NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA CR-141834

(NASA-CR-141834) RESULTS OF AN INVESTIGATION OF HYPERSONIC VISCOUS INTERACTION EFFECTS OF THE SPACE SHUTTLE ORBITER USING A 0.010-SCALE MODEL (51-0) IN THE AEDC-VKF TUNNEL F (OA160) (Chrysler

N76-16147

HC $5.00

Unclas

G3/18 13394

SPACE SHUTTLE

AEROTHERMODYNAMIC DATA REPORT

JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANagement services

SPACE DIVISION CHRYSLER CORPORATION

December, 1975

DMS DR-2247

NASA CR-141,834

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by

D. J. Elder
Shuttle Aerosciences
Rockwell International Space Division

Prepared under NASA Contract Number NAS9-13247

by

Data Management Services
Chrysler Corporation Space Division
New Orleans, La. 70189

for

Engineering Analysis Division

Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number: AEDC VKF V41F-28A
NASA Series Number: OA160
Model Number: 51-0
Test Dates: February 5 through February 11, 1975
Occupancy Hours: 12

FACILITY COORDINATOR:

L. L. Trimmer
VKF-SH
ARO, Inc.
Arnold Air Force Station,
Tenn. 37389

Phone: (615) 455-2611, x7377

AERO ANALYSIS ENGINEER:

D. J. Elder
Mail Code AC07
Rockwell International Space Div.
12214 Lakewood Blvd.
Downey, CA 90241

Phone: (213) 922-2092

PROJECT ENGINEERS:

E. C. Allen
Southern Regional Office
Rockwell International
3322 Memorial Parkway SW
Suite 143
Huntsville, AL 35801

Phone: (205) 881-5000

L. G. Siler
VKF-ADP
ARO, Inc.
Arnold Air Force Station
Tenn. 37389

Phone: (615) 455-2611, x7154

DATA MANAGEMENT SERVICES:

Prepared by: Liaison--D. A. Sarver
Operations-- J. E. Vaughn

Reviewed by: G. G. McDonald

Approved by: J. L. Glynn
J. L. Glynn, Manager
Data Operations

Concurrence: N. D. Kemp
N. D. Kemp, Manager
Data Management Services

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RESULTS OF AN INVESTIGATION OF HYPERSONIC VISCOUS INTERACTION EFFECTS OF THE SPACE SHUTTLE ORBITER USING A 0.010 SCALE MODEL (51-0) IN THE AEDC-VKF TUNNEL F (OA160)

by

D. J. Elder, Rockwell International

ABSTRACT

An experimental aerodynamic investigation was conducted in the AEDC-VKF Hypervelocity Wind Tunnel (Tunnel F) at a nominal Mach number of 19 to determine hypersonic viscous interaction effects on the Space Shuttle Orbiter. The tests were conducted at an angle-of-attack of 30 degrees over a free-stream Reynolds number (based on fuselage length) variation from 0.1 to 0.4 million. Viscous interaction parameter ($\overline{V}'_\infty$) was varied from 0.02 to 0.06. Six component static stability force and moment data were measured by an internally compensated internal strain gage balance. Resulting data are presented in this report.

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NOMENCLATURE

SYMBOL	PLOT SYMBOL	DEFINITION
A_b		Base area, in^2
b_{ref}	BREF	Reference span, 936.7 in.
C_{A_f}	CAF	Forebody axial force coefficient, $C_{A_T} - C_{A_b}$
C_{A_b}	CAB	Base axial force coefficient, $[(P_\infty - P_b)/q_\infty]\ A_b/S_{ref}$
C_{A_T}	CA	Total axial-force coefficient, $F_{A_T}/q_\infty\ S_{ref}$
C_D	CD	Drag force coefficient in the stability axis system, $C_A \cos \alpha - C_N \sin \alpha$
C_L	CL	Lift force coefficient (stability or wind axis), $C_N \cos \alpha - C_A \sin \alpha$
C_m	CLM	Pitching-moment coefficient about Sta 1076.7, pitching moment/$q_\infty S_{ref} \ell_{ref}$
C_N	CN	Normal-force coefficient in the body axis system, $F_N/q_\infty S_{ref}$
C_∞		Chapman Rubensin viscosity coefficient
C_∞'		Viscosity coefficient, see data reduction section
F_{A_T}		Total axial force, lb
F_N		Normal force, lb
F_{N_A}		Normal-force component measured at aft normal-force gage location, lb
F_{N_F}		Normal-force component measured at forward normal-force gage location, lb
H		Enthalpy
IML	IML	Inner Mold Line

NOMENCLATURE (Continued)

SYMBOL	PLOT SYMBOL	DEFINITION
L/D	L/D	Lift-to-drag ratio, C_L/C_D (stability axis system)
ℓ		Body reference length, 1290.3 in. (actual model body length was 12.875 in.)
ℓ_{ref}	LREF	Reference chord, 474.8 in.
M	MACH	Free-stream Mach number
MRP	MRP	Moment reference point
OML	OML	Outer mold line
P_b		Model base pressure, psia
P_o	P(0)	Reservoir pressure, psi
P_o'	PITOT	Total pressure behind normal shock in test section, psia
P_∞	P	Free-stream static pressure, psia x 10 in Tabulated Data Listing
$\dot{q}_o$	QDOT	Stagnation heat-transfer rate on 1.0 in.-diam probe, Btu/ft^2-sec
q_∞	Q(PSI)	Free-stream dynamic pressure, psia
$Re_{\infty\ell}$	RN/L	Reynolds number based on free-stream conditions and model length
Re_∞/ft	RN/FT	Reynolds number based on free-stream conditions and 1-ft length
S_{ref}	SREF	Reference area, = 2690.0 ft^2
T_o	T(0)	Reservoir temperature, ^oR
T_w		Model surface temperature, ^oR
T_∞	T	Free-stream temperature, ^oR

SYMBOL	PLOT SYMBOL	DEFINITION
t	TIME	Time, msec
V		Velocity, ft/sec
U_∞	U	Free-stream velocity, ft/sec
$\bar{V}_\infty$	VBAR	Hypersonic viscous parameter, $M_\infty\sqrt{C_\infty}/\sqrt{Re_{\infty\ell}}$
$\bar{V}'_\infty$	VLBAR	Hypersonic viscous parameter, (as defined by NASA/LaRC), $M_\infty\sqrt{C'_\infty}/\sqrt{Re_{\infty\ell}}$
X_{cp_N}/ℓ	XCP/L	Center-of-pressure location, $[0.65 - (C_m \times \ell_{ref})/(C_N \times \ell)]$ measured from inner mold line
XMRP	XMRP	Moment reference point on x-axis XMRP = 8.417 in. from nose, X_o = 1076.70 in.
YMRP	YMRP	Moment reference point on y-axis, YMRP = 0
ZMRP	ZMRP	Moment reference point on z-axis, ZMRP = 25.0 in. below Z = 400, Z_o = 375 in.
X_o	XO	Longitudinal coordinate of model axis system, in.
Y_o	YO	Lateral coordinate of model axis system, in.
Z_o	ZO	Vertical coordinate of model axis system, in.
α	ALPHA	Angle-of-attack, deg.
αs		Sector angle of attack, deg.
β	BETA	Angle of sideslip, deg.
δ		Control surface deflection angle, deg, positive deflections are as follows:
	ELEVON	(δ_e) Elevator, trailing edge down positive
	BDFLAP	(δ_{BF}) Body flap, trailing edge down positive

NOMENCLATURE (Continued)

SYMBOL	PLOT SYMBOL	DEFINITION
	SPDBRK	(δ_{SB}) Speed brake, deflected out from the vertical stabilizer centerline, SB is the included angle
μ_W		Viscosity at wall temperature
μ_∞	MU	Free-stream viscosity
ρ_∞	RHO	Free-stream density, slugs/ft^3 x 10^6 in Tabulated Data Listing
ϕ	PHI	Model roll angle, deg.

SUBSCRIPTS

BF	Body flap
b	Base
e	Elevons
o	Reservoir
SB	Speed brake
ref	Reference conditions
w	Model wall conditions
δ	Edge of boundary layer
∞	Free-stream conditions

CONFIGURATIONS INVESTIGATED

The test model was a 0.010-scale representation (model 51-0) of a modified NASA Vehicle 4 Orbiter. The full-scale vehicle has a body length of 1290.3 in. and a wingspan of 936.68 in., which corresponds to a model reference length and wingspan of 12.903 and 9.367 in., respectively. The model actual length was 12.875 inches making it shorter than the full scale vehicle configuration. A sketch of the model indicating the general arrangement and pertinent reference stations and dimensions is shown in Fig. 2. A photograph of the orbiter model is presented in Fig. 3.

The model was designed and fabricated prior to the first tunnel F test series (OA81) by AEDC/VKF with the outside contours and overall dimensions traced from a master model provided by Rockwell International (RI), Huntsville, Alabama. The master model was fabricated in conformance with the line drawings as follows:

Nose	VL70-000143A
Mid-body and wing	VL70-000200
Aft body	VL70-000145
Vertical tail	VL70-000146A

The model was constructed of magnesium with all components hollowed or milled out where possible to reduce the overall weight. The upper surfaces of the wings were milled out and filled with foam with an epoxy coating. The model weighed approximately 1.8 lbm. Slight modifications to the outside contours of this model were made under the direction of RI, prior to the present test series (OA160) and according to the revised model dimensional data dated April 24, 1974.

The wings were equipped with positionable elevons with deflection angles obtained by exchanging angle plates machined to the desired angles. The elevon deflection angles used were $\delta_e = -40$, 0, and 15 deg with the extremes representing the limits of elevon travel for this configuration. Both the right and left elevons were split approximately midway of each span to represent the full-scale vehicle. However, all elevon surfaces for this test were deployed at the same deflection angle for any given run. The elevon slits were added after the model was installed in the tunnel. A positionable body flap was provided by interchanging separate flaps machined to the proper deflection angles. Body flap angles used were $\delta_{BF} = -11.7$, 0, and 16.3 deg. The vertical stabilizer component had a fixed rudder and speed brake. Interchangeable stabilizers were available with speed brake deflection angles (δ_{SB}) of 0 and 55 deg. However, only the stabilizer with $\delta_{SB} = 0$ was used during this test series.

Model components were designated as:

B26	Orbiter body
C9	Canopy
E26	Elevon
F7	Body flap
M7	OMS pods
N28	OMS nozzle

R5	Rudder
V8	Vertical tail
W116	Wing

Table III provides detailed model dimensional da

INSTRUMENTATION

The aerodynamic forces were measured with a six-component force balance developed by AEDC/VKF for use in hotshot-type tunnels (Refs. 1 and 2). The balance load cells were instrumented with semiconductor strain gages, and semiconductor accelerometers provided compensation for model inertial loads that result from vibrations of the model and its support hardware. Tunnel F balances are now operated with constant current excitation. This type of excitation in combination with the characteristics of the semiconductor strain gages makes possible a compensation of the balance bridges so that the sensitivities are not affected significantly by changes in temperature. The result is an improvement in calibration accuracy and stability.

The balance used during the test series was calibrated before and after its use in the tunnel. The following uncertainties represent residuals which are differences between combined axial-and normal-force loads applied statically in the calibration laboratory and the corresponding values calculated from the data reduction equations. The applied range of static loading closely approximated the aerodynamic test loads.

Balance Component	Range of Static Load Applied, lb	Measurement Uncertainty, Absolute, lb
F_{A_T}	0.5 - 3	$\pm$ 0.013
F_{N_F}	0.8 - 12	$\pm$ 0.008
F_{N_A}	1.2 - 18	$\pm$ 0.009

Base pressure measurements were made using variable reluctance differential pressure transducers with a range from 0.001 to 0.1 psia. The gages were mounted on the sting with the gage orifice positioned approximately 1/16 in. downstream of the model base.

Two gages were mounted in the nose of the orbiter model ("T" arrangement on a single orifice) to measure p'_o. The gages used were 15-psid strain-gage pressure transducers calibrated at the specific pressure level occurring during each test condition.

The arc chamber pressure, test section pitot pressure, and test section heat-transfer rates on a hemisphere-cylinder probe were monitored to determine tunnel flow conditions. The arc chamber reservoir pressure was measured using two strain-gage transducers, each having full-scale calibrated ranges of 5, 10, and 25 thousand psia. The test section pitot pressures were measured using 2.0-psid strain-gage transducers calibrated for the range of the specific test condition. The stagnation heat-transfer rates used in determining the tunnel flow conditions were inferred from measurements made on the cylindrical section of a 1.0 in.-diam hemisphere-cylinder probe using resistance thermometer slug calorimeters. Slug calorimeters have a thin-film platinum resistance thermometer to sense the temperature of an aluminum disk which is exposed to the heat flux to be measured. The calorimeters are optimized to measure a given range of heat transfer by appropriate selection of the aluminum disk thickness.

Detailed information about the force, heat-transfer, and pressure instrumentation may be found in Refs. 2, 3, and 4.

TEST FACILITY DESCRIPTION

The von Karman Gas Dynamics Facility (VKF) Hypervelocity Wind Tunnel (F) is an arc-driven wind tunnel of the hotshot type (Refs. 3 and 4) and is capable of providing Mach numbers from about 7.5 to 20 over a Reynolds number per foot range from 0.05×10^6 to 70×10^6. Tests are conducted in the 108-in.-diam test section (M_∞ = 14 to 20) using a 4-deg half-angle conical nozzle. The range of Mach numbers is obtained by using various throat diameters. Tests are conducted in the 54-in.-diam test section (M_∞ = 8 to 16) utilizing contoured nozzles as shown in Fig. 2. The M_∞ = 8, 12, and 16 contoured nozzles have 25-, 40-, and 48-in. exit diameters, respectively, which connect to the 54-in.-diam test station and provide a free-jet exhaust. The gas for aerodynamic and aerothermodynamic testing is nitrogen. Air is used for combustion tests. The test gas is confined in either a 1.0-ft^3, a 2.5-ft^3, or a 4.0-ft^3 arc chamber, where it is heated and compressed by an electric arc discharge. The increase in pressure results in a diaphragm rupture with the subsequent flow expansion through the nozzle. Test durations are typically from 50 to 200 msec. Shadowgraph and schlieren coverage are available at both test sections.

This test was conducted in the 108-in.-diam test section of the conical nozzle at $M_\infty \approx 19$ with nitrogen as the gas. The 1.0-ft^3 volume arc chamber was used, and useful test times up to approximately 50 msec were obtained. Because of the relatively short test times, the model wall temperature remained essentially invariant from the initial value of approximately 540^oR; thus $T_w/T_o \simeq 0.12$ and approximates the condition of practical interest for reentry vehicles.

TEST PROCEDURE

The test objective was to determine the static stability and axial-force characteristics of the modified Vehicle 4 Orbiter configuration at Mach number 19 over a Reynolds number ($Re_{\infty,\ell}$) range from 0.1 x 10^6 to 0.4 x 10^6 at an angle of attack of 30 deg. The elevon and body flap deflection angles were varied for determination of control effectiveness. The primary model configuration tested had all the control surfaces at zero deflection angle, including the speed brake, which was fixed at zero deflection throughout the test series.

A series of runs was made with both the elevons and body flap positioned at their positive deflection limits (δ_e = 15 deg, δ_{BF} = 16.3 deg). This series was tested primarily to verify the trim capability of the configuration at these control surface settings. Both these series of runs were made at the two Reynolds number conditions.

Additional runs were made during both test series with the model inverted (ϕ = 180 deg) and the model nose pitched toward the bottom of the tunnel. These runs were made to assist in determining the corrections to apply to the data for small tunnel flow nonuniformities. One run was made with both the elevons and the body flap positioned at their negative deflection limits (δ_e = -40 deg, δ_{BF} = -11.7 deg). A complete test summary indicating the primary variables during the test is given in Table II.

The method of determining the tunnel flow conditions is briefly summarized as follows: instantaneous values of reservoir pressure (p_o)

are measured and an instantaneous value of the stagnation heat transfer rate ($\dot{q}_\infty$) is inferred from a direct measurement of a shoulder heat rate on a 1.0 in.-diam hemisphere cylinder heat probe. Total enthalpy (H_o) is calculated from p'_o, $\dot{q}_o$, and the heat probe radius, using Fay-Riddell theory, Ref. 5. The value of H_o determined in this manner and the measured value of reservoir-pressure are then used to determine corresponding values of reservoir temperature, density, and entropy from tabulated thermodynamic data for nitrogen (Ref. 6). The reservoir conditions, the measured value of p'_o, and the assumption of isentropic flow in the nozzle are then used to compute the free stream conditions. The basic procedure followed in this computation is given in Refs. 7 and 8.

A summary of the reservoir and free-stream conditions is given in Table I.

All data were recorded on a 70-channel digitial system capable of scanning all channels in 1 msec and storing up to 150 scans of data. Basic data reduction was done off-line on a digital computer. As a backup to the digital system, as well as to provide a quick look at the data results, the output of each data channel was also recorded on an oscillograph.

DATA REDUCTION

The model nose p_o' measurements were used in the calculations for determining the free-stream test section conditions. The force data are normalized by the dynamic pressure, which is thus dependent on the measured model nose pressure.

Since the Tunnel F nozzle providing flow in the 108-in.-diameter test section is conical, source flow effects are present. Adjustments were made to the data to correct for these following the discussion of source flow corrections in Ref. 11. Corrections were determined assuming the pressure coefficient at any station on the "flat-bottomed" orbiter vehicle could be described by the Newtonian expression as a function of angle of attack and source flow angle. The calculated corrections indicated a 0.22-percent rearward shift in X_{cpN}/ℓ was required to correct for source flow. The normal- and axial-force coefficient corrections were less than 1 percent and were considered insignificant when compared to the measurement uncertainties; thus no corrections to C_N and C_A were made.

Additional corrections to X_{cpN}/ℓ and C_N were applied to compensate for flow nonuniformities and a source flow angle resulting from the location of the model in the test section. These corrections were determined from a comparison of the aerodynamic data obtained with the model in the normal upright mode and data obtained with the model and balance inverted (ϕ= 180 deg) and pitched toward the bottom of the tunnel. The model was tested in the top half of the tunnel with the trailing edge of the body flap approximately 1 in. above the tunnel centerline for the inverted position. The accompanying source flow angle and the flow nonuniformities were accounted for by averaging the X_{cp_N}/ℓ and C_N coefficients for the upright and inverted runs for each of the respective configurations at each of the Reynolds number conditions. The resulting corrections were a maximum 2-percent change in C_N and a maximum 0.4-percent shift in X_{cp_N}/ℓ. The pitching moments were recomputed to reflect the corrections to the center of pressure, X_{cp_N}/ℓ, and the normal-force coefficient, C_N.

The following constants were used to reduce the data:

Parameter		Full Scale	Model Scale
Reference Area (S_{ref})		2690.0 ft^2	38.736 $in.^2$
Reference Chord (ℓ_{ref})		474.8 in.	4.748 in.
Reference Span (b_{ref}) (wing span)		936.7 in.	9.367 in.
Moment Reference Center	XMRP	1076.68 in. X_o	10.768 in. X_o
	YMRP	0.0 in. Y_o	0.0 in. Y_o
	ZMRP	375.0 in. Z_o	3.750 in. Z_o
Body Reference Length (ℓ)		1290.3 in.	12.903 in.
Base Area (A_b)		421.7 in^2	6.072 $in.^2$

The NASA/LaRC viscous interaction parameter is defined as:

$$\bar{V}'_\infty = \frac{M_\infty \sqrt{C'_\infty}}{\sqrt{Re_{\infty_\ell}}}$$

where

$$C'_\infty = \left[\frac{T'}{T_\infty}\right]^K \left[\frac{T_\infty + 122.1 \times 10^{-(5/T_\infty)}}{T' + 122.1 \times 10^{-(5/T')}}\right]^J$$

with the Monaghan's empirical relationship (reference 12 given by:*

$$\frac{T'}{T_\infty} = 0.468 + 0.532\left(\frac{T_W}{T_\infty}\right) + 0.195\left(\frac{\gamma-1}{2}\right) M_\infty^2$$

where

T_∞ = Freestream static temperature, degrees Kelvin

T_W = Wall temperature (367°K), degrees Kelvin

T' = Reference temperature, degrees Kelvin

and

K and J are empirical constants. For nitrogen, K = 0.5 and J = 1.0

The hypersonic viscous parameter is also given in the tabulated data and was calculated by:

$$\overline{V}_\infty = M_\infty \sqrt{C_\infty} \;/\; \sqrt{R_{e_\infty}\, \ell}$$

where

$$\sqrt{C_\infty} = \mu_W T_\infty / \mu_\infty T_W \quad \text{(Chapman-Rubesin viscosity coefficient)}$$

* These equations are based on temperature in °K but the tab. data are °R units.

DISCUSSION OF RESULTS

The uncertainties in the monitor probe measurements (p_o' and $\dot{q}_o$) and arc chamber measurements (p_o) considering both static load calibrations, system errors, and data repeatability, are estimated to be $\pm$ 4, $\pm$ 7, and $\pm$ 5 percent, respectively. The p_o' and p_o uncertainties are based on the average of two measurements and the uncertainty of $\dot{q}_o$ on the inferred value from the average of two probe shoulder measurements. These values were used to estimate uncertainties in the tunnel flow parameters using the Taylor series method of error propagation. Representative parameters are given below.

Uncertainty ($\pm$), percent

M_∞	$Re_\infty \ell$	T_∞	p_∞	q_∞	$\dot{q}_o$	p_o	p_o'
1.5	12	7	6	4	7	5	4

The uncertainties in the calculated force data were estimated by using the Taylor series method of error propagation to combine the uncertainties in each measurement occurring in the calculations. In general, it is estimated that for nominal loads the uncertainty in the force measurements is $\pm$ 6 percent for each balance component. This uncertainty includes calibration linearity and repeatability, instrumentation system error, and errors introduced by dynamic effects resulting from the impulsive operating nature of the facility. The uncertainty of $\pm$ 6 percent of each balance component measurement combined with a $\pm$ 4 percent uncertainty in the dynamic pressure gives an uncertainty in the force coefficient C_N, of $\pm$ 6 percent for the load distribution observed during this test. An uncertainty of $\pm$ 6 percent of the measured axial force combined with a $\pm$ 4 percent uncertainty in the dynamic pressure gives an uncertainty in C_A of $\pm$ 7 percent.

The absolute uncertainities in pitching-moment and center of pressure location were determined using the Taylor series method of error propagation. The uncertainties are primarily a function of the load distribution of the normal-force component measurements with the axial force component being a minor influence.

Absolute Uncertainties

C_m	$X_{cp_N/\ell}$
$\pm$0.0163	$\pm$0.0076

The above-quoted percent uncertainties in C_N and C_A and the absolute uncertainties in C_m and $X_{cp_N/\ell}$ apply to all the tabulated data presented in this report. It should be noted that these uncertainties apply to each data point and are not necessarily indicative of the overall uncertainty of a force coefficient when the data are plotted versus some parameter, e.g., $\overline{V}'_\infty$, and a fairing is made through all the data. The following near-minimum load uncertainties were determined using the balance residuals as discussed under Instrumentation in conjunction with the Taylor series method of error propagation and are included here to indicate the lower resolution limits of the balance.

Near-Minimum Load Uncertainties

Nominal $Re_{\infty \ell}$	Nominal q_∞	C_A	C_N	C_m
0.35	0.50	0.00067	0.00062	0.00020
0.12	0.17	0.00197	0.00183	0.00059

However, for this report the uncertainty levels to be applied to the data are not the above near-minimum load uncertainties but rather the previously mentioned percent C_N and C_A uncertainties of $\pm$ 6 and $\pm$ 7 percent, respectively, and the absolute uncertainty of $\pm$ 0.0163 for C_m and $\pm$ 0.0076 for $X_{cp_N/\ell}$. The model attitude was set prior to each run; the pitch angle is estimated to be accurate within $\pm$0.10 deg. The estimated uncertainties for the model base pressure measurements are $\pm$10 percent.

All of the data taken during this test series were at an approximate Mach number of 19 and at an angle of attack of 30 deg. Analysis of these data over the Reynolds number range tested and comparisons with previous AEDC data obtained at Mach numbers of 8, 10, and 16 show a definite dependence of the aerodynamic characteristics of the Orbiter configuration upon the visous parameter $\overline{V}'_\infty$ (hence altitude and velocity). A detailed discussion of the $\overline{V}'_\infty$ parameter can be found in Ref. 9.

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Table I. Test Conditions

Run No.*	Time, msec	p_o, psia	T_o, °R	$\dot{q}_o$ Btu/ft^2 sec	p'_o psia	$p_\infty \times 10^3$, psia	$\rho_\infty \times 10^6$, slugs/ft^3	q_∞, psia	U_∞, ft/sec	M_∞	$Re_{\infty,\ell}$ x 10	$\bar{V}_\infty$
4998	94	4843	5171	42.1	0.32	0.588	0.668	0.17	8619	20.5	0.11	0.057
4999	90	4631	5123	40.5	0.31	0.559	0.643	0.16	8573	20.5	0.11	0.058
5000	70	8839	4977	78.6	1.21	2.92	2.61	0.65	8466	17.9	0.34	0.029
5001	90	8142	4711	66.5	1.01	2.31	2.31	0.54	8214	18.3	0.32	0.030
5002	90	8210	4782	70.0	1.08	2.52	2.42	0.58	8281	18.1	0.33	0.029
5003	110	3950	5513	41.1	0.26	0.481	0.503	0.14	8914	20.3	0.08	0.067
5004	100	6999	3969	48.7	0.87	1.92	2.41	0.49	7477	18.7	0.38	0.028
5005	60	3749	5142	47.8	0.42	0.966	0.891	0.23	8568	18.3	0.12	0.049
5006	60	3603	5190	45.9	0.38	0.849	0.794	0.20	8612	18.6	0.11	0.052
5008	80	2997	4606	33.4	0.28	0.578	0.666	0.15	8067	19.3	0.11	0.055
5009	80	6944	4572	58.3	0.85	1.91	2.01	0.45	8071	18.4	0.29	0.032
5010	80	3082	4757	37.1	0.32	0.680	0.724	0.17	8209	18.9	0.11	0.054
5011	60	8121	4896	69.5	1.00	2.28	2.19	0.53	8387	18.3	0.30	0.031
5012	90	6439	4519	53.9	0.75	1.67	1.81	0.40	8016	18.6	0.27	0.034

*See Table II for model test attitude and configuration.

Table II

TEST: ØA-160 (V41F-28A)

DATA SET/RUN NUMBER COLLATION SUMMARY

DATE: 10/10/75

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	SCHD. β	PARAMETERS/VALUES φ	δ_e	δ_{BF}	δ_{SB}	δ_R	RN/L		MACH			NO. OF RUNS	RUN NUMBERS			
RVA001	ØRBITER (MODEL 51-Ø)	30	0	0	0	0	0	0	.08		20.3					5003		
02		30	0	0	0	0	0	0	.11		20.5					4998		
03		30	0	0	0	0	0	0	.12		18.3					5005		
04		30	0	0	0	0	0	0	.32		18.3					5001		
05		30	0	0	0	0	0	0	.38		18.7					5004		
06		30	0	180	0	0	0	0	.11		18.6					5006		
07		30	0	180	0	0	0	0	.11		20.5					4999		
08		30	0	180	0	0	0	0	.27		18.6					5012		
09		30	0	180	0	0	0	0	.34		17.9					5000		
10		30	0	0	15	16.3	0	0	.11		19.3					5008		
11		30	0	0	15	16.3	0	0	.29		18.4					5009		
12		30	0	180	15	16.3	0	0	.11		18.9					5010		
13		30	0	180	15	16.3	0	0	.30		18.3					5011		
14		30	0	0	-40	-11.7	0	0	.33		18.1					5002		

TEST RUN NUMBERS

	1	7	13	19	25	31	37	43	49	55	61	67	75 76
'R' DATA	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR	MACH	ALPHA	1.0

COEFFICENTS IDVAR (1) IDVAR (2) NDV

α OR β SCHEDULES

IV(2) = time - seconds

'S' DATA - RHO, VBAR, U, QDOT, T, P, PITOT, P(0), T(0), Q(PSI).

TABLE III MODEL DIMENSIONAL DATA

MODEL COMPONENT : BODY - B_{26}

GENERAL DESCRIPTION : Configuration 140A/B orbiter fuselage

NOTE: B_{26} is identical to B_{24} except underside of fuselage has been refaired to accept W_{116}.

MODEL SCALE: 0.010 MODEL DWG NO.: SS-A00147, Release 12

DRAWING NUMBER . VL70-000143B, -000200, -000205, --006089, -000145
VL70-000140A, --000140B

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (OML: Fwd Sta. X_O=235), In.	1293.3	12.933
Length (IML: Fwd Sta. X_O=238), In.	1290.3	12.903
Max Width (@ X_O = 1528.3), In.	264.0	2.640
Max Depth (@ X_O = 1464), In.	250.0	2.500
Fineness Ratio	0.264	0.264
Area - Ft^2		
Max. Cross-Sectional	340.88	0.034
Planform		
Wetted		
Base		

TABLE III (Cont'd)

MODEL COMPONENT : CANOPY - C_9

GENERAL DESCRIPTION : Configuration 3A. Canopy used with fuselage B_{26}.

