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—SPACE SHUTTLE—

AERODYNAMIC CHARACTERISTICS OF THE GRUMMAN H-33 ORBITER MATED TO A THREE SEGMENT SOLID PROPELLANT BOOSTER

BY

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NASA STI FACILITY
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MSFC 14-INCH
TRISONIC WIND TUNNEL

Marshall Spaceflight Center

NASA

SADSAC SPACE SHUTTLE
AEROTHERMODYNAMIC
DATA MANAGEMENT SYSTEM

THIS DOCUMENT SHOULD BE REFERENCED AS NASA CR 120,010

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MARSHALL SPACE FLIGHT CENTER

SPACE DIVISION CHRYSLER CORPORATION

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SADSAC/SPACE SHUTTLE

WIND TUNNEL TEST DATA REPORT

CONFIGURATION: Grumman H-33 Orbiter & 3 Segment 156-In. Solid Propellant Booster

TEST PURPOSE: To Investigate Aerodynamic Characteristics of the Grumman H-33 Orbiter Mated to 3 Segment Solid Propellant Booster

TEST FACILITY: MSFC 14-x-14 Inch Trisonic Wind Tunnel

TESTING AGENCY: NASA/MSFC

TEST NO. & DATE: MSFC TWT 504; August 30 to Sept. 1, 1971

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CONTRACT NAS 8-4016 AMENDMENT 153 DRL 184-58

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A B S T R A C T

Experimental aerodynamic investigations were conducted on a .003366-scale model of the Grumman Space Shuttle configuration mounted to a three (3) segmented solid propellant booster. These tests were conducted in the MSFC 14-Inch Trisonic Wind Tunnel over a Mach number range of 0.6 to 4.96. The purpose of the test was to determine the aerodynamic characteristics of this configuration. Aerodynamic data was taken over a nominal angle of attack and angle of sideslip of -10 degrees to 10 degrees at zero degrees β and α respectively. In addition, H-33 orbiter alone data was obtained to supplement data from TWT 502 and TWT 503.

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SUMMARY

These tests were conducted at the MSFC 14-Inch Trisonic Wind Tunnel August 30 through September 1, 1971. Configurations tested included an orbiter with drop tanks alone and an orbiter with drop tanks mated to a 3-segment solid propellant booster. In addition, test were performed with drop tanks removed.

Six component static aerodynamic force and moment data were recorded over a Mach number range of 0.6 to 4.96 with Reynolds number varying from 5.1 to 7.5 x 10^6 per foot. Longitudinal data were taken over an angle of attack range of $\pm 10^\circ$ at 0° sideslip while lateral-directional data covered a range of $\pm 10^\circ$ sideslip at 0° angle of attack.

CONFIGURATIONS INVESTIGATED

The configurations investigated were 0.003366 scale models of the Grumman H-33 Orbiter Launch Configuration with/without drop tanks, and mated with three expendable solid propellant booster motors.

Configuration Nomenclature

01	Grumman H-33 Orbiter with drop tanks
02	Grumman H-33 Orbiter without drop tanks
H33/3x156	Grumman H-33 Orbiter with drop tanks and cluster of three 156 diameter solid propellant booster motors

Model Component Nomenclature

O	-	Orbiter
W	-	Clipped delta wing
V	-	Vertical stabilizer
T	-	Drop tanks

Pertinent dimensional details are presented in the Model Component Description Section of this document.

COEFFICIENT	COEFFICIENT NAME	SADSAC NOMENCLATURE		
		BODY AXIS	STABILITY AXIS	WIND AXIS
C_A	Total Axial Force	CA	-	-
C_{AB}	Base Axial Force	CAB	--	-
C_{AF}	Forebody Axial Force	CAF	-	-
C_D	Total Drag Force	-	CD	CDTOTL
C_{DB}	Base Drag Force	-	CDB	CDBASE
C_{DF}	Forebody Drag Force	-	CDF	CDFORE
C_L	Lift Force	-	CL	CL
C_N	Normal Force	CN	-	-
C_Y	Side Force	CY	CY	CC
C_ℓ	Rolling Moment	CBL	CSL	CWL
C_m	Pitching Moment	CLM	CLM	CPM
C_n	Yawing Moment	CYN	CLN	CLN
L/D	Lift-To-Drag Force Ratio	-	L/D	CL/CD
L/D	Lift-To-Forebody Drag Force Ratio	-	L/DF	CL/CDF
N/A	Normal-To-Axial Force Ratio	N/A	-	-
N/A	Normal-To-Forebody Axial Force Ratio	CN/CAF	-	-

