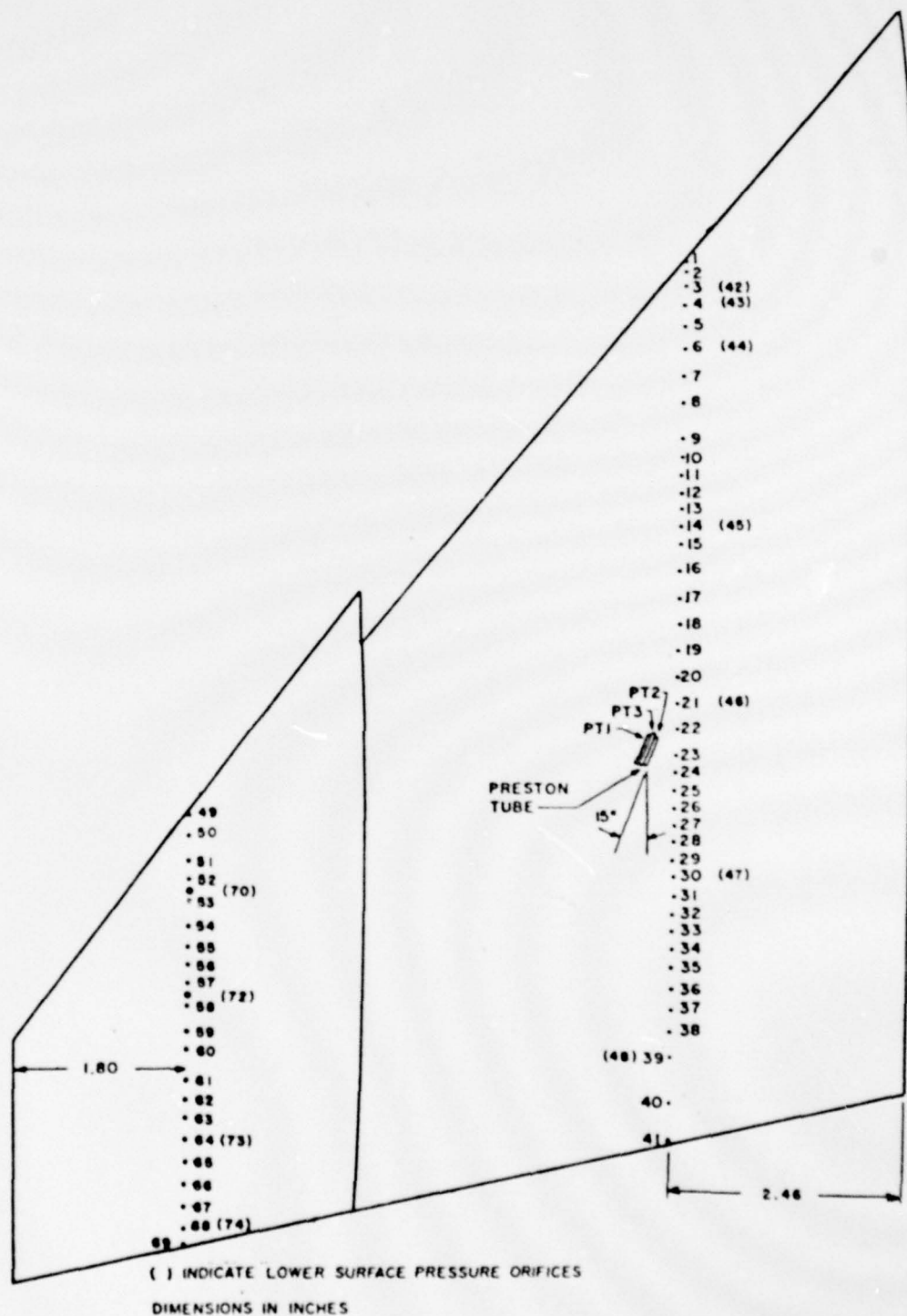
a. General arrangement drawing

Figure 1. Details and Dimensions of the F-4C Model



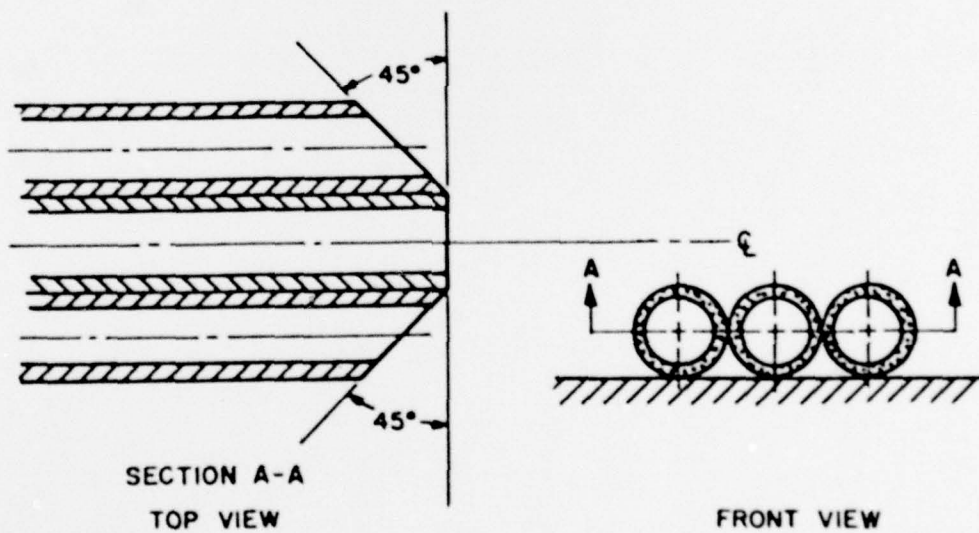
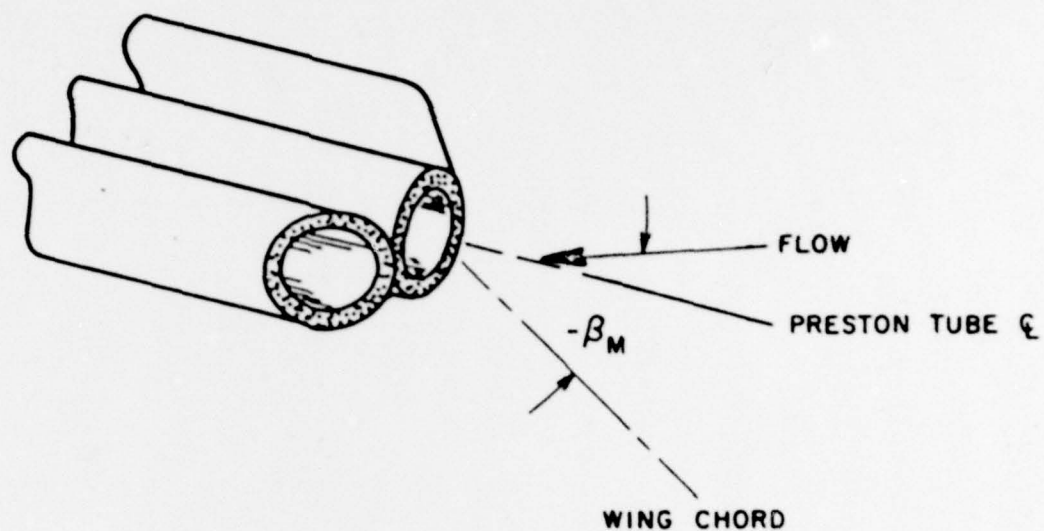
b. Wing cross-section of pressure orifice locations