MODEL SCALE: 0.010 MODEL DWG NO.: SS-A00147, Release 12

DRAWING NUMBER . VL70-000143A

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (X_O= 434.643 to 578), In.	143.357	1.434
Max Width (@ X_O = 513.127), In.	152.412	1.524
Max Depth (@ X_O = 485.0), In.	25.000	0.250
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE III (Cont'd)

MODEL COMPONENT: ELEVON - E_{26}

GENERAL DESCRIPTION: Configuration 140A/B orbiter elevons

MODEL SCALE: 0.010 MODEL DWG: SS-A00148, Release 6

DRAWING NUMBER: VL70-000200, -006089, -006092

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	205.25	0.0205
Span (equivalent), In.	346.68	3.467
Inb'd equivalent chord, In.	115.3	1.153
Outb'd equivalent chord, In.	55.189	0.552
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.214	0.214
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	0.00	0.00
Tailing Edge	-10.056	-10.056
Hingeline	0.00	0.00
Area Moment (~~Normal to hinge line~~ Product of area & $\bar{c}$), Ft^3	1518.27	0.0015
Mean Aerodynamic Chord, In.	88.777	0.888

TABLE III (Cont'd)

MODEL COMPONENT : BODY FLAP - F_7

GENERAL DESCRIPTION : Configuration 140A/B orbiter body flap

MODEL SCALE: 0.010 MODEL DWG: SS-A00147, Release 12

DRAWING NUMBER . VL70-000140A, -000145

DIMENSIONS .	FULL SCALE	MODEL SCALE
Length (X_0 = 1520 to X_0 = 1613), In.	93.000*	0.930
Max Width , In.	262.0	2.620
Max Depth (@ X_0 = 1520), In.	23.000	0.230
Fineness Ratio		
Area - Ft^2		
Max. Cross-Sectional		
Planform	142.6	0.014
Wetted		
Base	41.847	0.004

*Model dim. measured from Model Sta. 15.20

MODEL COMPONENT : OMS/RCS PODS - M_7

GENERAL DESCRIPTION : Configuration 140A/B Orbiter OMS/RCS pods

MODEL SCALE: 0.010 MODEL DRAWING: SS-A00147, RELEASE 12

DRAWING NUMBER : VL70-000145

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (OMS Fwd Sta X_o=1233.0), In.	327.000	3.270
Max Width (@ X_o = 1450.0), In.	94.50	0.945
Max Depth (@ X_o = 1493.0), In.	109.000	1.090
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE III (Cont'd)

MODEL COMPONENT: OMS NOZZLES - N_{28}

GENERAL DESCRIPTION: Configuration 140A/B orbiter OMS Nozzles

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000140A (Location), SS-A00106, Release 5 (Contour)

DIMENSIONS:	FULL SCALE	MODEL SCALE
MACH NO.		
Length - In.		
Gimbal Point to Exit Plane		
Throat to Exit Plane		
Diameter - In.		
Exit		
Throat		
Inlet		
Area - ft^2		
Exit		
Throat		
Gimbal Point (Station) - In.		
Left ~~Upper~~ Nozzle		
X_0	1518.00	15.180
Y_0	- 88.0	- 0.880
Z_0	492.0	4.920
Right ~~Lower~~ Nozzles		
X_0	1518.0	15.180
Y_0	88.0	0.880
Z_0	492.0	4.920
Null Position - Deg.		
Left ~~Upper~~ Nozzle		
Pitch	15°49'	15°49'
Yaw	12°17'	12°17'
Right ~~Lower~~ Nozzle		
Pitch	15°49'	15°49'
Yaw	12°17'	12°17'

TABLE III (Cont'd)

MODEL COMPONENT: RUDDER - R_5

GENERAL DESCRIPTION: Configuration 140C orbiter rudder (identical to configuration 140A/B rudder).

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000146B, -000095

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	100.15	0.010
Span (equivalent), In.	201.00	2.010
Inb'd equivalent chord, In.	91.585	0.916
Outb'd equivalent chord, In.	50.833	0.508
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge		
Tailing Edge	26.25	26.25
Hingeline	34.83	34.83
Area Moment (Product of Area & $\bar{c}$) ~~Normal to hinge line~~, Ft^3	610.92	0.0006
Mean Aerodynamic Chord, In.	73.2	0.732

TABLE III (Cont'd)

MODEL COMPONENT: VERTICAL - V_8

GENERAL DESCRIPTION: Configuration 140C orbiter vertical tail (identical to configuration 140A/B vertical tail)

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000140C, -000146B

DIMENSIONS:

TOTAL DATA	FULL SCALE	MODEL SCALE
Area (Theo) - Ft^2		
Planform	413.253	0.041
Span (Theo) - In.	315.72	3.157
Aspect Ratio	1.675	1.675
Rate of Taper	0.507	0.507
Taper Ratio	0.404	0.404
Sweep-Back Angles, Degrees.		
Leading Edge	45.000	45.000
Trailing Edge	26.25	26.25
0.25 Element Line	41.13	41.13
Chords:		
Root (Theo) WP	268.50	2.685
Tip (Theo) WP	108.47	1.085
MAC	199.81	1.998
Fus. Sta. of .25 MAC	1463.35	14.633
W.P. of .25 MAC	635.52	6.355
B.L. of .25 MAC	0.00	0.0
Airfoil Section		
Leading Wedge Angle - Deg.	10.00	10.0
Trailing Wedge Angle - Deg.	14.92	14.92
Leading Edge Radius	2.00	0.020
Void Area	13.17	0.0013
Blanketed Area	0.00	0.00

TABLE III (Cont'd)

MODEL COMPONENT: WING-W_{116}

GENERAL DESCRIPTION: Configuration 4

TEST NO. DWG. NO.

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.) Ft^2		
Planform	2690.00	0.269
Span (Theo In.	936.68	9.367
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	0.500	0.500
Aerodynamic Twist, degrees		
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	- 10.026	- 10.056
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.O.O.	689.24	6.892
Tip, (Theo) B.P.	137.85	1.379
MAC	474.81	4.748
Fus. Sta. of .25 MAC	1136.83	11.368
W.P. of .25 MAC	290.58	2.906
B.L. of .25 MAC	182.13	1.821
EXPOSED DATA		
Area (Theo) Ft^2	1751.50	0.175
Span, (Theo) In. BP108	720.68	7.207
Aspect Ratio	2.059	2.059
Taper Ratio	0.245	0.245
Chords		
Root BP108	562.09	5.621
Tip 1.00 $\frac{b}{2}$	137.85	1.379
MAC	392.83	3.928
Fus. Sta. of .25 MAC	1185.98	11.860
W.P. of .25 MAC	294.30	2.943
B.L. of .25 MAC	251.77	2.518
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root $\frac{b}{2}$ =	0.113	0.113
Tip $\frac{b}{2}$ =	0.120	0.120
Data for (1) of (2) Sides		
Leading Edge Cuff Planform Area Ft^2	113.18	0.011
Leading Edge Intersects Fus M. L. @ Sta	500.00	5.00
Leading Edge Intersects Wing @ Sta	1024.00	10.240

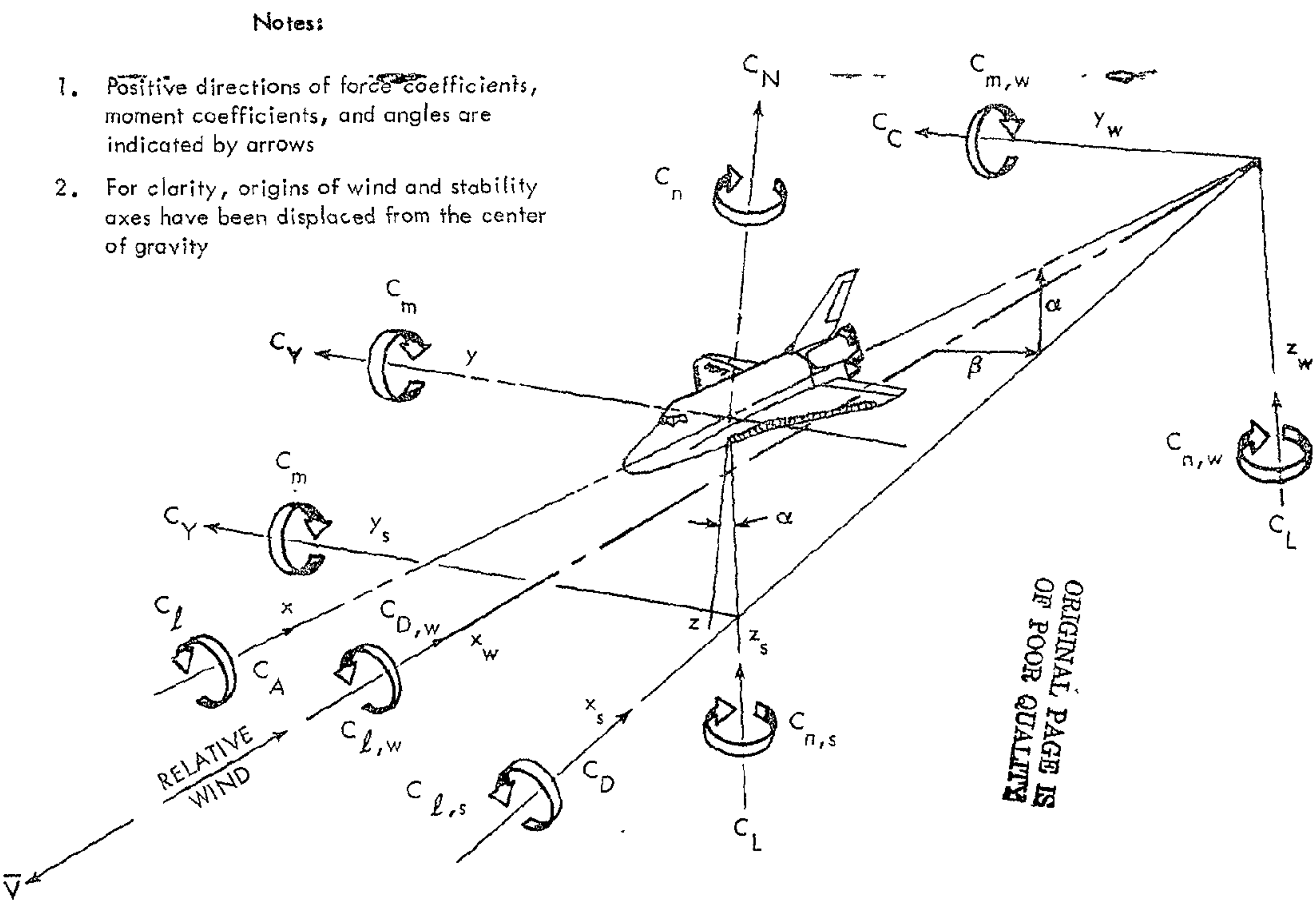

Figure 1. Axis Systems

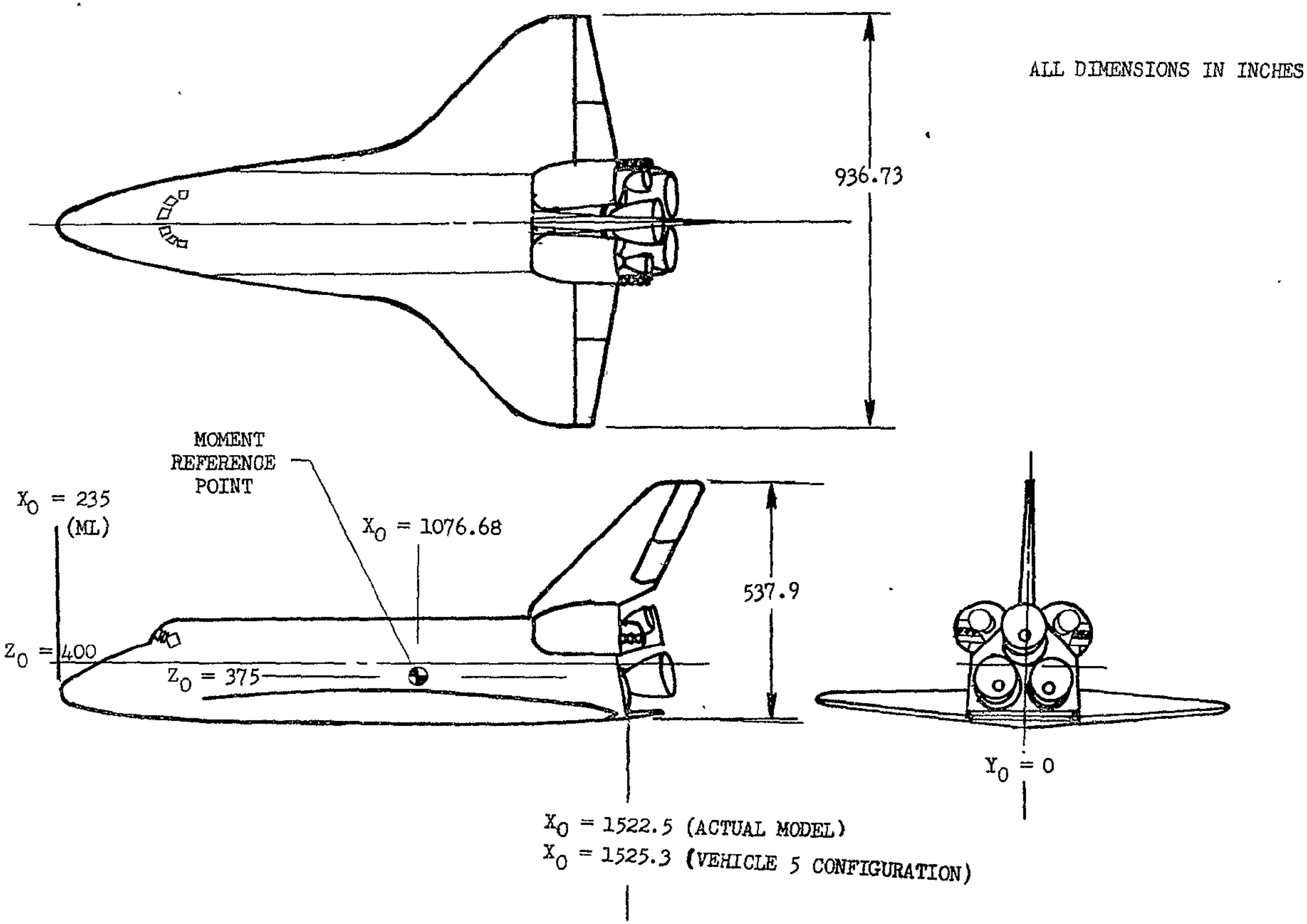

Figure 2. Model Sketch

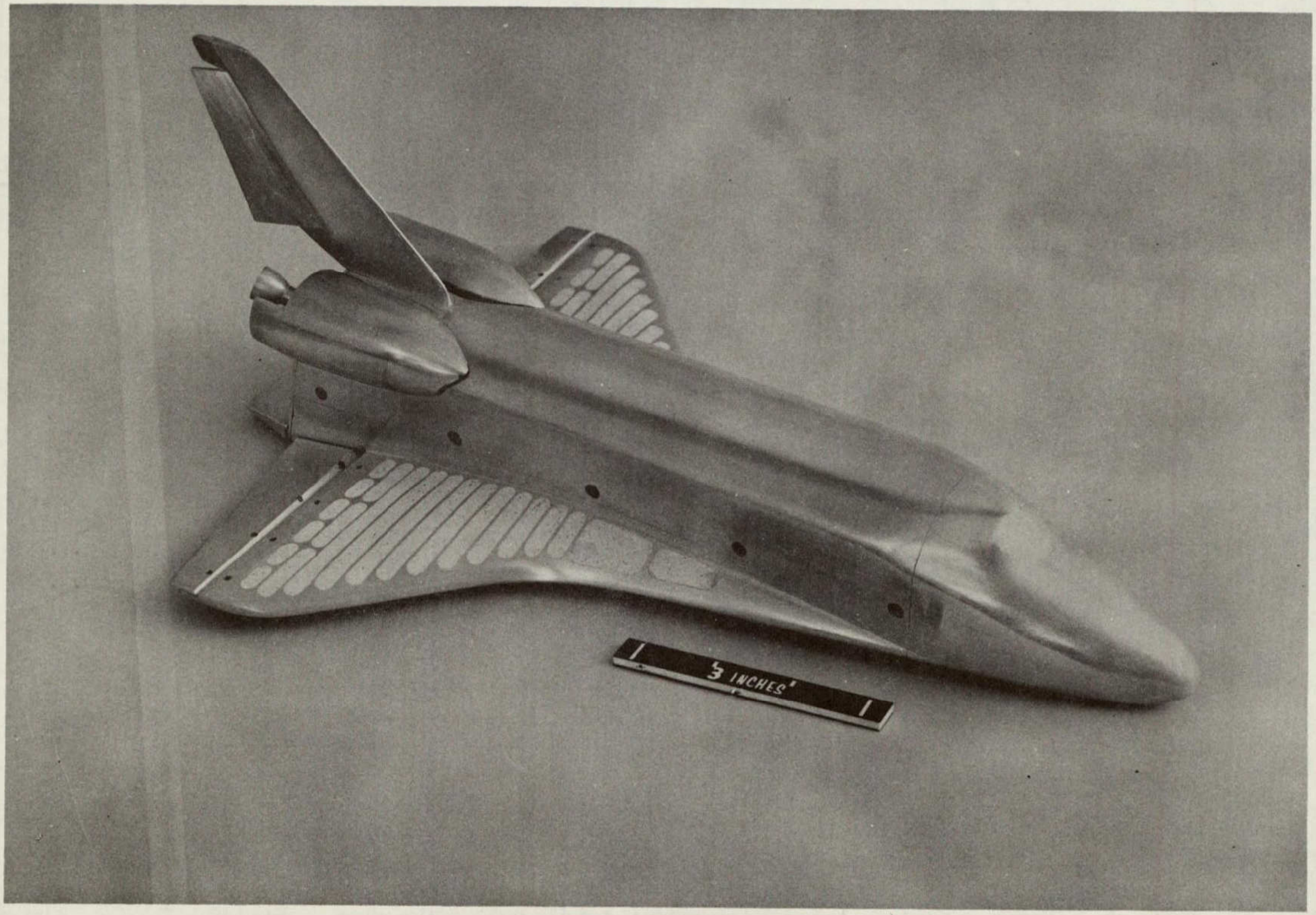

Figure 3. - Model Photograph.

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.080

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. X0
YMRP	.0000	IN. Y0
ZMRP	375.0000	IN. Z0
SCALE	.0100	

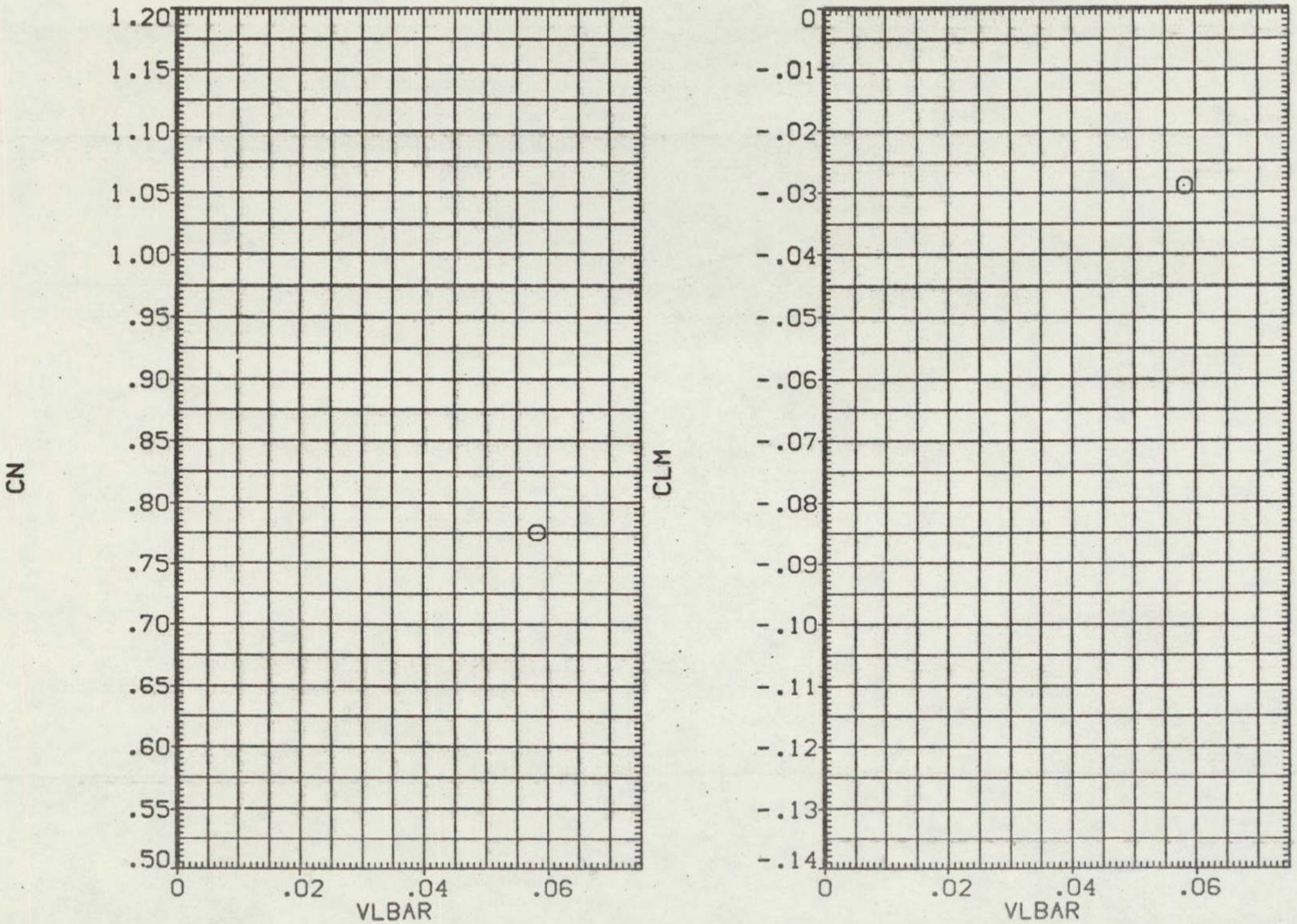

FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA014) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		
SCALE =	.0100				

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	-40.000
BDFLAP =	-11.700	RUDDER =	.000
SPDBRK =	.000	RN/L =	.320

RUN NO. 5002/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
17.800	80.000	2.50000	.02960	8634.00000	82.40000	84.28000	.02910	1.21000	8985.00000	5162.00000	.65000
18.100	90.000	2.42000	.02940	8281.00000	70.00000	84.27000	.02520	1.08000	8210.00000	4782.00000	.58000
17.900	100.000	2 29000	.03030	8279.00000	68.00000	85.68000	.02420	1.01000	7489.00000	4790.00000	.54000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA011) (09 DEC 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100,

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000 RN/L = .290

RUN NO. 5009/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.200	70.000	2.14000	.03140	8317 00000	66.80000	84.26000	.02220	.96000	7565.00000	4828.00000	.51000
18.400	80 000	2.01000	.03190	8071.00000	58.30000	77.22000	.01910	.85000	6944.00000	4572.00000	.45000
18.600	90.000	1.84000	.03300	7929.00000	52.40000	73.19000	.01660	.75000	6338.00000	4430.00000	.40000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA012) (09 DEC 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = 0000 IN. YO
BREF = 936 7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180 000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000 RN/L = .130

RUN NO. 5010/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.700	60.000	.98100	.04540	7998.00000	39.40000	73.44000	.00889	.41000	3689.00000	4530.00000	.22000
18.700	70.000	.88300	.04790	7995.00000	37.30000	73.31000	.00798	.36000	3333.00000	4530.00000	.20000
18.900	80.000	.72400	.05360	8209.00000	37.10000	76.17000	.00680	.32000	3082.00000	4757.00000	.17000
19 500	90.000	.67900	.05370	7743 00000	29.20000	63.43000	.00531	.26000	2849.00000	4274.00000	.14000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA013) (09 DEC 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000 RN/L = .330

RUN NO. 5011/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.300	60.000	2.19000	.03120	8387.00000	69.50000	84.68000	.02280	1.00000	8121.00000	4896.00000	.53000
18.500	65.000	2.45000	.02840	7788.00000	56.80000	71.14000	.02150	.96000	7713.00000	4272.00000	.52000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA008) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		
SCALE =	.0100				

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	180.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000	RN/L =	.260

RUN NO. 5012/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.200	60.000	2.02000	.03320	8786.00000	78.60000	93.26000	.02320	1 01000	8593.00000	5332 00000	.54000
18.200	70.000	2.00000	03290	8571.00000	71.80000	89.51000	.02210	.95000	7770.00000	5102.00000	.51000
18.300	80.000	1.83000	.03420	8466.00000	65.70000	86.29000	.01950	.85000	7073.00000	4993.00000	.46000
18.600	90.000	1.81000	.03350	8016.00000	53.90000	74.73000	.01670	.75000	6439.00000	4519.00000	.40000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA009) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	180.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000	RN/L =	.350

RUN NO. 5000/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
17.900	70.000	2.61000	.02870	8466.00000	78.60000	90.52000	.02920	1.21000	8839.00000	4977.00000	.65000
18.000	80.000	2.58000	.02830	8138.00000	68.00000	82.06000	.02610	1.11000	8112.00000	4631.00000	.59000
18.100	90 000	2.44000	02880	7960.00000	61.20000	77.49000	.02330	1.00000	7440.00000	4453.00000	.54000
18 300	100.000	2.36000	.02880	7703.00000	53.60000	71.55000	.02080	.90000	6768.00000	4198.00000	.49000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA010) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474 8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	15.000
BDFLAP =	16.300	RUDDER =	.000
SPDBRK =	.000	RN/L =	.100

RUN NO. 5008/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.900	70.000	.67400	.05670	8556.00000	41.30000	82.83000	.00689	.32000	3251.00000	5129.00000	.17000
19.300	80.000	.66600	.05540	8067.00000	33.40000	70.38000	.00578	.28000	2997.00000	4606.00000	.15000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA005) (09 DEC 75)

REFERENCE DATA					PARAMETRIC DATA			
SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		ALPHA =	30.000	BETA =	.000
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		PHI =	.000	ELEVON =	.000
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		BDFLAP =	.000	RUDDER =	.000
SCALE =	.0100				SPDBRK =	.000	RN/L =	.430

RUN NO. 5004/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.700	70.000	2.99000	.02540	7631.00000	58.40000	66.90000	.02470	1.13000	9142.00000	4097.00000	.60000
18.600	80.000	2.78000	.02640	7635.00000	56 30000	67.87000	02320	1 05000	8299.00000	4111 00000	.55000
18.600	90.000	2.70000	.02640	7466.00000	51.40000	64 60000	.02150	.97000	7700.00000	3951.00000	.52000
18.700	100.000	2.41000	.02800	7477.00000	48.70000	64.56000	.01920	.87000	6999.00000	3969.00000	.49000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA006) (09 DEC 75)

REFERENCE DATA					PARAMETRIC DATA			
SREF =	2690.0000 SQ.FT.	XMRP =	1076 7000 IN. XO		ALPHA =	30.000	BETA =	.000
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		PHI =	180.000	ELEVON =	.000
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		BDFLAP =	.000	RUDDER =	.000
SCALE =	.0100				SPDBRK =	.000	RN/L =	.100

RUN NO. 5006/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.600	60.000	.79400	.05240	8612.00000	45.90000	86.67000	.00849	.38000	3C03.00000	5190.00000	.20000
18.900	70.000	.69500	.05530	8407.00000	39.50000	79.24000	.00679	.32000	3244.00000	4966.00000	.17000
19.300	80.000	.62800	.05740	8171.00000	34.00000	72.00000	.00558	.27000	2962.00000	4715.00000	.15000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA007) (09 DEC 75)

REFERENCE DATA					PARAMETRIC DATA			
SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		ALPHA =	30.000	BETA =	.000
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		PHI =	180.000	ELEVON =	.000
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		BDFLAP =	.000	RUDDER =	.000
SCALE =	.0100				SPDBRK =	.000	RN/L =	.110

RUN NO. 4999/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
20.300	70.000	.68300	.05770	8981.00000	49.20000	78.50000	.00662	.36000	5454.00000	5573.00000	.19000
20.500	90.000	.64300	.05810	8573.00000	40.50000	70.42000	.00559	.31000	4631.00000	5123.00000	.16000
20.700	110.000	.58400	.06040	8422.00000	36.30000	66.53000	.00479	.27000	4204.00000	4961.00000	.14000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA002) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		
SCALE =	.0100				

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000	RN/L =	.120

RUN NO. 4998/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
20.000	84.000	.80200	.052u0	8565 00000	45.20000	73.39000	.00726	.38000	5156.00000	5110.00000	.20000
20.500	94.000	.66800	.05/20	8619.00000	42.10000	71.41000	.00588	.32000	4843.00000	5171.00000	.17000
20.800	104.000	.65100	.05670	8271 00000	36.00000	63.32000	.00508	.29000	4558.00000	4795.00000	.15000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA003) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000	RN/L =	.130

RUN NO. 5005/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.300	60.000	.89100	.04930	8568.00000	47.80000	87.86000	.00966	.42000	3749.00000	5142.00000	.23000
18.800	70.000	.88300	.04780	7968.00000	36.90000	72.08000	.00785	.36000	3383.00000	4501.00000	.19000
19.000	80.000	85400	.04770	7686 00000	32.00000	65 54000	.00691	.33000	3112.00000	4216.00000	.17000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA004) (09 DEC 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000	RN/L =	.300

RUN NO. 5001/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
18.300	90.000	2.31000	.03000	8214.00000	66.50000	80.80000	.02310	1.01000	8142.00000	4711.00000	.54000
18.300	100.000	2.02000	.03230	8342.00000	65.60000	83.74000	.02090	.91000	7437.00000	4855.00000	.49000

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OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA013) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000

RUN NO. 5011/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.300	60.000	.30000	.89500	-.00088	.13600	-.12000	.69900	.70700	.56500	1.25000	.02750
18.500	65.000	.37000	.89500	-.00086	.13500	-.12000	.70000	.70800	.56400	1.25000	.02550

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA014) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30 000 BETA = .000
PHI = .000 ELEVON = -40.000
BDFLAP = -11.700 RUDDER = .000
SPDBRK = .000

RUN NO. 5002/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
17.800	80.000	.32000	.72500	- 00088	.11200	.02440	.63800	.57200	.45900	1.24000	.02580
18.100	90.000	.33000	.72200	-.00086	.11100	.02490	.63700	.57000	.45700	1 25000	.02600
17.900	100 000	.31000	.71700	-.00086	.11000	.02460	.63700	.56600	.45400	1.25000	.02670

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (SVA001) (09 DEC 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000 RN/L = .080

RUN NO. 5003/ 0

MACH	TIME	RHO	VBAR	U	QDOT	T	P	PITOT	P(O)	T(O)	Q(PSI)
20.300	110.000	.50300	.06700	8914.00000	41.10000	77.49000	.00481	.26000	3950.00000	5513.00000	.14000

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA010) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000

RUN NO. 5008/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.900	70.000	.10000	.88900	-.00095	.17500	-.12300	.70100	.68200	.59600	1.14000	.04970
19.300	80.000	.11000	.89500	-.00090	.17300	-.11700	.69800	.68900	.59700	1.15000	.04930

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA011) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000