TABLE I. SUMMARY OF SADSAC NOMENCLATURE - AERODYNAMIC FORCE AND MOMENT COEFFICENTS

TEST MSFC TWT 204 DATA SET/RUN NUMBER

COLLATION SUMMARY

☐ PRETEST

☐ POSTTEST

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	SCHD. β	PARAMETERS/VALUES				NO. of RUNS	MACH NUMBERS (OR ALTERNATE INDEPENDENT VARIABLE) 0.6	0.9	1.0	1.1	1.2	1.4	1.96	3.50	4.9				TEST RUN NUMBERS
R46011	O_1	A	O					9	1	2	3	4	5	61	60	51	52				
R46012	O_1	O	B					9	10	9	8	7	6	62	59	50	49				
R46021	O_2	A	O					9	20	19	18	17	16	63	58	54	53				
R46022	O_2	O	B					5	11	12	13	14	15								
R46041	H33/3x156 W/O DROP TANKS	A	O					5	21	22	23	24	25								
R46042	"	O	B					5	30	29	28	27	26								
R46031	H33/3x156 W/DROP TANKS	A	O					9	37	36	35	34	33	32	44	46	45				
R46032	"	O	B					9	38	39	40	41	42	31	43	47	48				

1	7	13	19	25	31	37	43	49	55	61	67	75	76
CLM	CN	CY	CBL	CYN	CDT	CDF	CAB	CPC	CABS				

COEFFICIENTS: → IDPVAR(1) | IDPVAR(2) | NDV

α or β SCHEDULES

αA = -10, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10

βB = -10, -8, -6, -4, -2, 0, 2, 4, 6, 8, 10

NASA-MSFC-MAF

TEST FACILITY DESCRIPTION

The Marshall Space Flight Center 14" x 14" Trisonic Wind Tunnel is an intermittent blowdown tunnel which operates by high pressure air flowing from storage to either vacuum or atmospheric conditions. A Mach number range from .2 to 5.85 is covered by utilizing two interchangeable test sections. The transonic section permits testing at Mach 0.20 through 2.50, and the supersonic section permits testing at Mach 2.74 through 5.85. Mach numbers between .2 and .9 are obtained by using a controllable diffuser. The range from .95 to 1.3 is achieved through the use of plenum suction and perforated walls. Mach numbers of 1.44, 1.93 and 2.50 are produced by interchangeable sets of fixed contour nozzle blocks. Above Mach 2.50 a set of fixed contour nozzle blocks are tilted and translated automatically to produce any desired Mach number in .25 increments.

Air is supplied to a 6000 cubic foot storage tank at approximately -40°F dew point and 500 psi. The compressor is a three-stage reciprocating unit driven by a 1500 hp motor.

The tunnel flow is established and controlled with a servo actuated gate valve. The controlled air flows through the valve diffuser into the stilling chamber and heat exchanger where the air temperature can be controlled from ambient to approximately 180°F. The air then passes through the test section which contains the nozzle blocks and test region.

Downstream of the test section is a hydraulically controlled pitch sector that provides a total angle of attack range of 20° (±10°). Sting offsets are available for obtaining various maximum angles of attack up to 25°.

TEST CONDITIONS
TEST MSFC TWT 504

MACH NUMBER	REYNOLDS NUMBER per unit length	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Fahrenheit)
0.6	5.1×10^6/IN	4.4	100
0.9	6.3×10^6/IN	7.4	100
1.0	6.6×10^6/IN	8.2	100
1.1	6.8×10^6/IN	8.7	100
1.2	6.8×10^6/IN	9.2	100
1.46	7.4×10^6/IN	10.8	100
1.96	7.5×10^6/IN	10.9	100
3.50	7.0×10^6/IN	6.8	100
4.96	5.4×10^6/IN	3.07	100

BALANCE UTILIZED: MSFC #201

CAPACITY:		ACCURACY:	COEFFICIENT TOLERANCE:
NF	60#		
SF	20#		
AF	30#		
PM	120 IN-#		
YM	40 IN-#		
RM	25 IN-#		

COMMENTS:

NASA-MSF -MAF

DATA REDUCTION

Six component aerodynamic force and moment data were measured on the model employing MSFC internal strain gage balance #201. Pressure orifices depicted in Figure 7 were used to measure the pressure acting on the base region of the orbiter, segmented booster, and the balance cavity. These pressures were reduced to coefficients and utilized to correct the measured total axial force ($\bar{C}AT$) coefficient to free-stream pressure acting on these regions (CAF). The following equations were used to make this correction:

$$C_{AF} = C_A - C_{ABO} - C_{ABS} - C_{AC}$$

$$C_{ABO} = -C_{P_{\substack{ORBITER \\ BASE}}} \cdot \frac{A_{BO}}{S_{REF}}$$

$$C_{AB} = -C_{P_{\substack{SOLIDS \\ BASE}}} \cdot \frac{A_{BS}}{S_{REF}}$$

$$C_{AC} = -C_{P_{CAVITY}} \cdot \frac{A_C}{S_{REF}}$$

The force and moment data were reduced to coefficient form using the following reference values:

$$S_{REF} = 9.376 \text{ IN.}^2$$

$$\ell_{REF} = 6.495 \text{ IN.}$$

$$b_{REF} = 3.940 \text{ IN.}$$

$$A_{BO} = 0.362 \text{ IN.}^2$$

$$A_{BS} = 1.348 \text{ IN.}^2$$

$$A_C = 0.399 \text{ IN.}^2$$

DATA REDUCTION
(Continued)

