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STATIC FORCE TESTS OF THE AEDC-VKF STANDARD 5 DEG CONE IN TUNNE--ETC(U)

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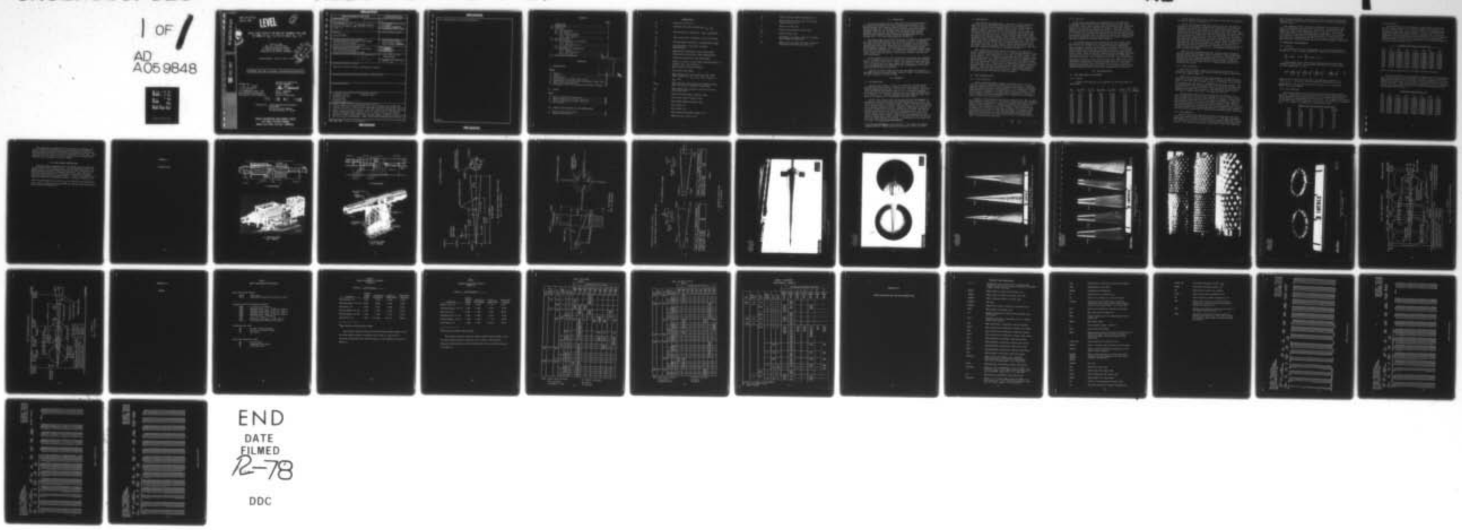

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AUGUST 1978

LEVEL II

STATIC FORCE TESTS OF THE AEDC-VKF STANDARD 5-DEG CONE IN TUNNELS A (M_∞ = 3.0 TO 5.5) AND B (M_∞ = 6)

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von Kármán Gas Dynamics Facility
Arnold Air Force Station, Tennessee

Period Covered: May 25 to July 7, 1978

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ARNOLD ENGINEERING DEVELOPMENT CENTER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Static stability and base pressure tests were conducted, on the AEDC-VKF standard force cone. The tests were performed at nominal Mach numbers of 3.01, 3.25, 3.51, 3.76, 4.02, 4.52, 5.04, 5.58, and 5.95 at free-stream unit Reynolds numbers ranging from 0.8×10^6 per foot to 7×10^6 per foot. The angle-of-attack and sideslip angle ranges were -13 to 13 deg. The effects of nose geometry, boundary layer trips, fins, Reynolds number, and model location in the test section were investigated. Model flow-field photographs were obtained on

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all configurations at selected conditions.

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III. SAMPLE TABULATED DATA AND DATA NOMENCLATURE

NOMENCLATURE

A_b	Base area, 28.274 in.^{2}
C_A	Forebody axial-force coefficient, $C_{A_t} - C_{A_b}$
C_{A_b}	Base axial-force coefficient, $-(p_b - p_\infty)A_b/(q_\infty S)$
C_{A_t}	Total axial-force coefficient, axial force/$(q_\infty S)$
C_ℓ	Rolling-moment coefficient, rolling moment/$(q_\infty S\ell)$
C_m	Pitching-moment coefficient, pitching moment/$(q_\infty S\ell)$
C_N	Normal-force coefficient, normal force/$(q_\infty S)$
C_n	Yawing-moment coefficient, yawing moment/$q_\infty S\ell)$
C_Y	Side-force coefficient, side force/$(q_\infty S)$
C.R.	Center of rotation of the tunnel pitch mechanism, in.
h	Boundary layer trip height, in.
ℓ	Model length (virtual), 34.290 in.
M_∞	Free-stream Mach number
p_b	Base pressure used to calculate the base axial force coefficient, $(p_{b_1} + p_{b_2} + p_{b_3} + p_{b_4})/4$ or p_{b_D}, psia
$p_{b_{1-4}}$	Base pressures measured with the standard system, psia (not valid on continuous sweep data)
p_{b_D}	Fast response base pressure, psia (not valid on point-pause data)
p_o	Tunnel stilling chamber pressure, psia
p_∞	Free-stream static pressure, psia
q_∞	Free-stream dynamic pressure, psia
r_n	Nose radius, in.
r_b	Base radius, 3 in.
Re_∞	Free-stream unit Reynolds number, ft^{-1}
S	Reference area, 28.274, in.^{2}

T_o	Tunnel stilling chamber temperature, °R
X	Model axial location in the test section, positive upstream, in.
α	Angle of attack, deg
α_s	Tunnel sector angle of attack, deg
β	Sideslip angle, deg
ϕ	Aerodynamic roll angle, positive clockwise when looking upstream, deg
ϕ_s	Tunnel roll mechanism roll angle, positive clockwise when looking upstream, deg

1.0 INTRODUCTION

The work reported herein was conducted by the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), under Program Element 65807F, Control Number 9T03-00-8. The results were obtained by ARO, Inc., AEDC Division (a Sverdrup Corporation Company), operating contractor for the AEDC, AFSC, Arnold Air Force Station, Tennessee. The test was conducted in the von Karman Gas Dynamics Facility (VKF), Tunnels A and B during the period of May 25, 1978 through July 7, 1978 under ARO Project No. V41A/B/C-02.

The primary objective of these tests was to provide a "high quality" data bank for the VKF standard cone in Tunnels A and B. The standard cone model (and data bank) will be used for defining test section flow nonuniformity effects and evaluating the performance of the total system (balance-support hardware, model dynamics, data acquisition systems, data reduction techniques, etc.) on a routine and systematic basis using "selected" test installations. The effects of transition, boundary layer trips, tunnel center of rotation, tunnel axial location, and fins were also investigated.

Static stability, axial force, and base pressure data were obtained at M_∞ = 3 through 5.5 in Tunnel A and at M_∞ = 6 in Tunnel B for Reynolds numbers from 0.8 x 10^6/ft to 7 x 10^6/ft. The angle-of-attack range was -13 to 13 deg and the roll angle ranged from -180 deg to 180 deg. Model flow-field photographs were obtained on all configurations at selected model attitudes and test conditions.

Inquiries to obtain copies of the test data should be directed to AEDC/DOOV, Arnold Air Force Station, Tennessee 37389. A microfilm record has been retained in the VKF at AEDC.

2.0 APPARATUS

2.1 TEST FACILITIES

Tunnels A and B (Figs. 1 and 2) are continuous, closed-circuit, variable density wind tunnels. Tunnel A has 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 6 at maximum stagnation pressures from 29 to 200 psia, respectively, and stagnation temperatures up to 750°R (M = 6). Minimum operating pressures range from about one-tenth to one-twentieth of the maximum at each Mach number.

Tunnel B has a 50-in.-diam test section and two interchangeable axisymmetric contoured nozzles to provide Mach numbers of 6 and 8. The tunnel can be operated continuously over a range of pressure levels from 20 to 300 psia at M_∞ = 6, and 50 to 900 psia at M_∞ = 8, with air supplied by the VKF main compressor plant. Stagnation temperatures sufficient to avoid air liquefaction in the test section (up to 1350°R) are obtained through the use of a natural gas fired combustion heater. The entire tunnel (throat, nozzle, test section, and diffuser) is cooled by integral, external water jackets. Each tunnel is equipped with a model injection system which allows removal of the model from the test section while the tunnel remains in operation. A description of the tunnels may be found in the Test Facilities Handbook*.

* Test Facilities Handbook (Tenth Edition). "von Karman Gas Dynamics Facility, Vol. 3." Arnold Engineering Development Center, May 1974.

2.2 TEST ARTICLE

The standard cone model (Figs. 3 and 4) is a 5-deg, half-angle cone with a 6-in. base diameter fabricated from stainless steel. There are two basic interchangeable nose sections: sharp (0.002-in. spherical radius), and 12.5 percent blunt (r_n/r_b = 0.125). The virtual length of the sharp cone is 34.290 inches and the model wall thickness is typically 0.25 in. Several boundary layer trips (Figs. 3c and 5) were used to ensure a fully turbulent boundary layer over the majority of the model surface. Most of these trips were machined; therefore, they will be unchanged for any furture tests. A cylindrical section with four rectangular fins was also provided (Fig. 3b). The model weight is about 30 lbs with its standard base plate and about 42 lbs with the fins. A wide range of balance adapters exist to fit the model to most VKF balances (normal load range from 80 to 1000 lbs). The model components designation is presented in Table 1.

The model/balance combinations were supported on a two-piece, slender, tapered sting as shown in Fig. 6. This sting assembly is about 28 in. long and tapers from about 2.3 in. near its base to about 1 in. at the balance. It is designed to accommodate the load capacity of the 500 lb-range balances. A small adapter can be used to accommodate 200 lb-range balances. The sting has a stainless steel core which allows water cooling passages near the outer surface and is covered by an 0.50-in. thick outer skin. Cooling water is transferred through fittings in the clutch faces between the sting sections. These features minimize warpage. Model base and cavity pressure tubes and balance cooling water lines are contained within the sting. Water is transferred to the balance through an O-ring and bellows assembly.

2.3 TEST INSTRUMENTATION

2.3.1 Test Conditions

Tunnel A stilling chamber pressure is measured with a 15-, 60-, 150-, or a 300-psid transducer referenced to a near vacuum. Based on periodic comparisons with secondary standards, the accuracy (a bandwidth which includes 95 percent of the residuals, i.e. 2σ deviation) of these transducers is estimated to be within ±0.2 percent of reading or ±0.015 psi, whichever is greater. Stilling chamber temperature is measured with a copper-constantan thermocouple with an accuracy of ±3°F based on repeat calibrations (2σ deviation).

Tunnel B stilling chamber pressure is measured with a 200- or 1000-psid transducer referenced to a near vacuum. Based on periodic comparisons with secondary standards, the accuracy (a bandwidth which includes 95 percent of the residuals, i.e. 2σ deviation) of these transducers is estimated to be within ±0.25 percent of reading or ±0.30 psi, whichever is greater for the 200-psid range and ±0.25 percent of reading or ±0.8 psi, whichever is greater for the 1000-psid range. Stilling chamber temperature measurements are made with Chromel®-Alumel® thermcouples which have an accuracy of ±(1.5°F + 0.375 percent of reading) based on repeat calibrations (2σ deviation).

2.3.2 Test Data

Model forces and moments were measured with a six-component, strain-gage balance (see Tables 2 and 3) calibrated by VKF. Prior to the test, static loads in each plane and combined static loads were applied to the balance to simulate the range of loads and center-of pressure locations anticipated during the test. The range of check loads applied and the measurement accuracies are given in Tables 2 and 3. The accuracies represent the bands of 95 percent (2σ deviation) of the measured residuals, based on differences between the applied loads and the corresponding values calculated from the balance calibration equations included in the final data reduction.

The standard Tunnel A base pressure system uses 15-psid transducers which are referenced to a near vacuum and are calibrated at 0.5, 1, 3, 6, 9, 12, and 15 psia. Based on periodic comparisons with secondary standards, the accuracy is estimated to be ±0.15 percent of pressure or ±0.003 psia, whichever is greater. The standard Tunnel B base pressure system uses 1-psid transducers referenced to a near vacuum. Based on periodic comparisons with secondary standards, the estimated accuracy is ±0.2 percent of reading or ±0.0015 psia, whichever is greater. Fast response base pressure (p_{b_D}) measurements taken during continuous sweep runs were made with a low volume 15 psid transducer (calibrated at 1 psia full scale) which has an estimated accuracy of ±0.06 percent of the calibrated full scale. The base pressure measurement accuracy, however, is no better than that of the standard pressure system to which these transducers are referenced.