Figure 1. Continued



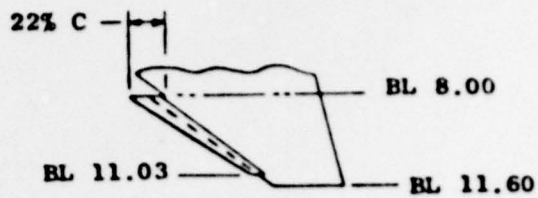
c. Identification of wing pressure orifices

Figure 1. Continued

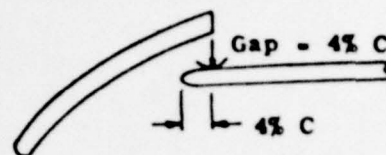


d. Preston tube details

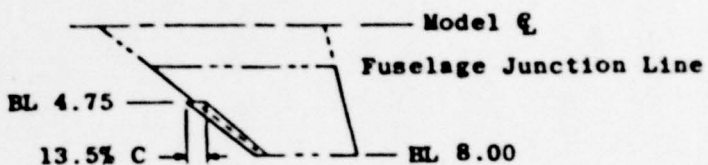
Figure 1. Continued



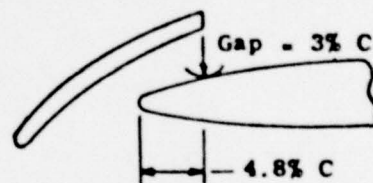
S1
PLAN VIEW OF OUTER PANEL



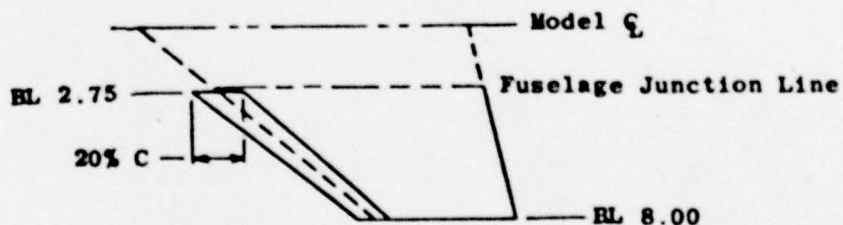
TYPICAL CROSS SECTION



S2
PLAN VIEW OF INNER PANEL

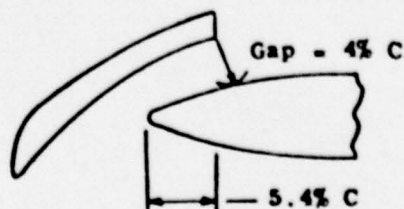


TYPICAL CROSS SECTION



S3
PLAN VIEW OF INNER PANEL

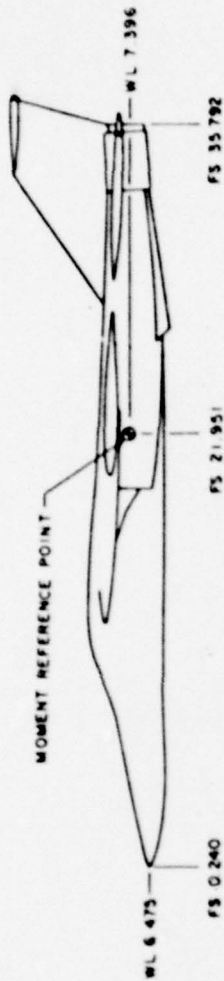
BL in Inches



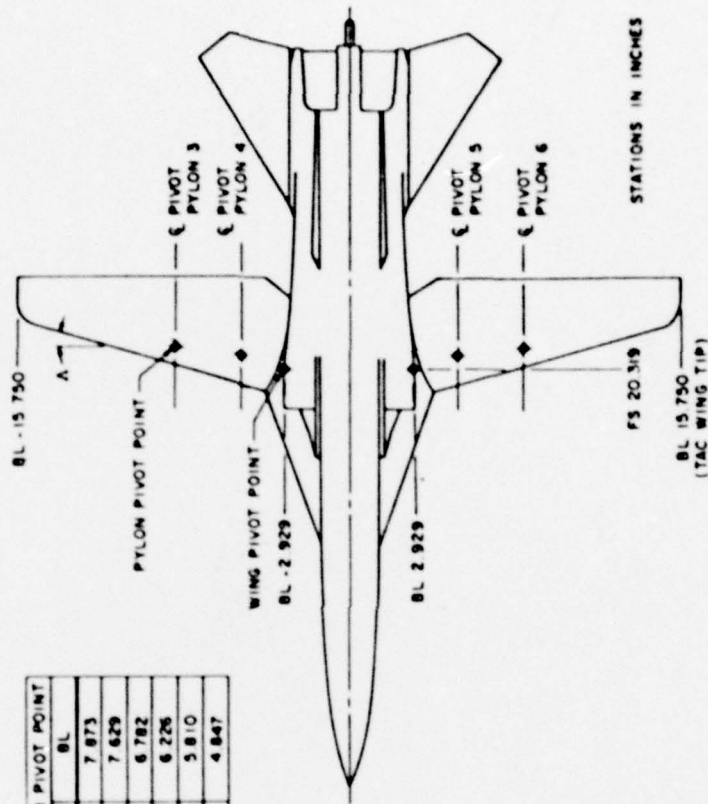
TYPICAL CROSS SECTION

e. Simulated leading-edge slats

Figure 1. Concluded



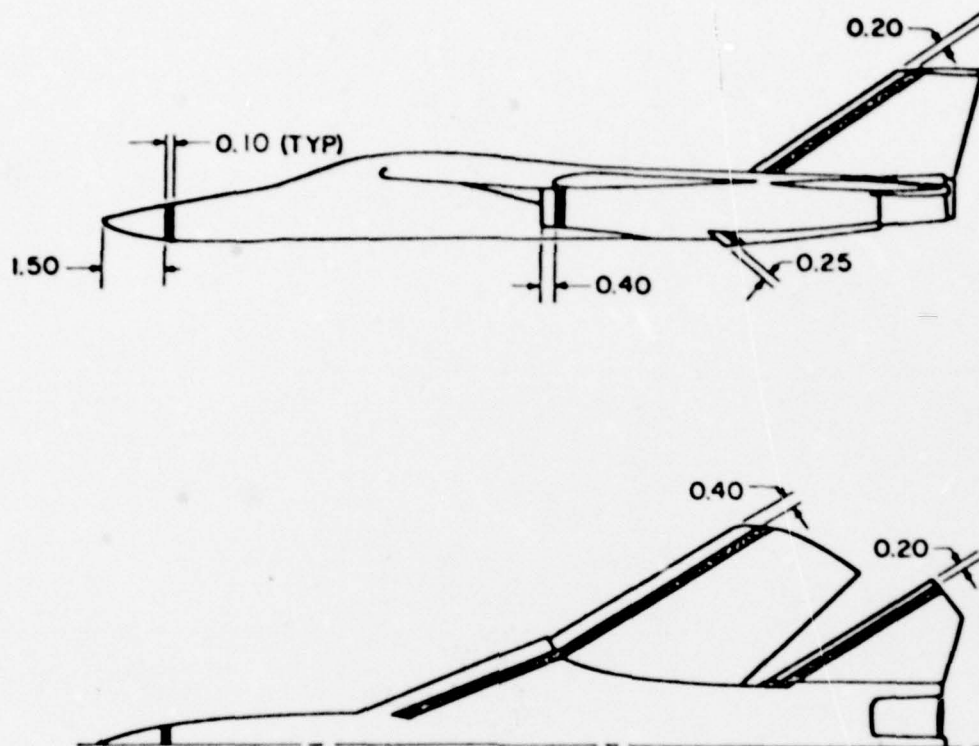
A	INBD PYLON PIVOT POINT		OUTBD PYLON PIVOT POINT	
	FS	BL	FS	BL
16 (Ref)	20 962	4 913	21 291	7 873
26	21 297	4 771	22 135	7 629
45	21 843	4 352	23 566	6 782
54	22 047	4 096	24 129	6 226
60	22 160	3 910	24 452	5 810
72.5	22 238	3 488	24 978	4 847