Moment Reference Center:

XMRP = 3.231 inches aft of orbiter nose

YMRP = 0.0 inch

ZMRP = 0.3024 inch below balance center line

SUMMARY DATA PLOT INDEX

PLOT TITLE	PLOTTED COEFFICIENTS SCHEDULE	CONDITION VARYING	PAGES
Longitudinal Stability	A	Mach Number	1-21
Lateral Stability	B	Mach Number	22-39
Longitudinal Stability at Alpha = Zero Degrees	C	Configuration	40-59
Lateral Stability at Beta = Zero Degrees	D	Configuration	60-75

PLOTTED COEFFICIENTS SCHEDULE:

SCHEDULE A:

CN, CLM, CAF } vs. α

SCHEDULE B:

CY, CYN, CBL } vs. β

SCHEDULE C.

CNAAFO, CMAAFO, CAFAFO, CDAFO, DCMLO } MACH NO.

SCHEDULE D:

CYBO, CYNBO, CBLBO, DCYNOL } MACH NO.

F I G U R E S

Notes:

1. Positive directions of force coefficients moment coefficients, and angles are indicated by arrows.

2. For clarity, origins of wind and stability axes have been displaced from the center of gravity.

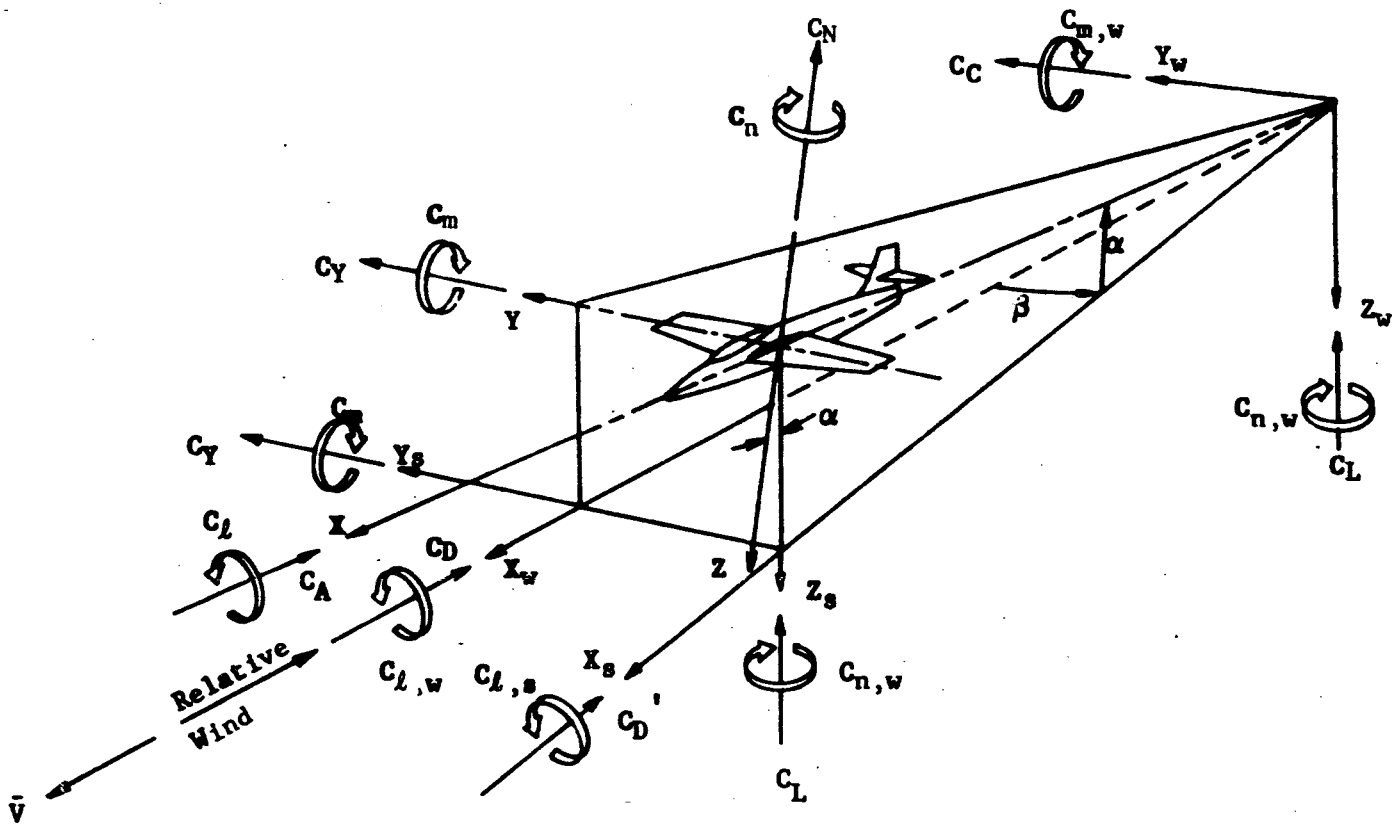


Figure 1. Axis systems, showing direction and sense of force and moment coefficients, angle of attack, and sideslip angle

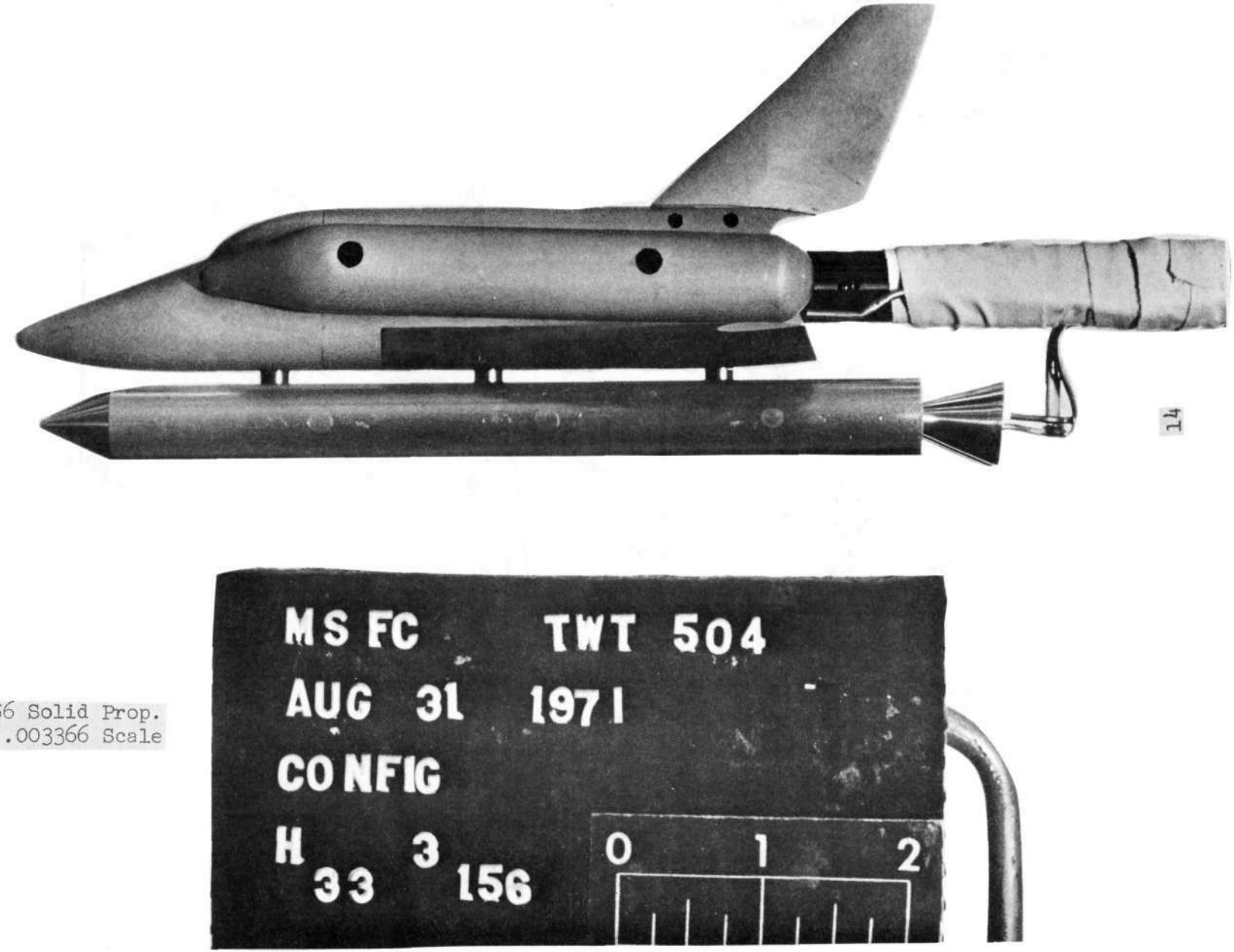


Figure 2 -
Side View of 3 x 156 Solid Prop. Boost/Grumman H-33 .003366 Scale Orbiter Model