3.0 TEST DESCRIPTION

3.1 TEST CONDITIONS AND PROCEDURES

3.1.1 General

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

M_∞	p_o, psia	T_o, °R	q_∞, psia	p_∞, psia	Re_∞/ft x 10^{-6}	Plant Staging
3.01	5.0	560	0.85	0.134	0.73	2
3.01	11.0	580	1.87	0.295	1.53	3
3.01	26.0	580	4.42	0.697	3.62	3
3.01	10.6	560	1.80	0.284	1.56	2
3.01	25.0	560	4.25	0.670	3.67	2
3.01	48.0	560	8.16	1.287	7.04	2
3.25	32.0	580	4.45	0.602	3.93	3
3.51	35.0	580	3.90	0.452	3.74	3
3.76	41.0	600	3.70	0.374	3.66	3
4.02	47.0	600	3.41	0.301	3.67	3
4.52	65.0	620	3.13	0.219	3.76	4
5.04	81.0	620	2.60	0.146	3.65	4
5.58	124.0	700	2.58	0.118	3.54	5
5.90	52.0	850	0.89	0.037	1.00	5
5.94	130.0	850	2.16	0.088	2.45	5
5.95	200.0	850	3.31	0.133	3.76	5
5.95	270.0	850	4.46	0.180	5.07	5

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

In the VKF continuous flow wind tunnels (A, B, C), 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, and the model is injected into the airstream, and the fairing doors are closed. After the data are completed, 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.

Model attitude positioning and data recording were accomplished with the point-pause and sweep modes of operation, using the VKF Model Attitude Control System (MACS). Model pitch and yaw requirements were entered into the controlling computer prior to the test. Model positioning and data recording operations were performed automatically during the test by selecting the list of desired model attitudes and initiating the system.

3.1.2 Data Acquisition

Data were recorded in either the point-pause or sweep mode of operation, using the MACS. The mode for each data group is identified in the test summary (Table 4).

Three types of point-pause data were recorded: (1) α-β data were obtained for finite values of α and ϕ with a time delay before each data point to allow the base pressures (p_{b_1}-p_{b_4}) to stabilize. (2) $\alpha=0$ data were obtained with the model at $\alpha=0$ before the sector was pitched. (3) X transverse data were recorded in Tunnel A as the model was moved downstream in the test section at $\alpha=\beta=0$. Each data point for this mode of operation represents the resultant of a Kaiser-Bessel digital filter utilizing 16 samples taken over a time span of 0.333 sec.

The continuous sweep data were obtained for a fixed value of ϕ with a sweep rate (α) of 0.5 deg/sec (Tunnel A) and 1.0 deg/sec (Tunnel B) or a fixed value of α with a rollrate (ϕ) of 3 deg/sec. A data sample was recorded every 0.0208 sec and 16 samples were applied to a Kaiser-Bessel digital filter to produce a data point every 0.01 deg (Tunnel A) and 0.02 deg (Tunnel B) in pitch and every 0.06 deg in roll. The data were then interpolated to obtain the data at the requested model attitudes. The base pressures were obtained from the fast response system described in Section 2.3 and were used to calculate the base axial force coefficient.

3.2. DATA REDUCTION

The cone static force data were obtained utilizing the tunnel data acquisition system as described in Section 3.1.2. 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. The coefficients were also corrected for model tare weight and balance-sting deflections. Model attitude, tunnel stilling chamber pressure, and fast response base pressure were also calculated from digitally filtered values.

The aerodynamic force and moment coefficients are presented in the body, and nonrolling body (missile) axis systems. For the missile axis system the normal-force direction is always in the pitch plane of the tunnel and normal to the longitudinal axis of the model. In the body axis system, the pitching and yawing moment coefficients are referenced to two points on the model centerline which were 1/2 ℓ and 2/3 ℓ from the model nose. Model length (34.290 in.) and base area (28.274 in.^{2}) were used as the reference length and area for the aerodynamic coefficients.

3.3 UNCERTAINTY OF MEASUREMENTS

3.3.1 General

The accuracy of the basic measurements (p_o and T_o) was discussed in Section 2.3. Based on repeat calibrations, these errors were found to be

$$\frac{\Delta p_o}{p_o} = 0.002 = 0.2\%, \quad \frac{\Delta T_o}{T_o} = 0.005 = 0.5\%$$

Uncertainties in the tunnel free-stream parameters and the model aerodynamic coefficients were estimated using the Taylor series method of error propagation, Eq. (1),

$$(\Delta F)^2 = \left(\frac{\partial F}{\partial X_1}\Delta X_1\right)^2 + \left(\frac{\partial F}{\partial X_2}\Delta X_2\right)^2 + \left(\frac{\partial F}{\partial X_3}\Delta X_3\right)^2 \dots + \left(\frac{\partial F}{\partial X_n}\Delta X_n\right)^2 \quad (1)$$

where ΔF is the absolute uncertainty in the dependent parameter $F = f(X_1, X_2, X_3 \dots X_n)$ and X_n are the independent parameters (or basic measurements). ΔX_n are the uncertainties (errors) in the independent measurements (or variables).

3.3.2 Test Conditions

The accuracy (based on 2σ deviation) of the basic tunnel parameters, p_o and T_o, (see Section 2.3) and the 2σ deviation in Mach number determined from test section flow calibrations were used to estimate uncertainties in the other free-stream properties using Eq. (1). The computed uncertainties in the tunnel free-stream conditions at which most of the data were recorded ($Re_\infty = 3.7 \times 10^6$/ft) are summarized in the following table.

	Uncertainty, (±) percent of actual value			
M_∞	M_∞	p_∞	q_∞	Re_∞/ft
3.01	0.56	2.6	1.4	1.2
3.25	0.80	3.8	2.2	1.6
3.51	0.34	1.7	1.0	1.0
3.76	0.53	2.8	1.7	1.3
4.02	0.45	2.4	1.5	1.2
4.52	0.49	2.7	1.8	1.3
5.04	0.52	3.0	2.0	1.4
5.58	0.30	1.8	1.2	1.1
5.95	0.17	1.1	0.7	0.8

3.3.3 Test Data

The uncertainties of the aerodynamic coefficients are presented in the following tables for the test conditions at which most of the data were recorded ($Re_\infty \approx 3.7 \times 10^6/ft$). These were established near the maximum aerodynamic loading condition for the cone without fins using the Taylor series method of error propagation (Eq. 1) with the independent variables determined from the accuracy of the six component balance (listed in Section 2.3), the accuracy of the base pressure transducer (Section 2.3), and the uncertainties in the tunnel parameters (p_∞, q_∞) listed in Section 3.3.2.

Maximum Coefficient Uncertainty (±)

M_∞	C_N	C_m	C_Y	C_n	C_ℓ	C_{A_t}	C_A
3.01	0.0110	0.00070	0.0095	0.00082	0.00005	0.0030	0.0018
3.25	0.0136	0.00067	0.0126	0.00079	0.00004	0.0039	0.0017
3.51	0.0105	0.00076	0.0086	0.00090	0.00005	0.0025	0.0020
3.76	0.0128	0.00081	0.0111	0.00095	0.00005	0.0032	0.0020
4.02	0.0128	0.00087	0.0110	0.00102	0.00005	0.0029	0.0022
4.52	0.0144	0.00095	0.0123	0.00111	0.00006	0.0031	0.0025
5.04	0.0169	0.00114	0.0143	0.00134	0.00007	0.0035	0.0030
5.58	0.0151	0.00115	0.0120	0.00135	0.00007	0.0031	0.0033
5.95	0.0040	0.00019	0.0046	0.00035	0.00002	0.0013	0.0014

Note: C_m and C_n referenced to 2/3 ℓ moment reference location.

The basic precision of the aerodynamic coefficients was also computed using only the balance and base pressure accuracies listed in Section 2.3 along with the nominal test conditions, using the assumption that the free-stream flow nonuniformity is a bias type of uncertainty which is constant for all test runs. These values therefore represent the data repeatability expected and are especially useful for detailed discrimination purposes in parametric model studies.

Coefficient Repeatability (±)

M_∞	C_N	C_m	C_Y	C_n	C_ℓ	C_{A_t}	C_A
3.01	0.0083	0.00070	0.0062	0.00082	0.00005	0.0029	0.0018
3.25	0.0080	0.00066	0.0060	0.00078	0.00004	0.0038	0.0017
3.51	0.0091	0.00076	0.0068	0.00089	0.00005	0.0024	0.0020
3.76	0.0096	0.00080	0.0072	0.00094	0.00005	0.0031	0.0020
4.02	0.0104	0.00087	0.0078	0.00102	0.00005	0.0028	0.0022
4.52	0.0113	0.00094	0.0085	0.00111	0.00006	0.0030	0.0025
5.04	0.0136	0.00114	0.0102	0.00134	0.00007	0.0034	0.0030
5.58	0.0137	0.00115	0.0103	0.00135	0.00007	0.0030	0.0033
5.95	0.0016	0.00018	0.0027	0.00034	0.00002	0.0012	0.0014

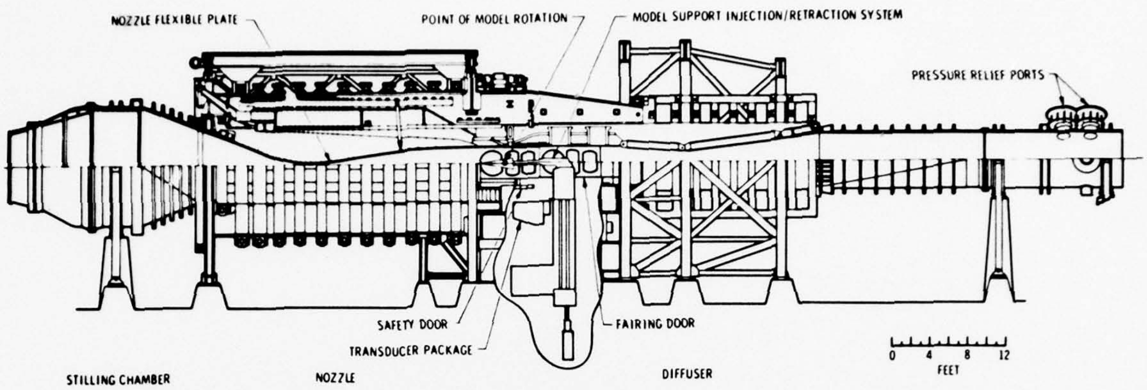
The uncertainty in model angle of attack (α) and sideslip (β), as determined from calibrations and consideration of the possible errors in model deflection calculations, is estimated to be ±0.1 deg. The uncertainty in model roll angle is estimated to be ±0.2 deg. The uncertainty of the tunnel center of rotation (C.R.) and model axial location (X) is estimated to be ±0.1 inches.

4.0 DATA PACKAGE PRESENTATION

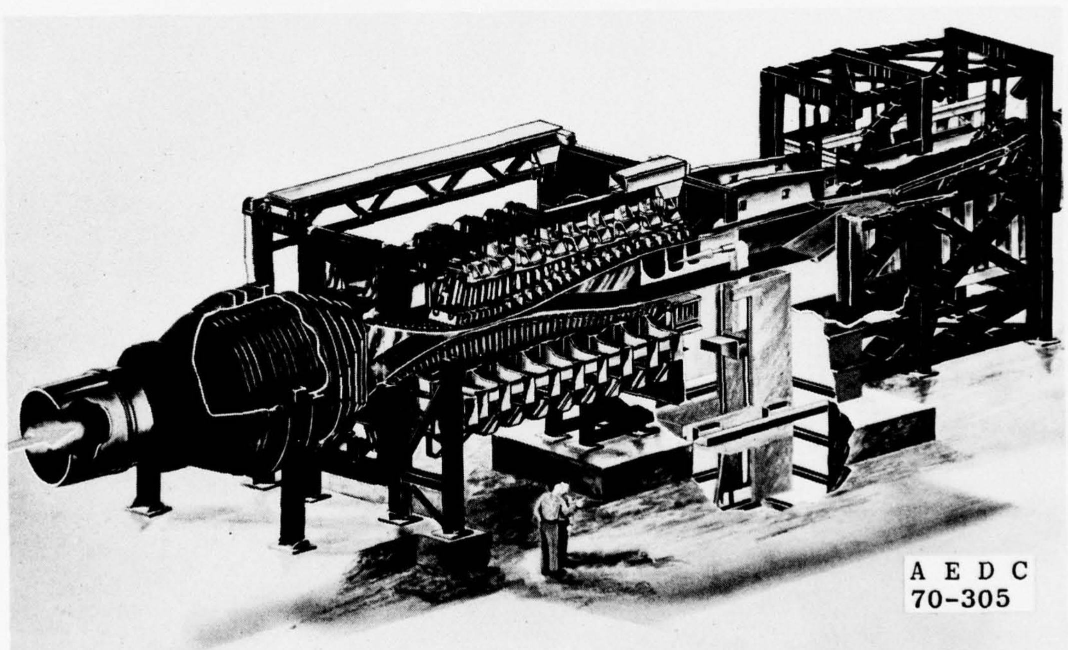
Tabulated model aerodynamic force and moment data are presented in the body and missile axis systems. For the body axis system, the pitching moment and yawing moment coefficients were referenced to two moment references points on the model centerline (1/2 ℓ and 2/3 ℓ). The model base pressure data are presented in the form of pressure ratios and base axial force coefficients. It should be noted that all five base pressures are tabulated; however, only p_{b_1} through p_{b_4} are valid for point-pause data and only p_{b_D} is valid for continuous sweep data. Sample tabulated data along with the tabulated data nomenclature are presented in Appendix III.