STATIONS IN INCHES

a. General arrangement drawing

Figure 2. Details and Dimensions of the F-111 Model

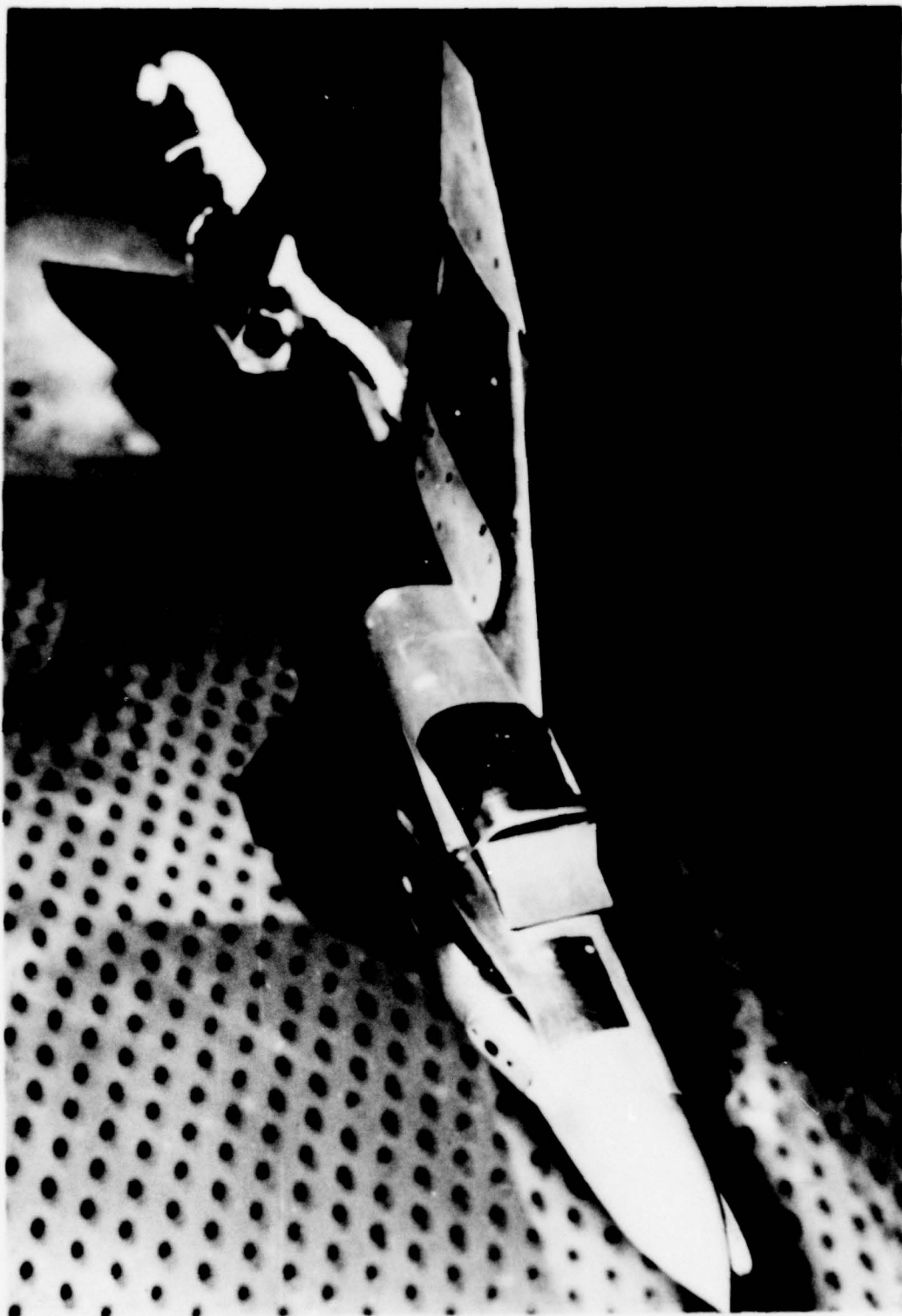


DIMENSIONS IN INCHES
#150 GLASS BEADS

NOTE:
TRANSITION STRIP USED ONLY
FOR LIMITED TESTING

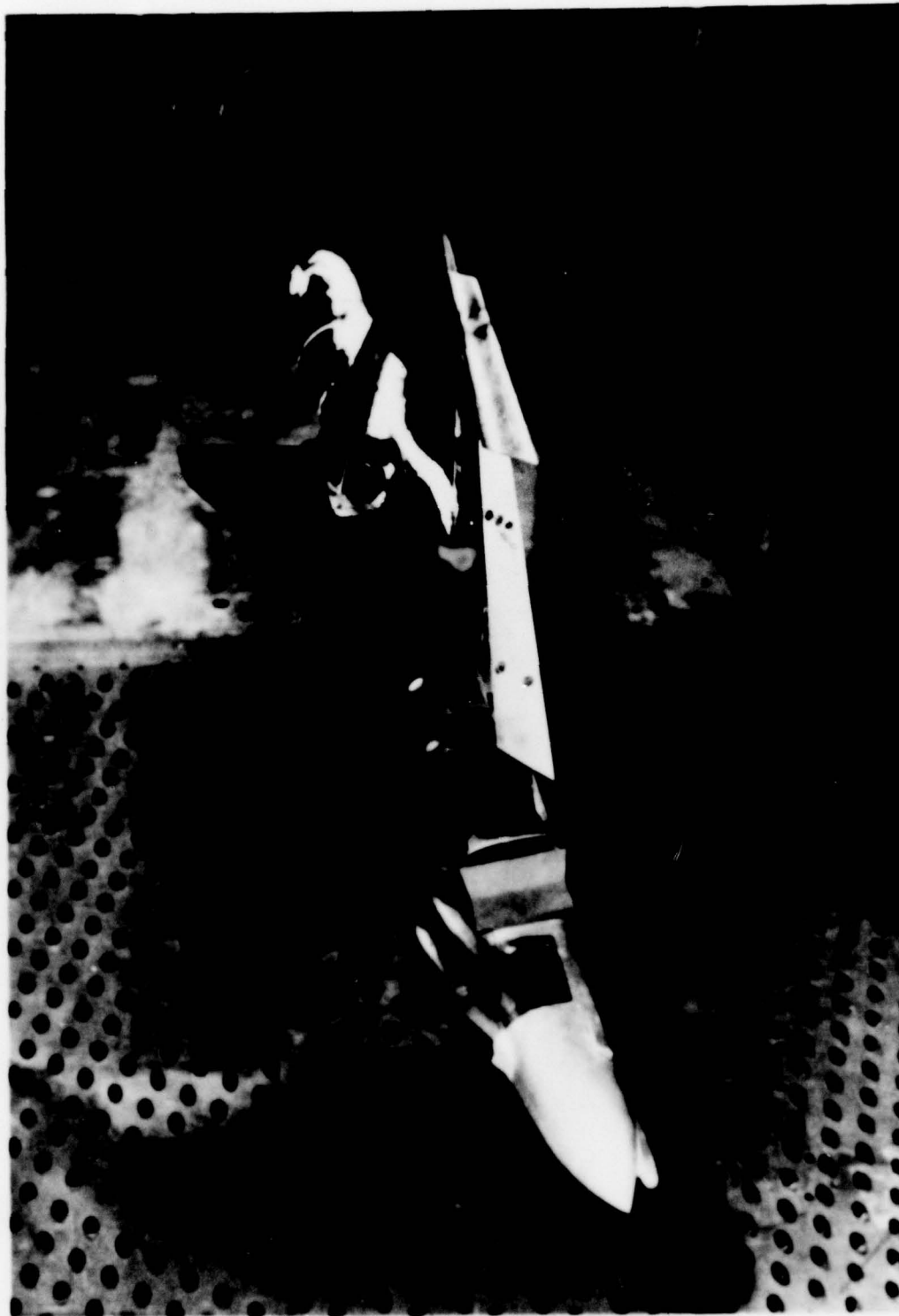
b. Boundary layer transition strip location