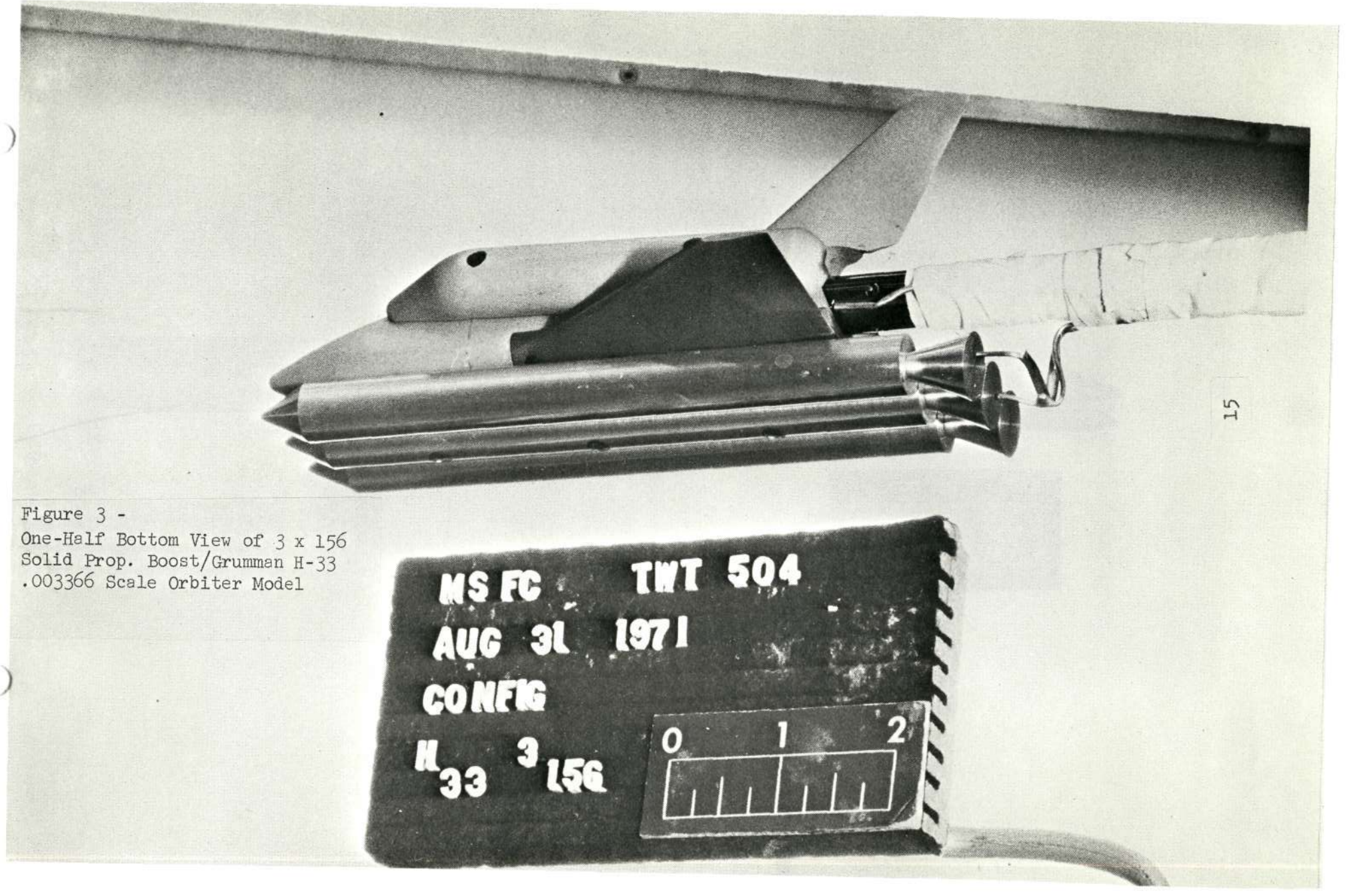


Figure 3 -
One-Half Bottom View of 3 x 156
Solid Prop. Boost/Grumman H-33
.003366 Scale Orbiter Model