RUN NO. 5009/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.200	70 000	.29000	.88900	-.00081	.14200	-.11800	.69900	.69900	.56700	1.23000	.02770
18.400	80 000	.29000	.90000	-.00079	.14400	-.12300	.70000	.70800	.57500	1.23000	.02840
18.600	90.000	.28000	.89600	-.00078	.14600	-.12100	.70000	.70300	.57400	1.22000	.02950

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA012) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = 15.000
BDFLAP = 16.300 RUDDER = .000
SPDBRK = .000

RUN NO. 5010/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.700	60.000	.15000	.86200	-.00125	.16000	-.11300	.69800	.66700	.56900	1.17000	.04050
18.700	70.000	.13000	.88300	-.00124	.16500	-.11800	.69900	.68200	.58500	1.17000	.04270
18.900	80.000	.11000	.90300	- 00150	.17000	-.12200	.70000	.69700	.59900	1.16000	.04750
19.500	90.000	.11000	.92000	-.00153	.17600	-.12700	.70100	.70900	.61200	1.16000	.04830

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA007) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = 000

RUN NO. 4999/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
20.300	70.000	.11000	.78400	-.00096	.15900	-.03060	.66400	.59900	.53000	1.13000	.05020
20.500	90 000	.11000	.79800	-.00082	.16400	-.02930	.66300	.60900	.54100	1.13000	.05090
20.700	110 000	.10000	.80000	-.00090	.16400	-.03030	.66400	.61100	.54200	1.13000	.05310

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA008) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000

RUN NO. 5012/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.200	60.000	.26000	.75800	- 00074	.10700	-.01630	.65800	.60300	.47100	1.28000	.02890
18.200	70.000	.26000	.76500	- 00075	.11100	-.01780	.65900	.60700	.47800	1.27000	.02880
18.300	80.000	.25000	.76400	-.00074	.11300	-.02080	.66000	.60500	.48000	1.26000	.03010
18 600	90.000	.27000	.75400	-.00071	.11100	-.02220	.66100	.59800	.47300	1.26000	.02990

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA009) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = 180.000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000

RUN NO. 5000/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
17.900	70.000	.34000	.77400	-.00074	.10500	-.02540	.66200	.61800	.47800	1.29000	.02510
18.000	80.000	.35000	.77200	-.00072	.10600	-.01980	.65900	.61600	.47800	1.29000	.02500
18.100	90.000	.35000	.76400	-.00071	.10600	-.01940	.65900	.60900	.47400	1.29000	.02560
18.300	100.000	.35000	.76000	-.00076	.10700	-.01820	.65900	.60500	.47200	1.28000	.02580

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA004) (25 OCT 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO		
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO		
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO		
SCALE =	.0100				

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000		

RUN NO. 5001/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.300	90.000	.32000	.75600	-.00080	.11000	-.02150	.66000	.60000	.47300	1.27000	.02650
18.300	100.000	.28000	.75100	-.00082	.10900	-.01910	.65900	.59600	.47000	1.27000	.02550

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA005) (25 OCT 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000		

RUN NO. 5004/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.700	70.000	.47000	.79700	-.00098	.10200	-.02290	.66100	.63900	.48700	1.31000	.02290
18.600	80.000	.43000	.78300	-.00099	.10200	-.02060	.66000	.62700	.48000	1.31000	.02380
18.600	90.000	.43000	.77300	-.00097	.10100	-.01850	.65900	.61900	.47400	1.31000	.02400
18.700	100.000	.38000	.76300	-.00093	.09990	-.01740	.65800	.61100	.46800	1.31000	.02540

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA006) (25 OCT 75)

REFERENCE DATA

SREF =	2690.0000 SQ.FT.	XMRP =	1076.7000 IN. XO
LREF =	474.8000 INCHES	YMRP =	.0000 IN. YO
BREF =	936.7000 INCHES	ZMRP =	375.0000 IN. ZO
SCALE =	.0100		

PARAMETRIC DATA

ALPHA =	30.000	BETA =	.000
PHI =	180.000	ELEVON =	.000
BDFLAP =	.000	RUDDER =	.000
SPDBRK =	.000		

RUN NO. 5006/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.600	60.000	.11000	.83800	-.00106	.14700	-.03490	.66500	.65200	.54600	1.19000	.04580
18.900	70.000	.10000	.85200	-.00118	.15400	-.03890	.66700	.66100	.56000	1.18000	.04870
19.300	80.000	.10000	.86600	-.00132	.16100	-.04190	.66800	.66900	.57300	1.17000	.05090

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA001) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000

RUN NO. 5003/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
20.300	110.000	.08000	.77600	-.00183	.17900	-.02890	.66400	.58300	.54300	1.07000	.05810

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA002) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000

RUN NO. 4998/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
20.000	84.000	.13000	.85700	- 00135	.14700	-.03690	.66600	.66900	.55600	1.20000	.04640
20.500	94.000	.11000	85600	-.00153	.15200	-.03710	.66600	.66600	.55900	1.19000	.05000
20.800	104.000	.12000	.84000	-.00143	.15300	-.03190	.66400	.65100	.55300	1.18000	.05010

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5) (RVA003) (25 OCT 75)

REFERENCE DATA

SREF = 2690.0000 SQ.FT. XMRP = 1076.7000 IN. XO
LREF = 474.8000 INCHES YMRP = .0000 IN. YO
BREF = 936.7000 INCHES ZMRP = 375.0000 IN. ZO
SCALE = .0100

PARAMETRIC DATA

ALPHA = 30.000 BETA = .000
PHI = .000 ELEVON = .000
BDFLAP = .000 RUDDER = .000
SPDBRK = .000

RUN NO. 5005/ 0

MACH	TIME	RN/L	CN	CAB	CAF	CLM	XCP/L	CL	CD	L/D	VLBAR
18.300	60.000	.12000	.84100	-.00113	.15100	-.03960	.66700	.65300	.55100	1.18000	.04320
18.800	70.000	.13000	.84700	-.00107	.14700	-.03560	.66500	.66000	.55100	1.20000	.04270
19.000	80.000	.14000	.84300	-.00105	.14300	-.03130	.66400	.65900	.54500	1.21000	.04300

APPENDIX

TABULATED SOURCE DATA

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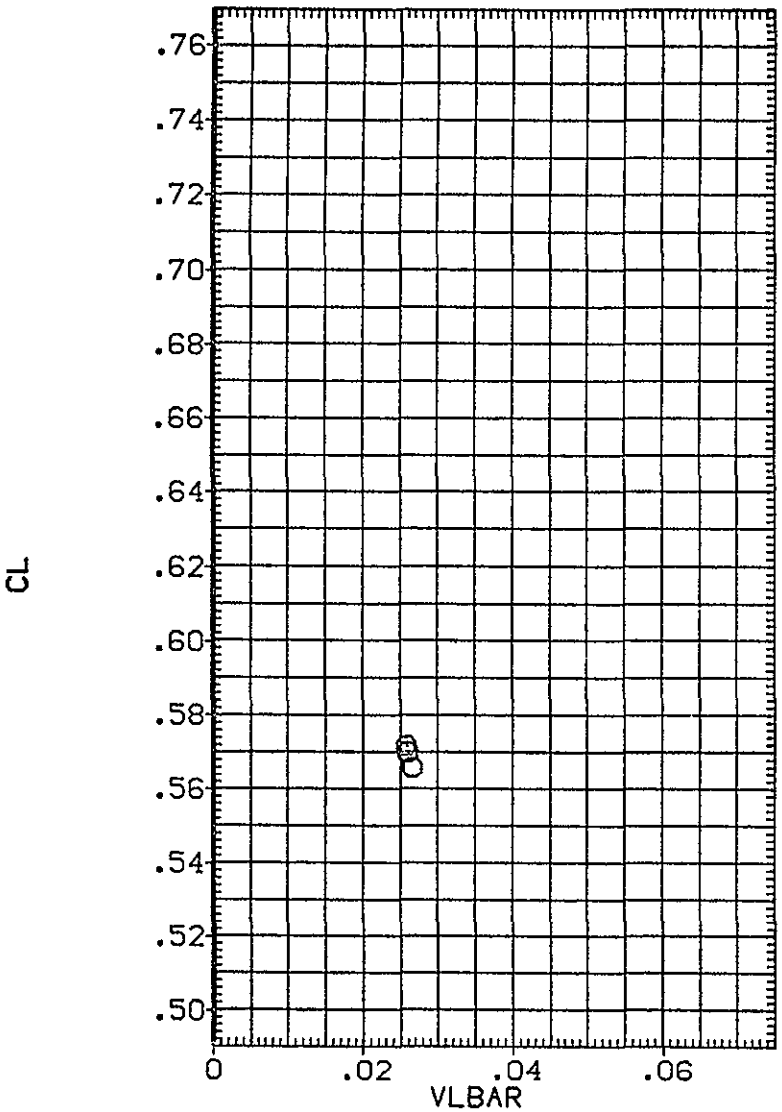
Plotted data tabulations available on request from the DMS

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA014)

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.800	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	-40.000
		BDFLAP	-11.700	RUDDER	.000
		SPDBRK	.000	RN/L	.320

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



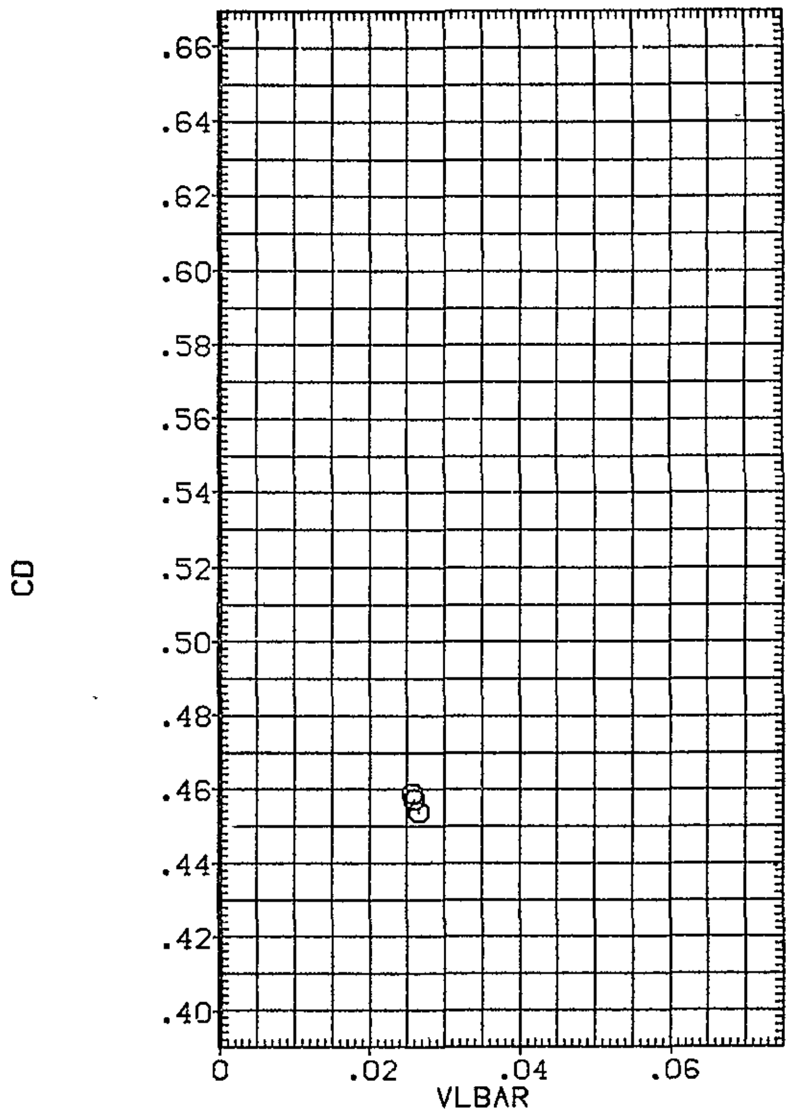


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA014)

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.800	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	-40.000
		BDFLAP	-11.700	RUDDER	.000
		SPDBRK	.000	RN/L	.320

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

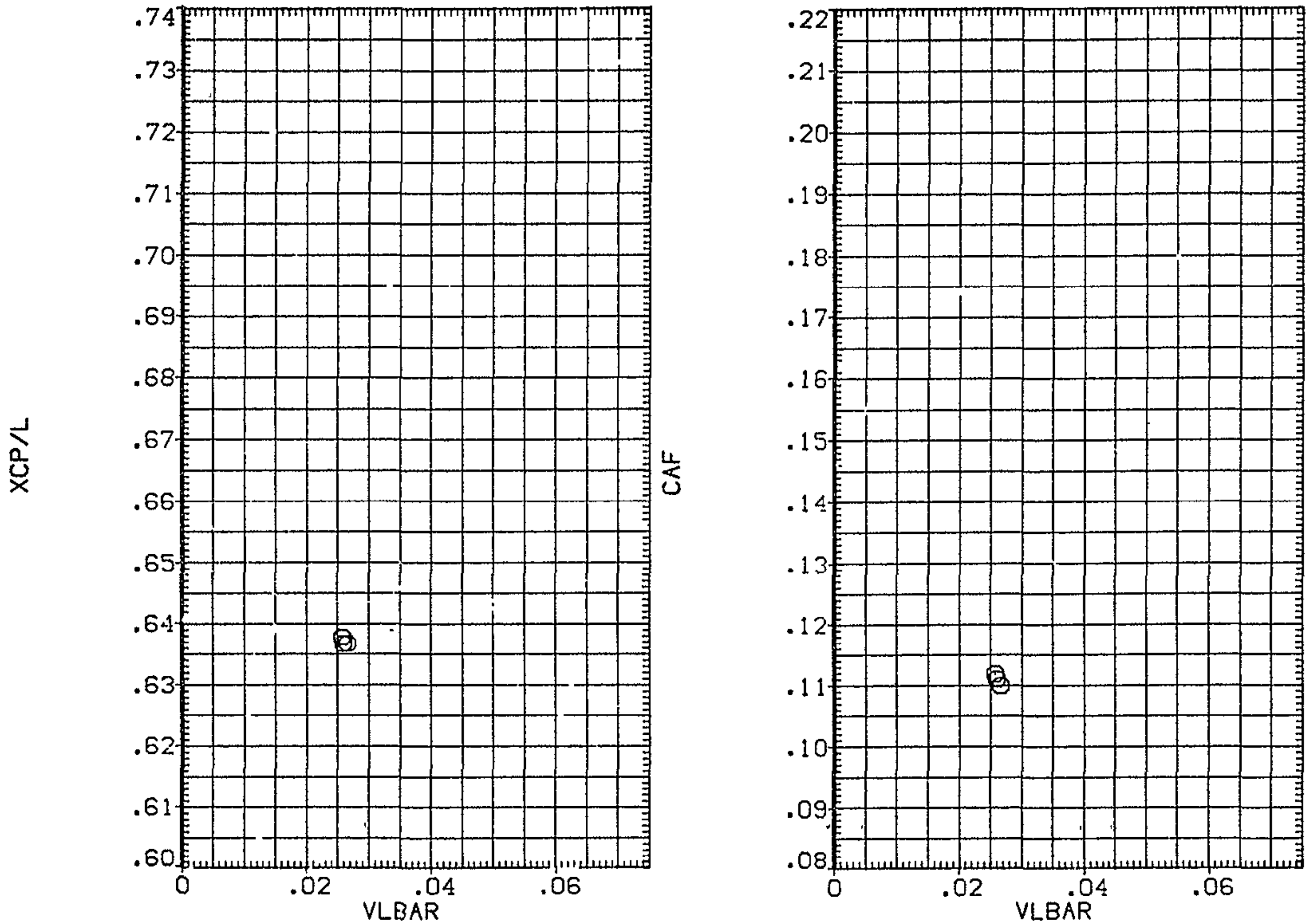


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA014)

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.800	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	-40.000
		BDFLAP	-11.700	RUDDER	.000
		SPDBRK	.000	RN/L	.320

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

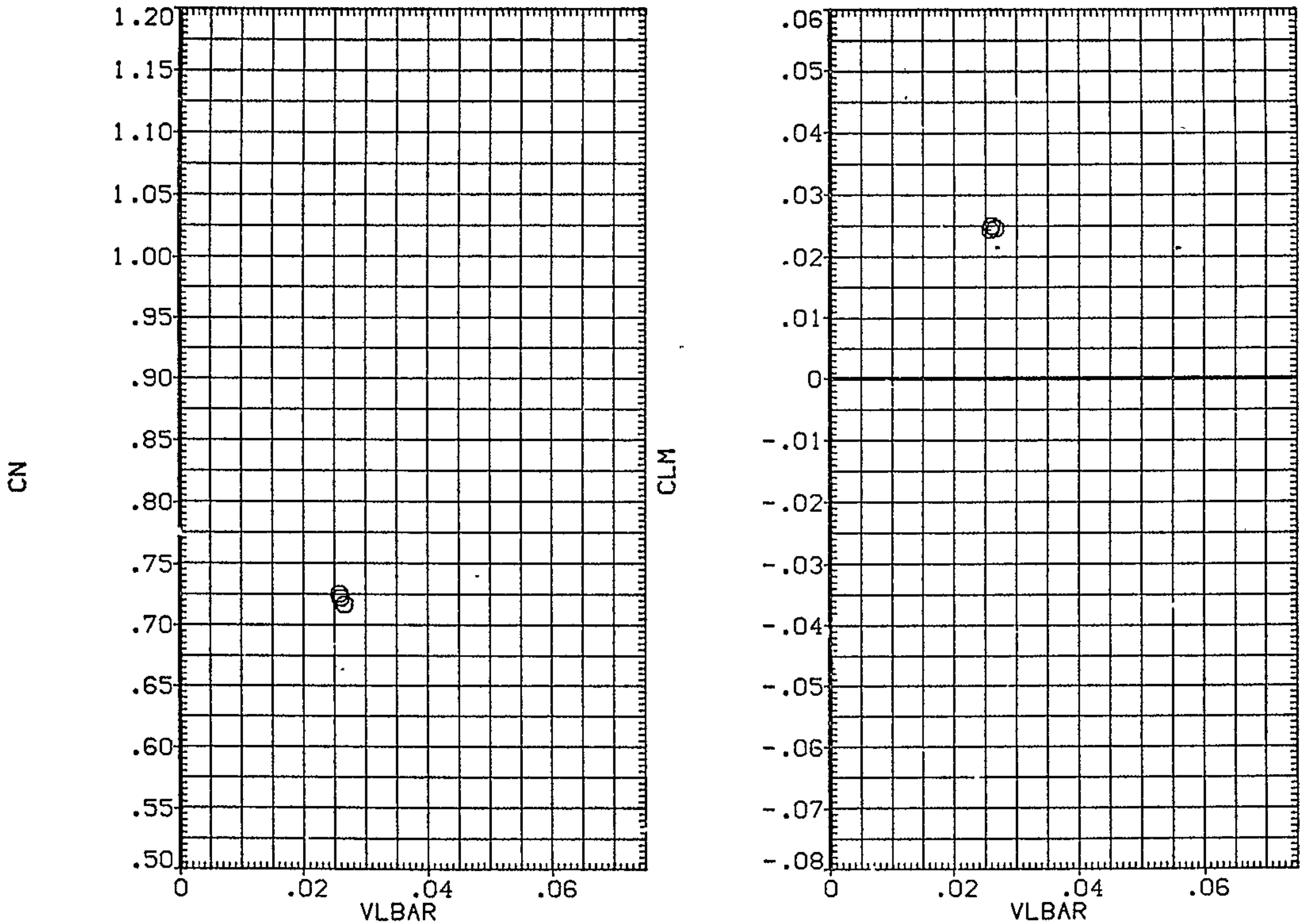


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA013)

SYMBOL	MACH		PARAMETRIC VALUES		
O	18.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.330

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

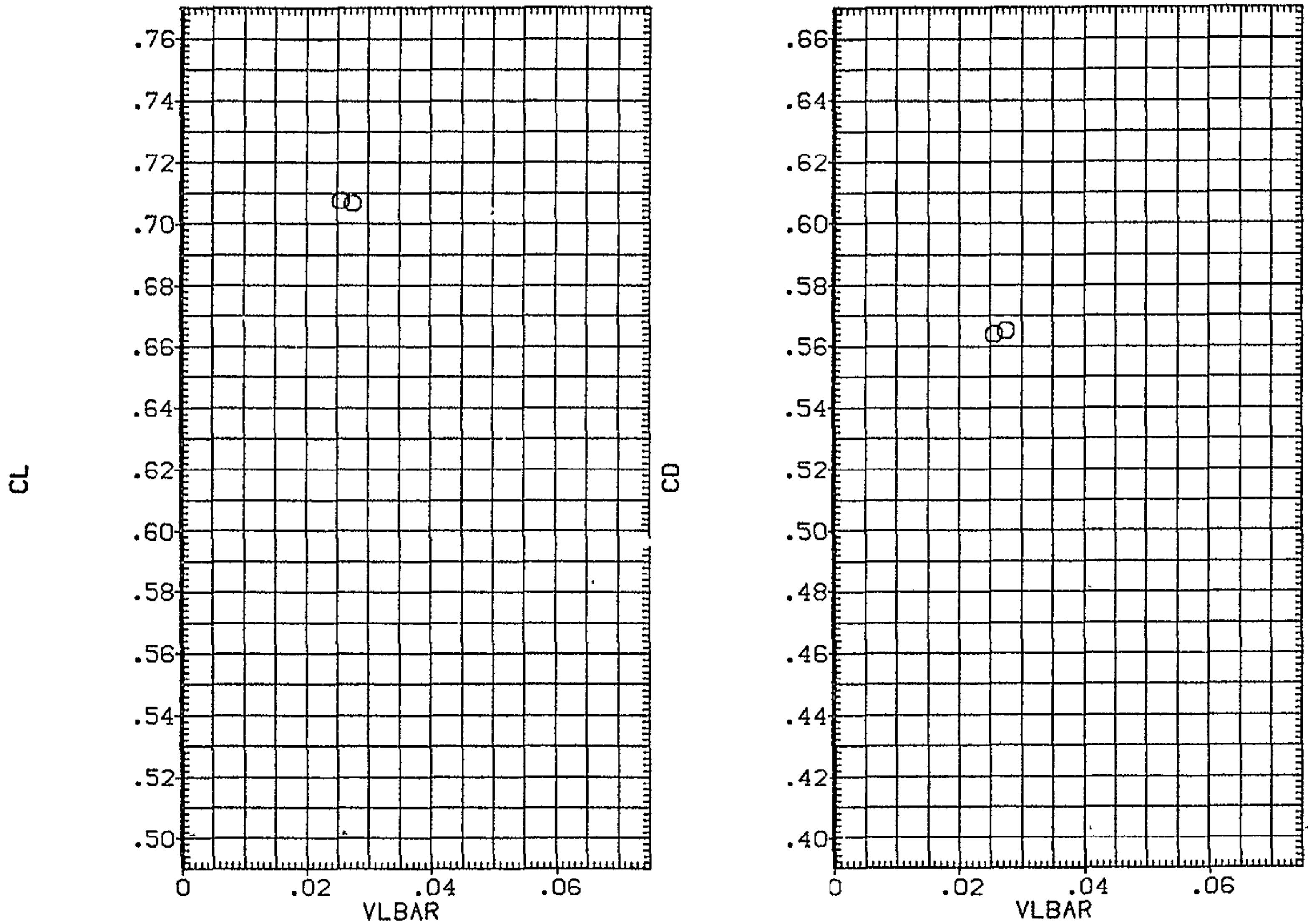


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA013)

SYMBOL	MACH	PARAMETRIC VALUES			
○	18.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.330

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474 8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

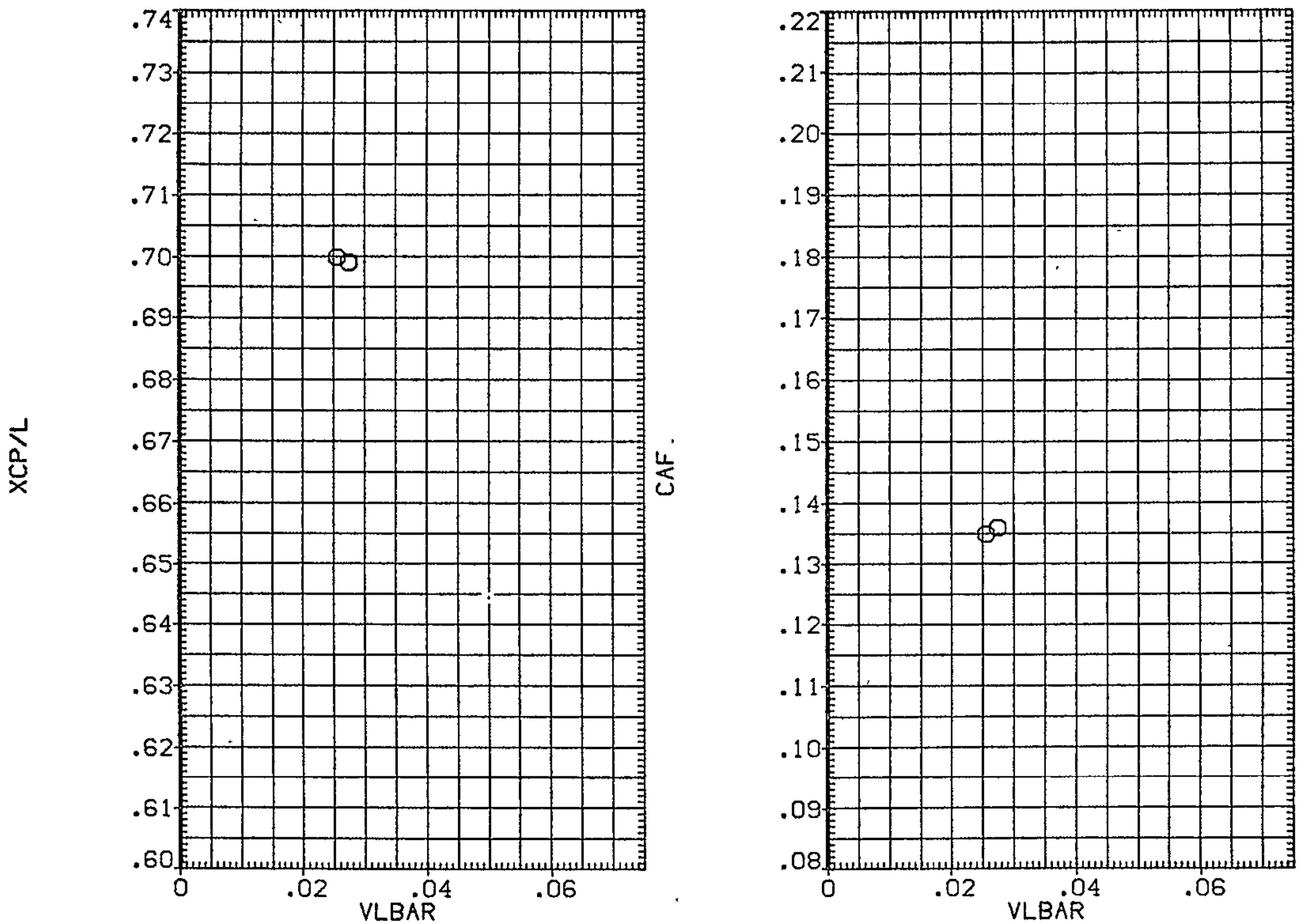


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA013)

SYMBOL	MACH		PARAMETRIC VALUES		
O	18.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.330