Figure 2. Concluded



a. F-4C - Configuration 1

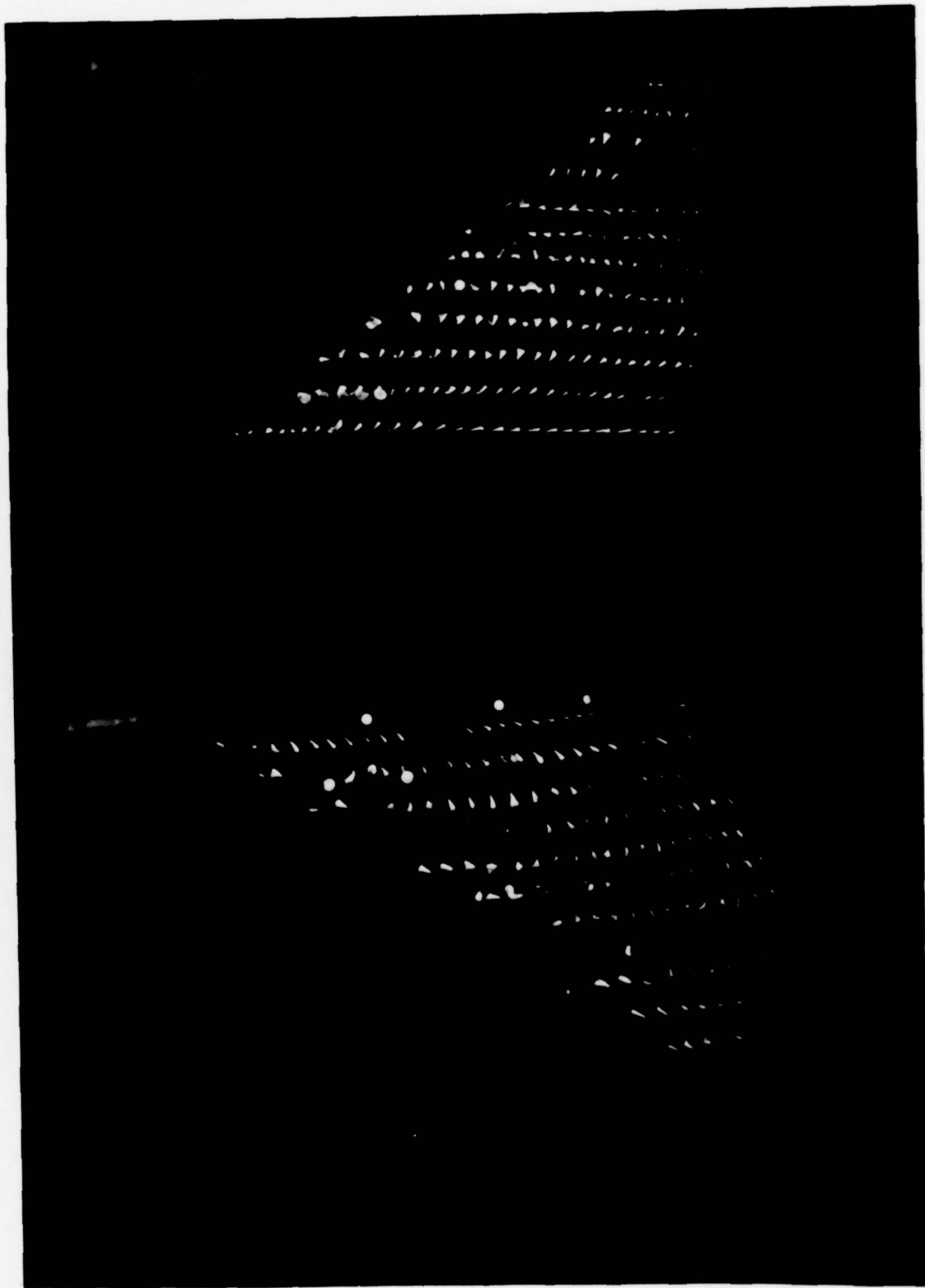
Figure 3. Model Installation in Tunnel 4T



b. F-4C - Configuration 2
Figure 3. Continued



c. F-111 - Configuration 7
Figure 3. Concluded



a. Tuft Flow Visualization

Figure 4. Typical Flow Visualization Results; $M = 0.9$,
 $\alpha = 15$ deg, $\beta = 2$ deg (Increasing β)



b. Oil-Flow
Figure 4. Concluded

Table 1. Tabulated Locations of Wing Static Pressure Orifices

Inboard Upper Surface								
NO.	X/C	Y/C	NO.	X/C	Y/C	NO.	X/C	Y/C
1	0	0	14	0.2998	0.03050	28	0.6610	0.02369
2	0.00997	0.00883	15	0.3199	0.03067	29	0.6822	0.02255
3	0.0255	0.01406	16	0.3509	0.03081	30	0.7013	0.02145
4	0.0501	0.01908	17	0.3811	0.03077	31	0.7204	0.02029
5	0.0755	0.02230	18	0.4104	0.03065	32	0.7410	0.01888
6	0.0999	0.02436	19	0.4405	0.02038	33	0.7613	0.01745
7	0.1291	0.02585	20	0.4708	0.02995	34	0.7810	0.01604
8	0.1611	0.02731	21	0.5007	0.02914	35	0.8006	0.01465
9	0.2004	0.02866	22	0.5308	0.02868	36	0.8259	0.01283
10	0.2212	0.02919	23	0.5611	0.02781	37	0.8514	0.01100
11	0.2409	0.02962	24	0.5812	0.02714	38	0.8760	0.00925
12	0.2606	0.02997	25	0.6019	0.02637	39	0.9010	0.00747
13	0.2801	0.03027	26	0.6204	0.02562	40	0.9506	0.00399
			27	0.6415	0.02465	41	1.0000	0.00042
Inboard Lower Surface								
NO.	X/C	Y/C	NO.	X/C	Y/C	NO.	X/C	Y/C
1	0	0	4	0.0986	0.01442	7	0.7035	0.01796
2	0.0232	0.00934	5	0.2995	0.02259	8	0.9013	0.00633
3	0.0528	0.01214	6	0.4983	0.02377	9	1.0000	0.00042
Outboard Upper Surface								
NO.	X/C	Y/C	NO.	X/C	Y/C	NO.	X/C	Y/C
1	0	0	8	0.2584	0.02294	15	0.6552	0.01825
2	0.0211	0.01016	9	0.3199	0.02350	16	0.7056	0.01621
3	0.0482	0.01432	10	0.3826	0.02356	17	0.7559	0.01377
4	0.0787	0.01684	11	0.4420	0.02308	18	0.8061	0.01092
5	0.1192	0.01888	12	0.5024	0.02235	19	0.8564	0.00695
6	0.1489	0.02022	13	0.5532	0.02132	20	0.9083	0.00569
7	0.2001	0.02178	14	0.6055	0.01992	21	1.0000	0.00085
Outboard Lower Surface								
NO.	X/C	Y/C	NO.	X/C	Y/C	NO.	X/C	Y/C
1	0	0	3	0.1055	0.00340	5	0.7056	0.00952
2	0.0627	0.00360	4	0.3525	0.00886	6	0.9083	0.00360
						7	1.0000	0.00085

Table 2. Model Configuration Nomenclature

<u>Configuration No.</u>	<u>Configuration</u>
1.	Baseline F-4C model
2.	F-4C with S_1 , S_2 , and S_3
3.	F-4C with S_3
4.	F-4C with S_2
5.	F-4C with S_1 and S_2
6.	F-4C with S_1
7.	F-111 with boundary layer transition strip, $\Lambda = 54$ deg
8.	F-111 clean, $\Lambda = 54$ deg
9.	F-111 clean, $\Lambda = 26$ deg

Table 3. Summary of Nominal Test Conditions

M	PT psfa	Q psf	R x 10 ⁻⁶ l/ft
0.70	1200	295	2.18
0.80		352	2.32
0.85		378	2.37
0.90		402	2.42
0.95		424	2.51
1.10		476	2.50
1.20		500	2.52
1.30	↓	513	2.50