APPENDIX I

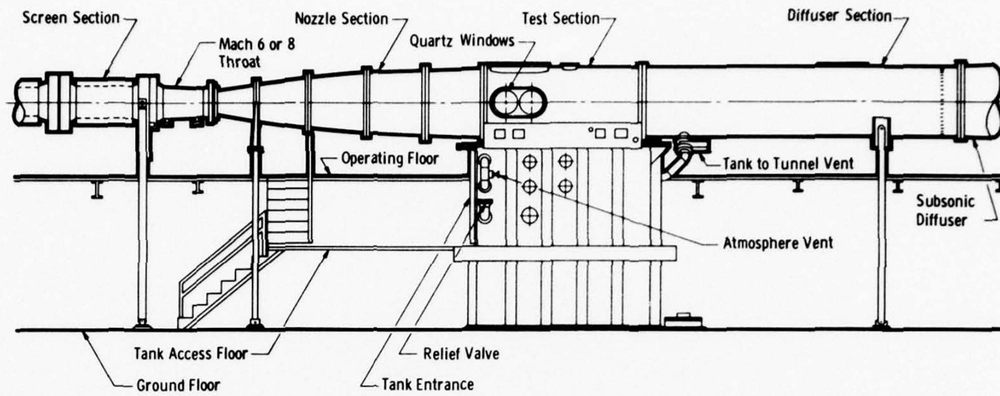
ILLUSTRATIONS



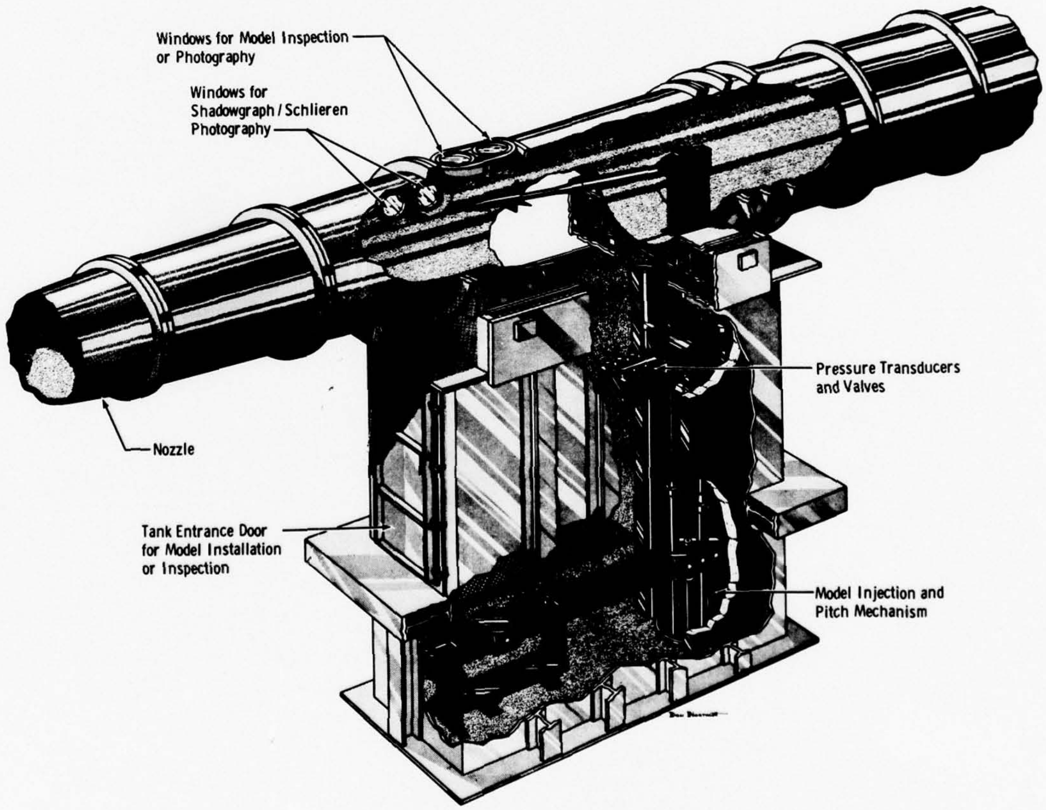
a. Tunnel assembly



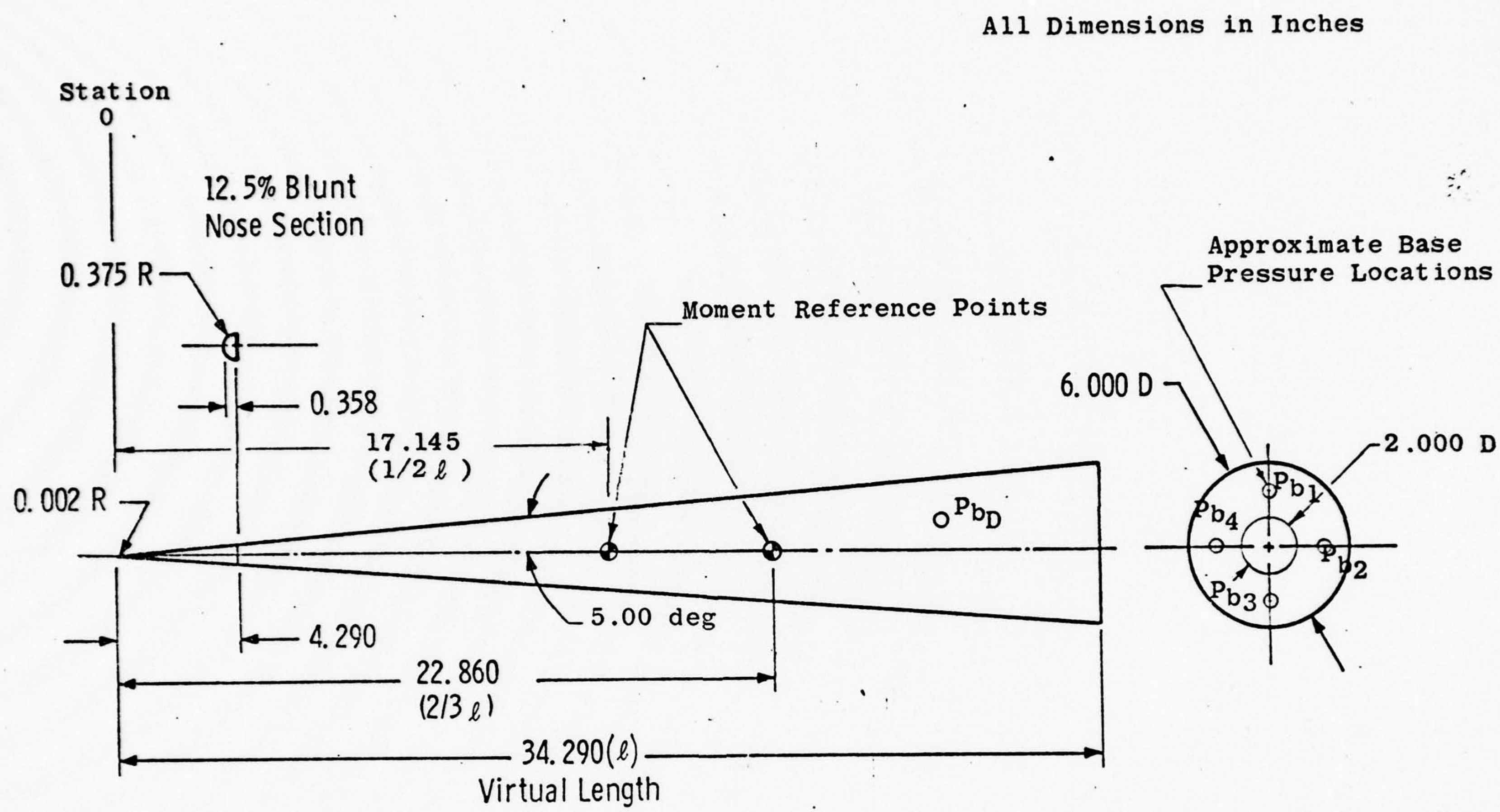
b. Tunnel test section
Fig. 1 Tunnel A



a. Tunnel assembly

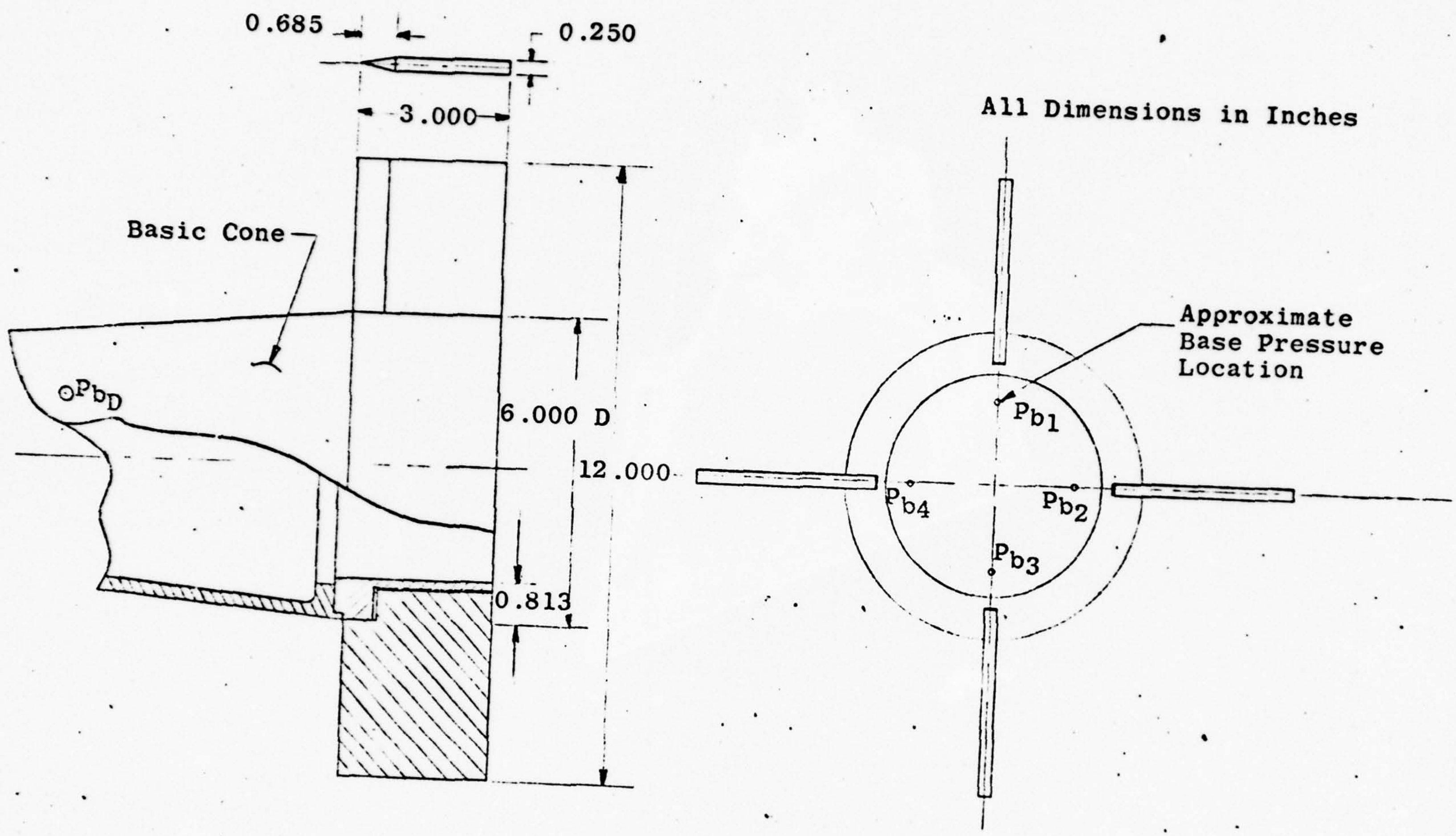


b. Tunnel test section
Fig. 2. Tunnel B



a. Model External Geometry (Basic Cone)

Fig. 3 Model Details



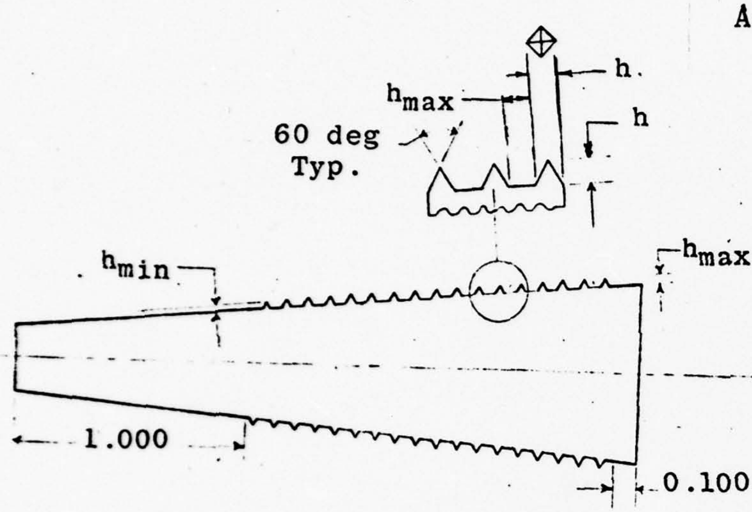
b. Fin Extension

Fig. 3 Continued

Trips are not drawn to scale.