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

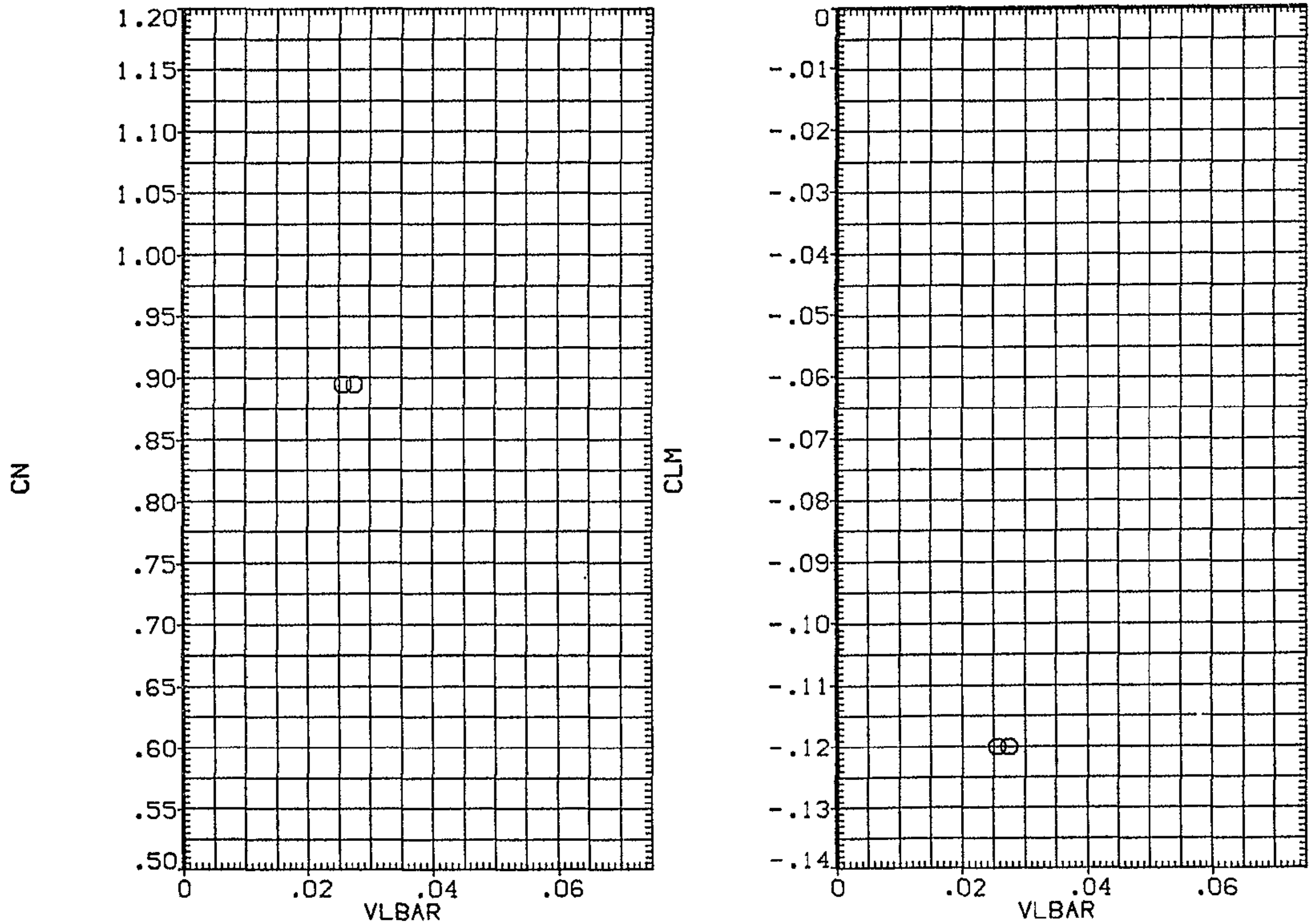


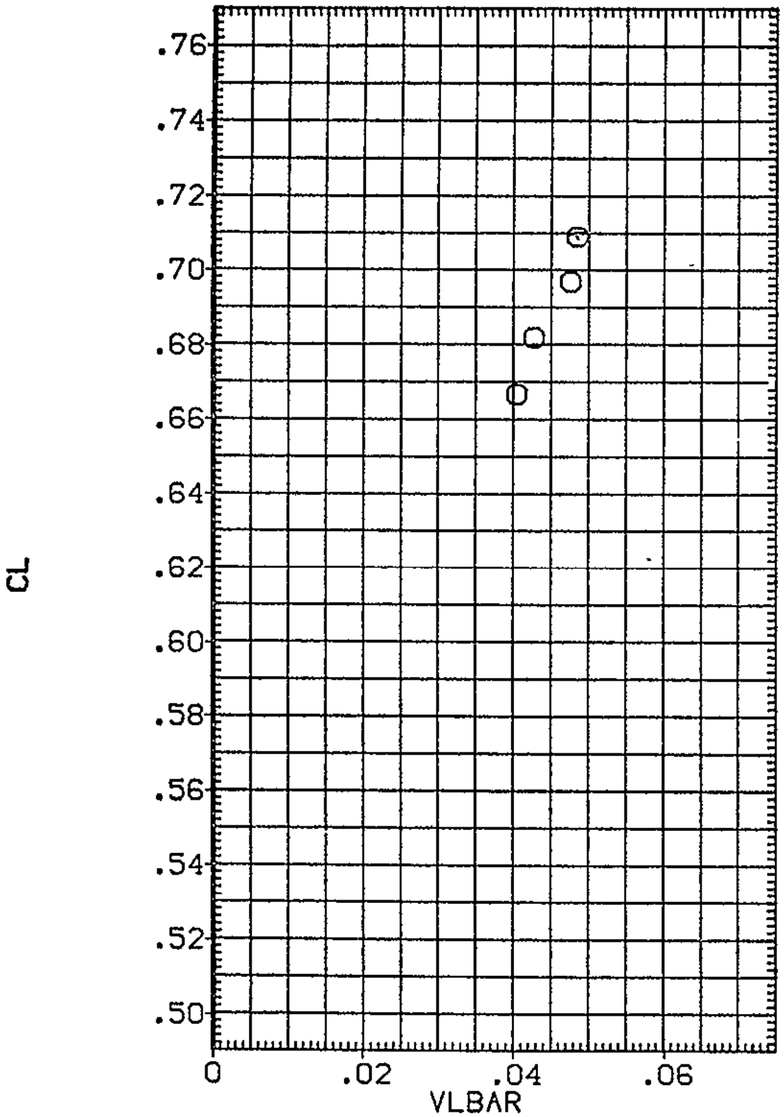
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160, (V41F-28A)   (B26C9F7M7N28)(W116E26)(V8R5)(AVA012)

SYMBOL	MACH		PARAMETRIC VALUES		
○	18.700	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN ZO
SCALE	.0100	



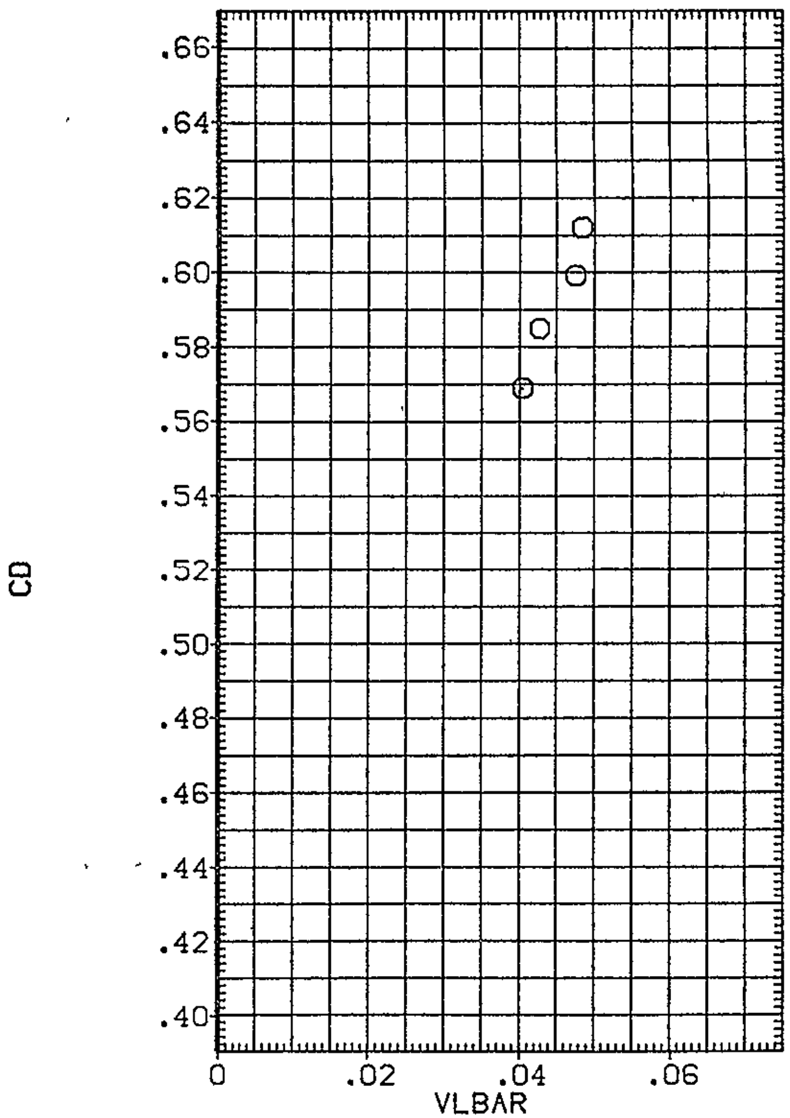


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA012)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.700	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

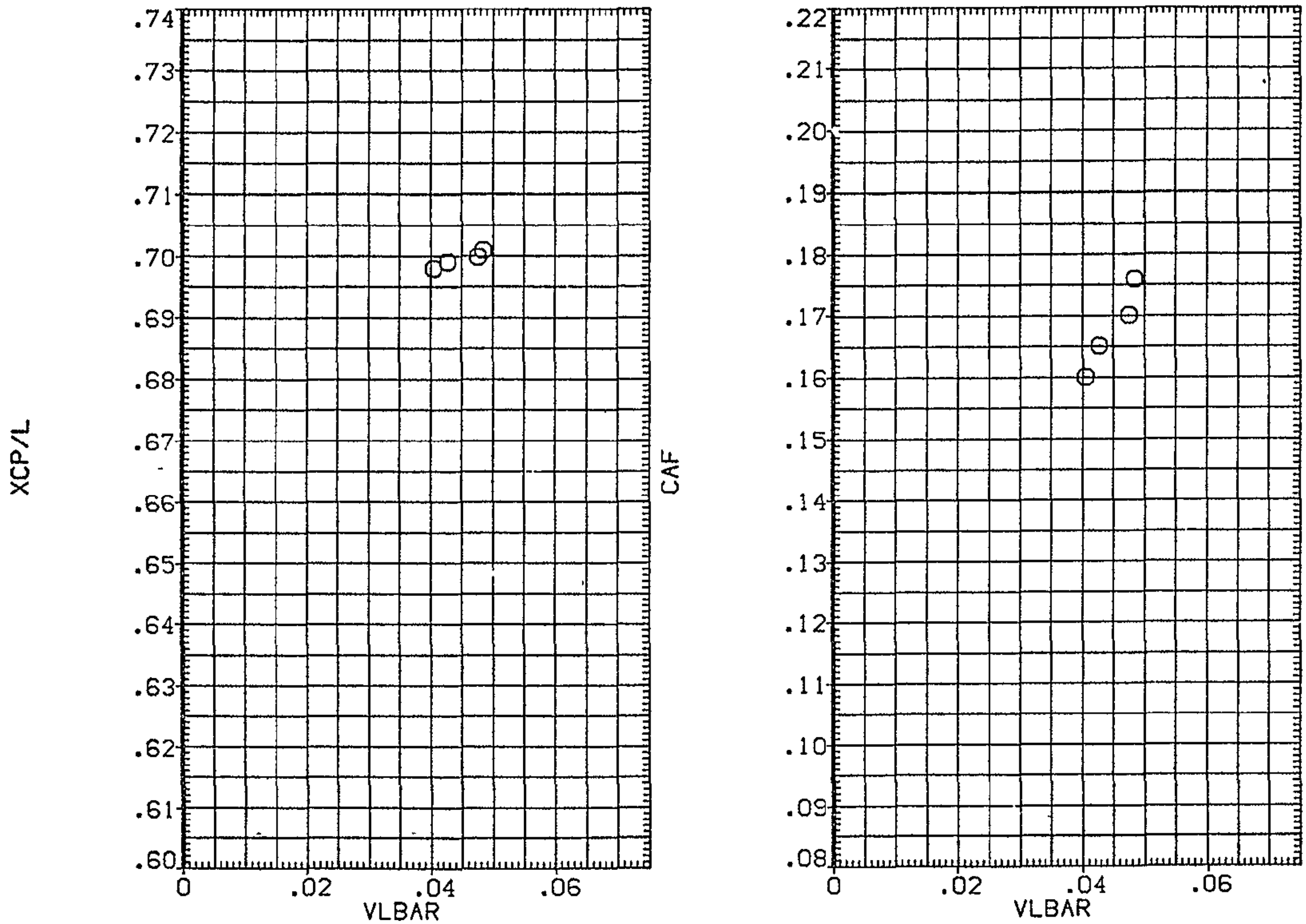


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA012)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.700	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

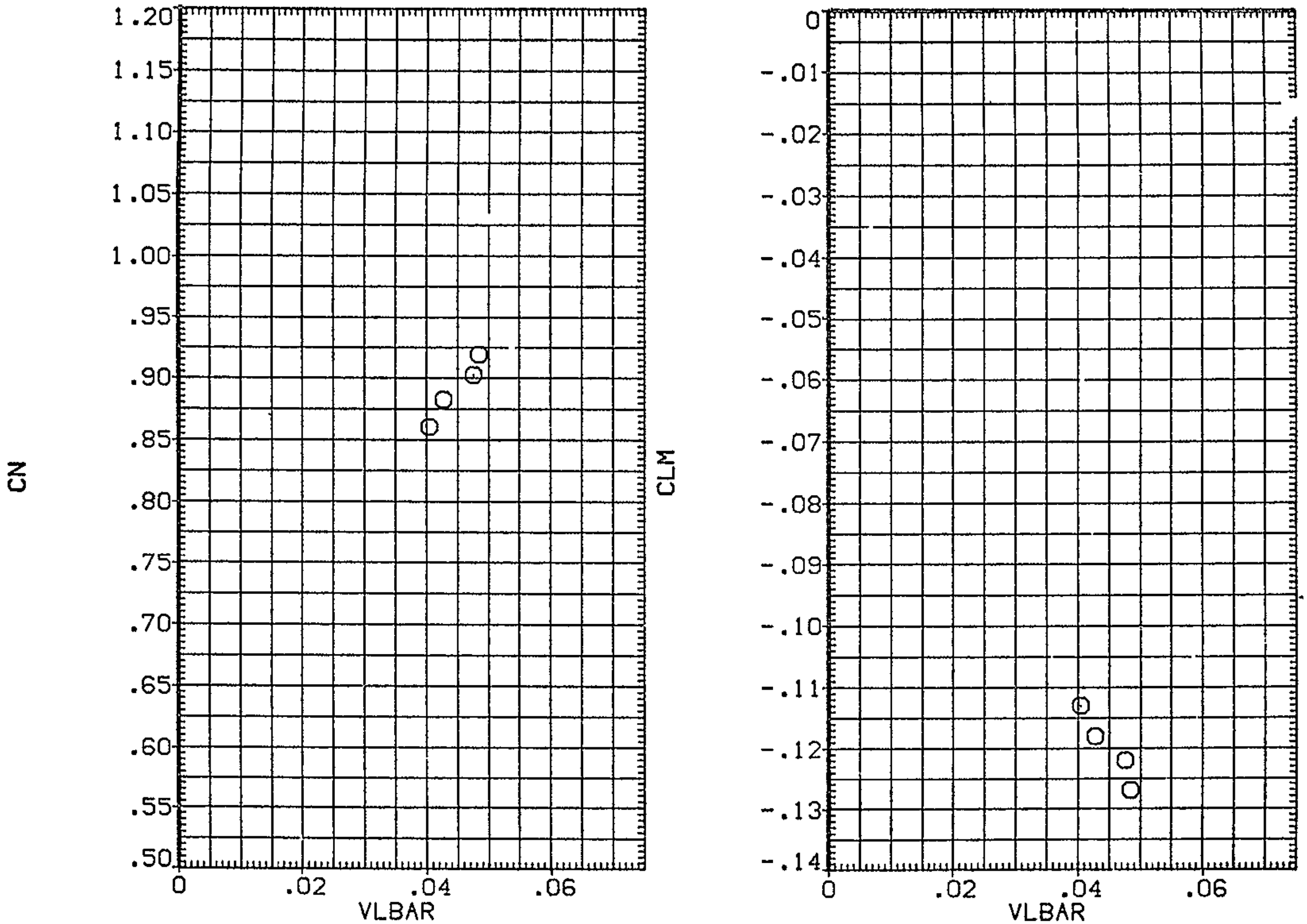


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA011)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.200	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.290

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

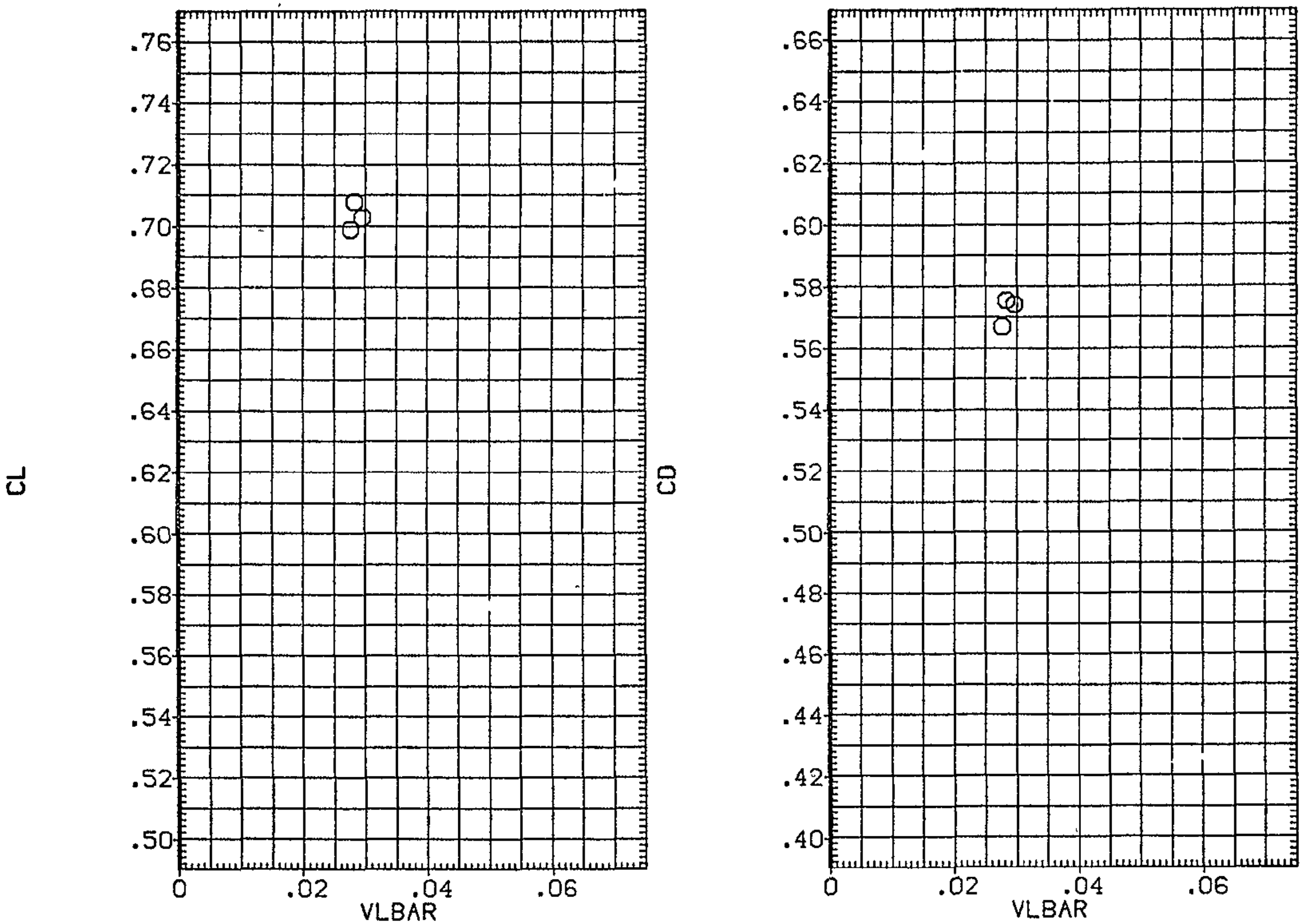


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C3F7M7N28)(W116E26)(V8R5)(AVA011)

SYMBOL	MACH		PARAMETRIC VALUES		
O	18.200	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.290

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

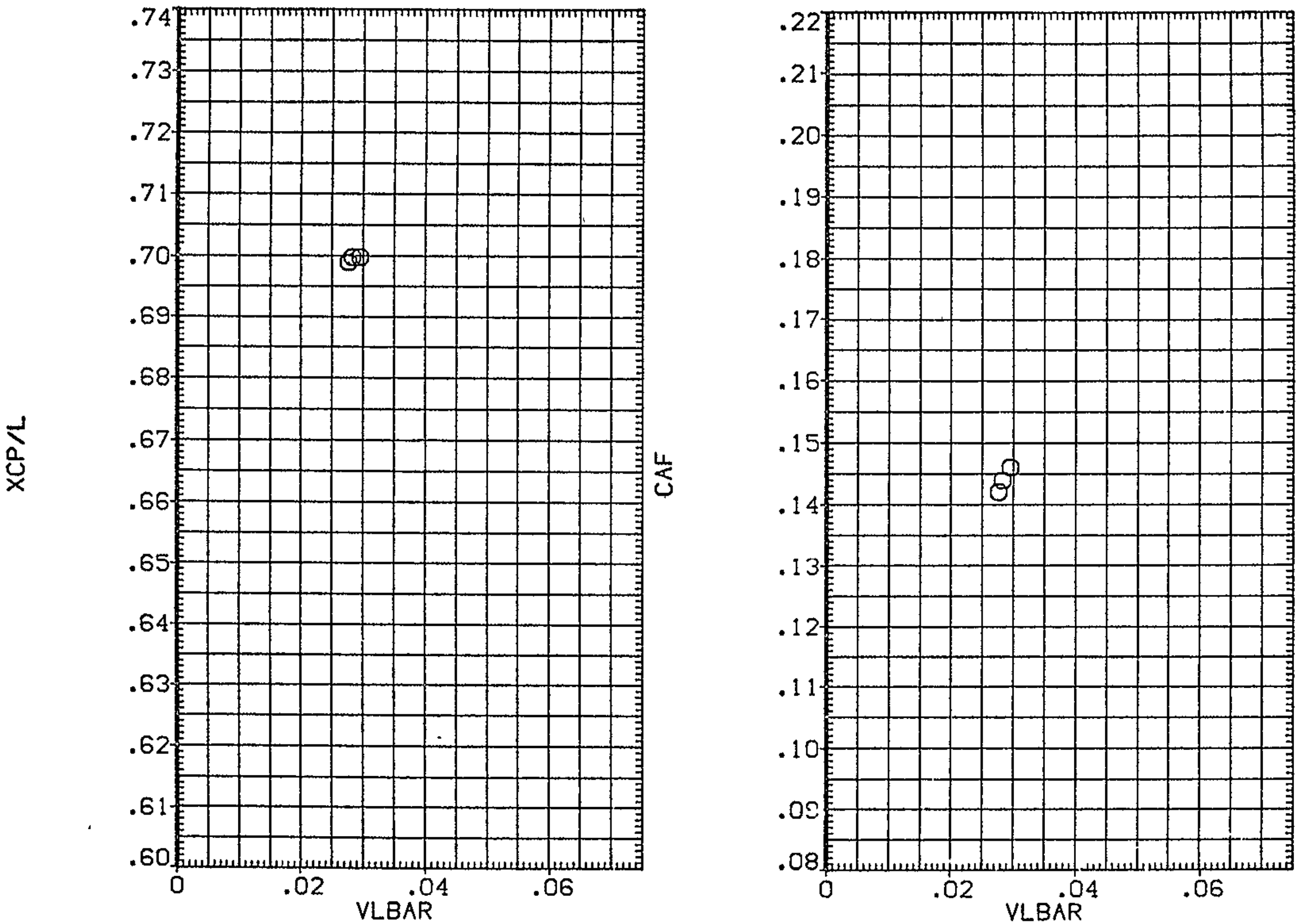


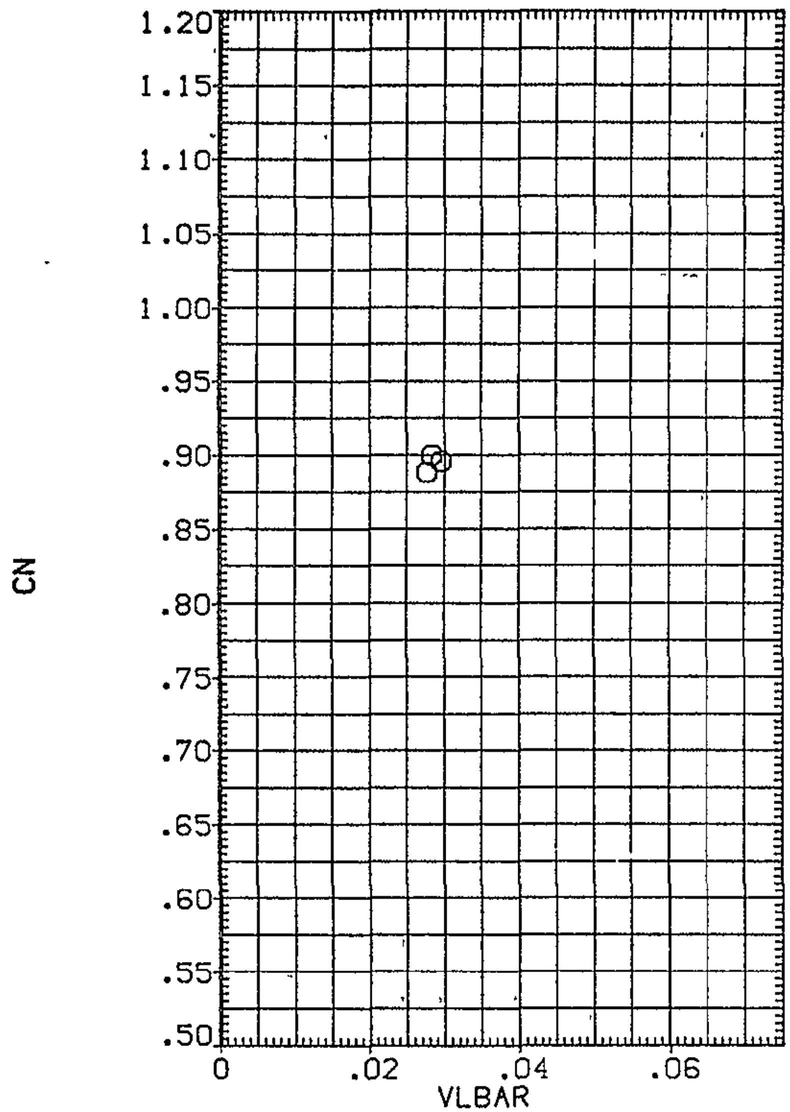
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA011)

SYMBOL	MACH		PARAMETRIC VALUES		
○	18.200	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.290

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



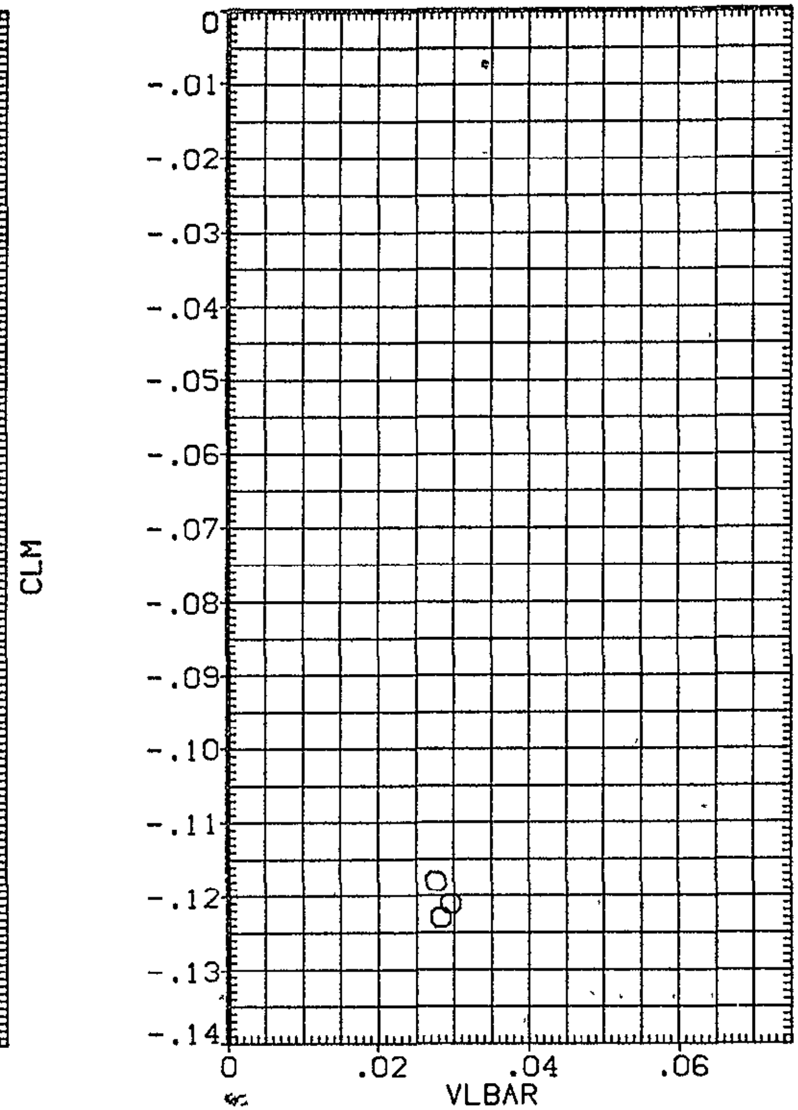


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA010)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.900	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