Table 4. Data Uncertainties

a. F-4 Model

M	$\pm \Delta CN$	$\pm \Delta CY$	$\pm \Delta CA$	$\pm \Delta CLM$	$\pm \Delta CLN$	$\pm \Delta CLL$	$\pm \Delta CP$
0.70	0.03	0.008	0.004	0.009	0.002	0.001	0.018 + 0.005 CP
0.80	0.02	0.007	0.003	0.007			0.015 + 0.004 CP
0.85		↓		↓			0.013 + 0.003 CP
0.90		0.006		0.006	↓		0.012 + 0.003 CP
0.95	↓	↓	↓	↓	0.001	↓	↓

Table 4. Concluded

b. F-111 Model

M	$\pm\Delta\text{CN}$	$\pm\Delta\text{CY}$	$\pm\Delta\text{CA}$	$\pm\Delta\text{CLM}$	$\pm\Delta\text{CLN}$	$\pm\Delta\text{CLL}$	$\pm\Delta\text{CP}$
0.70	0.02	0.005	0.003	0.007	0.001	0.001	0.018 + 0.005 CP
0.80	↓	0.004	↓	0.006			0.015 + 0.004 CP
0.90	0.01	0.003	0.002	0.005			0.012 + 0.003 CP
0.95				↓			↓
1.10				0.004			0.010 + 0.002 CP
1.20				↓			0.009 + 0.002 CP
1.30	↓	↓	↓	↓	↓	↓	↓

Table 5. Test Program Part Number Summary

PHASE	CONFIG	ALFA	BETA	PHIA	M				
					0.70	0.80	0.85	0.90	0.95
1	1	V	0	0/180	65/66	70/71	73/74	25/26	89/90
		V	↓	0	67/68	72	82	28	92
		5	V					34	
		10						35	
		15			69	81/88		32/33	93
		20						49	
	↓	15	↓					50→63 ¹	
	2	V	0	0		108	106	98	105
	↓	15	V			109	107	99	100
	3	V	0	0				114	
	↓	15	V					115	
	4	V	0	0				122 ²	
	↓	15	V					121 ²	
	6	V	0	0				126 ²	
↓	↓	15	V					127	

V - Variable
1 - Time Dependence/Model Movement Studies
2 - Flow-Visualization

Table 5. Continued

PHASE	CONFIG	ALFA	BETA	PHIA	M				
					0.70	0.80	0.85	0.90	0.95
2	1	V	0	0	153	155	157	135	159
		5	V					137	
		10						138	
		15			154	156	158	136	160
		20						139	
		15						140 → 152 ¹	
								167 ² /168 ²	
								185 ² /187 ² /193 ²	
	2	V	0	0				180	
		15	V					178 ² /179 ²	

V - Variable
1 - Time Dependence/Model Movement Studies
2 - Flow Visualization

Table 5. Concluded

PHASE	CONFIG	ALFA	BETA	PHIA	M							
					0.70	0.80	0.90	0.95	1.10	1.20	1.30	
3	7	V	0	0								
		↓	↓	180					240	244	248	
		15	V	90					239	245	249	
	↓	↓	↓	-90					241	246	250	
										247	251	
	8	V	0	180	266				265	260	259	
		15	V	90					263	262	257	
		↓	↓	-90						261	258	
	↓	↓	↓							270 ²		
	9	V	0	0	275	277	278		282			
		↓	↓	180	274	276	279		283			
		15	V	90								
		↓	↓	-90			280		281			
↓	↓	↓	↓	↓					287→289 ²			

V - Variable
2 - Flow Visualization

DATE: 4-20-74 PROJECT NO. 6811-ABD

ARM, INC.

AEC DIVISION

A STEADY-STATE COMPUTATION COMPANY

PRODUCTION WIND TUNNEL

ABDOL AIR FORCE STATION, TENNESSEE

Table 6. Continued

b. Summary data

PART POINT PROJECT TEST DATE DAY MONTH YEAR DM SCHEM CODE ER CODE PHOS DATE WIND-OFF AEDC PRODUCTION WIND TUNNEL
250 5 1011-ABD 1066A 4/5/74 95 1011-ABD 1.300 0.005 10 0.04-20-74 231/ 3 TRANSONIC 61

1.299 1202.9 513.5 414.0 2.445 0.31 90.0 101.4 103.8 1202.9 1203.7 446.0 445.5 803.8 1.497 0.00 4.22 0.110 1031. -7.2