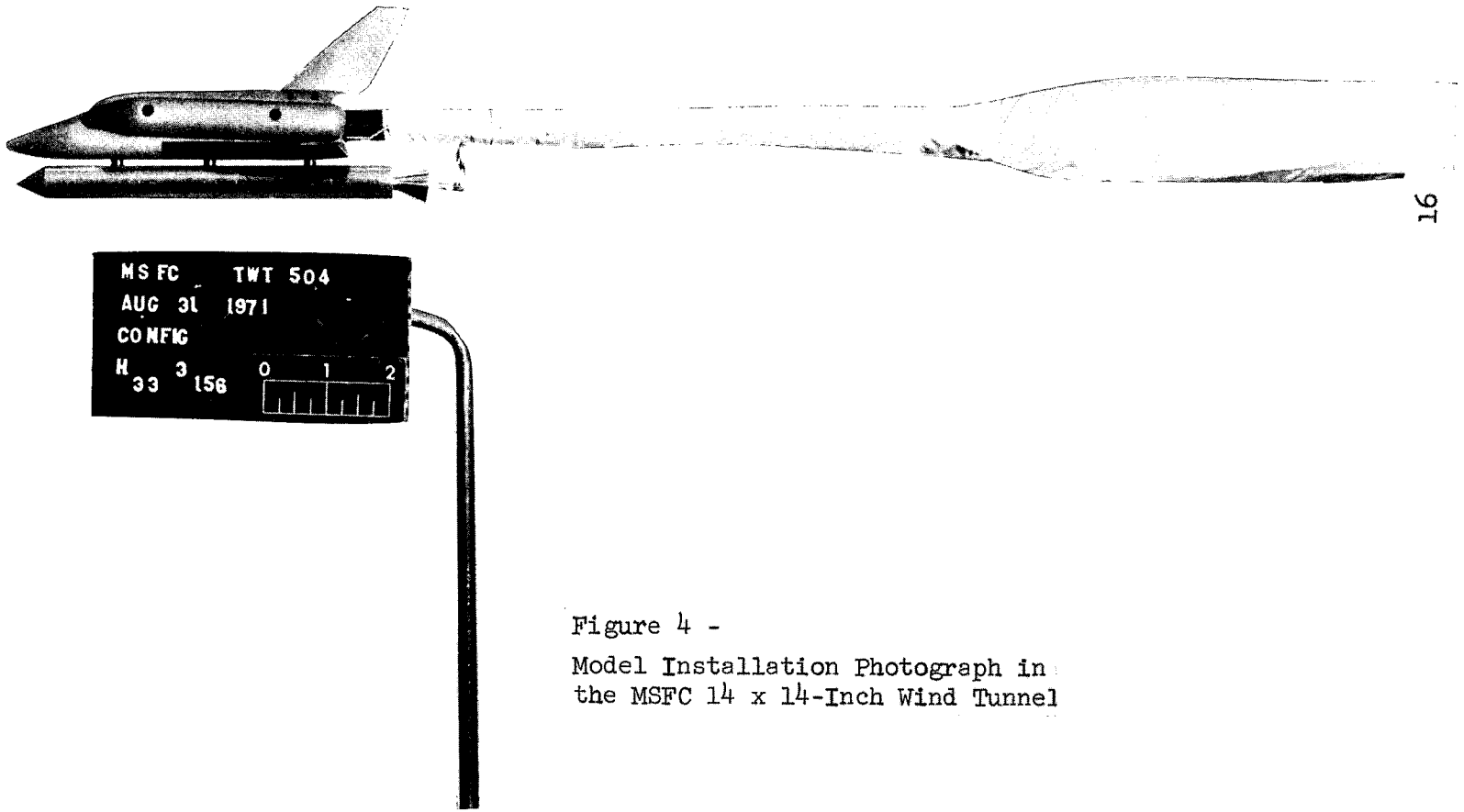


Figure 4 -

Model Installation Photograph in the MSFC 14 x 14-Inch Wind Tunnel