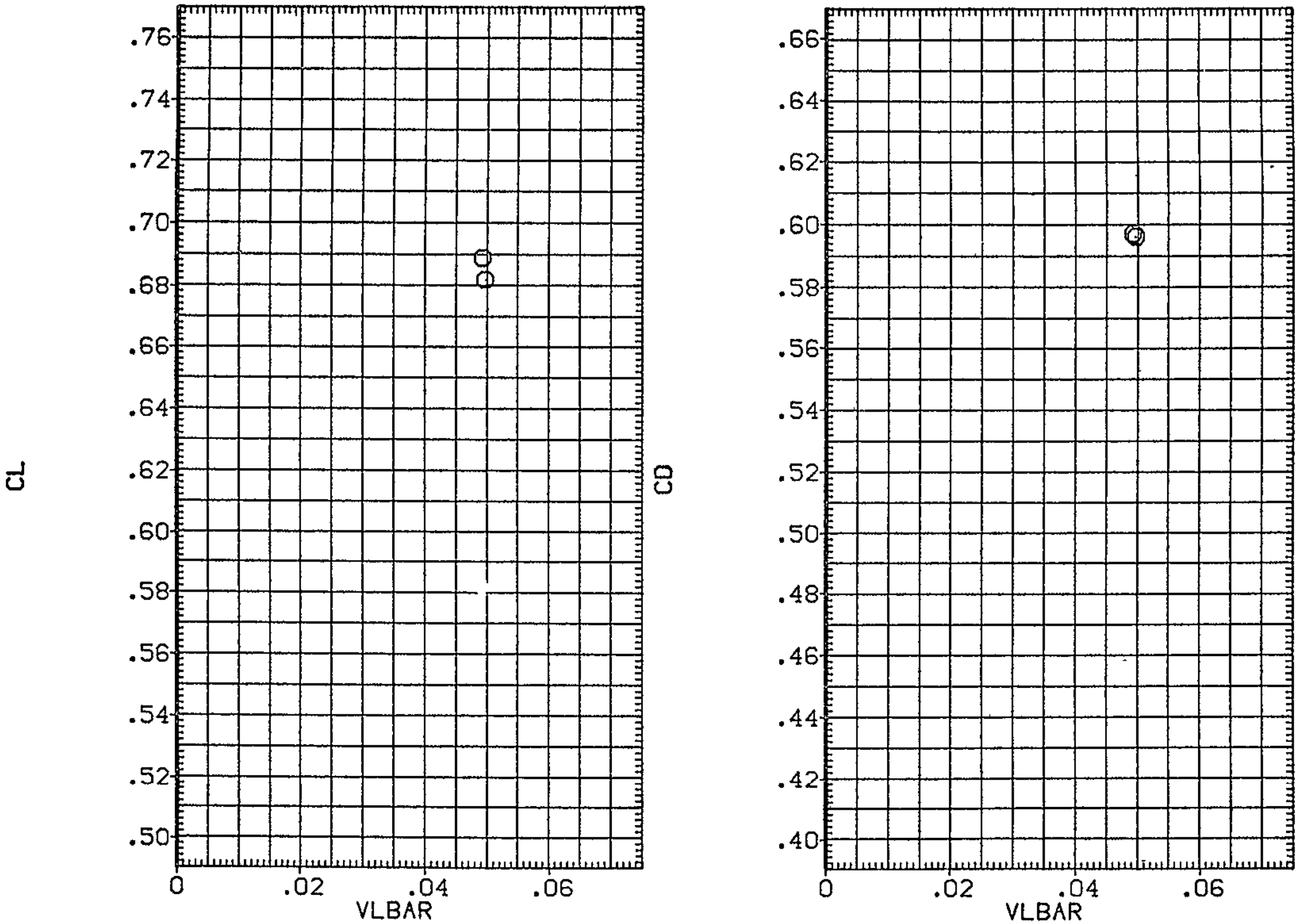


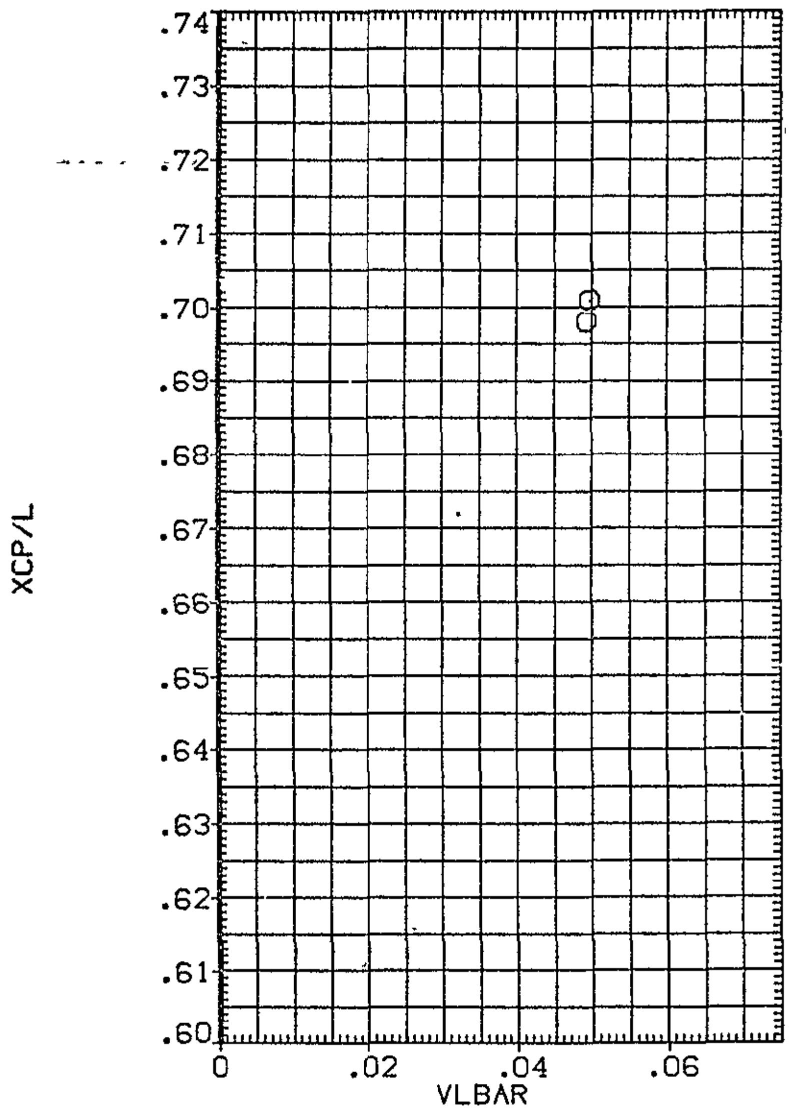
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA010)

SYMBOL	MACH	PARAMETRIC VALUES			
○	18.900	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



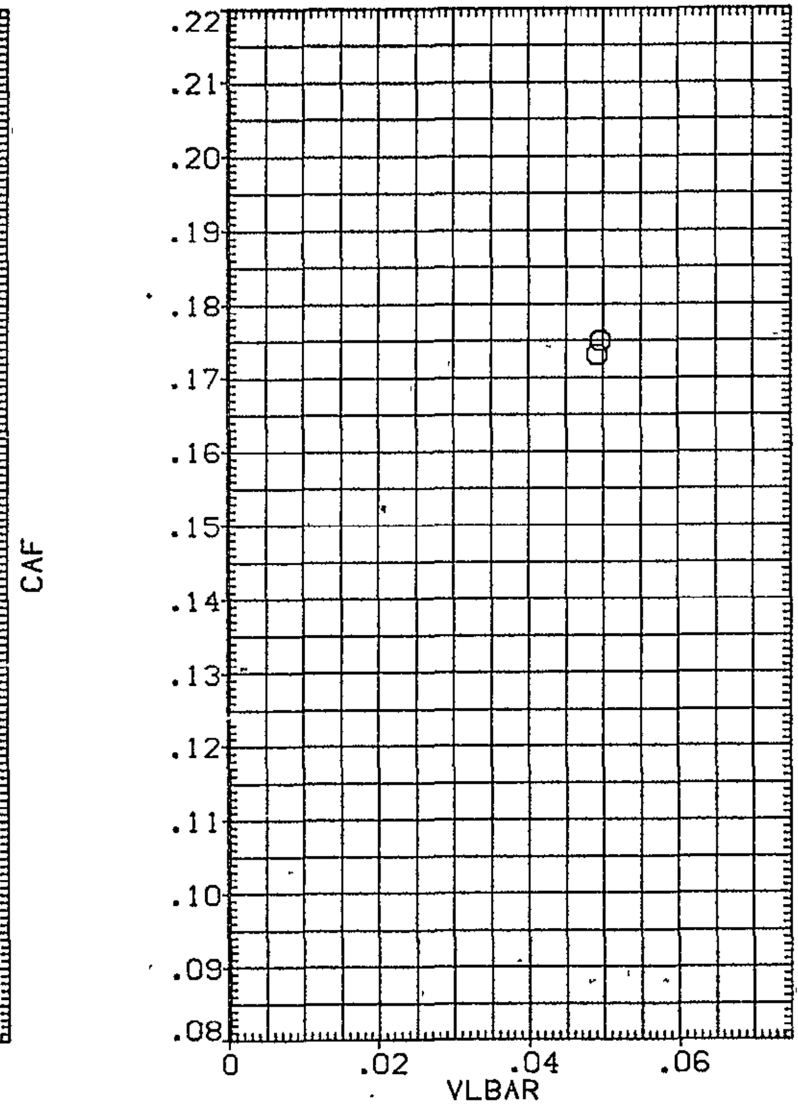


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA010)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.900	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	15.000
		BDFLAP	16.300	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

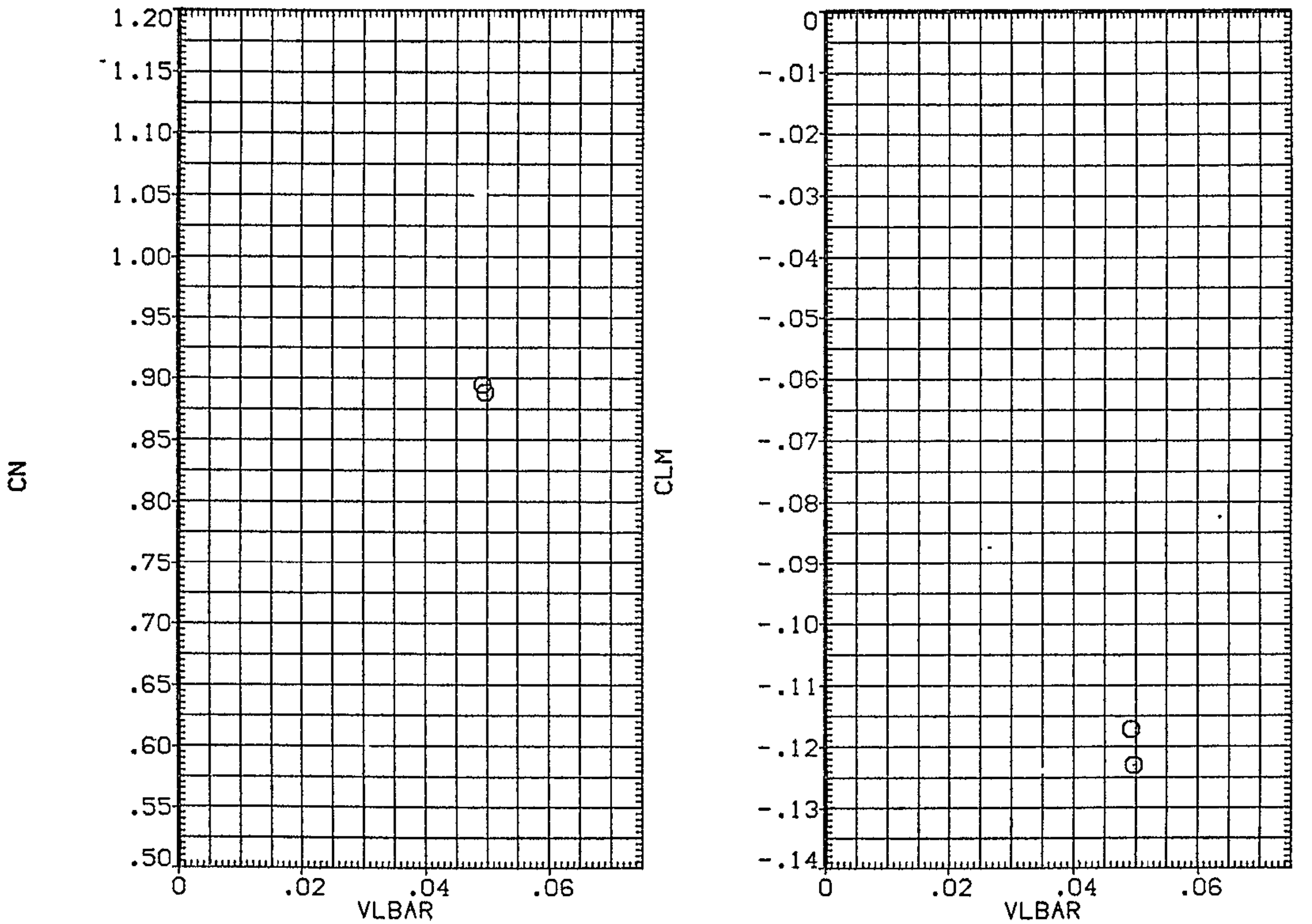


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.900	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.350

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

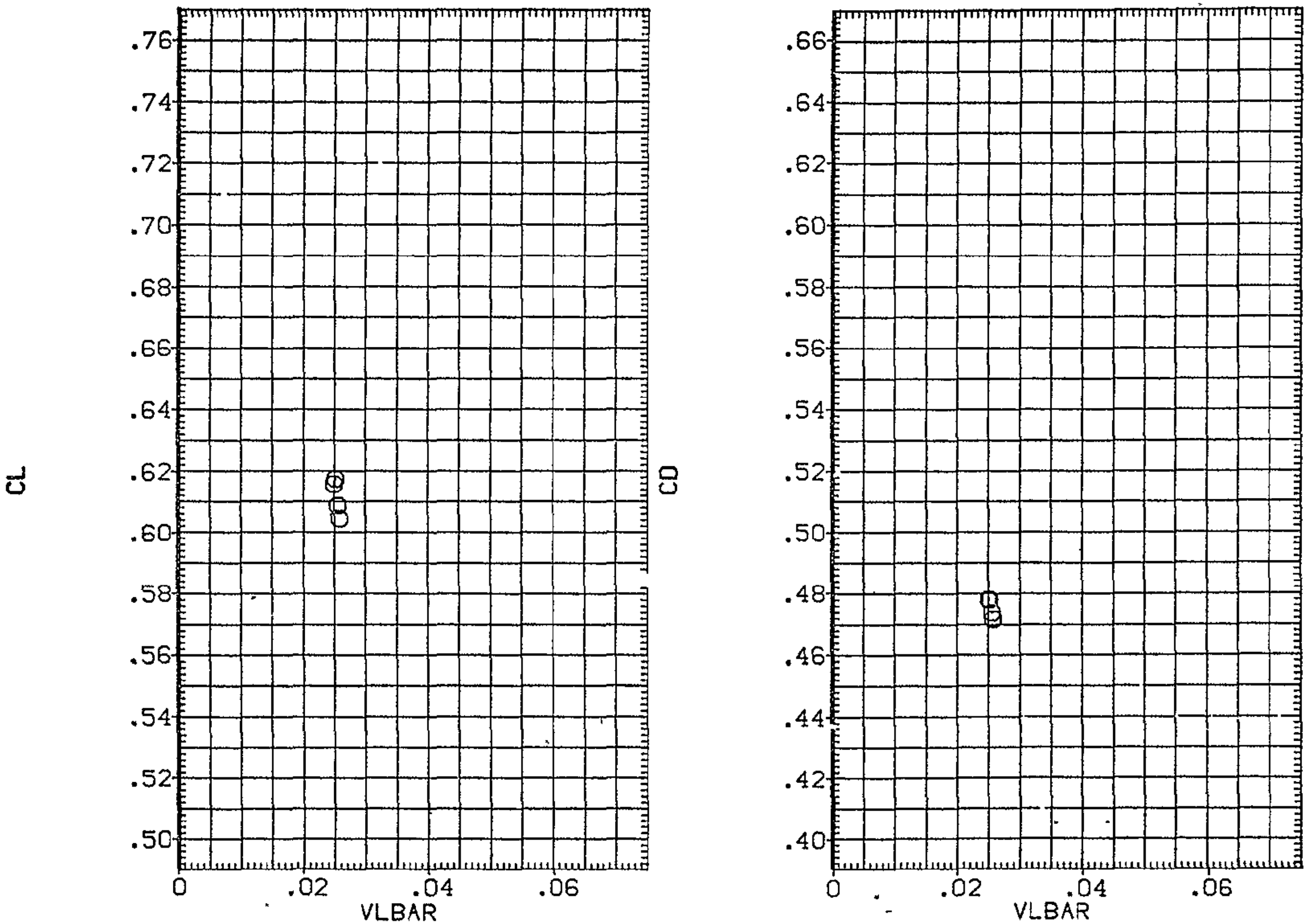


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA009)

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.900	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.350

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

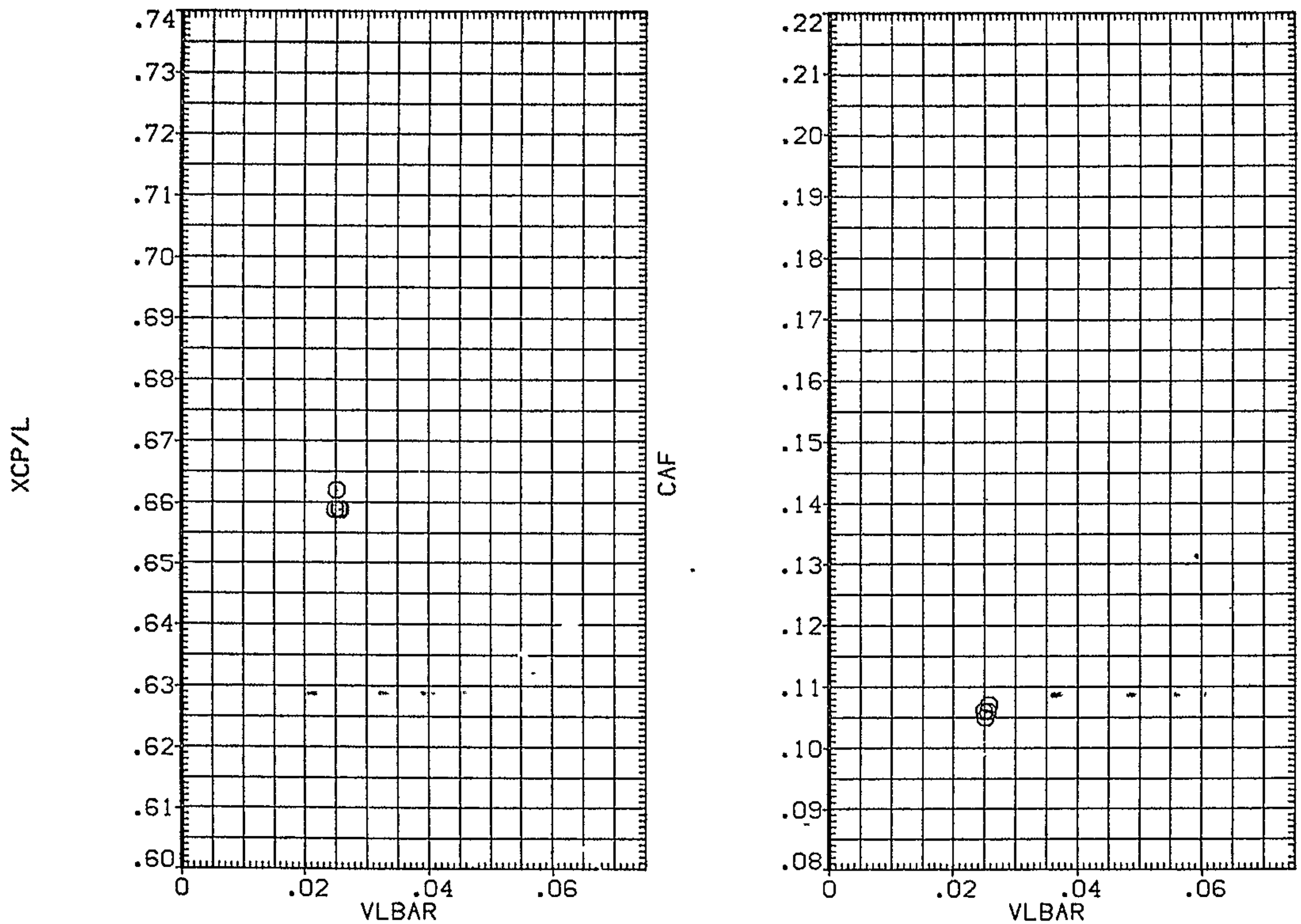


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA009)

SYMBOL	MACH	PARAMETRIC VALUES			
O	17.900	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.350

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

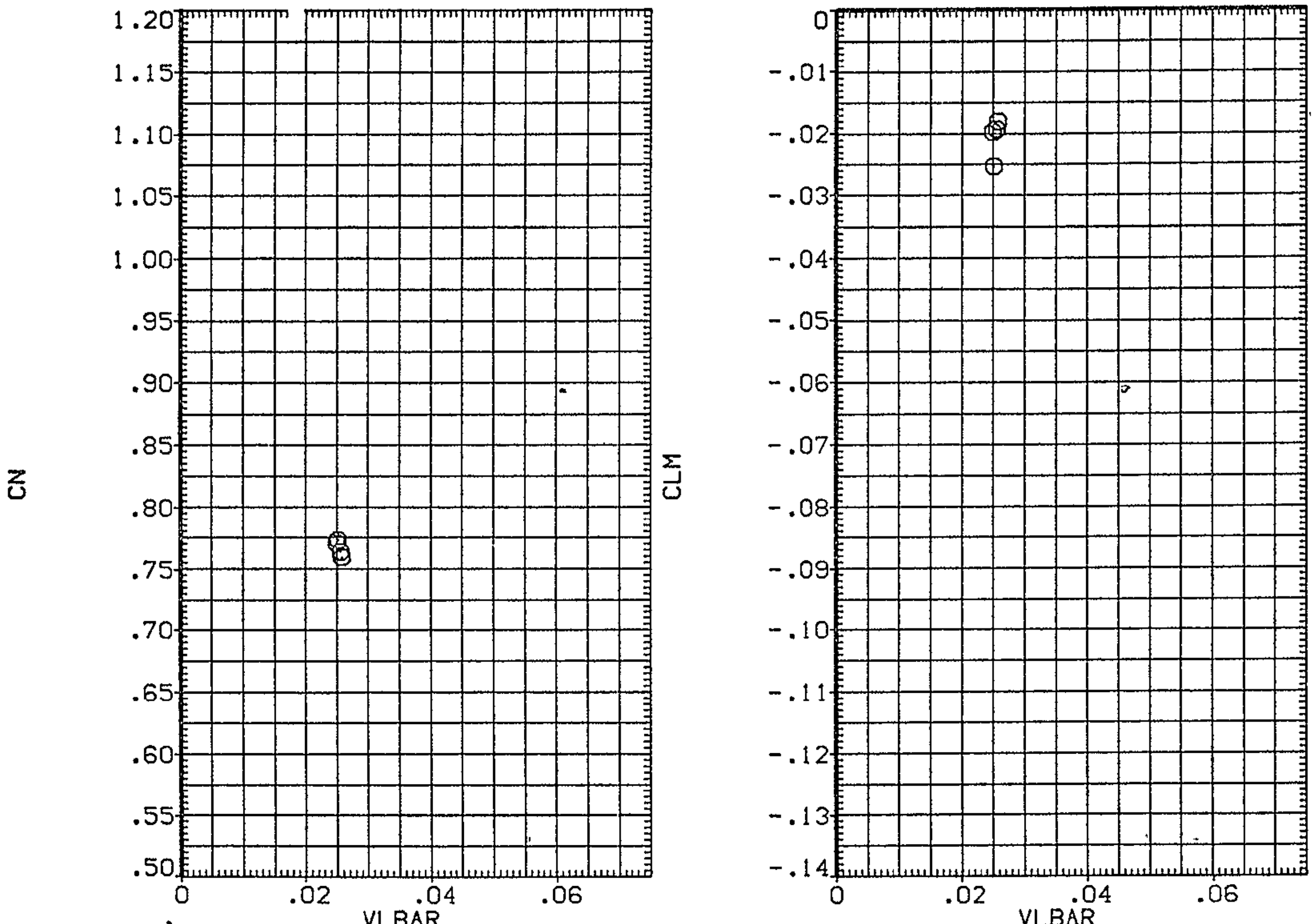


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA008)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.200	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.260

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

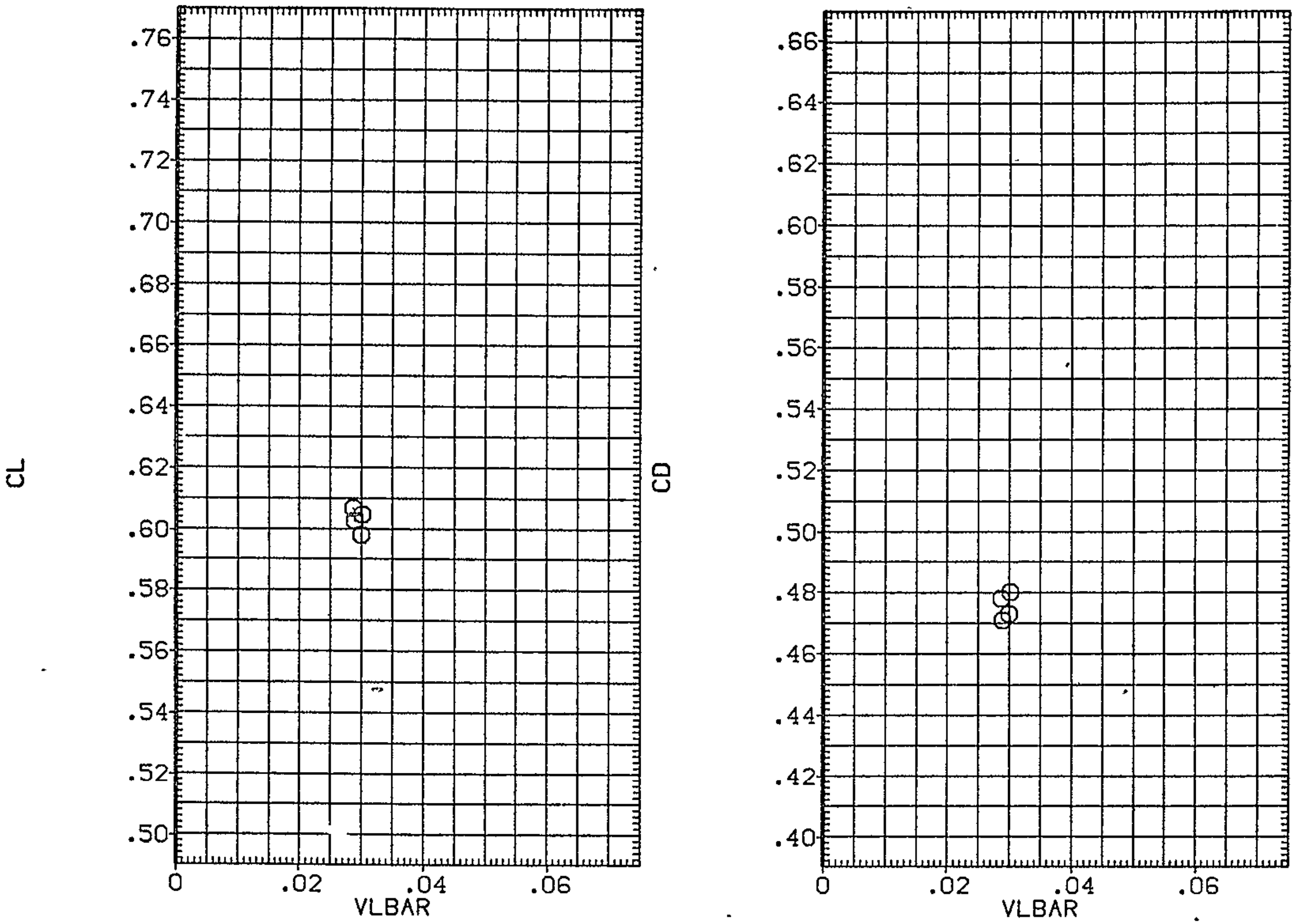


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA008)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.200	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.260

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

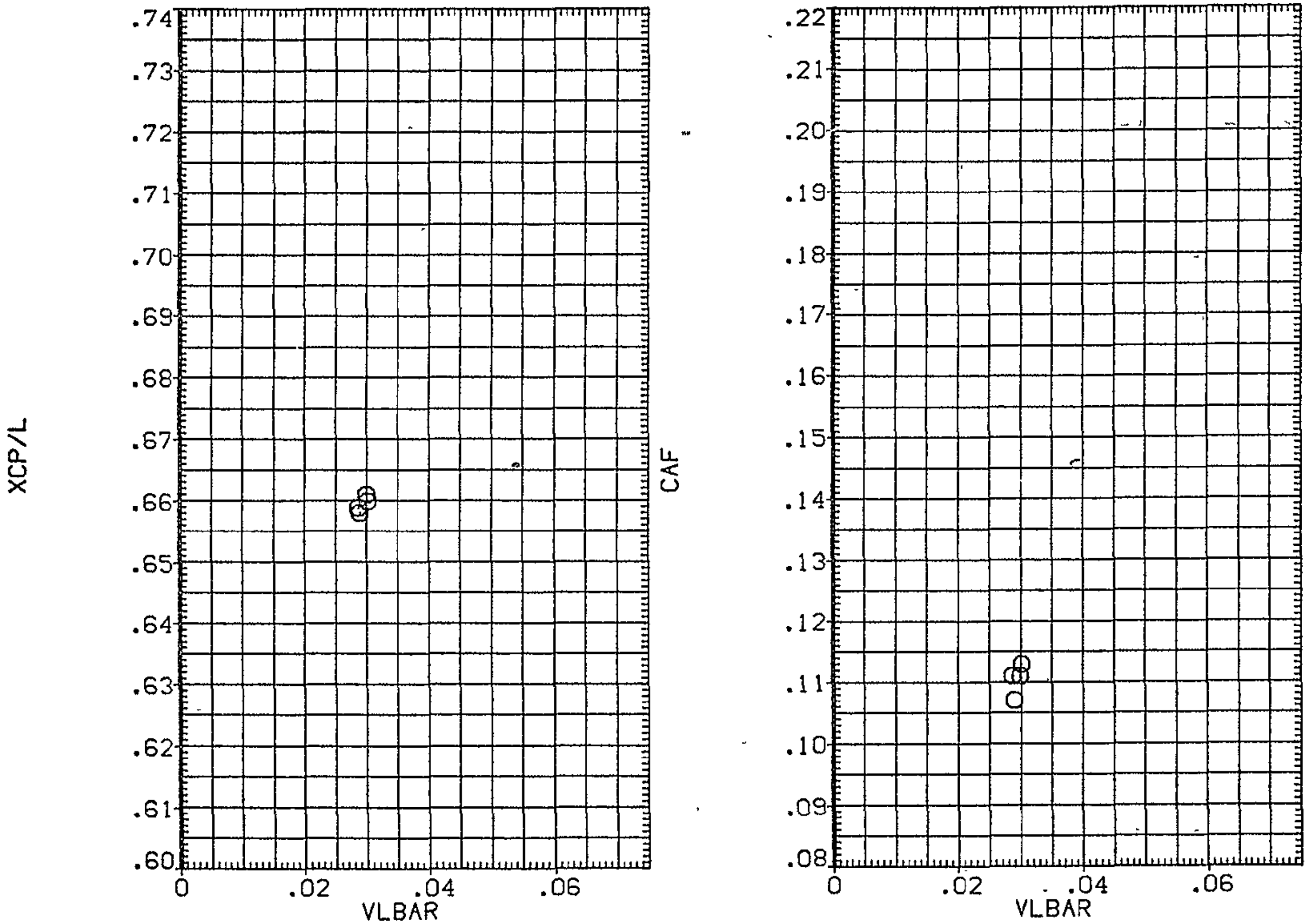


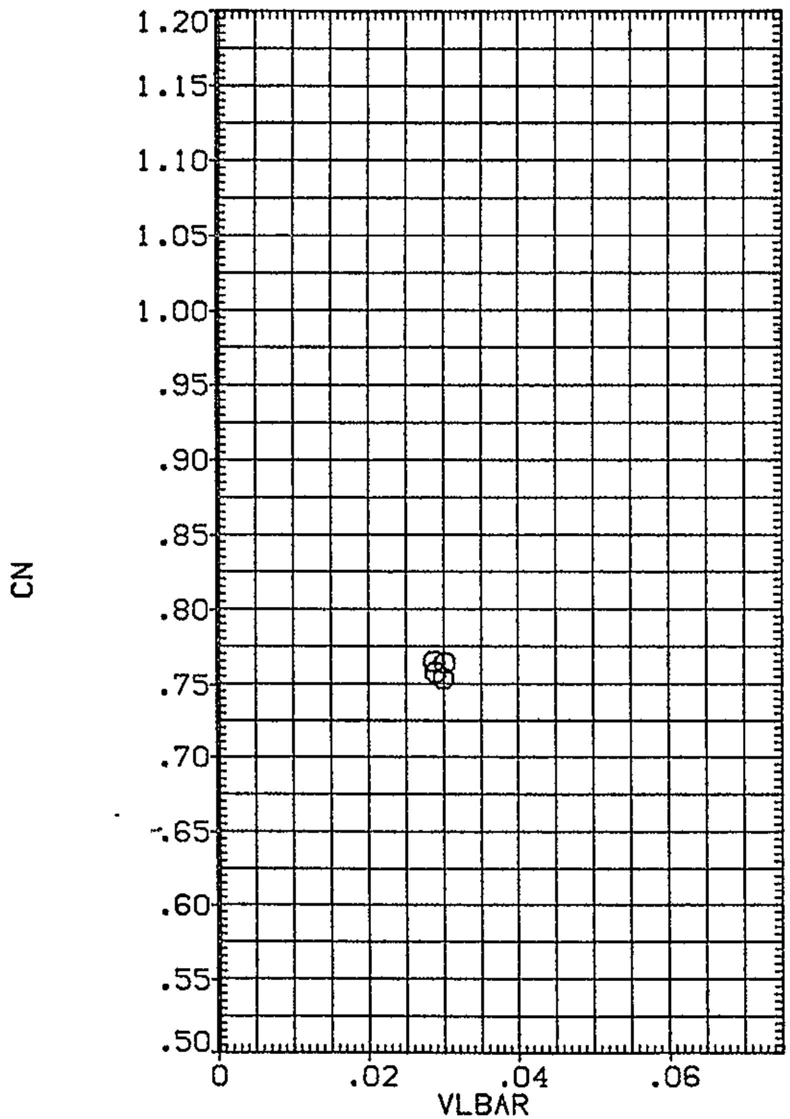
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA008)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.200	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.260