AERODYNAMIC SYNTHESIS PHASE 3
CONFIGURATION 7 SWEET 56.0

SUMMARY 1 BODY AXIS

POINT	ALFA	BETA	PHIA	CM	CT	CA	CLL	CLM	CLN	CAF	CPH1	CPH2	CPH3	CPH4
5	18.90	0.15	90.0	1.1009	-0.0056	0.0346	-0.0019	-0.5754	-0.0024	0.0287	-0.2870	-0.2872	0.0	-0.1032
6	18.90	-1.92	90.0	1.0763	0.0213	0.0392	0.0016	-0.5699	-0.0008	0.0295	-0.2854	-0.2760	0.0	-0.1044
11	18.91	-3.90	90.1	1.0734	0.0561	0.0454	0.0050	-0.5638	-0.0018	0.0355	-0.2919	-0.2733	0.0	-0.1059
13	18.91	-5.01	90.2	1.0713	0.0902	0.0567	0.0128	-0.5557	-0.0031	0.0367	-0.3027	-0.2733	0.0	-0.1119
16	18.91	-7.94	90.0	1.0717	0.1265	0.0475	0.0172	-0.5472	-0.0033	0.0372	-0.3176	-0.2737	0.0	-0.1161
17	18.89	-6.92	89.9	1.0856	0.0843	0.0442	0.0119	-0.5539	-0.0003	0.0341	-0.3073	-0.2717	0.0	-0.1139
18	18.99	-8.95	90.0	1.0704	0.0483	0.0425	0.0067	-0.5609	0.0017	0.0325	-0.3022	-0.2689	0.0	-0.1080
19	18.98	-1.89	89.2	1.0950	0.0116	0.0405	0.0020	-0.5875	0.0024	0.0307	-0.2938	-0.2729	0.0	-0.1067
21	18.99	-0.00	90.0	1.0942	-0.0275	0.0443	-0.0011	-0.5847	0.0043	0.0345	-0.2891	-0.2776	0.0	-0.1024
21	18.88	2.01	89.9	1.0941	-0.0591	0.0323	-0.0044	-0.5703	0.0044	0.0222	-0.2832	-0.2786	0.0	-0.0977
23	18.99	4.99	90.0	1.0706	-0.0406	0.0318	-0.0092	-0.5681	0.0045	0.0219	-0.2774	-0.2781	0.0	-0.1090
24	18.89	6.01	90.0	1.0615	-0.1208	0.0303	-0.0180	-0.5824	0.0065	0.0283	-0.2795	-0.2780	0.0	-0.1167
25	18.91	8.03	89.9	1.0730	-0.1597	0.0400	-0.0202	-0.5574	0.0062	0.0244	-0.2803	-0.3039	0.0	-0.1205
26	18.91	9.98	89.9	1.0661	-0.1925	0.0465	-0.0258	-0.5541	0.0064	0.0361	-0.2849	-0.3139	0.0	-0.1339
27	18.97	4.01	90.1	1.0728	-0.1872	0.0411	-0.0206	-0.5568	0.0029	0.0309	-0.2800	-0.3102	0.0	-0.1238
28	18.89	6.08	89.1	1.0811	-0.1086	0.0404	-0.0149	-0.5605	0.0008	0.0308	-0.2775	-0.3044	0.0	-0.1173
29	18.99	8.05	90.1	1.0909	-0.0696	0.0344	-0.0100	-0.5656	-0.0015	0.0264	-0.2767	-0.2949	0.0	-0.1114
30	18.89	2.03	90.2	1.0948	-0.0361	0.0380	-0.0050	-0.5890	-0.0022	0.0281	-0.2791	-0.2894	0.0	-0.1017
31	18.90	0.04	90.0	1.0950	-0.0087	0.0417	-0.0017	-0.5887	-0.0022	0.0319	-0.2844	-0.2844	0.0	-0.0946
32	18.90	-1.98	90.1	1.0938	0.0217	0.0441	0.0016	-0.5849	-0.0007	0.0362	-0.2844	-0.2795	0.0	-0.1021
33	18.92	-3.91	90.2	1.0918	0.0537	0.0459	0.0060	-0.5592	-0.0012	0.0360	-0.2944	-0.2750	0.0	-0.1072
34	18.91	-5.89	90.1	1.0862	0.0888	0.0485	0.0111	-0.5528	-0.0022	0.0385	-0.3024	-0.2722	0.0	-0.1098
35	18.92	-7.92	90.1	1.0808	0.1263	0.0504	0.0111	-0.5462	-0.0035	0.0402	-0.3127	-0.2740	0.0	-0.1180

DATE: 11-20-79 PROJECT NO. 2411-430
 ARO, INC.
 AEC DIVISION
 A SYNERGIC CORPORATION COMPANY
 PROPOSITION WIND TUNNEL
 ARNOLD AIR FORCE STATION, KENTUCKY

Table 6. Concluded
 b. Concluded

PART POINT PROJECT TEST DATE DAY HR MN SC Mm DM SCHEM MODE ERCODE PROS DATE WIND-OFF AEDC PROPOSITION WIND TUNNEL