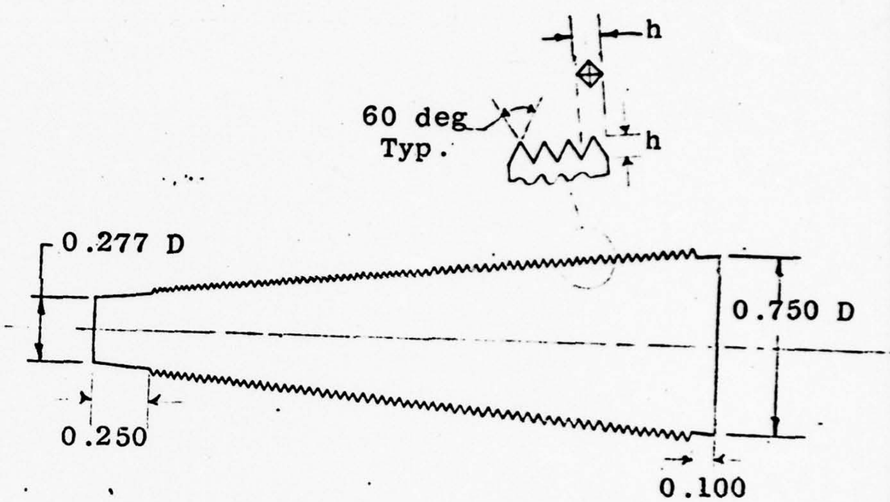
* Spacing between pyramids is 0.022 in.

All dimensions in inches



CODE	h_{max}	h_{min}	Number of Pyramids around the Circumference
T08A	0.008*	0.002	66
T15B	0.015	0.009	66
T30C	0.030	0.019	33

TYPE II

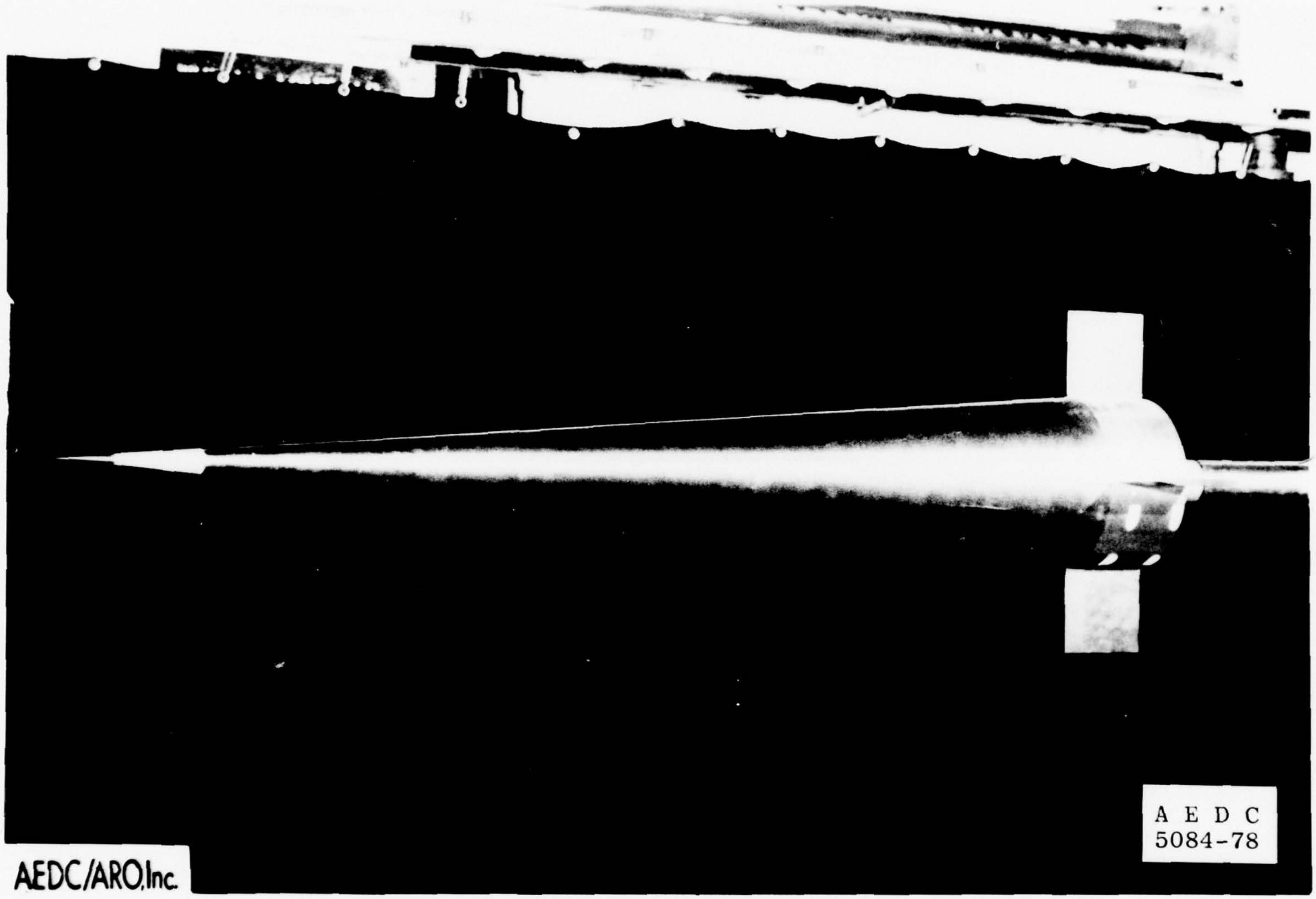


CODE	h_{max}	h_{min}	Number of Pyramids around the Circumference
T15A	0.015	0.006	133
T30A	0.030	0.012	66

TYPE I

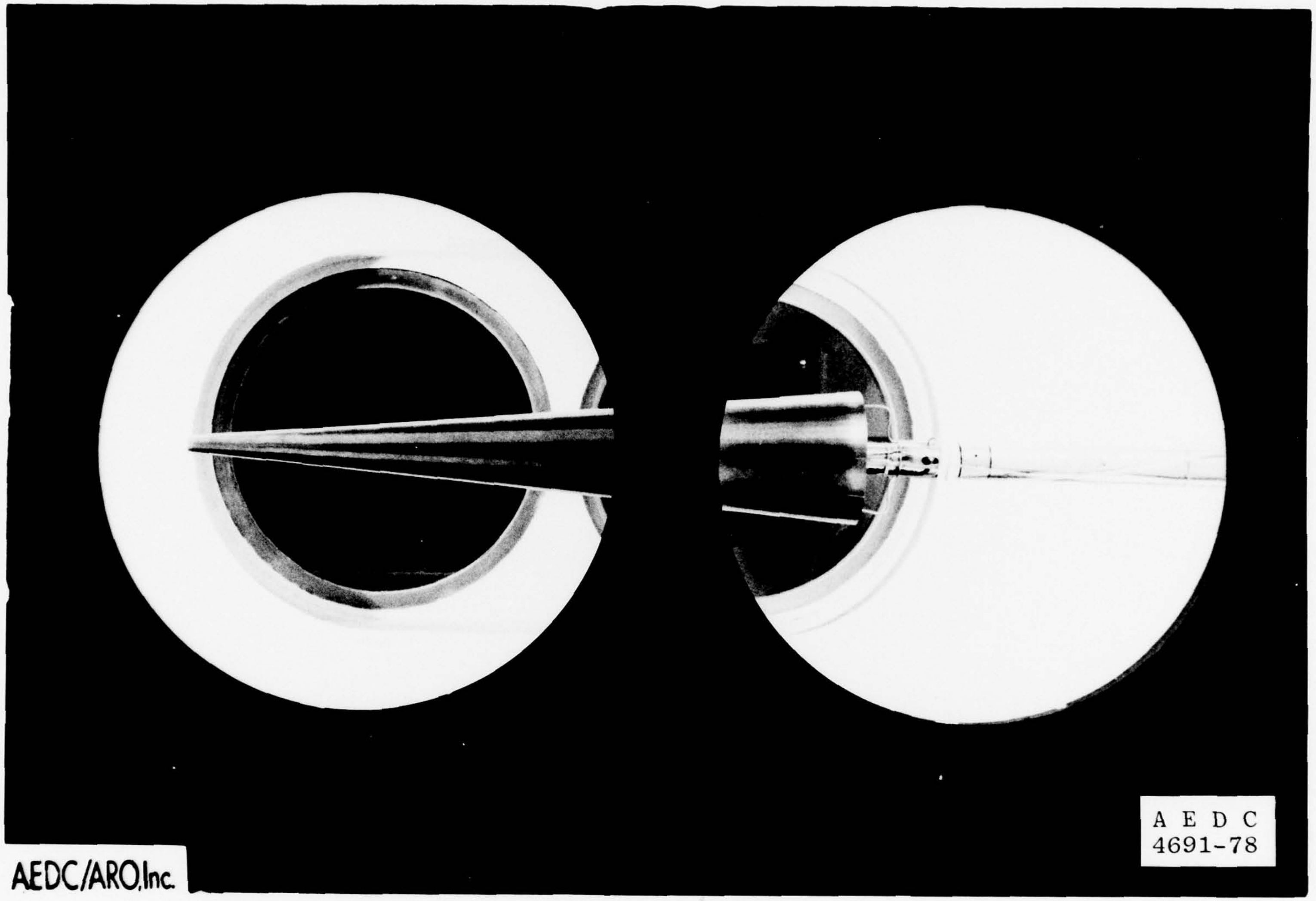
c. Boundary Layer Trips

Fig. 3 Concluded

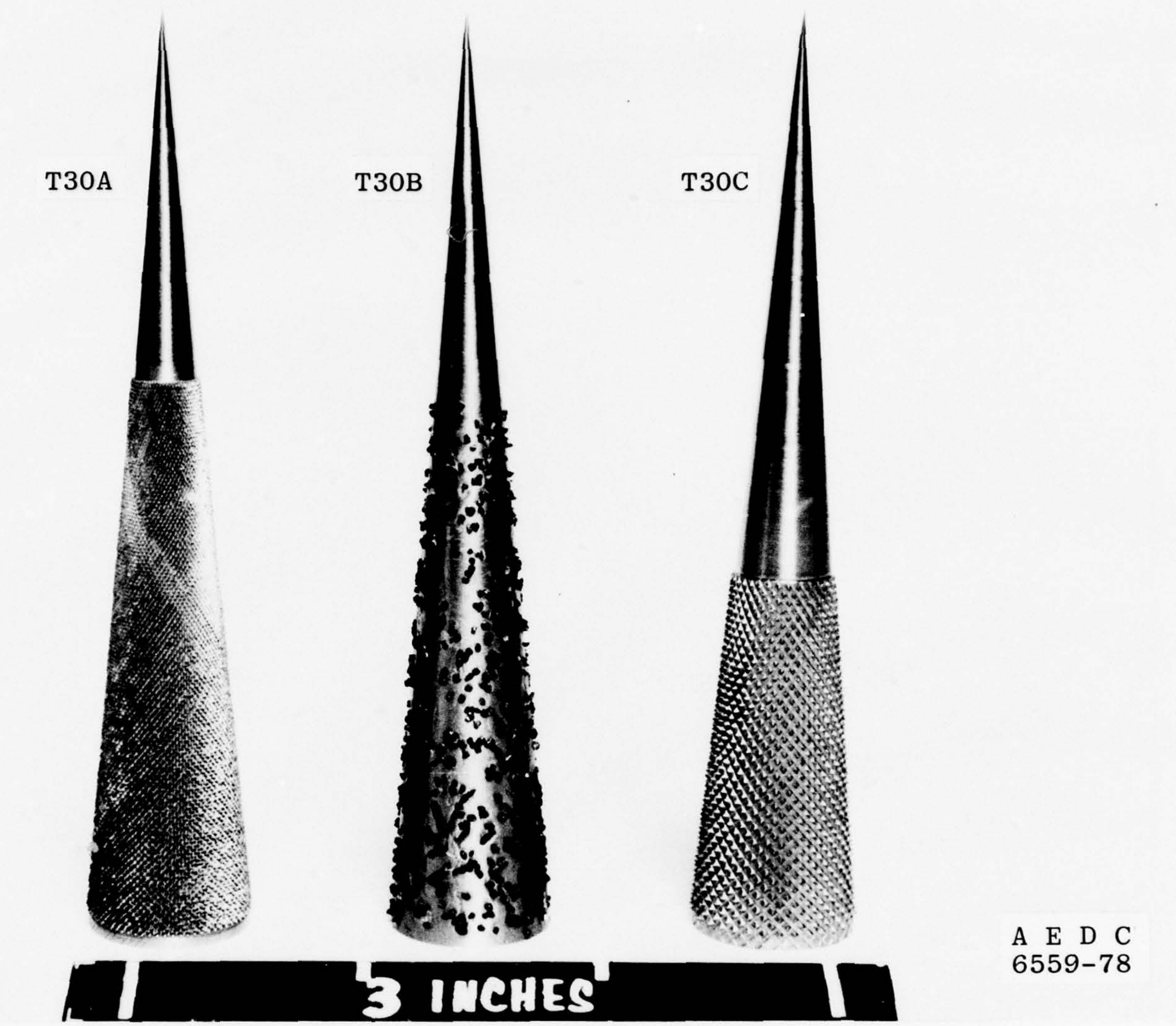


a. Tunnel A Tank (Configuration N00.0-T30A-F4-B0)
Fig. 4 Photographs of the Model Installation