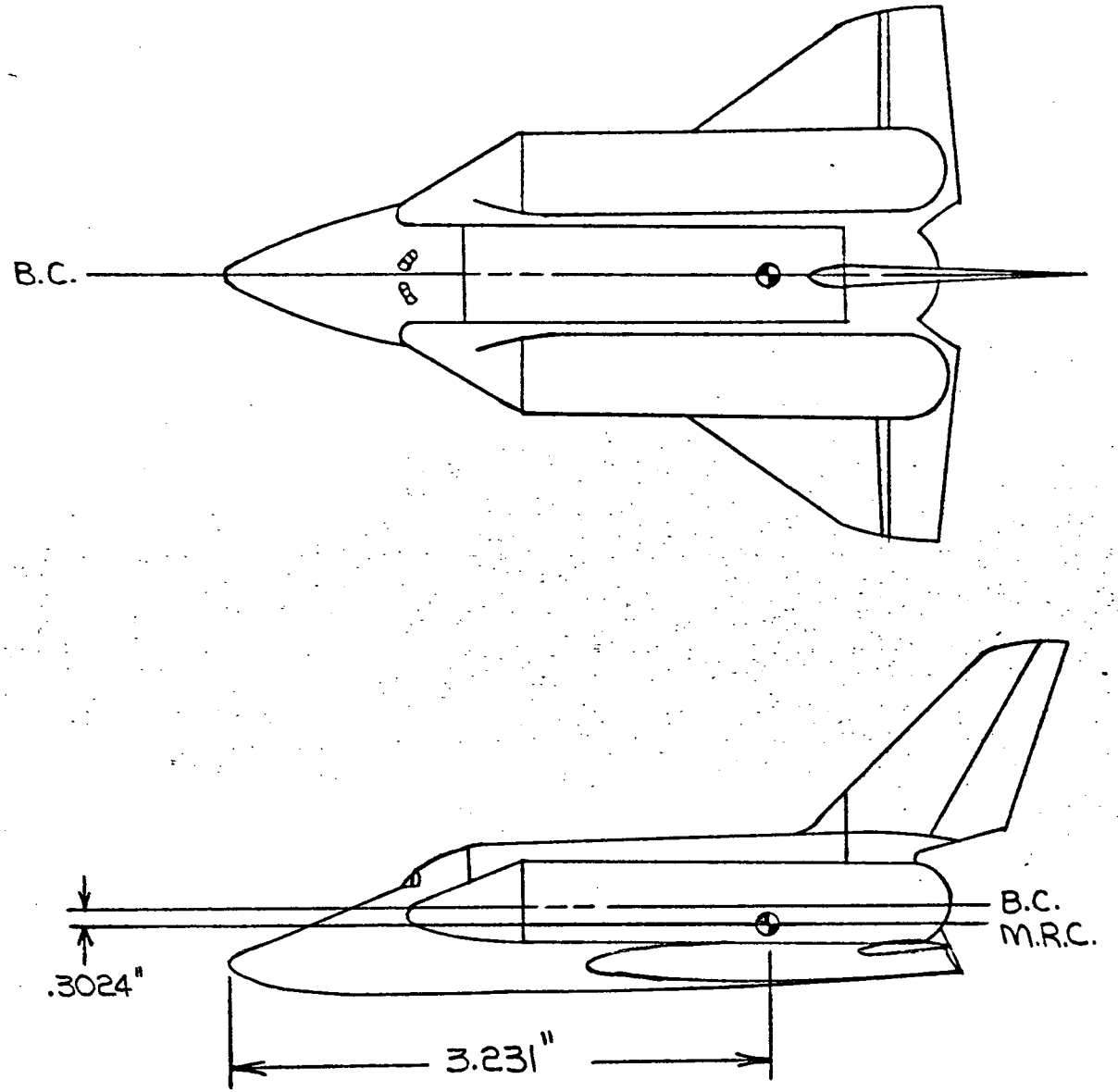


Figure 5. Side and Planview Sketch of the Grumman H-33 Orbiter With Drop Tanks Installed