 250 5 2411-430 1600 4/ 5/79 95 18147135 1.300 0.005 H 10 0 04-20-79 237/ 3 TRANSONIC AT

W DT Q P MALL-6 ALL-1 MALL-2 PIA-1 PIA-2 PCA-1 PCA-2 PE TPA WA PM SCAL00 PM TOP
 1.299 1202.9 513.5 436.4 2.495 0.31 90.0 101.4 100.8 1202.9 1203.7 666.0 665.5 803.8 1.497 0.00 4.22 0.110 1031. -7.2

AERODYNAMIC SYNTHESIS PHASE 3
 CONFIGURATION 7 SWEEP SA.0

SUMMARY 2 STABILITY AXIS																	
POINT	ALFA	WETA	W-1A	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
5	14.90	0.15	90.0	1.0539	-0.0056	0.3203	-0.0024	-0.5754	-0.0018	0.3107	0.0094	1.2700	1.3079				
6	14.90	-1.42	90.0	1.0494	0.0213	0.3194	0.0013	-0.5699	-0.0012	0.3103	0.0094	1.2924	1.3105				
11	14.91	-1.90	90.1	1.0449	0.0561	0.3251	0.0053	-0.5638	-0.0033	0.3165	0.0094	1.3179	1.2161				
13	14.91	-5.81	90.2	1.0267	0.0202	0.3269	0.0037	-0.5557	-0.0058	0.3152	0.0097	1.3292	1.1541				
14	14.91	-7.94	90.0	1.0331	0.1265	0.3242	0.0184	-0.5472	-0.0077	0.3142	0.0099	1.3144	0.9411				
17	14.89	-6.02	90.9	1.0374	0.0943	0.3217	0.0114	-0.5539	-0.0034	0.3119	0.0094	1.3293	1.0499				
18	14.93	-0.05	90.0	1.0424	0.0453	0.3214	0.0070	-0.5499	-0.0001	0.3114	0.0096	1.3144	1.2007				
19	14.94	-1.94	90.9	1.0478	0.0116	0.3206	0.0024	-0.5475	-0.0014	0.3111	0.0095	1.2937	1.3249				
20	14.94	-0.00	90.9	1.0461	-0.0275	0.3241	0.0066	-0.5467	0.0044	0.3146	0.0095	1.2682	1.3100				
21	14.92	-2.01	90.4	1.0491	-0.0591	0.3121	-0.0031	-0.5703	0.0054	0.3027	0.0094	1.2804	1.3222				
23	14.94	4.00	90.9	1.0454	-0.0906	0.3110	-0.0077	-0.5441	0.0047	0.3015	0.0095	1.2162	1.3403				
24	14.94	6.01	92.0	1.0353	-0.1204	0.3150	-0.0119	-0.5624	0.0100	0.3053	0.0097	1.0910	1.3423				
25	14.91	4.03	90.9	1.0266	-0.1597	0.3147	-0.0179	-0.5574	0.0111	0.3049	0.0098	0.9486	1.3442				
26	14.91	9.80	90.9	1.0182	-0.1925	0.3193	-0.0232	-0.5541	0.0128	0.3043	0.0101	0.8245	1.3499				
27	14.97	4.01	90.1	1.0263	-0.1472	0.3150	-0.0192	-0.5564	0.0081	0.3051	0.0094	0.9462	1.3467				
28	14.89	6.04	90.1	1.0263	-0.1406	0.3171	-0.0182	-0.5505	0.0044	0.3075	0.0098	1.0857	1.3412				
29	14.94	4.05	90.1	1.0450	-0.0496	0.3154	-0.0101	-0.5456	0.0012	0.3058	0.0097	1.2107	1.3353				
30	14.94	2.09	90.0	1.0482	-0.0361	0.3181	-0.0054	-0.5490	-0.0008	0.3045	0.0095	1.2453	1.3212				
31	14.90	0.04	90.0	1.0485	-0.0047	0.3221	-0.0022	-0.5447	-0.0017	0.3126	0.0095	1.2730	1.3042				
32	14.90	-1.94	90.1	1.0457	0.0217	0.3239	0.0014	-0.5449	-0.0011	0.3144	0.0095	1.2921	1.3071				
33	14.92	-4.91	90.2	1.0432	0.0537	0.3254	0.0034	-0.5492	-0.0027	0.3158	0.0096	1.3159	1.2149				
34	14.91	-5.89	90.1	1.0472	0.0888	0.3204	0.0102	-0.5528	-0.0050	0.3167	0.0097	1.3288	1.1014				
35	14.92	-7.92	90.1	1.0314	0.1263	0.3270	0.0156	-0.5462	-0.0078	0.3171	0.0099	1.3352	0.9449				