5084 (6-7-78) V41A-02C FACILITY IMPROVEMENT
STANDARD FORCE CONE

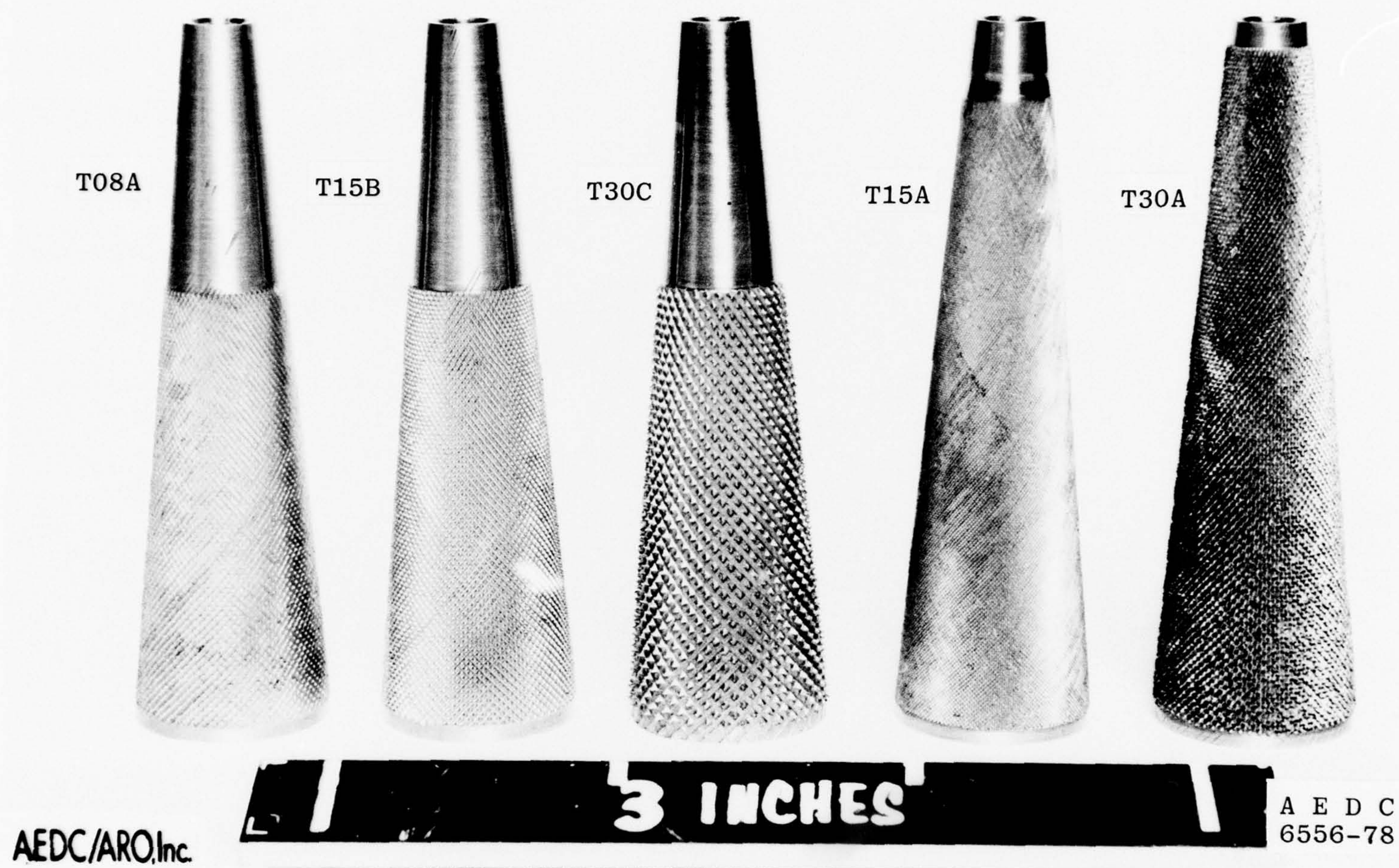


b. Tunnel B Test Section (Configuration N12.5-T00-F0-B1)
Fig. 4 Concluded



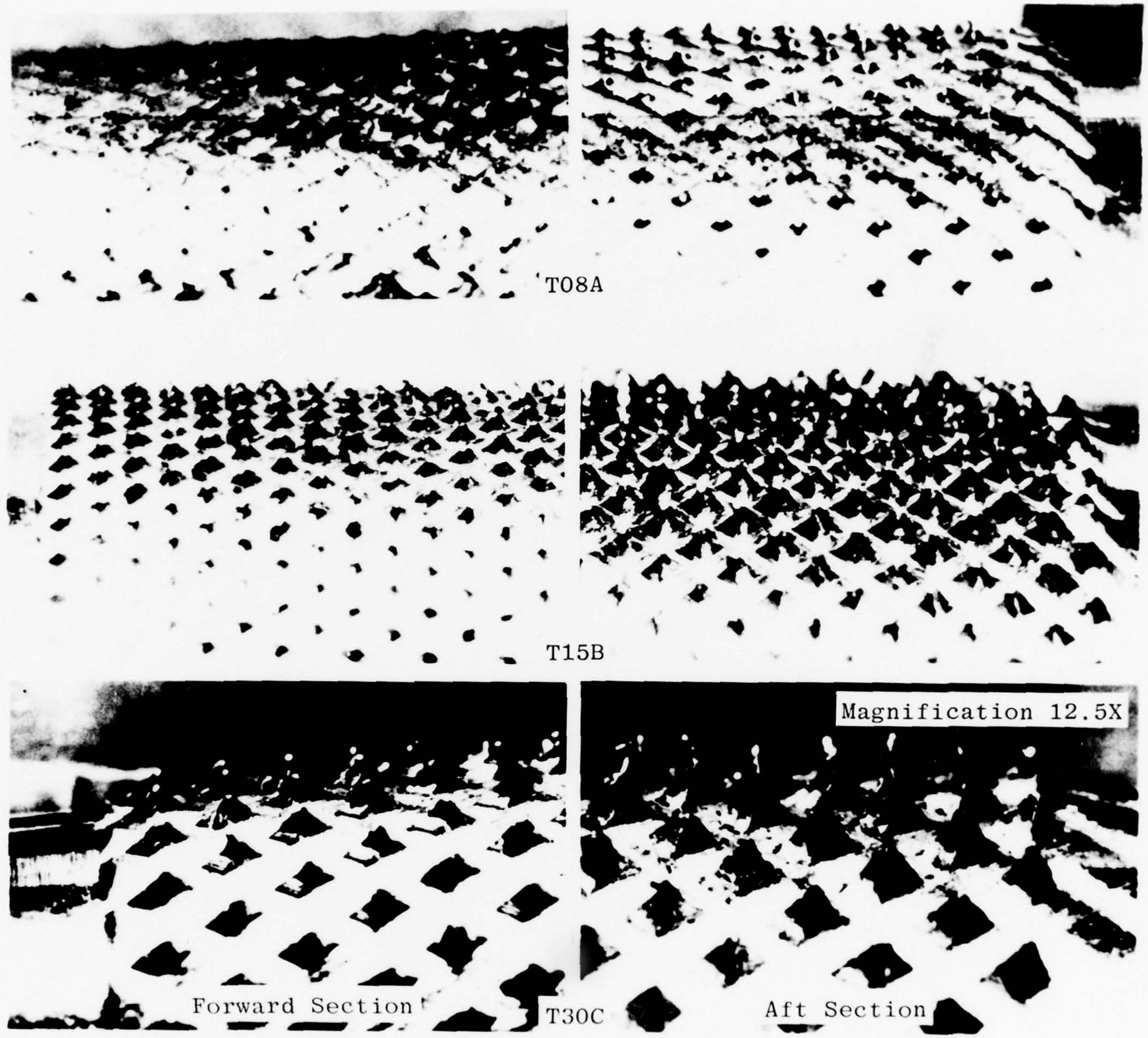
a. Sharp Noses (T30X)
Fig. 5 Photographs of the Model Noses and Boundary Layer Trips

6559 (7-26-78) V41A/B-02 VKF STANDARD FORCE CONE NOSE TIPS



b. Machined Boundary Layer Trips
Fig. 5 Continued

6556 (7-26-78) V41A/B-02 VKF STANDARD FORCE CONE NOSE TIPS



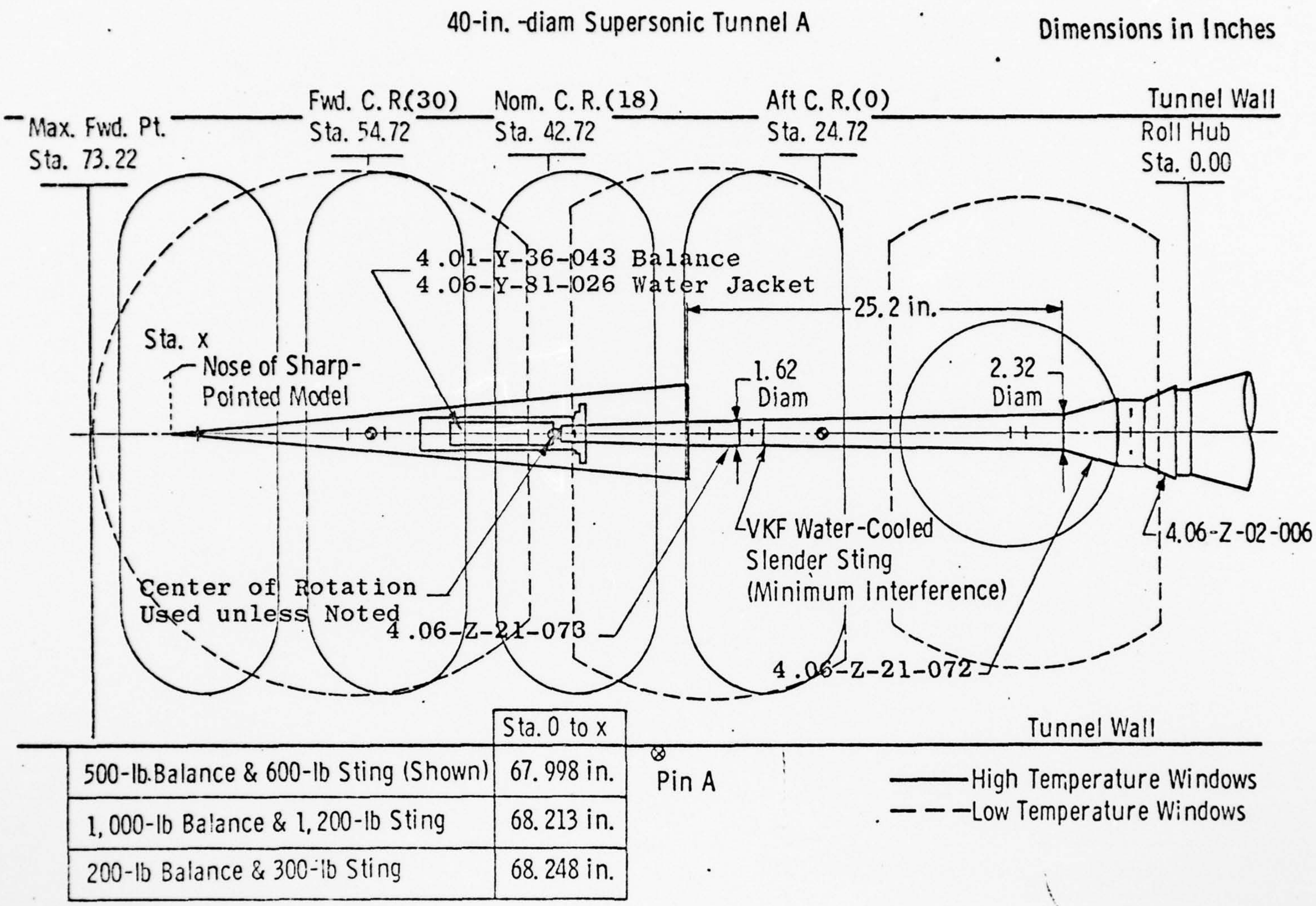
d. Type II Machined Boundary Layer Trip Details
Fig. 5 Continued

AEDC/ARO,Inc.