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



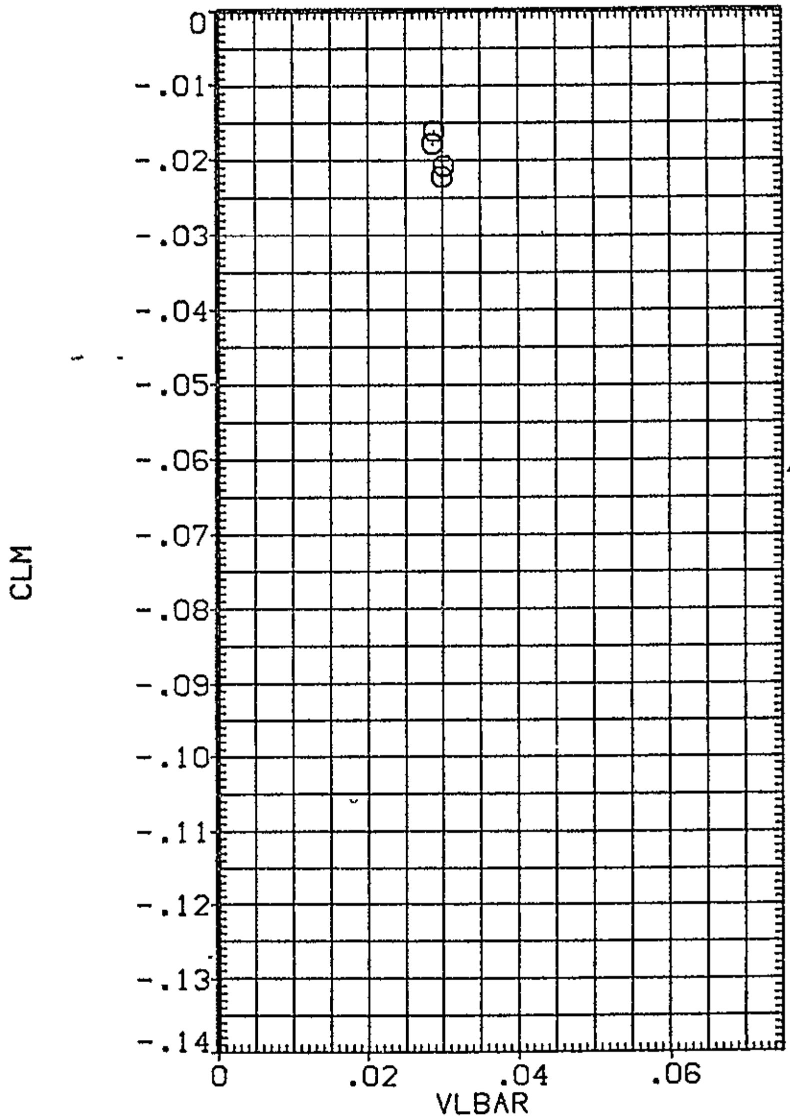


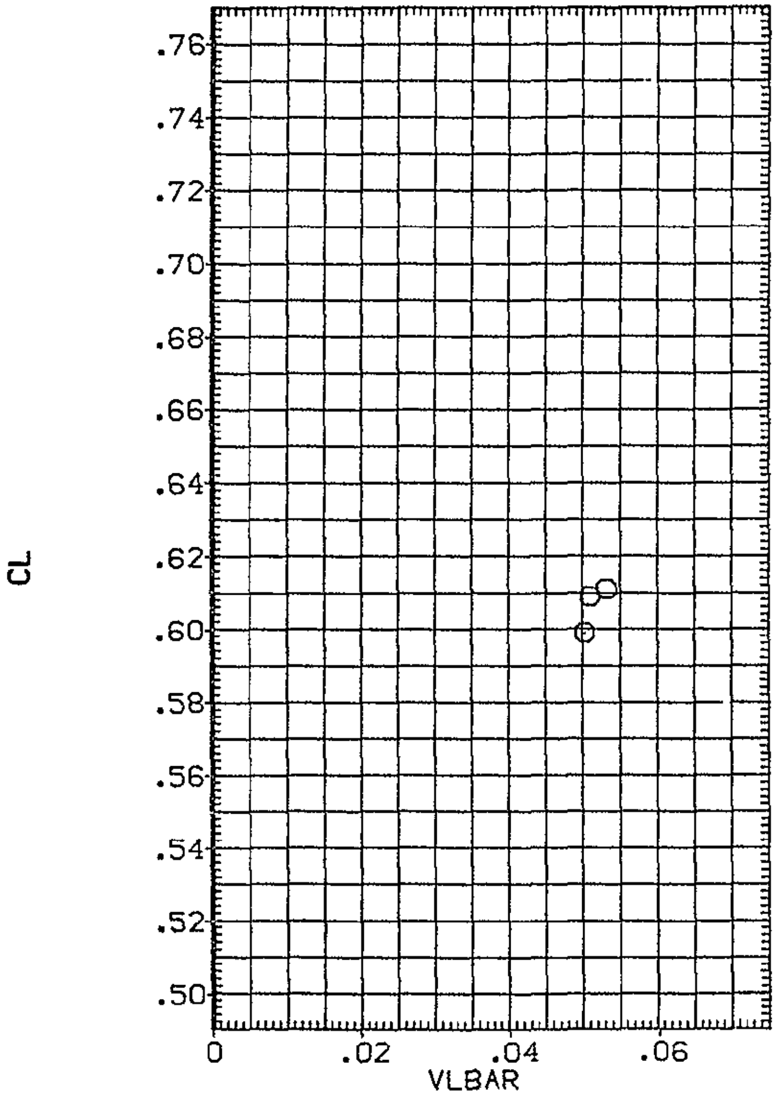
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA007)

SYMBOL	MACH	PARAMETRIC VALUES			
○	20.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.110

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



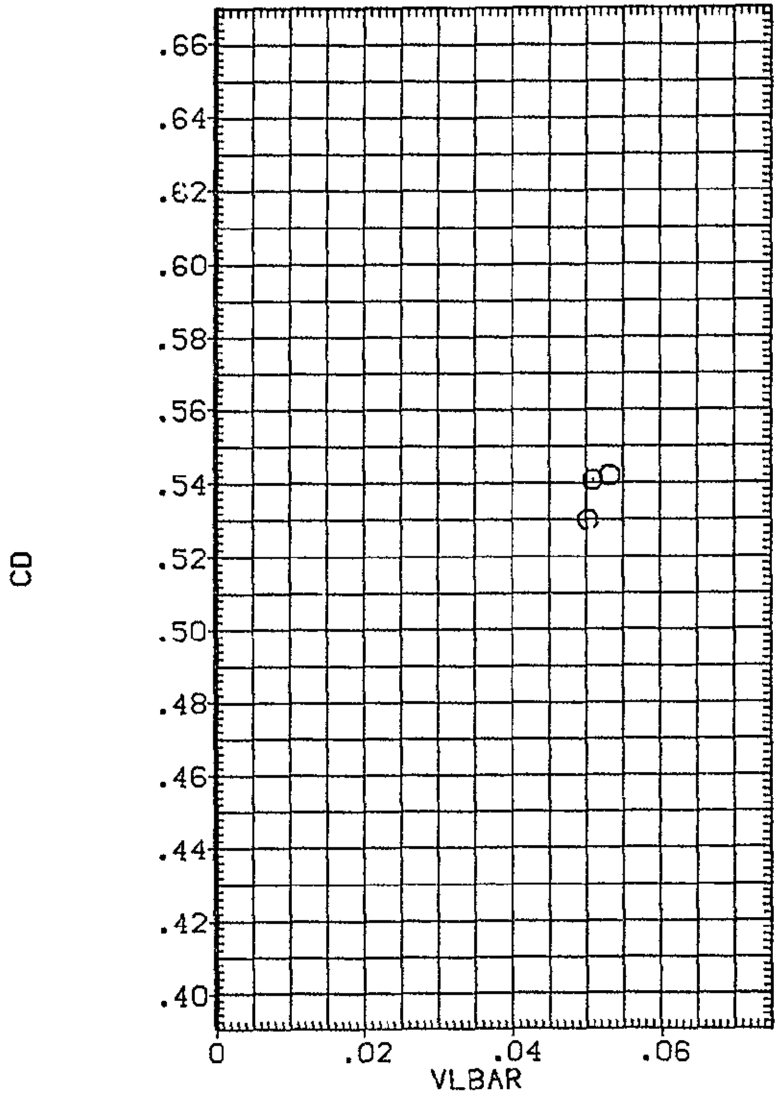


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA007)

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.110

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

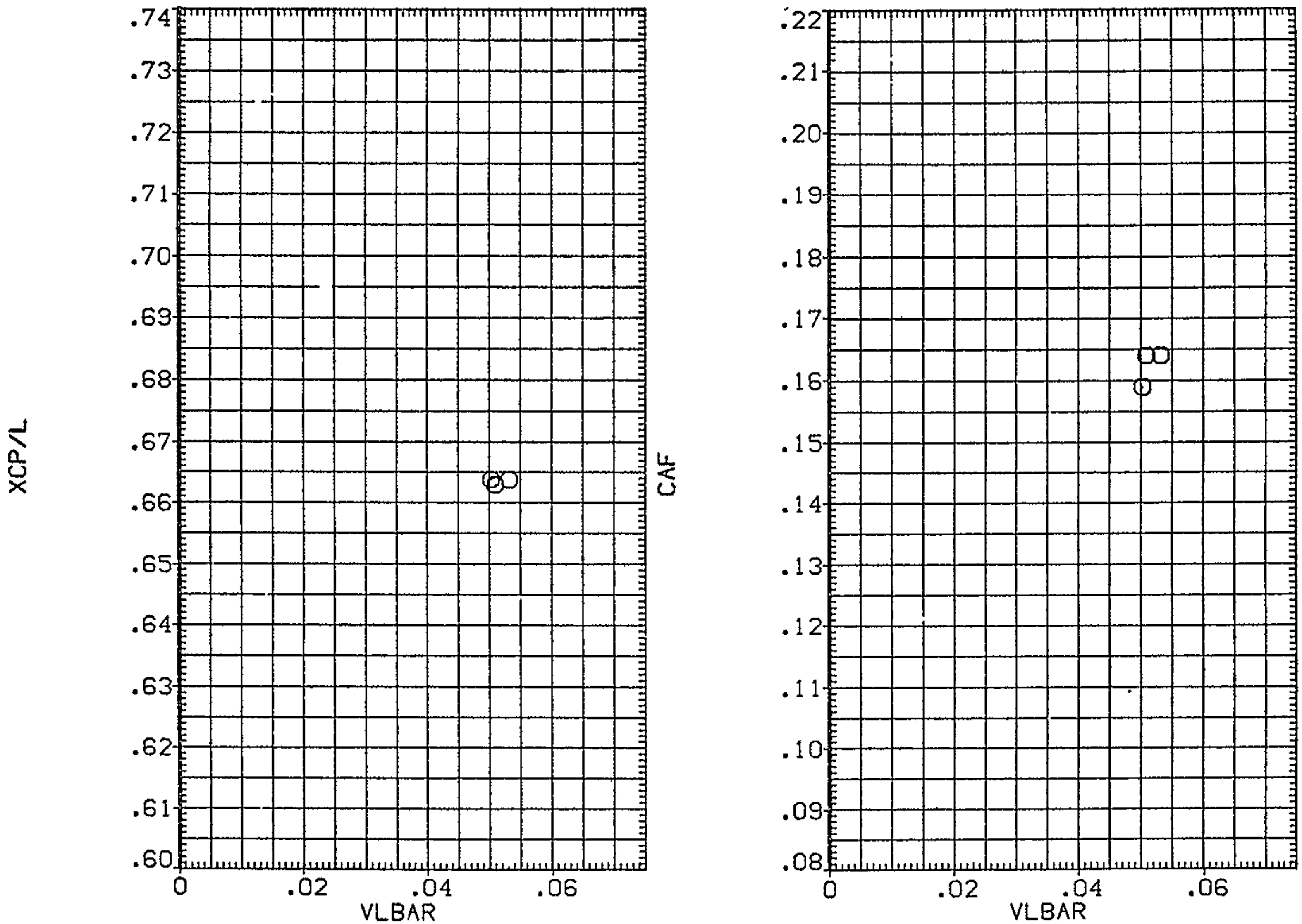


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

SYMBOL	MACH	PARAMETRIC VALUES			
○	20.300	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.110

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

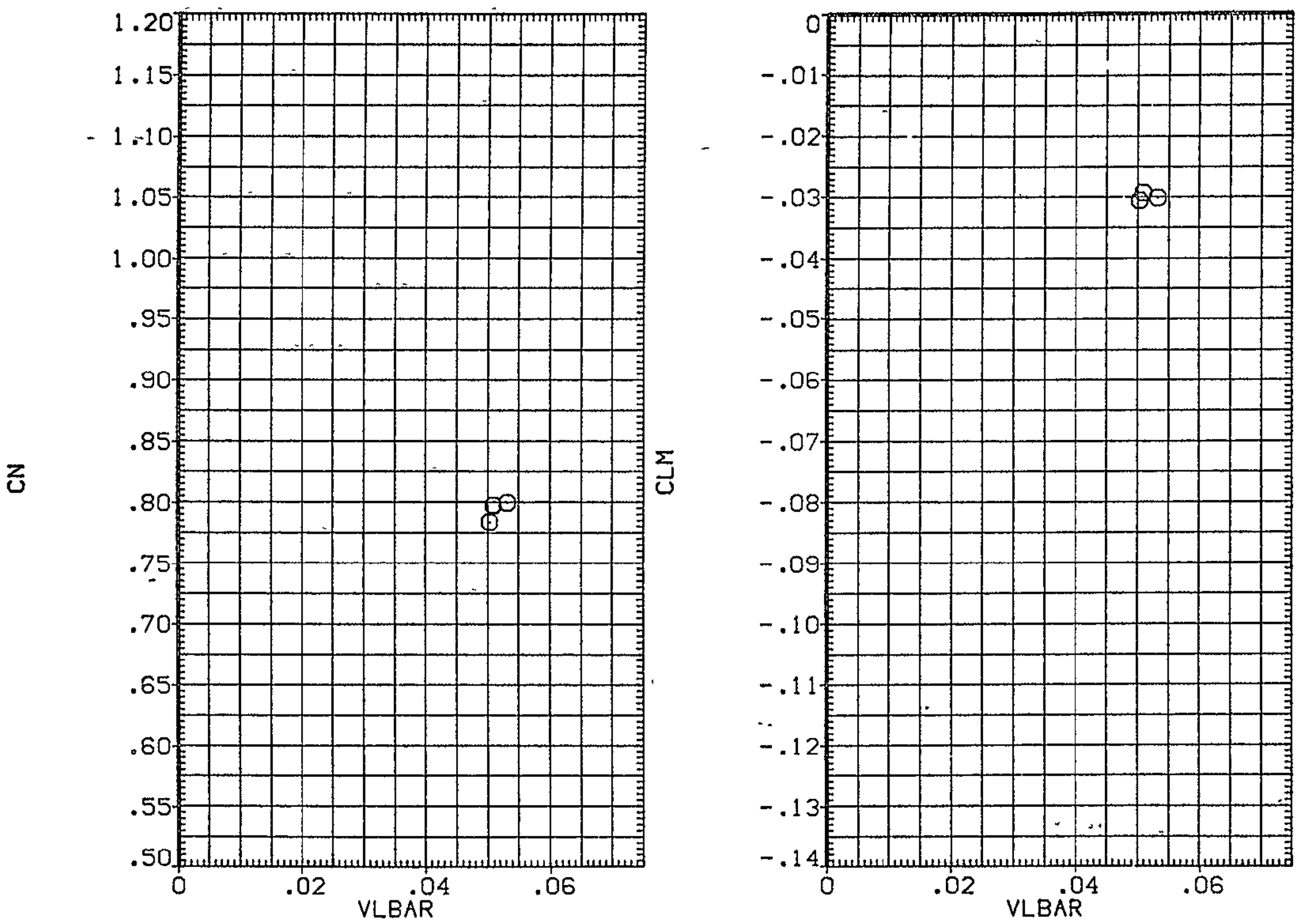


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA006)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.600	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

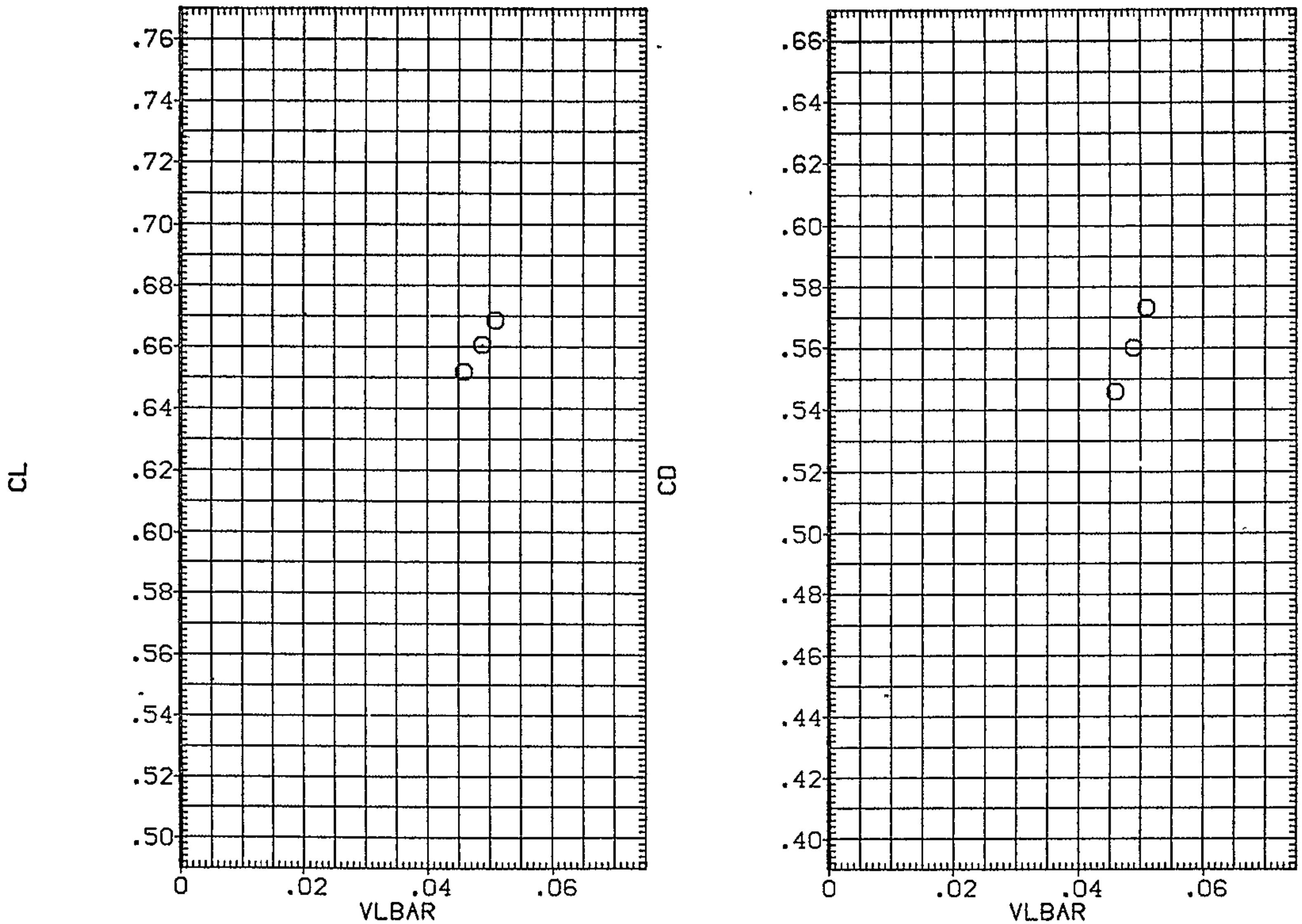


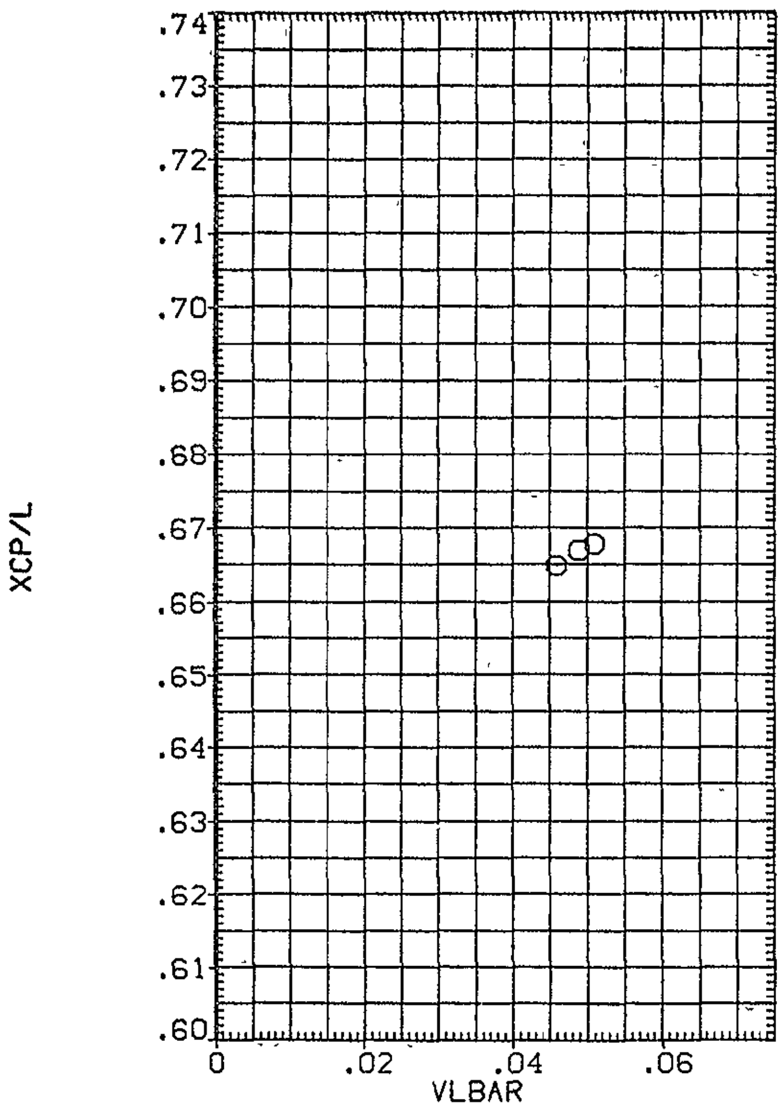
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA006)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.600	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



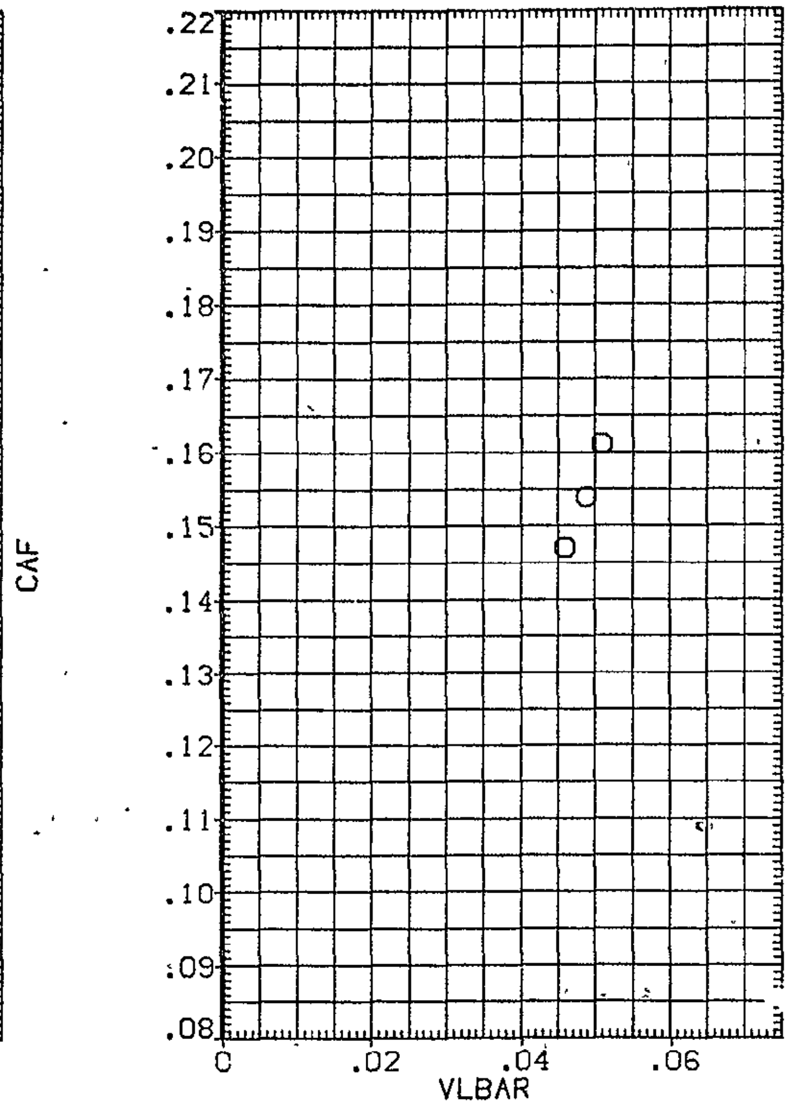


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA006)

SYMBOL	MACH		PARAMETRIC VALUES		
O	18.600	ALPHA	30.000	BETA	.000
		PHI	180.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.100

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

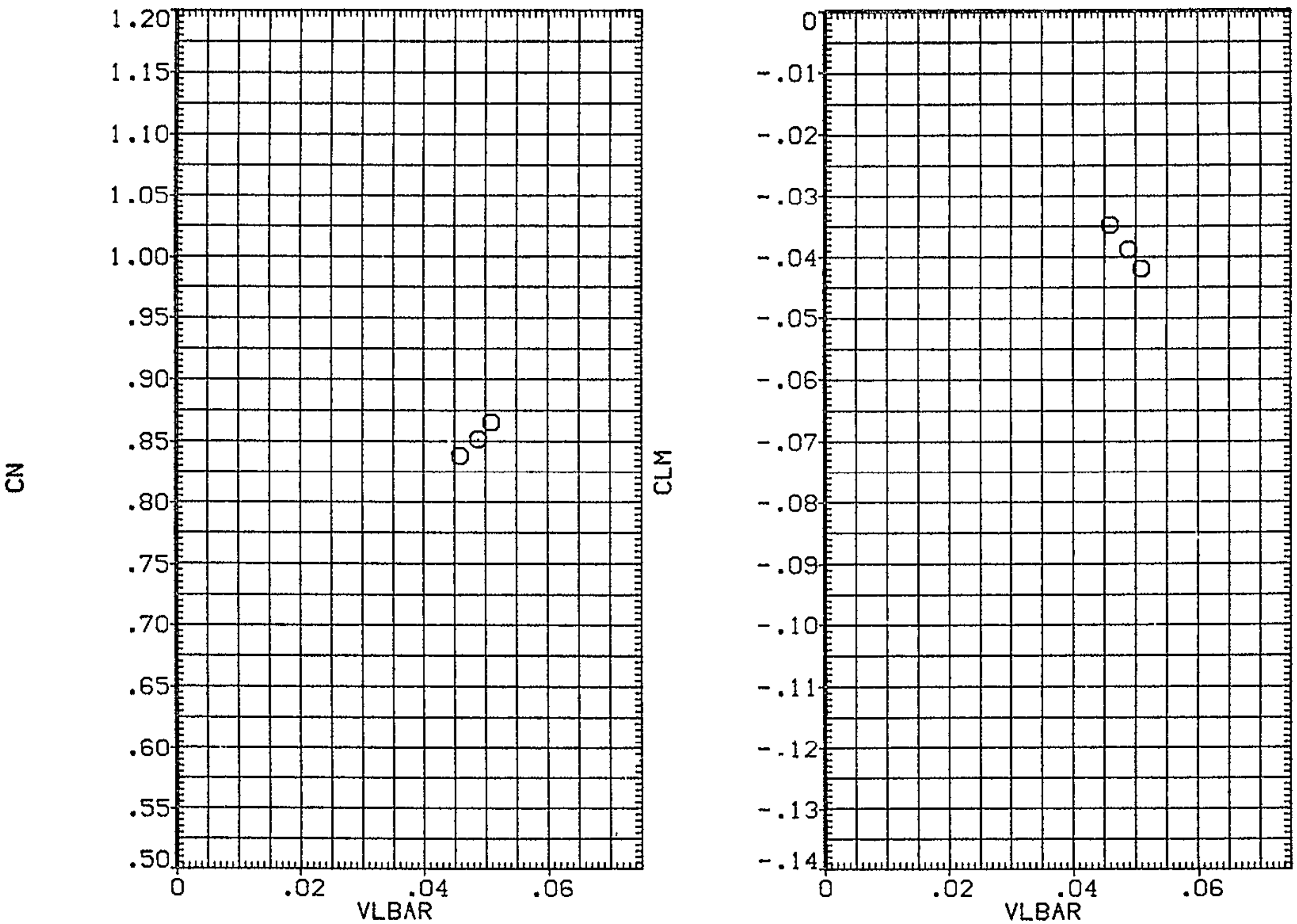


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA005)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.700	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.430