Table 7. Tabulated Data Nomenclature

Test Data Identification and Wind Tunnel Parameters

PART	Run (data set) identification number
POINT	Data point number
PROJECT	Project number
TEST	Test number
DATE	Date of data acquisition
DAY	Day (of year) of data acquisition
HR	Hour of data acquisition
MN	Minute of data acquisition
SC	Second of data acquisition
MB	Set point Mach number
DM	Mach number tolerance
SCHED	Tunnel wall porosity schedule
MODE	Data acquisition mode
ERCODE	Error code
PROS DATE	Date of data processing
WIND OFF	Wind-off part and point number
M	Free-stream Mach number
PT	Free-stream stagnation pressure, psfa
Q	Free-stream dynamic pressure, psf
P	Free-stream static pressure, psfa
RX10-6	Free-stream unit Reynolds number $\times 10^{-6}$, $10^6/\text{ft}$
ALFI	Pitch sector indicated pitch angle, deg
PHII	Pitch sector indicated roll angle, deg
TTA-X	Total temperature measured in the tunnel stilling chamber - A system, °F
TTB-X	Total temperature measured in the tunnel stilling chamber - B system, °F

Table 7. Continued

PTA-X	Total pressure measured in the tunnel stilling chamber - A system, psfa
PTB-X	Total pressure measured in the tunnel stilling chamber - B system, psfa
PCA-X	Tunnel plenum chamber pressure - A system, psfa
PCB-X	Tunnel plenum chamber pressure - B system, psfa
PE	Tunnel diffuser pressure, psfa
TPR	Tunnel pressure ratio, PT/PE
WA	Test section wall angle, deg
POR	Average tunnel wall porosity , percent of wall area open to test section plenum
SCX100	Tunnel specific humidity x 100, lb/lb x 10 ⁻²
PM	Hygrometer mixture pressure, psfa
TDP	Hygrometer dew point temperature, °F

Note: The suffixed "X's" with TT, PT, and PC indicate the primary system and the program checks on system agreement. The suffixed nomenclature is as follows:

X = 1	Primary system
X = 2	Secondary system
X = 0	Delete checks on system agreement

Body Axes Coefficients/Base Pressures/Exit Pressures

ALFA	Model angle of attack measured between the relative wind vector and the reference water line, deg
BETA	Model sideslip angle, deg
PHIA	Model roll angle, positive right wing down, deg
CN	Normal-force coefficient
CLM	Pitching-moment coefficient
CY	Side-force coefficient
CLN	Yawing-moment coefficient

Table 7. Continued

CLL	Rolling-moment coefficient
CA	Total axial-force coefficient
CAF	Forebody axial-force coefficient, CA-CAB
CPB _i	Base pressure coefficient
CPE _i	Flow-thru duct total exit pressure coefficients

Stability Axes

CLS	Lift coefficient
CLM	Pitching-moment coefficient
CY	Side-force coefficient
CLNW	Yawing-moment coefficient
CLLS	Rolling-moment coefficient
CD	Total drag coefficient
CDB	Base drag coefficient
CDF	Forebody drag coefficient, CD-CDB
PB _i	Base pressure, psfa
PE _i	Flow thru duct total exit pressure, psfa

Balance Readings/Gross Forces

RMM1	Balance forward pitching moment gage reading
RMN1	Balance forward yawing moment reading
RFA	Balance axial force gage reading
RML	Balance rolling moment gage reading
RMM2	Balance aft pitching moment gage reading
RMN2	Balance aft yawing moment gage reading
FNG	Gross normal force, lb
MMG	Gross pitching moment, in.-lb
FYG	Gross side force, lb

Table 7. Continued

MNG	Gross yawing moment, in.-lb
FAG	Gross axial force, lb
MLG	Gross rolling moment, in.-lb
PCAV	Cavity pressure, psfa

Net Forces and Transferred Moments/Static Tares

FN	Net normal force, lb
MM	Net transferred pitching moment, in.-lb
FY	Net side force, lb
MN	Net transferred yawing moment, in.-lb
FA	Net total axial force, lb
ML	Net rolling moment, in.-lb
ALFO	Flow correction angle in pitch, deg
FNST	Normal force tare, lb
MMST	Pitching moment tare, in.-lb
FYST	Side force tare, lb
MNST	Yawing moment tare, in.-lb
FAST	Axial force tare, lb
MLST	Rolling moment tare, in.-lb

4T Pressure System Information

SLOPE	Pressure settling slope criteria, psf/sec
T-OUT	Time out criteria, sec
FLAG _i	Indicator if pressure settling criteria was settled at time of data acquisition (i = 1, loop 1; i = 2, loop 2)
TREQ _i	Time required for settling
LCS _i	Last channel to settle
NLCS _i	Next to last channel to settle

Table 7. Concluded

NCNSi Number of channels not settled at time of data acquisition

Phase 1 Pressures - Wing/Preston Tube/Tunnel Conditions

X/C Fraction of wing chord measured from the leading edge

CPi Wing pressure coefficient

PTi Preston tube pressures, psfa

BETAM Measured local wing surface flow angle in the yaw plane (Preston tube), deg

PCBLi Tunnel plenum chamber pressure during data cycle - B system, psfa

PTBLi Total pressure measured in the tunnel stilling chamber during data cycle - B system, psfa