A E D C
6561-78

e. Trip Ring Details (T78A)
Fig. 5 Concluded

6561 (7-26-78) V41A/B-02 VKF STANDARD FORCE CONE NOSE TIPS

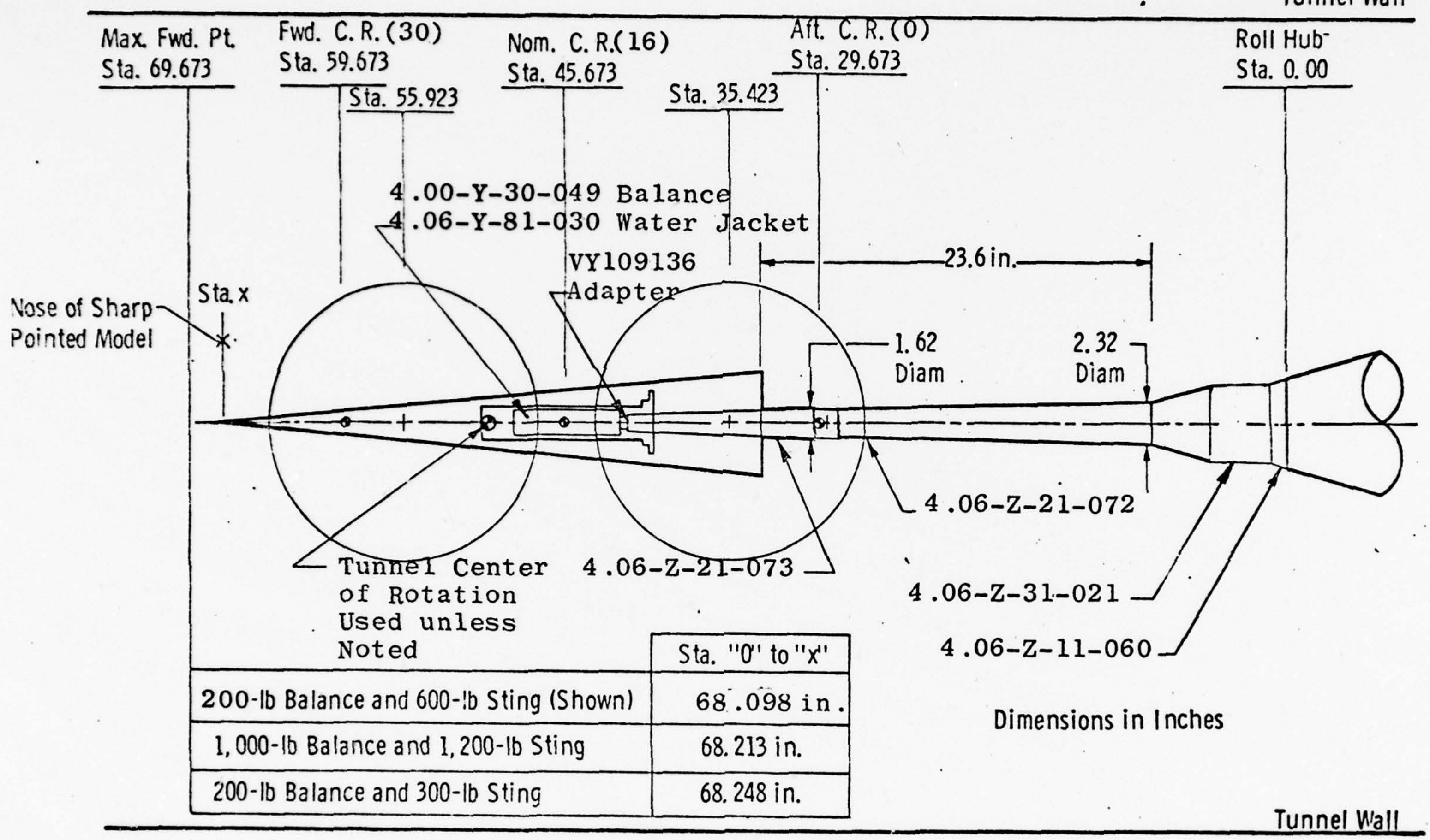


	Sta. 0 to x
500-lb Balance & 600-lb Sting (Shown)	67.998 in.
1,000-lb Balance & 1,200-lb Sting	68.213 in.
200-lb Balance & 300-lb Sting	68.248 in.

a. Tunnel A

Fig. 6 Model Installation Sketches

50-in.-diam Hypersonic Tunnels B & C



	Sta. "0" to "x"
200-lb Balance and 600-lb Sting (Shown)	68.098 in.
1,000-lb Balance and 1,200-lb Sting	68.213 in.
200-lb Balance and 300-lb Sting	68.248 in.

b. Tunnel B

Fig. 6 Concluded

APPENDIX II

TABLES

TABLE 1

MODEL CONFIGURATION DESIGNATION

Nose Designation (NXX.X)

N00.0	sharp nose
N12.5	spherically blunted nose (r_n/r_b = 0.125)

Boundary-Layer Trip Designation (TXXX)

T000	no trips (clean model)
T08A	machined trips, h_{max} = 0.008 in., Type II
T15A	machined trips, h_{max} = 0.015 in., Type I
T15B	machined trips, h_{max} = 0.015 in., Type II
T30A	machined trips, h_{max} = 0.030 in., Type I
T30B	grit trips, $h_{max} \approx$ 0.030 in.
T30C	machined trips, h_{max} = 0.030, Type II
T78A	trip ring with 0.078-in.-diam balls

Fin Designation (FX)

F0	no fins or body extension
F2	two fins (horizontal plane)
F4	four fins

Base Plate Designation (BX)

B0	no base plate
B1	lightweight base plate
B2	heavy base plate

TABLE 2
BALANCE MEASUREMENT ACCURACY
(TUNNEL A)

Balance 4.01-Y-36-043

Component	Balance Design Loads	Calibration Load Range	Range of Check Loads	Measurement Accuracy
Normal force, lb	± 500	± 500	± 500	±1.00
Pitching moment,* in.-lb	±1850	±1850	±1100	±2.00
Side force, lb	± 250	± 250	± 250	±0.75
Yawing moment,* in.-lb	± 925	± 925	± 550	±3.00
Rolling moment, in.-lb	± 100	± 100	± 20	±0.18
Axial force, lb	± 300	0 to 300	0 to 50	±0.20

*About balance forward moment bridge.

The transfer distances from the balance forward moment bridge to the two model moment reference locations were -2.052 in. and 3.663 in. along the longitudinal axis and were measure to an estimated accuracy of ±0.005 in.

TABLE 3

BALANCE MEASUREMENT ACCURACY
(TUNNEL B)

Balance 4.00-Y-36-049

Component	Balance Design Loads	Calibration Load Range	Range of Check Loads	Measurement Accuracy
Normal force, lb	± 200	± 200	± 120	±0.15
Pitching moment,* in.-lb	± 680	± 680	± 230	±0.50
Side force, lb	± 200	± 200	± 120	±0.25
Yawing moment,* in.-lb	± 680	± 680	± 230	±1.00
Rolling moment, in.-lb	± 100	± 100	± 20	±0.06
Axial force, lb	± 100	± 100	0 to 20	±0.10

*About balance forward moment bridge.

The transfer distances from the balance forward moment bridge to the two model moment reference locations were -1.826 in. and 3.889 in. along the longitudinal axis and were measured with an estimated accuracy of ±0.005 in.

TABLE 4 TEST SUMMARY

Tunnel A

M_∞	$Re_\infty \times 10^6\text{-ft}^{-1}$	C.R., in.	Data Type Polar	ϕ_s, deg	α_s, deg	Configuration Number and Code								
						1	4	15	16	18	5	9	17	19
						N00.0 T000 F0 B1	N00.0 T30A F0 B1	N00.0 T30B F0 B1	N00.0 T30C F0 B1	N00.0 T15B F0 B1	N12.5 T000 F0 B1	N00.0 T30A F4 B0	N00.0 T30C F4 B0	N00.0 T15B F4 B0
3.01	0.8	0.8	α	0	V				432* 433 434					
	1.6	0.8	α	0	V	428* 429			423* 424 425					
		18.0	α	0	V	295* 296 297	305* 306 307	300* 301 302						
	3.7	0.8	α	0	V		437* 438 439		420* 421 422				382* 383	
				180	V								384	
			α-β	V	V						385 386			
		18.0	α	0	V	264	270 275 471* 472 473 276‡ 277# 284+	267		477 478	288 292	254 259		482
				180	V		282* 283+ 273				291	257		485
			β	90	V		272				290	256		484
				-90	V		271				289	255		483
			α-β	V	V									487 488
			φ	V	0		274					258		
			X	0	0		279					260		
3.25	3.7	18.0	α	0	V		310* 311 315							
				180	V		314							
			β	90	V		313							
				-90	V		312							
			X	0	0		316							
3.51	3.7	18.0	α	0	V	330 331	319* 320 325							
				180	V		323							
			β	90	V		322							
				-90	V		321							
			φ	V	0		324							
			X	0	0		327							

NOTES: Letter V stands for variable

*α = 0, point-pause

+0 recorded at $\phi = 180^\circ$

X = 46.56 in. unless noted

‡X = 40.56 in.

#X = 34.56 in.

TABLE 4 TEST SUMMARY (continued)

Tunnel A

M_∞	Re_∞ x 10^6-ft^{-1}	C.R., in.	Data Type Polar	ϕ_s, deg	α_s, deg	Configuration Number and Code								
						1	4	15	16	18	5	9	17	19
						N00.0 T000 F0 B1	N00.0 T30A F0 B1	N00.0 T30B F0 B1	N00.0 T30C F0 B1	N00.0 T15B F0 B1	N12.5 T000 F0 B1	N00.0 T30A F4 B0	N00.0 T30C F4 B0	N00.0 T15B F4 B0
3.76	3.7	18.0	α	0	V		334* 335							
				180	V		337							
			β	90	V		336							
			X	0	0		338							
4.02	3.7	0.8	α	0	V								390* 391 396	
				180	V								394	
			β	90	V								393	
				-90	V								392	
			α-β	V	V								397 398	
			ϕ	V	0								395	
			X	0	0								399	
		18.0	α	0	V		341* 342 347					351* 352 353		492
				180	V		345							495
			β	90	V		344							494
				-90	V		343							493
			α-β	V	V									496 497
			ϕ	V	0		346							
			X	0	0		348							
4.52	3.7	18.0	α	0	V									
				180	V									
			β	90	V									
			X	0	0									
5.04	3.7	0.8	α	0	V								402* 403 407	
				180	V								406	
			β	90	V								405	
				-90	V								404	
			α-β	V	V								409 410	
			ϕ	V	0								407	
			X	0	0								411	
		18.0	α	0	V	363* 364 365	368* 369							
				180	V		371							
			β	90	V		370							
			ϕ	V	0		372							
			X	0	0		373							
5.58	3.7	18.0	α	0	V							376* 377		
			α-β	V	V							378		
			X	0	0							379		

NOTES: Letter V stands for variable

*α = 0, point-pause

+0 recorded at ϕ = 180°

X = 46.56 in. unless noted

‡X = 40.56 in.

#X = 34.56 in.

TABLE 4 CONCLUDED

TEST SUMMARY - TUNNEL B

M_∞	Re_∞ x 10^6-ft^{-1}	C.R., in.	Data Type Polar	ϕ_s, deg	α_s, deg	Configuration Number and Code: 1 N00.0 T000 F0 B1	4 N00.0 T30A F0 B1	3 N00.0 T15A F0 B1	12 N00.0 T78A F0 B1	5 N12.5 T00D F0 B1	13 N12.5 T78A F0 B1	9 N00.0 T30A F4 B0
5.90	1.0	4.1	α	0	V		238 239					
		21.0	α	0	V	244 245	240 241			249 250		
			β	90	V	246						
		30.0	α	0	V		236 237					
5.94	2.4	21.0	α	0	V	226 227	231 232					
5.95	3.7	4.1	α	0	V		183 184					
		21.0	α	0	V	130 131 132 133°	141 142 143 156 157 158 174 175 185	136 137 138	146 147 148	151 152 153 188 189 194	197 198	203 204 208
				180	V		169 170 171 178			192		207
			β	90	V		165 166 177			191		206
				-90			161 162 176			190		205
			φ	V	0		179			193		209
				V	10							210
		30.0	α	0	V		181 182					
	5.0	21.0	α	0	V	217 218	213			222		
			β	90	V	219	214			223		

Letter V stands for variable

* α = 0, point-pause

° point-pause

APPENDIX III

SAMPLE TABULATED DATA AND DATA NOMENCLATURE

TABULATED DATA NOMENCLATURE

A.C.	Aerodynamic center of pressure in missile axis system ratioed to model length, (CM-ALPHA)/(CN-ALPHA) + XMR/L, sweep data only
ALPHA	Model angle of attack in body axis, deg
ALPHAP	Model angle of attack in missile axis, deg
ALPHA-I	Sector indicated angle of attack, deg
ALPHA-2	Not used
BALCAL	Balance and balance calibration identification
BETA	Model angle of sideslip, deg
CA	Forebody axial-force coefficient (CAT-CAB), body axis system
CA-P	Forebody axial-force coefficient (CAT-P - CAB-P), missile axis system
CAB	Base axial-force coefficient, body axis system
CAB-P	Base axial-force coefficient, missile axis system
CAT	Total axial-force coefficient, body axis system
CAT-P	Total axial-force coefficient, missile axis system
CLL	Rolling-moment coefficient, body axis system
CLL-P	Rolling-moment coefficient, missile axis system
CLM	Pitching-moment coefficient, body axis system
CLM-P	Pitching-moment coefficient, missile axis system
CLN	Yawing-moment coefficient, body axis system
CLN-BETA	Slope of CLN versus BETA curve at BETA=0, calculated from a first degree least-squares curve fit over BETA range -1 to 1 deg, deg^{-1}
CLN-P	Yawing-moment coefficient, missile axis system
CM-ALPHA	Slope of CLM versus ALPHA curve at ALPHA = 0, calculated from a first degree least-squares curve fit over ALPHA range from -1 to 1 deg, deg^{-1}
CN	Normal-force coefficient, body axis system
CN-ALPHA	Slope of CN versus ALPHA curve at ALPHA = 0, calculated from a first degree least-squares curve fit over ALPHA range -1 to 1 deg, deg^{-1}