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

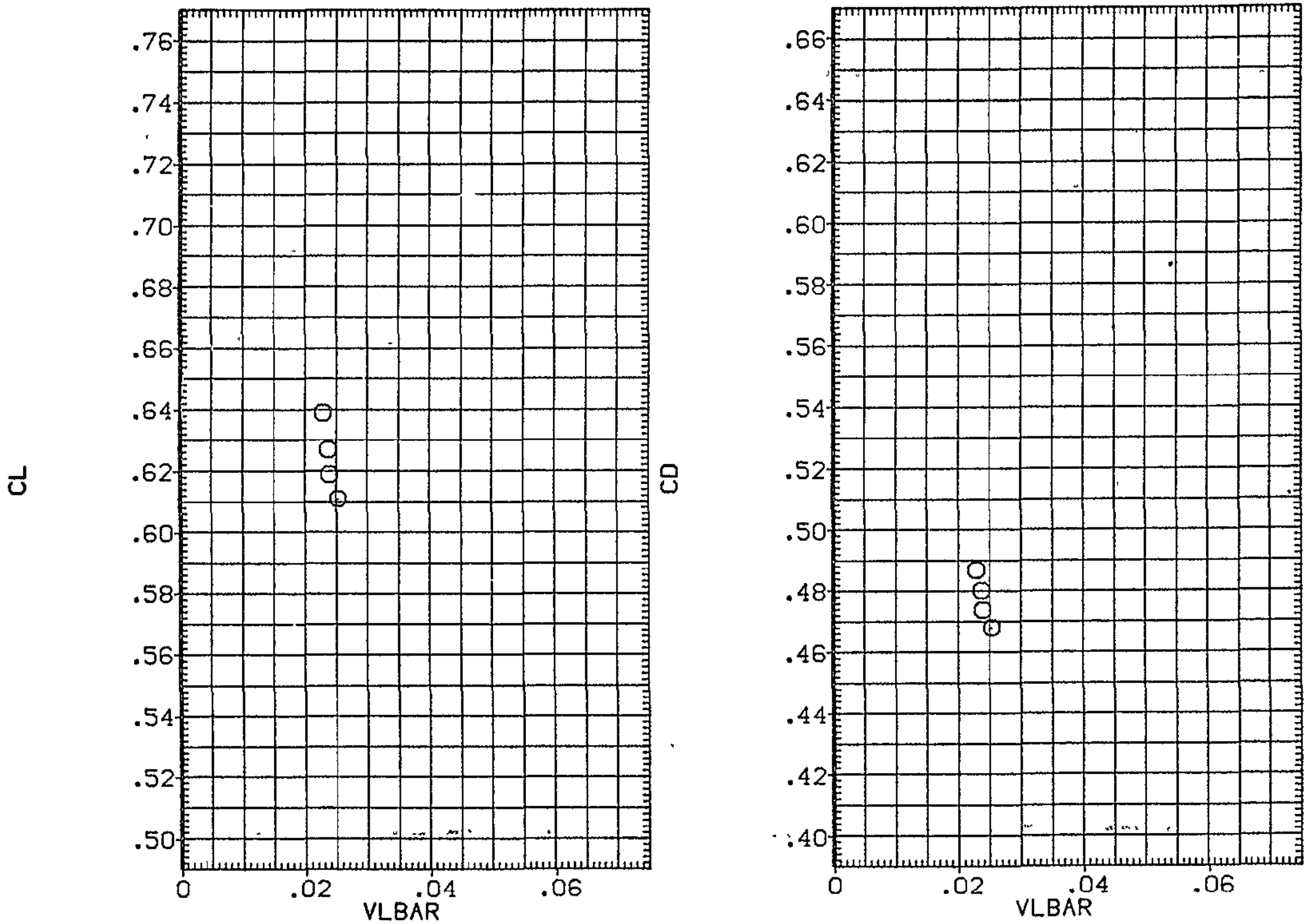


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

OA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA005)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.700	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.430

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

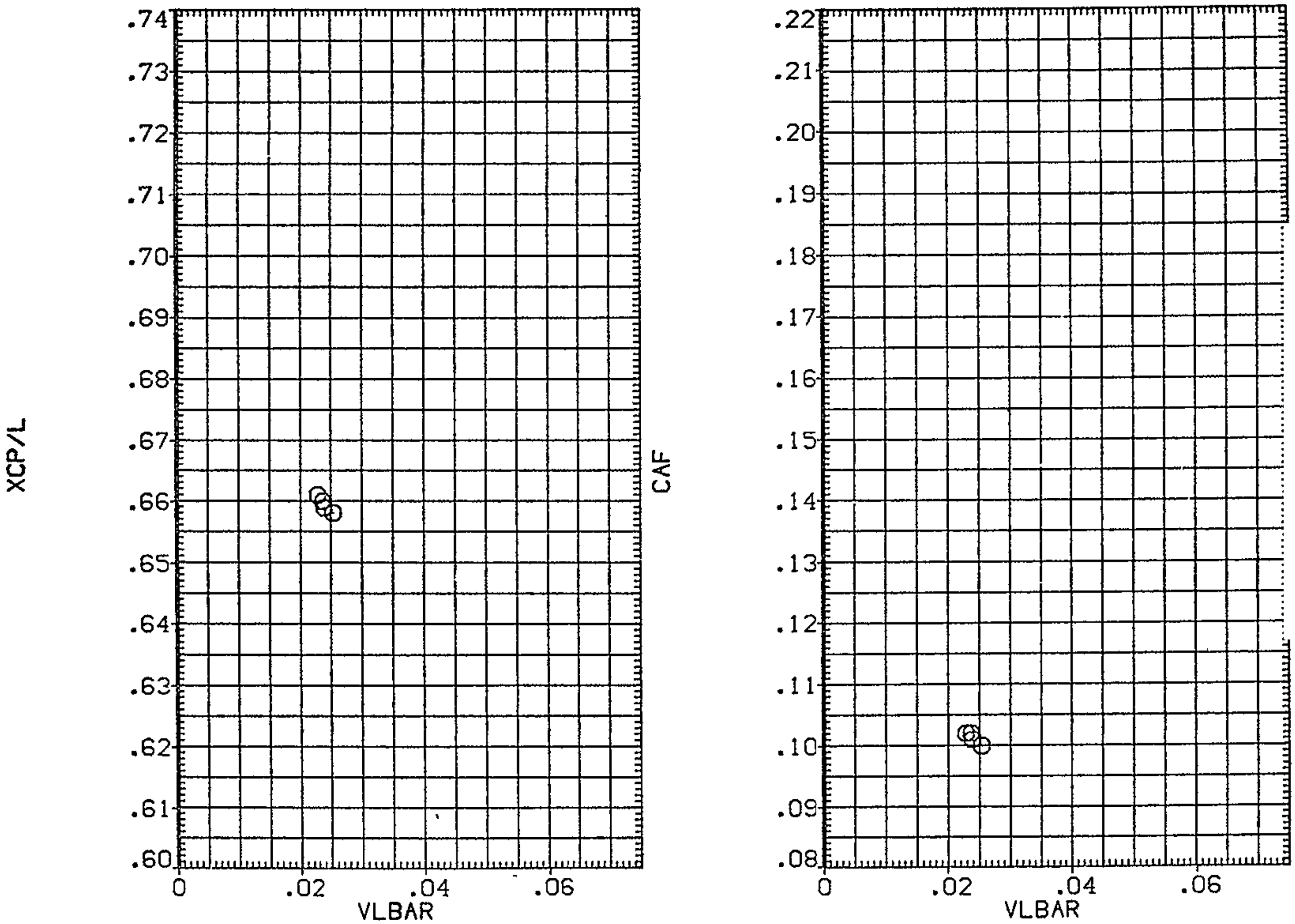


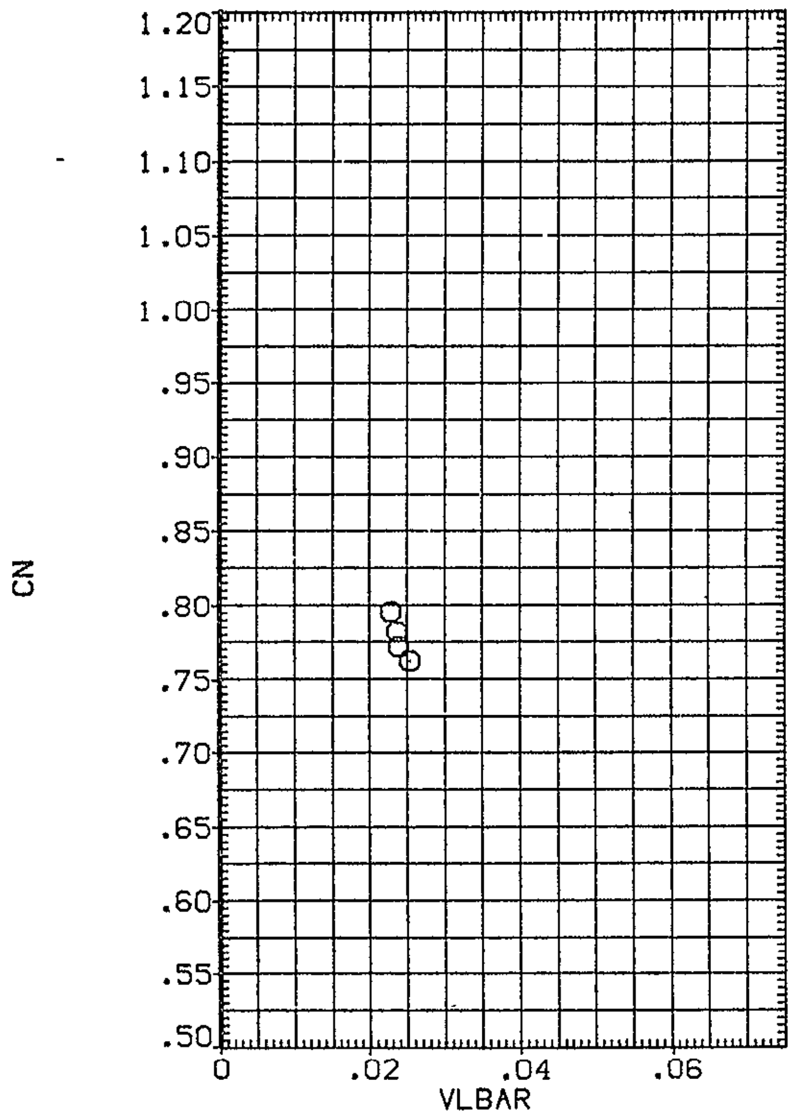
FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA005)

SYMBOL	MACH	PARAMETRIC VALUES			
○	18.700	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.430

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



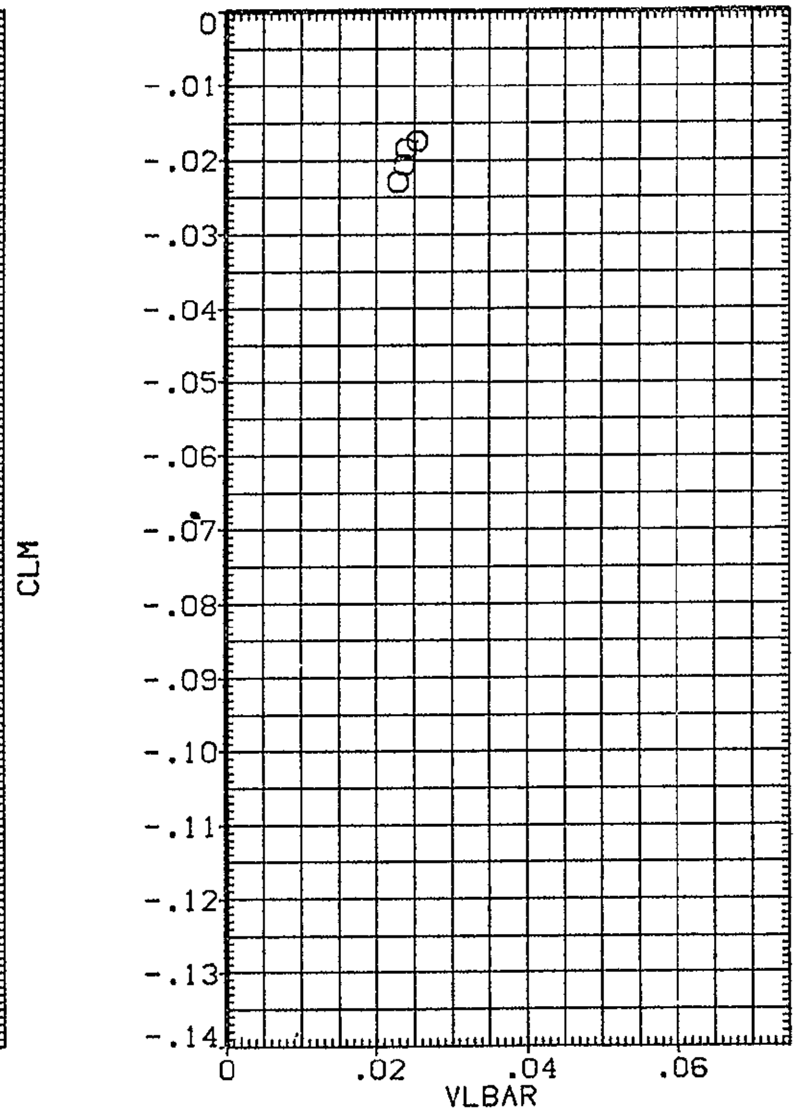


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA004)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.300

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

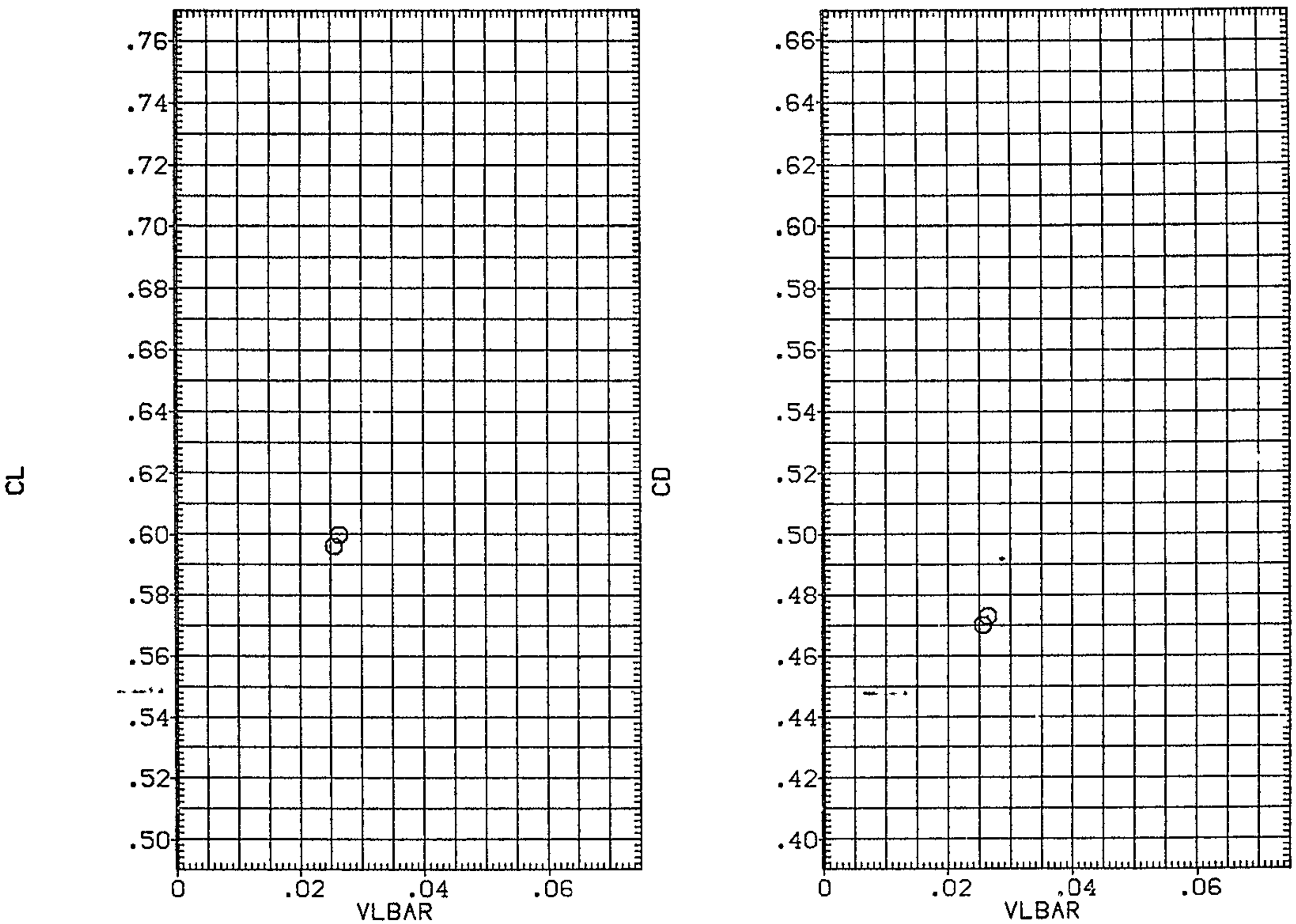
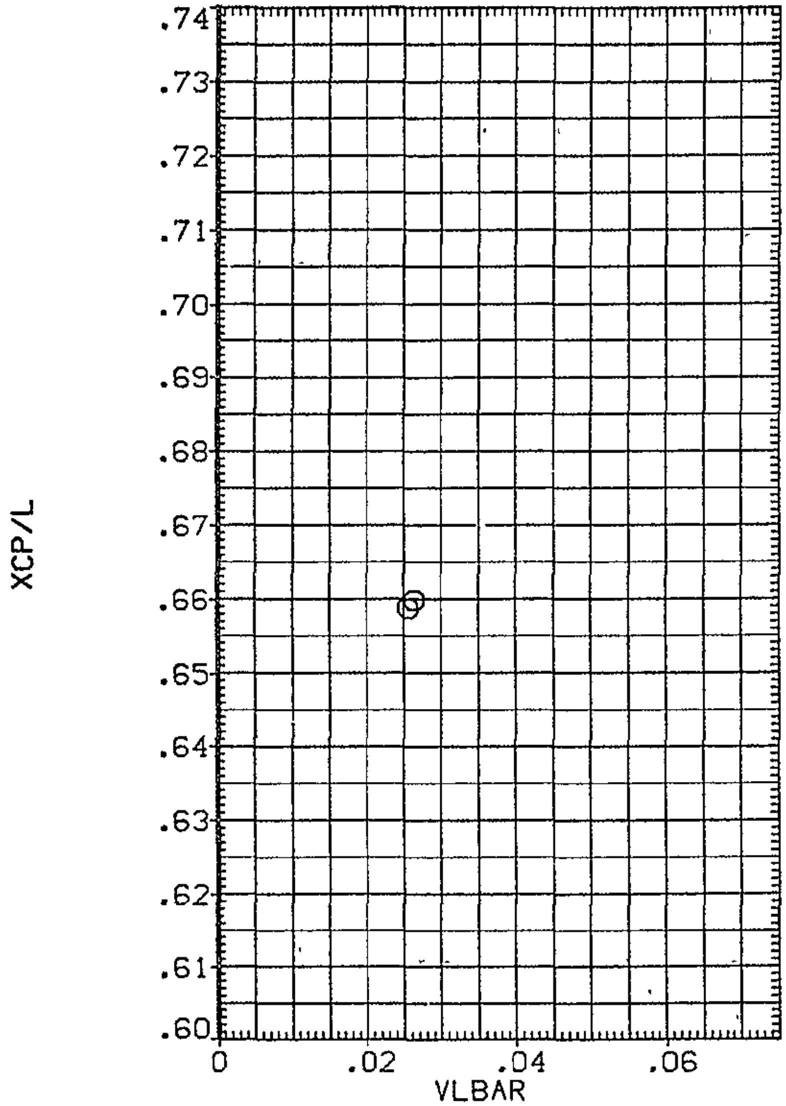


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.300

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



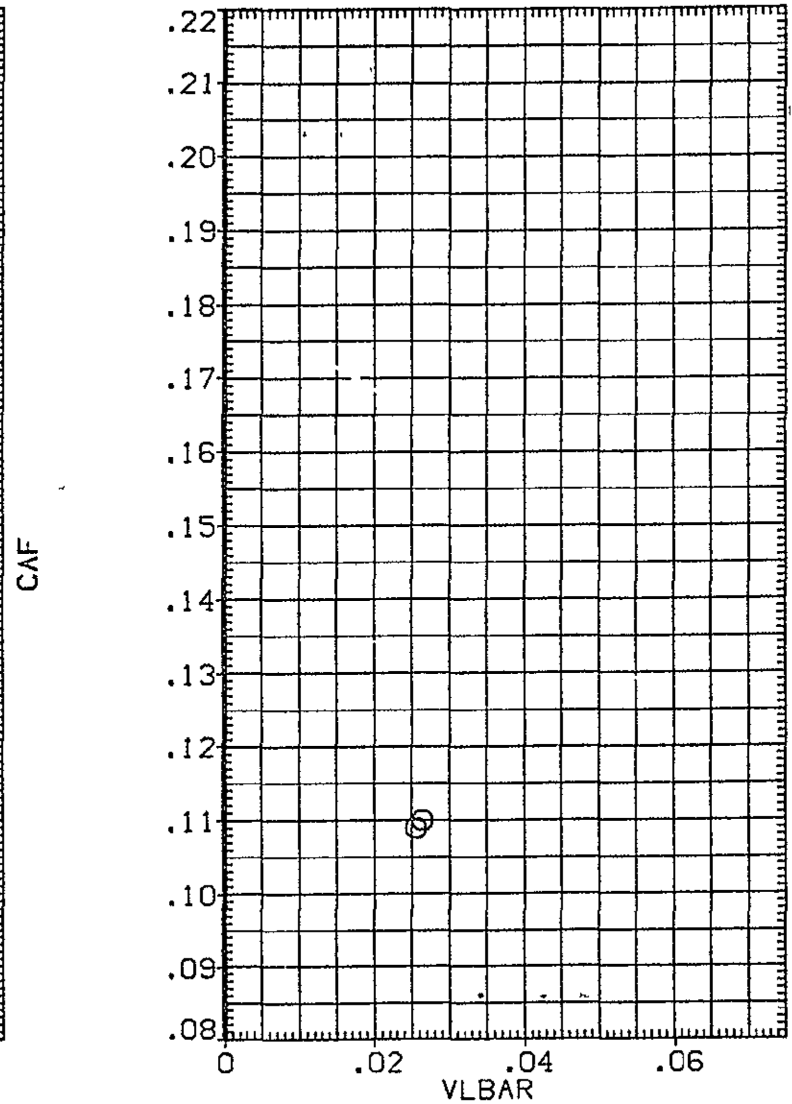
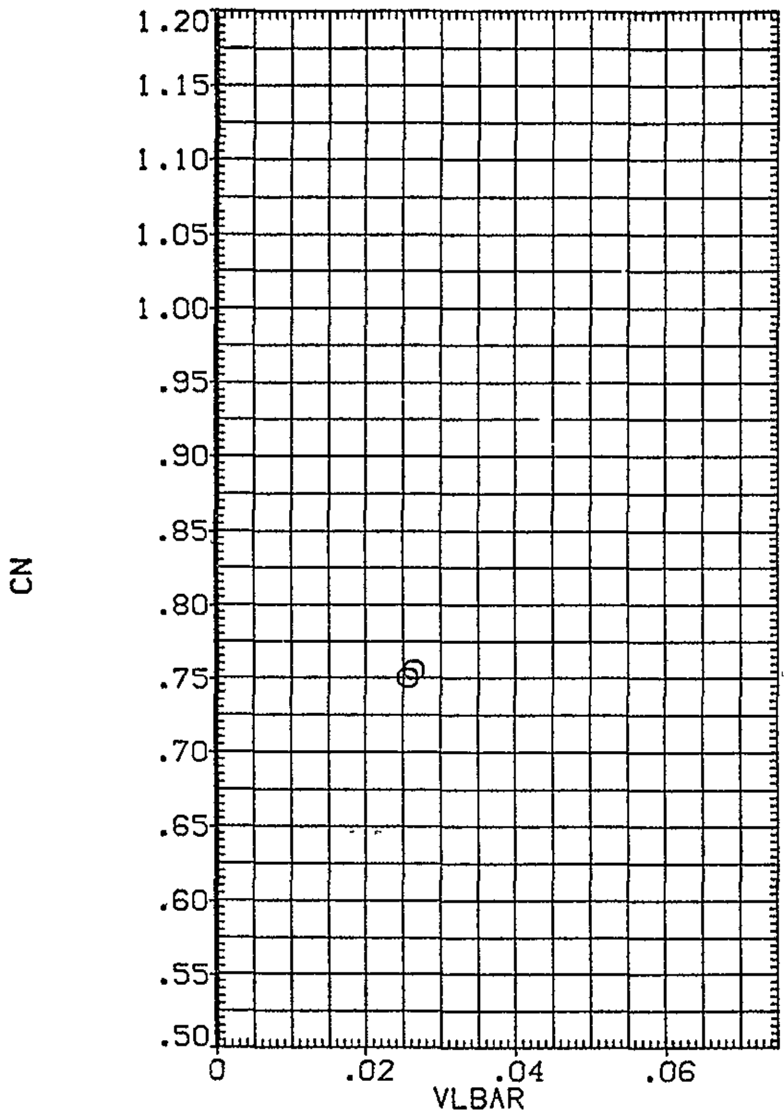


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA004)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.300

REFERENCE INFORMATION		
SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	



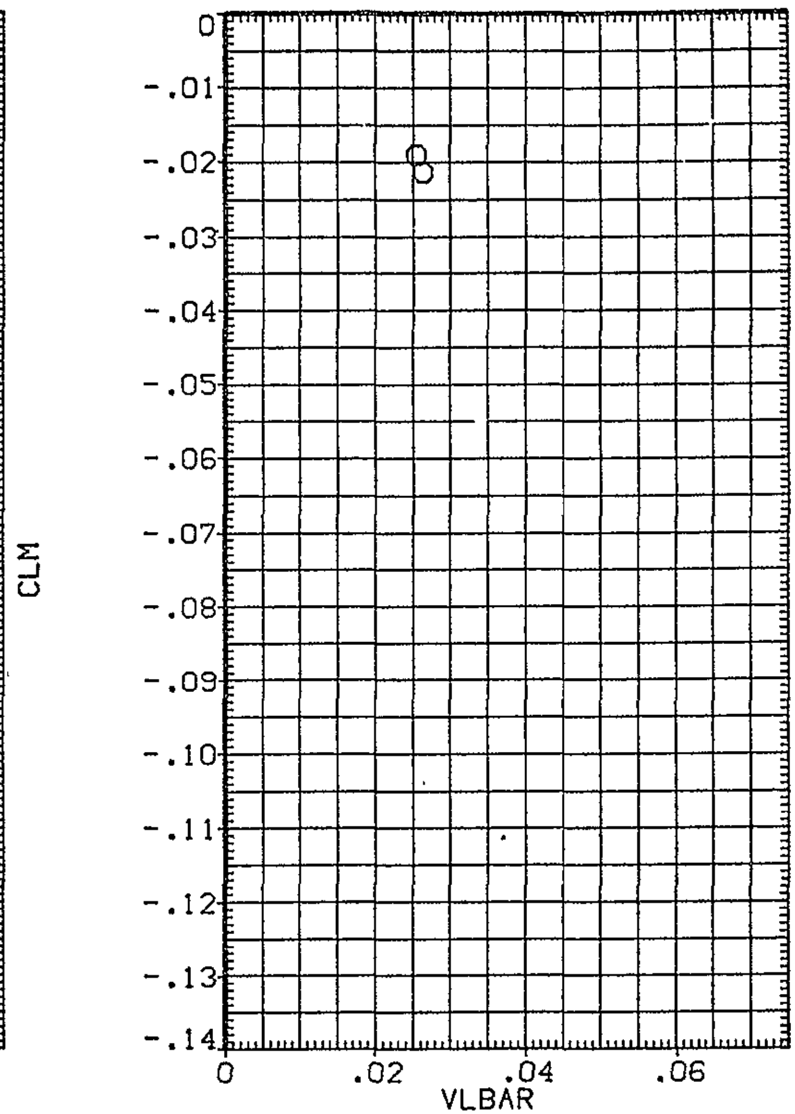


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160. (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA003)

SYMBOL	MACH		PARAMETRIC VALUES		
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