CN-P	Normal-force coefficient, missile axis system
CODE	Configuration code number
CONFIG	Configuration designation
CR	Tunnel center of rotation, in.
CY	Side-force coefficient, body axis system
CY-BETA	Slope of CY versus BETA curve at BETA=0, calculated from a first degree least-squares curve fit over BETA range -1 to 1 deg, deg^{-1}
CY-P	Side-force coefficient, missile axis system
DLP	Data loop period, 0.0208 sec
FREQ	Natural frequence of the model-balance-sting system, HZ
GROUP	Data group number
L	Virtual model length, 34.290 in.
MACH	Free-stream Mach number
NCP/L	Normal-force center-of-pressure location in the body axis system, in. from model station 0 ratioed to model length (calculated using CN and CLM)
P-INF, P8	Free-stream static pressure, psia
PBA/P8	Ratio of average base pressure to free-stream
PBD/P8	Ratio of fast response base pressure to free-stream static pressure
PB1/P8, PB2/P8, PB3/P8, PB4/P8	Ratio of base pressure to free-stream static pressure for base pressures one, two, three and four, respectively
PB5/P8	Not used
PHI	Model roll angle, deg
PHIT	Total model roll angle, deg
PHI-I	Sector indicated roll angle, deg
POINT	Point number of a data group
PO	Tunnel stilling chamber pressure, psia
PS	VKF plant compressor staging configuration

Q-INF, Q8	Free-stream dynamic pressure, psia
RE/FT	Free-stream Reynolds number, ft^{-1}
SR	Tunnel sector pitch rate, deg/sec
T-INF	Free-stream static temperature, °R
TO	Tunnel stilling chamber temperature, °R
TXL	Model axial location in the test section (Tunnel A), 0 is the most aft position and positive is upstream, in.
XMR	Distance from the model nose (virtual tip) to the moment reference point, in.
YCP/L	Side force center-or-pressure location in the body axis system, in. from model station 0 ratioed to model length (calculated using CY and CLN)

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ARNOLD AIR FORCE STATION, TENNESSEE
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PAGE 1

DATE COMPU' 23-JUN-78
TIME COMPU. 10:55:21
DATE RECORDED 9-JUN-78
TIME RECORDED 20:41:12
PROJECT NUMBER V41A-02A

GROUP	CODE	CONFIG	MACH	PO	TO	Q-INF	P-INF	T-INF	RE/FT	CN-ALPHA	CM-ALPHA
383	17	NOO,O-T3OC-F4-BO	3.01	26.5	579.7	4.501	0.7097	206.1	0.369E+07	0.0624	-0.0106

DLP	CR	SR	PS	BALCAL	FREQ	TXL
0.0208	0.8	0.50	3.	43-13	11.0	46.56

POINT	ALP-I	ALP-2	PHI-I	PO,PSIA	TO,R	P8,PSIA	Q8,PSIA	PBD/P8	CAB	PBA/P8	PB1/P8	PB2/P8	PB3/P8	PB4/P8	PB5/P8
1	11.16	0.00	-0.04	26.5	579.7	0.7097	4.501	0.2037	0.1256	0.2052	0.2047	0.2074	0.2048	0.2039	0.0000
2	10.15	0.00	-0.00	26.5	579.7	0.7100	4.503	0.2015	0.1259	0.2051	0.2046	0.2073	0.2047	0.2038	0.0000
3	9.13	0.00	-0.00	26.4	579.7	0.7092	4.498	0.2032	0.1256	0.2053	0.2046	0.2075	0.2049	0.2041	0.0000
4	8.11	0.00	-0.00	26.5	579.7	0.7096	4.500	0.1962	0.1267	0.2052	0.2047	0.2074	0.2048	0.2039	0.0000
5	7.08	0.00	0.01	26.4	579.7	0.7089	4.496	0.1997	0.1262	0.2054	0.2049	0.2076	0.2050	0.2041	0.0000
6	6.06	0.00	0.00	26.5	579.7	0.7106	4.507	0.2064	0.1251	0.2049	0.2044	0.2071	0.2045	0.2037	0.0000
7	5.03	0.00	0.01	26.4	579.7	0.7092	4.498	0.2133	0.1240	0.2053	0.2048	0.2075	0.2049	0.2041	0.0000
8	4.00	0.00	0.01	26.4	579.7	0.7092	4.498	0.2200	0.1230	0.2053	0.2048	0.2075	0.2049	0.2041	0.0000
9	2.97	0.00	0.01	26.4	579.7	0.7093	4.499	0.2267	0.1219	0.2053	0.2047	0.2075	0.2049	0.2040	0.0000
10	1.94	0.00	0.01	26.5	579.7	0.7095	4.500	0.2322	0.1211	0.2052	0.2047	0.2074	0.2048	0.2040	0.0000
11	1.43	0.00	0.01	26.5	579.7	0.7095	4.500	0.2348	0.1207	0.2052	0.2047	0.2074	0.2048	0.2040	0.0000
12	0.91	0.00	0.01	26.4	579.7	0.7090	4.496	0.2372	0.1203	0.2054	0.2048	0.2076	0.2050	0.2041	0.0000
13	0.65	0.00	0.02	26.5	579.7	0.7097	4.501	0.2379	0.1202	0.2052	0.2046	0.2074	0.2048	0.2039	0.0000
14	0.40	0.00	0.02	26.5	579.7	0.7107	4.507	0.2366	0.1204	0.2049	0.2044	0.2071	0.2045	0.2036	0.0000
15	0.14	0.00	0.02	26.5	579.7	0.7097	4.501	0.2356	0.1205	0.2052	0.2046	0.2074	0.2048	0.2039	0.0000
16	-0.12	0.00	0.02	26.4	579.7	0.7079	4.490	0.2346	0.1207	0.2057	0.2051	0.2079	0.2053	0.2044	0.0000
17	-0.38	0.00	0.03	26.4	579.7	0.7074	4.487	0.2340	0.1208	0.2058	0.2053	0.2080	0.2054	0.2046	0.0000
18	-0.63	0.00	0.03	26.4	579.7	0.7080	4.490	0.2338	0.1208	0.2057	0.2051	0.2079	0.2053	0.2044	0.0000
19	-0.89	0.00	0.03	26.4	579.7	0.7085	4.493	0.2336	0.1208	0.2055	0.2050	0.2077	0.2051	0.2043	0.0000
20	-1.15	0.00	0.03	26.5	579.7	0.7097	4.501	0.2342	0.1208	0.2052	0.2046	0.2074	0.2048	0.2039	0.0000
21	-1.66	0.00	0.03	26.5	579.7	0.7112	4.511	0.2334	0.1209	0.2047	0.2042	0.2069	0.2043	0.2035	0.0000
22	-2.18	0.00	0.01	26.5	579.7	0.7095	4.500	0.2324	0.1210	0.2052	0.2047	0.2074	0.2048	0.2040	0.0000
23	-3.21	0.00	-0.01	26.5	579.7	0.7094	4.499	0.2297	0.1215	0.2053	0.2047	0.2075	0.2048	0.2040	0.0000
24	-4.23	0.00	-0.01	26.5	579.7	0.7103	4.505	0.2246	0.1223	0.2050	0.2045	0.2072	0.2046	0.2037	0.0000
25	-5.26	0.00	-0.01	26.4	579.7	0.7086	4.494	0.2184	0.1232	0.2055	0.2050	0.2077	0.2051	0.2042	0.0000
26	-6.29	0.00	-0.01	26.5	579.7	0.7099	4.502	0.2120	0.1242	0.2051	0.2046	0.2073	0.2047	0.2038	0.0000
27	-7.31	0.00	-0.00	26.4	579.7	0.7075	4.487	0.2067	0.1251	0.2058	0.2053	0.2080	0.2054	0.2045	0.0000
28	-8.34	0.00	-0.00	26.5	579.7	0.7105	4.506	0.2072	0.1250	0.2049	0.2044	0.2071	0.2045	0.2037	0.0000
29	-9.36	0.00	-0.01	26.5	579.7	0.7096	4.500	0.2062	0.1252	0.2052	0.2047	0.3074	0.2048	0.2039	0.0000
SCHLIEREN PHOTOGRAPH ANGLES				10.00	5.04	0.16		-4.67	-9.60						

Sample Tabulated Data

ARO, INC. - AEDC DIVISION
A SVERDRUP CORPORATION COMPANY
VON KARMAN S DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
STANDARD FORCE CONE (5 DEG)
PAGE 2

DATE COMPUTED 23-JUN-78
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GROUP	CODE	CONFIG	MACH	PO	TO	Q-INF	P-INF	T-INF	RE/FT	CN-ALPHA	CM-ALPHA
383	17	NOO.0-T30C-F4-BO	3.01	26.5	579.7	4.501	0.7097	206.1	0.369E+07	0.0624	-0.0106

DLP	CR	SR	PS	BALCAL	FREQ	TXL
0.0208	0.8	0.50	3.	43-13	11.0	46.56

BODY AXIS------------------------------ MOMENT REFERENCE AT (2/3)L

ALPHA	BETA	PHI	CN	CLM	CY	CLN	CLL	CAT	CAB	CA	NCP/L	YCP/L	A.C.
11.000	-0.080	-0.0	0.8122	-0.12409	-0.0046	-0.00039	0.000116	0.2296	0.1256	0.1041	0.8194		0.7883
10.000	-0.074	-0.0	0.7166	-0.11232	-0.0049	-0.00018	0.000097	0.2291	0.1259	0.1032	0.8234		0.7950
9.000	-0.075	-0.0	0.6253	-0.10011	-0.0031	-0.00021	0.000050	0.2285	0.1256	0.1028	0.8268		0.8028
8.000	-0.076	-0.0	0.5427	-0.08847	-0.0016	-0.00023	0.000016	0.2298	0.1267	0.1031	0.8297		0.8105
7.000	-0.076	0.0	0.4648	-0.07689	-0.0004	-0.00024	-0.000005	0.2290	0.1262	0.1028	0.8321		0.8168
6.000	-0.077	0.0	0.3911	-0.06558	0.0006	-0.00029	-0.000001	0.2286	0.1251	0.1034	0.8344		0.8223
5.000	-0.078	0.0	0.3214	-0.05454	0.0013	-0.00030	0.000011	0.2278	0.1240	0.1037	0.8364		0.8272
4.000	-0.078	0.0	0.2526	-0.04332	0.0017	-0.00032	0.000032	0.2266	0.1230	0.1036	0.8381		0.8321
3.000	-0.079	0.0	0.1877	-0.03241	0.0022	-0.00033	0.000052	0.2264	0.1219	0.1045	0.8393		0.8364
2.000	-0.078	0.0	0.1247	-0.02151	0.0024	-0.00035	0.000074	0.2257	0.1211	0.1046	0.8391		0.8386
1.500	-0.079	0.0	0.0927	-0.01600	0.0027	-0.00037	0.000096	0.2253	0.1207	0.1047	0.8394		0.8377
1.000	-0.079	0.0	0.0621	-0.01079	0.0027	-0.00038	0.000095	0.2255	0.1203	0.1052	0.8403		0.8371
0.750	-0.079	0.0	0.0470	-0.00824	0.0027	-0.00038	0.000100	0.2255	0.1202	0.1053	0.8419		0.8364
0.500	-0.079	0.0	0.0300	-0.00531	0.0031	-0.00040	0.000107	0.2251	0.1204	0.1047	0.8440		0.8369
0.250	-0.079	0.0	0.0162	-0.00301	0.0030	-0.00039	0.000110	0.2254	0.1205	0.1049	0.8527		0.8366
0.000	-0.079	0.0	-0.0010	-0.00004	0.0031	-0.00039	0.000116	0.2256	0.1207	0.1049	0.6237		0.8359
-0.250	-0.079	0.0	-0.0150	0.00229	0.0032	-0.00041	0.000120	0.2259	0.1208	0.1051	0.8192		0.8361
-0.500	-0.079	0.0	-0.0325	0.00524	0.0033	-0.00042	0.000125	0.2260	0.1208	0.1052	0.8281		0.8358
-0.750	-0.079	0.0	-0.0468	0.00768	0.0032	-0.00042	0.000127	0.2261	0.1208	0.1053	0.8309		0.8364
-1.000	-0.080	0.0	-0.0644	0.01067	0.0034	-0.00043	0.000132	0.2261	0.1208	0.1054	0.8324		0.8365
-1.500	-0.080	0.0	-0.0964	0.01610	0.0027	-0.00032	0.000138	0.2255	0.1209	0.1046	0.8337		0.8358
-2.000	-0.080	0.0	-0.1279	0.02142	0.0025	-0.00029	0.000144	0.2250	0.1210	0.1040	0.8342		0.8349
-3.000	-0.079	-0.0	-0.1914	0.03205	0.0026	-0.00027	0.000153	0.2261	0.1215	0.1046	0.8341		0.8321
-4.000	-0.079	-0.0	-0.2567	0.04276	0.0030	-0.00025	0.000155	0.2262	0.1223	0.1039	0.8333		0.8285
-5.000	-0.080	-0.0	-0.3261	0.05390	0.0032	-0.00018	0.000154	0.2273	0.1232	0.1041	0.8320		0.8246
-6.000	-0.081	-0.0	-0.3968	0.06492	0.0035	-0.00009	0.000152	0.2273	0.1242	0.1031	0.8303		0.8202
-7.000	-0.082	-0.0	-0.4709	0.07619	0.0039	-0.00001	0.000150	0.2279	0.1251	0.1029	0.8285		0.8150
-8.000	-0.083	-0.0	-0.5499	0.08776	0.0048	0.00008	0.000158	0.2272	0.1250	0.1022	0.8262		0.8099
-9.000	-0.084	-0.0	-0.6361	0.09982	0.0059	0.00018	0.000176	0.2278	0.1252	0.1027	0.8236		0.8054

Sample Tabulated Data

ARO, INC. - AEDC DIVISION
A SVERDRUP C[illegible]PORATION COMPANY
VON KARMAN [illegible] DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
STANDARD FORCE CONE (5 DEG)
PAGE 3

DATE COMPUTE[illegible] 23-JUN-78
TIME COMPUT[illegible] 10:55:22
DATE RECORDED 9-JUN-78
TIME RECORDED 20:41:12
PROJECT NUMBER V41A-02A

GROUP	CODE	CONFIG	MACH	PO	TO	Q-INF	P-INF	T-INF	RE/FT	CN-ALPHA	CM-ALPHA
383	17	N00.0-T30C-F4-B0	3.01	26.5	579.7	4.501	0.7097	206.1	0.369E+07		

DLP	CR	SR	PS	BALCAL	FREQ	TXL
0.0208	0.8	0.50	3.	43-13	11.0	46.56

BODY AXIS------------------------------- MOMENT REFERENCE AT (1/2)L

ALPHA	BETA	PHI	CN	CLM	CY	CLN	CLL	CAT	CAB	CA	NCP/L	YCP/L	TXL
11.000	-0.080	-0.0	0.8122	-0.25945	-0.0046	0.00037	0.000116	0.2296	0.1256	0.1041	0.8194		46.5600
10.000	-0.074	-0.0	0.7166	-0.23176	-0.0049	0.00064	0.000097	0.2291	0.1259	0.1032	0.8234		0.0000
9.000	-0.075	-0.0	0.6253	-0.20432	-0.0031	0.00029	0.000050	0.2285	0.1256	0.1028	0.8268		0.0000
8.000	-0.076	-0.0	0.5427	-0.17892	-0.0016	0.00004	0.000016	0.2298	0.1267	0.1031	0.8297		0.0000
7.000	-0.076	0.0	0.4648	-0.15436	-0.0004	-0.00018	-0.000005	0.2290	0.1262	0.1028	0.8321		0.0000
6.000	-0.077	0.0	0.3911	-0.13075	0.0006	-0.00039	-0.000001	0.2286	0.1251	0.1034	0.8344		0.0000
5.000	-0.078	0.0	0.3214	-0.10811	0.0013	-0.00051	0.000011	0.2278	0.1240	0.1037	0.8364		0.0000
4.000	-0.078	0.0	0.2526	-0.08543	0.0017	-0.00060	0.000032	0.2266	0.1230	0.1036	0.8381		0.0000
3.000	-0.078	0.0	0.1877	-0.06369	0.0022	-0.00069	0.000052	0.2264	0.1219	0.1045	0.8393		0.0000
2.000	-0.078	0.0	0.1247	-0.04229	0.0024	-0.00074	0.000074	0.2257	0.1211	0.1046	0.8391		0.0000
1.500	-0.079	0.0	0.0927	-0.03145	0.0027	-0.00082	0.000086	0.2253	0.1207	0.1047	0.8394		0.0000
1.000	-0.079	0.0	0.0621	-0.02114	0.0027	-0.00084	0.000095	0.2255	0.1203	0.1052	0.8403		0.0000
0.750	-0.079	0.0	0.0470	-0.01607	0.0027	-0.00084	0.000100	0.2255	0.1202	0.1053	0.8419		0.0000
0.500	-0.079	0.0	0.0300	-0.01031	0.0031	-0.00091	0.000107	0.2251	[illegible]	0.1047	0.8440		0.0000
0.250	-0.079	0.0	0.0162	-0.00570	0.0030	-0.00090	0.000110	0.2254	0.1205	0.1049	0.8527		0.0000
0.000	-0.079	0.0	-0.0010	0.00012	0.0031	-0.00091	0.000116	0.2256	0.1207	0.1049	0.6237		0.0000
-0.250	-0.079	0.0	-0.0150	0.00479	0.0032	-0.00094	0.000120	0.2259	0.1208	0.1051	0.8192		0.0000
-0.500	-0.079	0.0	-0.0325	0.01066	0.0033	-0.00098	0.000125	0.2260	0.1208	0.1052	0.8281		0.0000
-0.750	-0.079	0.0	-0.0469	0.01547	0.0032	-0.00096	0.000127	0.2261	0.1208	0.1053	0.8209		0.0000
-1.000	-0.080	0.0	-0.0644	0.02139	0.0034	-0.00099	0.000132	0.2261	0.1208	0.1054	0.8324		0.0000
-1.500	-0.080	0.0	-0.0964	0.03216	0.0027	-0.00077	0.000138	0.2255	0.1209	0.1046	0.8337		0.0000
-2.000	-0.080	0.0	-0.1279	0.04274	0.0025	-0.00072	0.000144	0.2250	0.1210	0.1040	0.8342		0.0000
-3.000	-0.079	-0.0	-0.1914	0.06396	0.0026	-0.00070	0.000153	0.2251	0.1215	0.1046	0.8341		0.0000
-4.000	-0.079	-0.0	-0.2567	0.08554	0.0030	-0.00074	0.000155	0.2262	0.1223	0.1039	0.8333		0.0000
-5.000	-0.080	-0.0	-0.3261	0.10825	0.0032	-0.00072	0.000154	0.2273	0.1232	0.1041	0.8320		0.0000
-6.000	-0.081	-0.0	-0.3968	0.13104	0.0035	-0.00068	0.000151	0.2273	0.1242	0.1031	0.8333		0.0000
-7.000	-0.082	-0.0	-0.4709	0.15467	0.0039	-0.00065	0.000150	0.2279	0.1251	0.1029	0.8285		0.0000
-8.000	-0.083	-0.0	-0.5499	0.17941	0.0048	-0.00072	0.000158	0.2272	0.1250	0.1022	0.8262		0.0000
-9.000	-0.084	-0.0	-0.6361	0.20583	0.0059	-0.00082	0.000176	0.2278	0.1252	0.1027	0.8236		0.0000

Sample Tabulated Data

ARO, INC. - AEDC DIVISION
A SVERDRUP CORPORATION COMPANY
VON KARMAN DYNAMICS FACILITY
ARNOLD AIR FORCE STATION, TENNESSEE
STANDARD FORCE CONE (5 DEG)
PAGE 4

DATE COMPUTED 23-JUN-78
TIME COMPUTED 10:55:23
DATE RECORDED 9-JUN-78
TIME RECORDED 20:41:12
PROJECT NUMBER V41A-02A

GROUP	CODE	CONFIG	MACH	PO	TO	Q-INF	P-INF	T-INF	RE/FT	CN-ALPHA	CM-ALPHA
383	17	NOO.0-T30C-F4-B0	3.01	26.5	579.7	4.501	0.7097	206.1	0.369E+07	0.0624	-0.0106

DLP	CR	SR	PS	BALCAL	FREQ	TXL
0.0208	0.8	0.50	3.	43-13	11.0	46.56

MISSILE AXIS-----------------------------

ALPHA	ALPHAP	PHIT	CN-P	CLM-P	CY-P	CLN-P	CLL-P	CAT-P	CAB-P	CA-P	NCP/L	YCP/L	A.C.
11.000	11.000	-0.0	0.8122	-0.12409	-0.0052	-0.00030	0.000116	0.2296	0.1256	0.1041	0.8195	0.6086	0.7683
10.000	10.000	-0.0	0.7166	-0.11232	-0.0049	-0.00018	0.000097	0.2291	0.1259	0.1032	0.8234	0.6301	0.7950
9.000	9.000	-0.0	0.6253	-0.10011	-0.0031	-0.00021	0.000050	0.2285	0.1256	0.1028	0.8268	0.5970	0.8028
8.000	8.000	-0.0	0.5427	-0.08847	-0.0016	-0.00023	0.000016	0.2298	0.1267	0.1031	0.8297	0.5225	0.8105
7.000	7.000	0.0	0.4648	-0.07689	-0.0003	-0.00025	-0.000005	0.2290	0.1262	0.1028	0.8321	-0.0940	0.8168
6.000	6.000	0.0	0.3911	-0.06558	0.0006	-0.00030	-0.000001	0.2286	0.1251	0.1034	0.8344	1.1362	0.8223
5.000	5.001	0.0	0.3214	-0.05454	0.0013	-0.00030	0.000011	0.2278	0.1240	0.1037	0.8364	0.8963	0.8272
4.000	4.001	0.0	0.2526	-0.04332	0.0019	-0.00032	0.000032	0.2266	0.1230	0.1036	0.8381	0.8502	0.8321
3.000	3.001	0.0	0.1877	-0.03241	0.0022	-0.00034	0.000052	0.2264	0.1219	0.1045	0.8393	0.8222	0.8364
2.000	2.002	0.0	0.1247	-0.02151	0.0024	-0.00035	0.000074	0.2257	0.1211	0.1046	0.8391	0.8116	0.8386
1.500	1.502	0.0	0.0927	-0.01600	0.0027	-0.00037	0.000086	0.2253	0.1207	0.1047	0.8394	0.8034	0.8377
1.000	1.003	0.0	0.0621	-0.01079	0.0027	-0.00038	0.000095	0.2255	0.1203	0.1052	0.8403	0.8054	0.8371
0.750	0.754	0.0	0.0470	-0.00824	0.0027	-0.00039	0.000100	0.2255	0.1202	0.1053	0.8419	0.8075	0.8364
0.500	0.506	0.0	0.0300	-0.00531	0.0031	-0.00040	0.000107	0.2251	0.1204	0.1047	0.8440	0.7971	0.8369
0.250	0.262	0.0	0.0162	-0.00301	0.0030	-0.00039	0.000110	0.2254	0.1205	0.1049	0.8527	0.7970	0.8366
0.000	0.035	0.0	-0.0010	-0.00004	0.0031	-0.00039	0.000116	0.2256	0.1207	0.1049	0.6239	0.7921	0.6359
-0.250	-0.262	0.0	-0.0150	0.00229	0.0032	-0.00041	0.000120	0.2259	0.1208	0.1051	0.8192	0.7961	0.8361
-0.500	-0.506	0.0	-0.0325	0.00524	0.0033	-0.00042	0.000125	0.2260	0.1208	0.1052	0.8281	0.7934	0.8358
-0.750	-0.754	0.0	-0.0468	0.00768	0.0032	-0.00042	0.000127	0.2261	0.1208	0.1053	0.8309	0.7973	0.8364
-1.000	-1.003	0.0	-0.0644	0.01067	0.0034	-0.00042	0.000132	0.2261	0.1208	0.1054	0.8324	0.7922	0.8365
-1.500	-1.502	0.0	-0.0964	0.01610	0.0026	-0.00031	0.000138	0.2255	0.1209	0.1046	0.8337	0.7855	0.8358
-2.000	-2.002	0.0	-0.1279	0.02142	0.0025	-0.00029	0.000144	0.2250	0.1210	0.1040	0.8342	0.7616	0.8349
-3.000	-3.001	-0.0	-0.1914	0.03205	0.0026	-0.00027	0.000153	0.2261	0.1215	0.1046	0.8341	0.7688	0.8321
-4.000	-4.001	-0.0	-0.2567	0.04276	0.0030	-0.00025	0.000155	0.2262	0.1223	0.1039	0.8333	0.7498	0.8285
-5.000	-5.001	-0.0	-0.3261	0.05390	0.0032	-0.00018	0.000154	0.2273	0.1232	0.1041	0.8320	0.7234	0.8246
-6.000	-6.001	-0.0	-0.3968	0.06492	0.0036	-0.00010	0.000152	0.2273	0.1242	0.1031	0.8303	0.6950	0.8202
-7.000	-7.000	-0.0	-0.4709	0.07619	0.0039	-0.00001	0.000150	0.2279	0.1251	0.1029	0.8285	0.6697	0.8150
-8.000	-8.000	-0.0	-0.5499	0.08776	0.0048	0.00007	0.000158	0.2272	0.1250	0.1022	0.8262	0.6515	0.8099
-9.000	-9.000	-0.0	-0.6361	0.09982	0.0060	0.00016	0.000176	0.2278	0.1252	0.1027	0.8236	0.6398	0.8054

Sample Tabulated Data