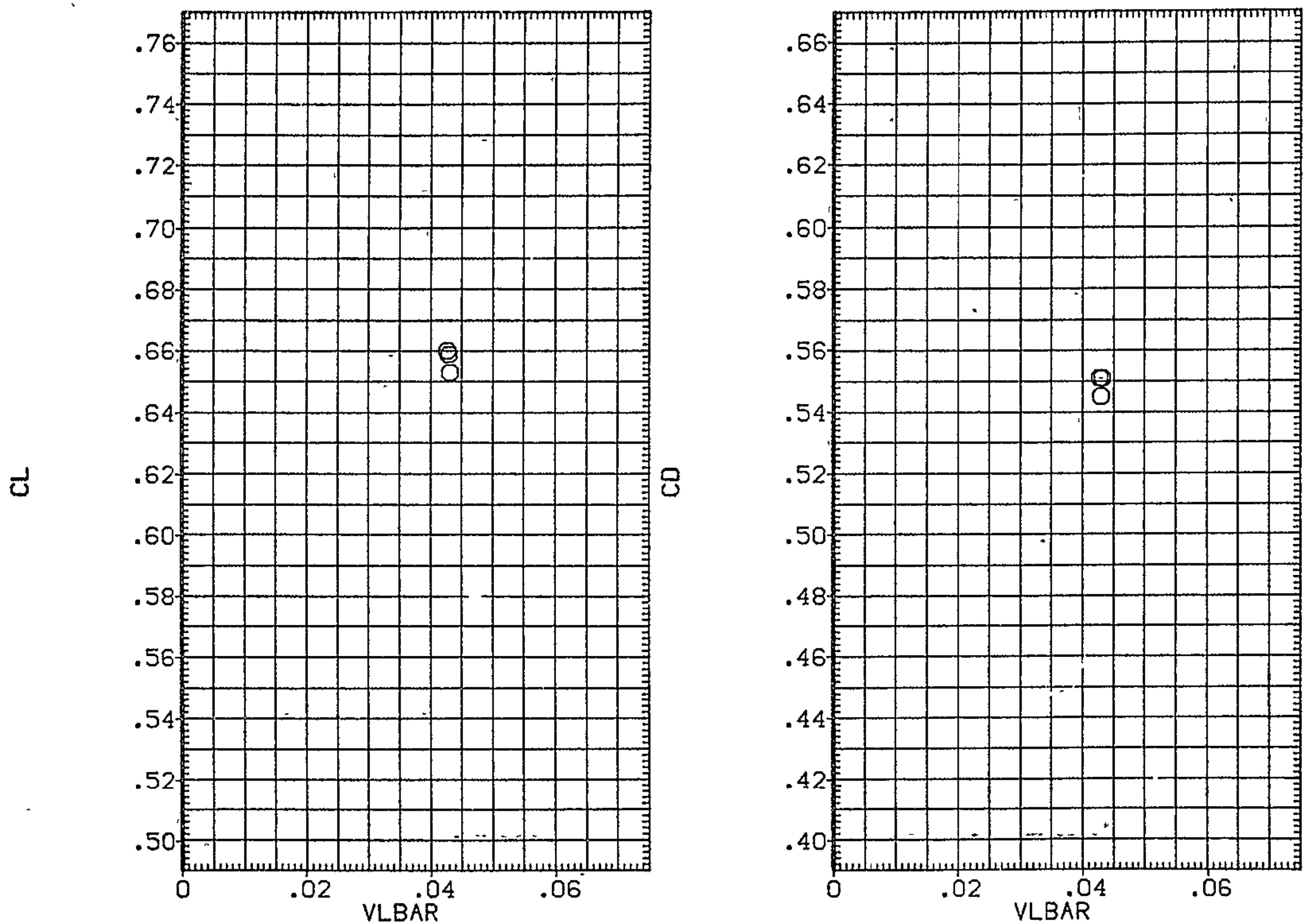


FIGURE 4. HYPERSØNIC CHARACTERISTICS ØF SPACE SHUTTLE ØRBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA003)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

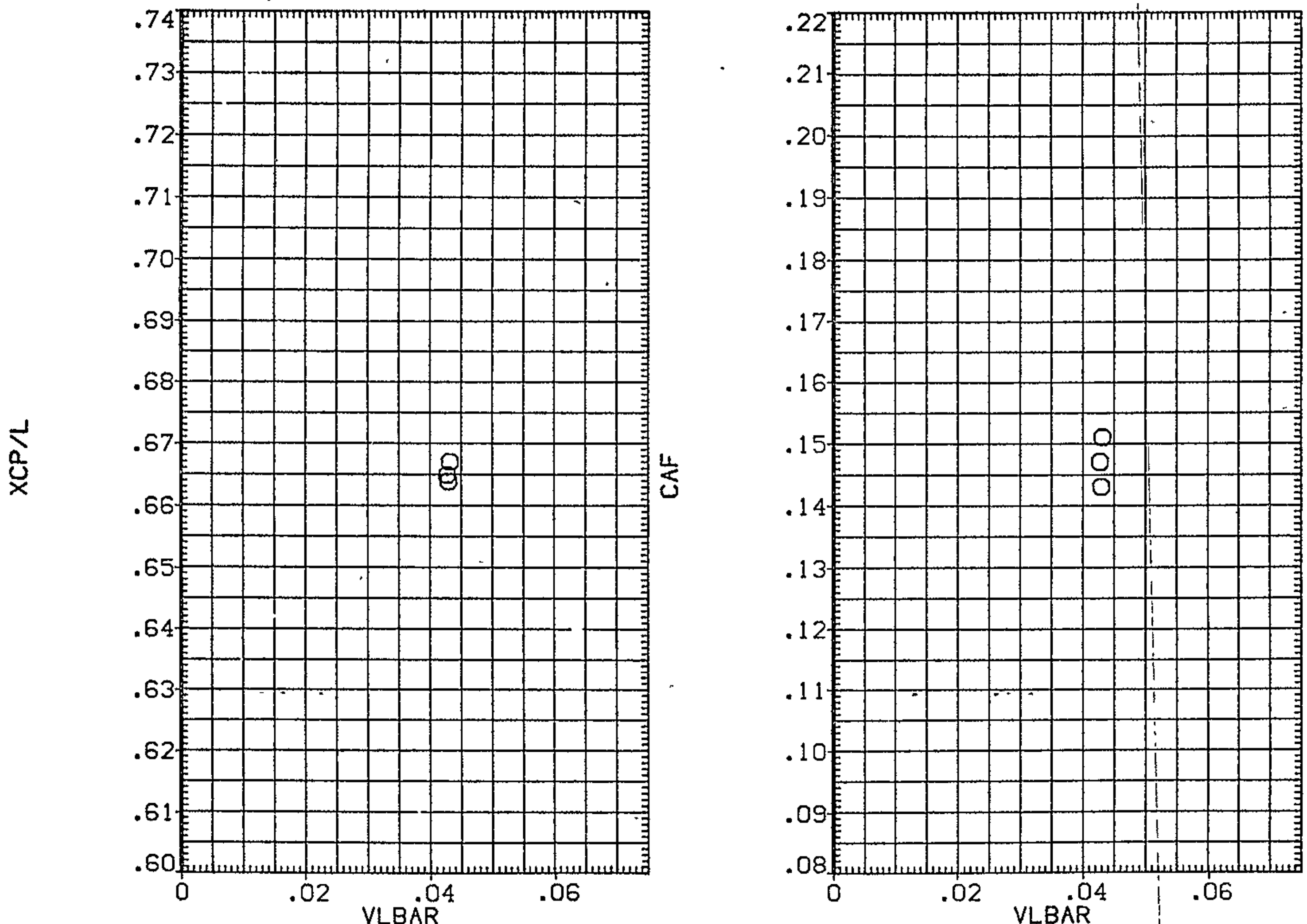


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA003)

SYMBOL	MACH	PARAMETRIC VALUES			
O	18.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.130

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

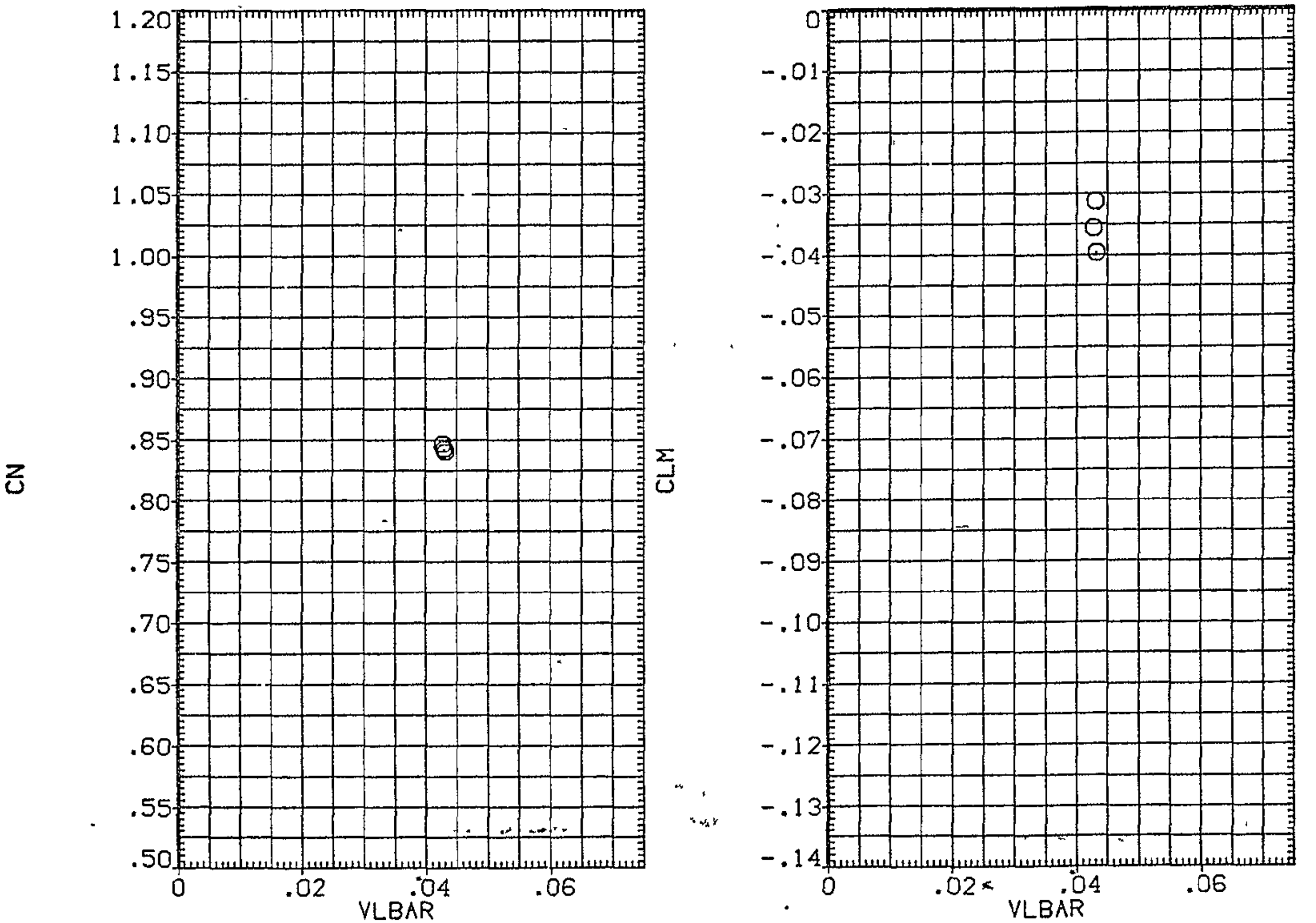


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA002)

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.000	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.120

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

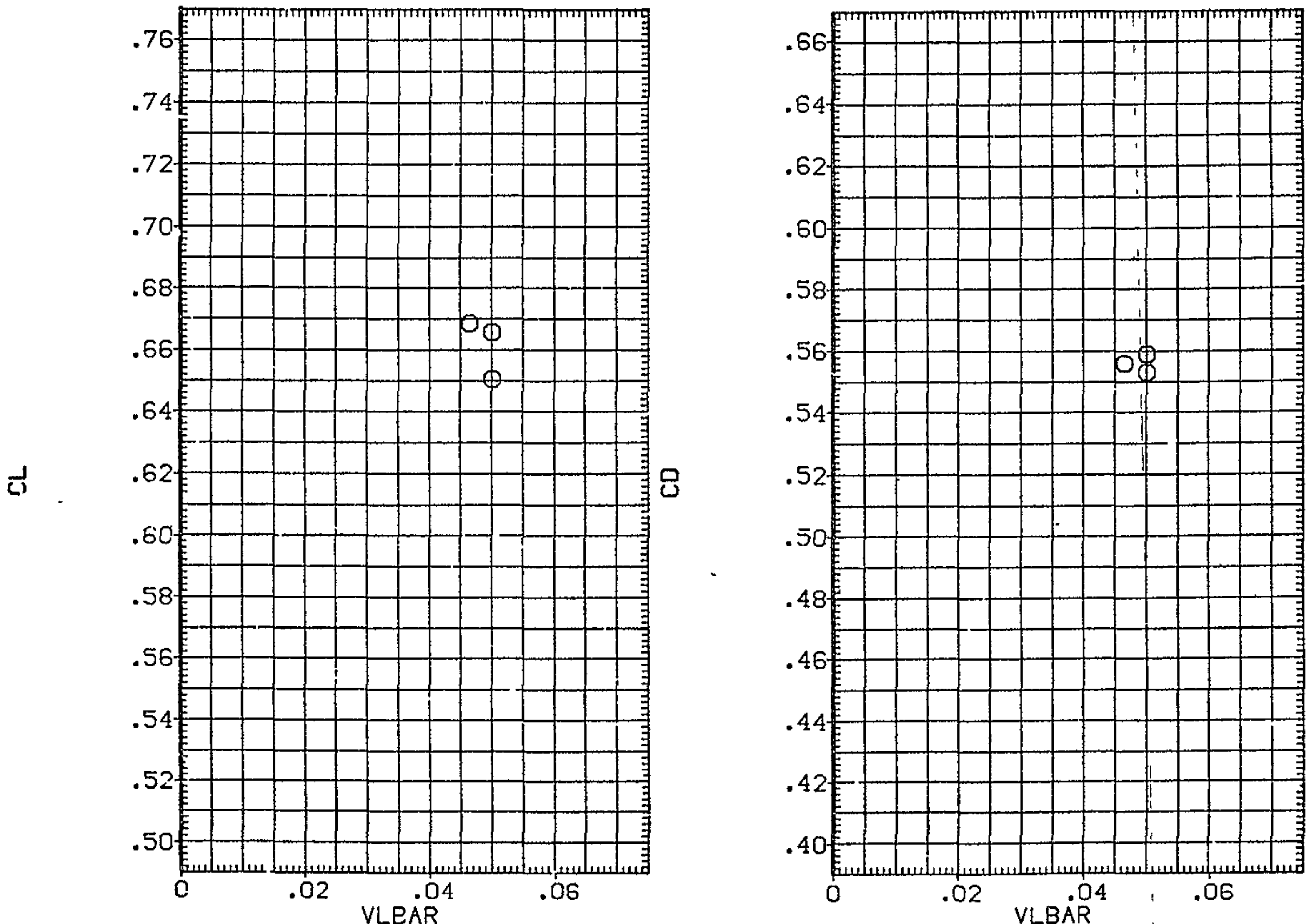


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA002)

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.000	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.120

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

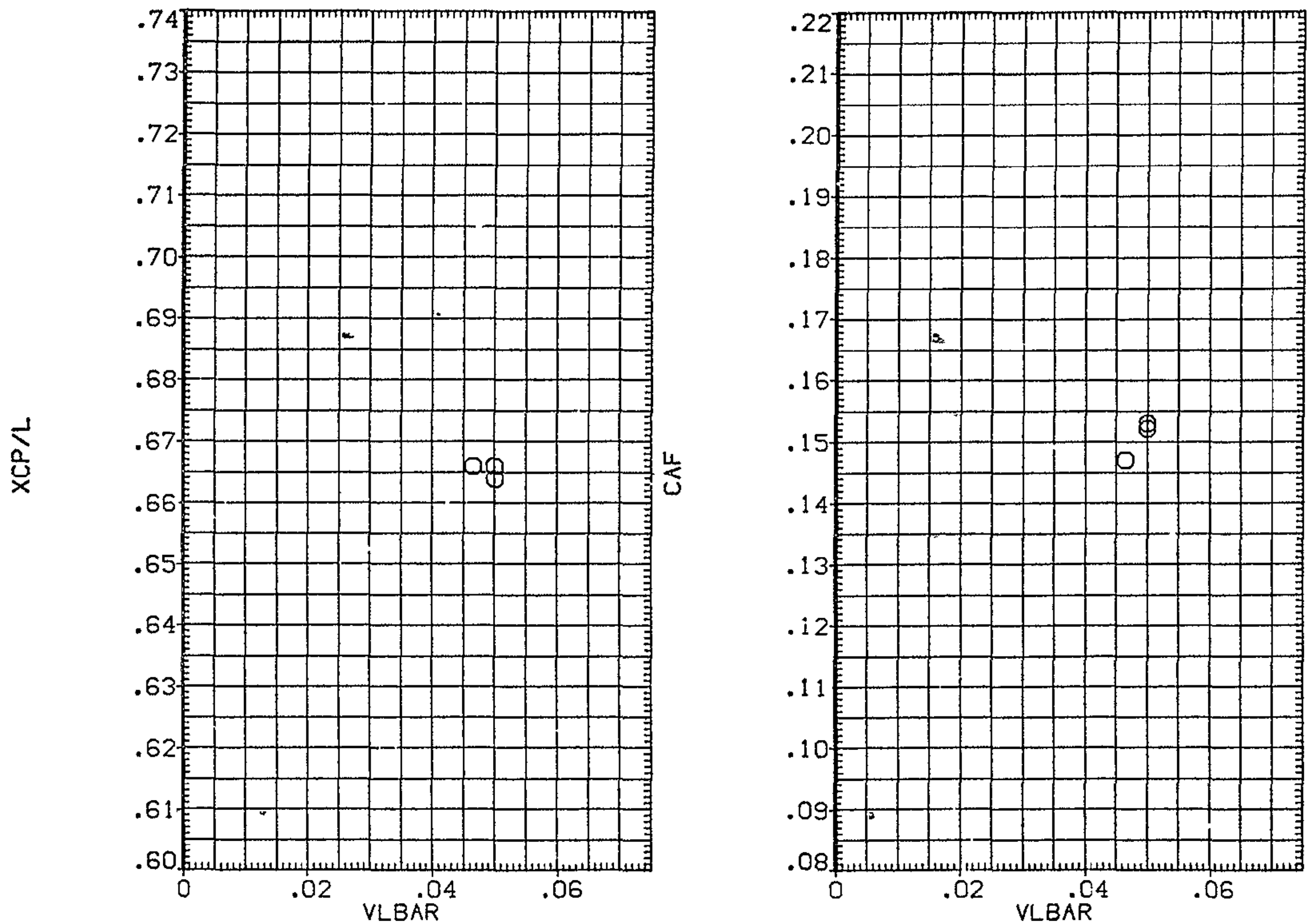


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

0A160. (V4'--26A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA002)

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.000	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.120

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

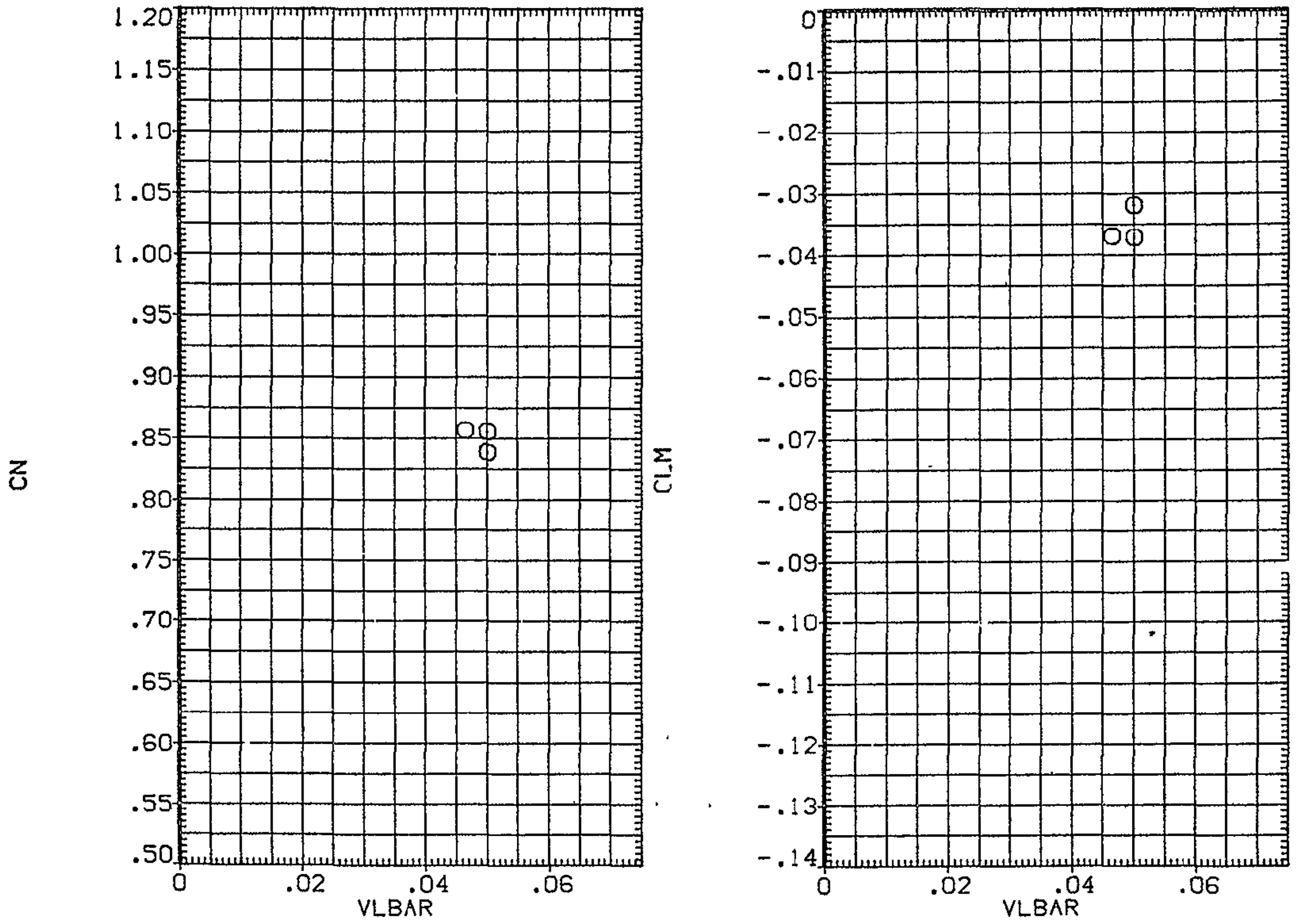


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B

ØA160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA001)

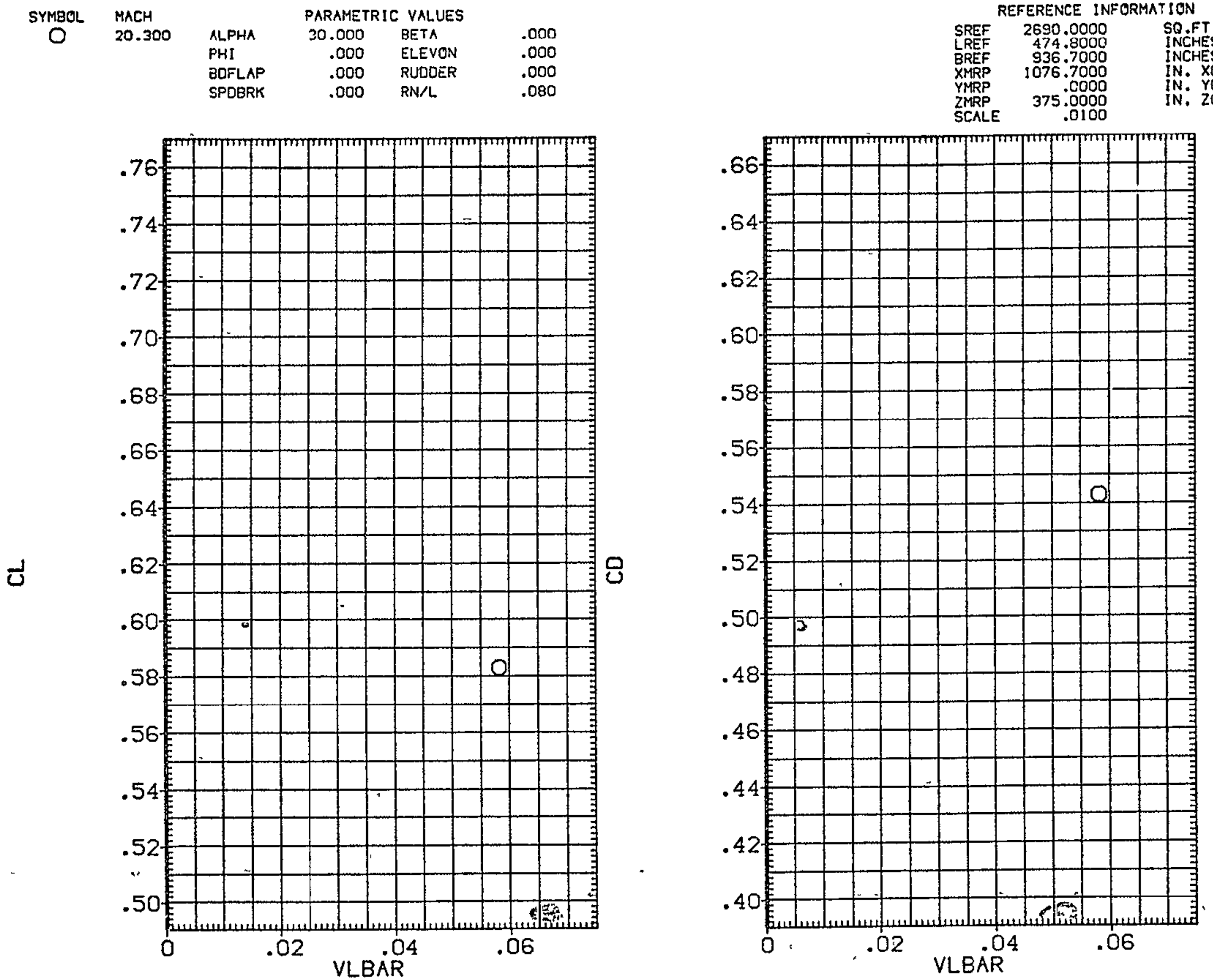


FIGURE 4. HYPERSØNIC CHARACTERISTICS ØF SPACE SHUTTLE ØRBITER 140 A/B

0A160, (V41F-28A) (B26C9F7M7N28)(W116E26)(V8R5)(AVA001)

SYMBOL	MACH	PARAMETRIC VALUES			
O	20.300	ALPHA	30.000	BETA	.000
		PHI	.000	ELEVON	.000
		BDFLAP	.000	RUDDER	.000
		SPDBRK	.000	RN/L	.080

REFERENCE INFORMATION

SREF	2690.0000	SQ.FT.
LREF	474.8000	INCHES
BREF	936.7000	INCHES
XMRP	1076.7000	IN. XO
YMRP	.0000	IN. YO
ZMRP	375.0000	IN. ZO
SCALE	.0100	

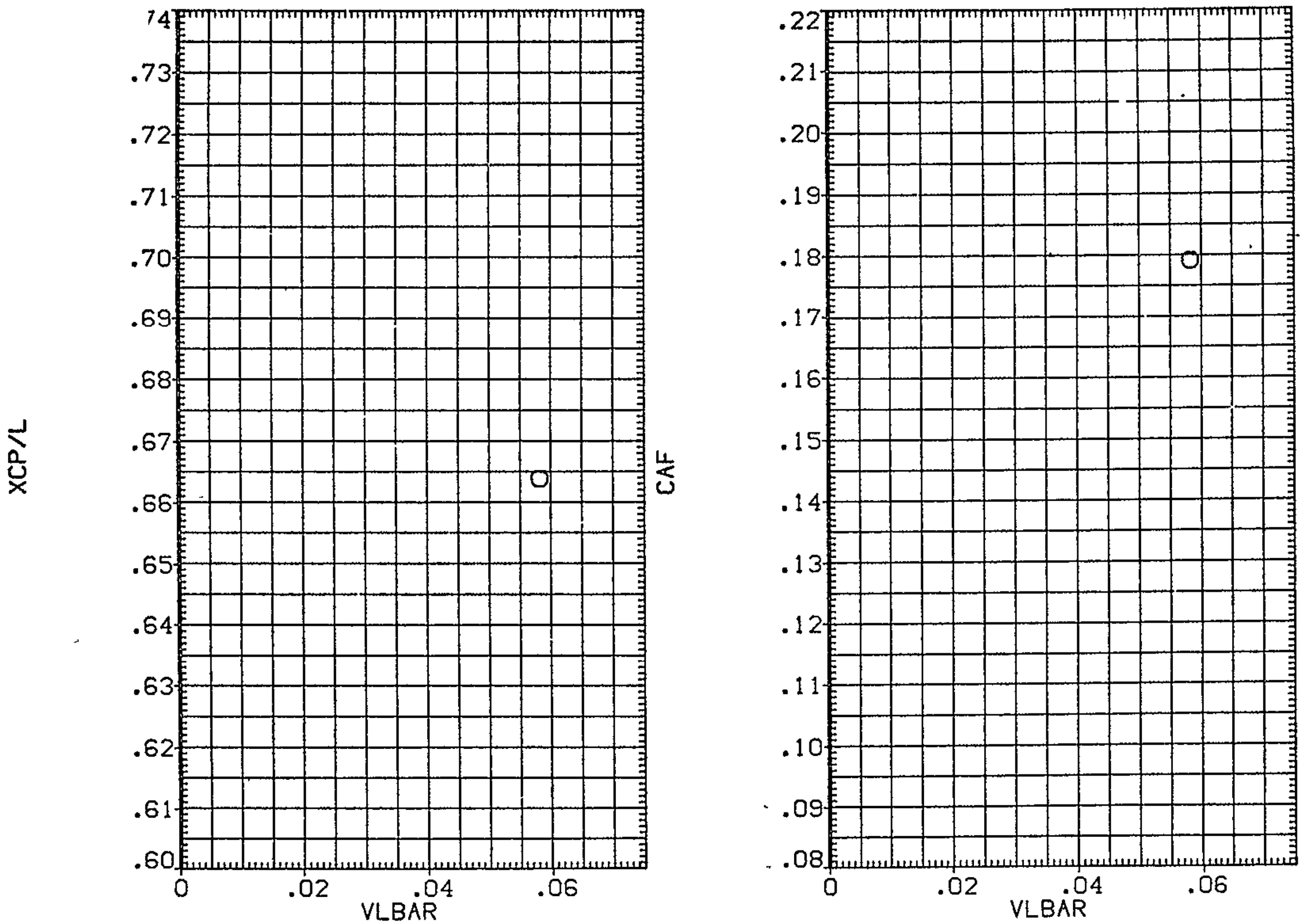


FIGURE 4. HYPERSONIC CHARACTERISTICS OF SPACE SHUTTLE ORBITER 140 A/B