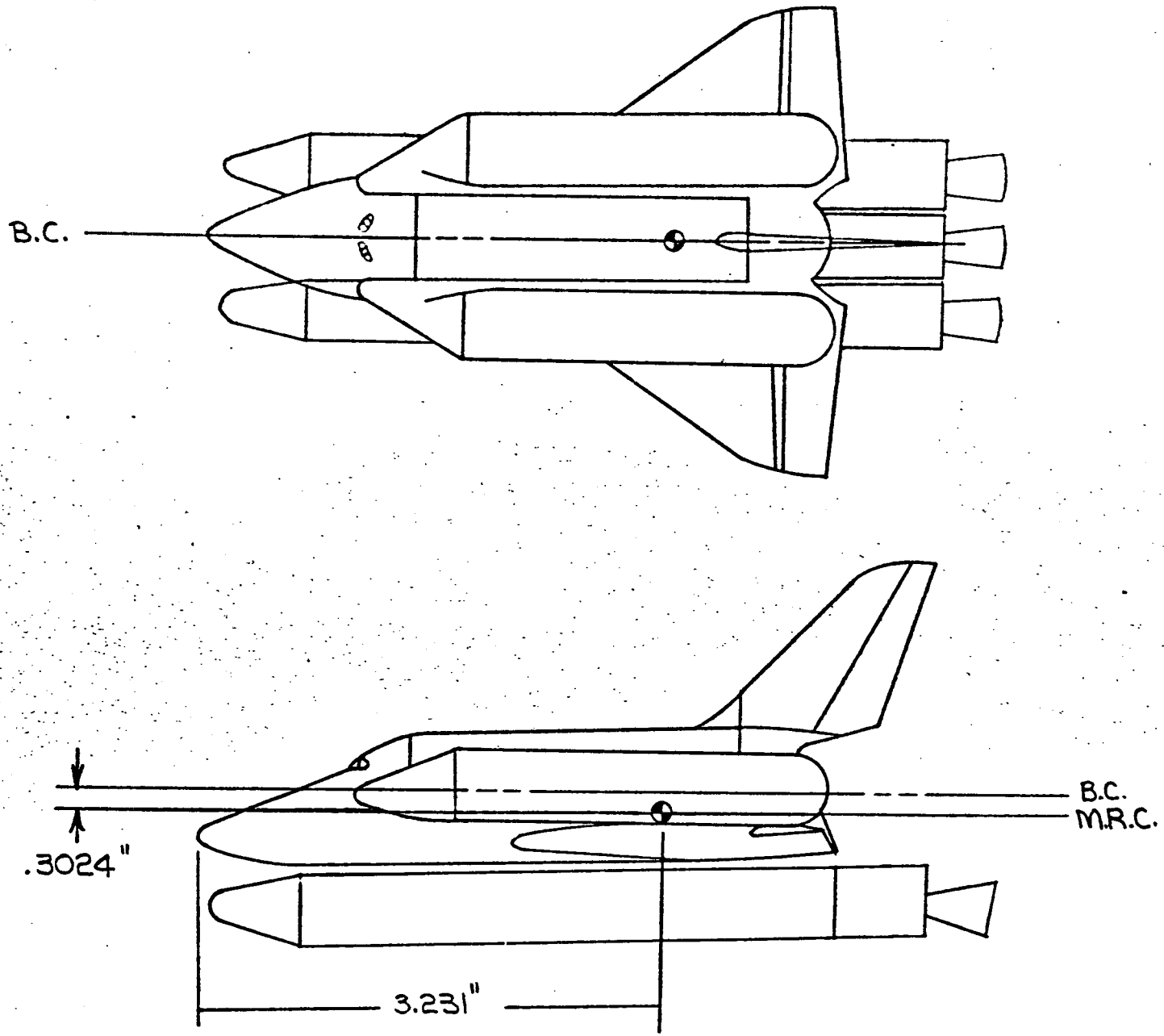


Figure 6. Side and Planview Sketch of the Grumman H-33 Orbiter With Drop Tanks and Three Solid Propellant Booster Motors Installed

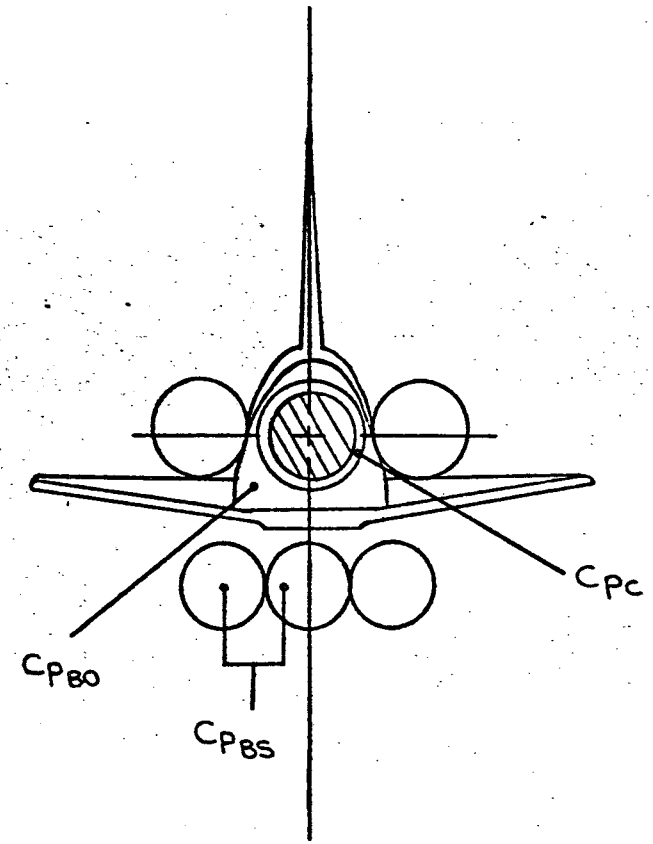


Figure 7. Base Pressure Measurements

MODEL COMPONENT DESCRIPTION SHEETS

MODEL COMPONENT: BODY - (O) ORBITER

GENERAL DESCRIPTION: 0.003366 SCALE GRUMMAN (H33) ORBITER

DRAWING NUMBER: _____

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length	1621 in	5.456 in
Max. Width	300 in	1.0098 in
Max. Depth	330 in	1.111 in
Fineness Ratio	5.4	5.4
Area		
Max. Cross-Sectional		
Planform	3,120 ft^2	5.09 in^2
Wetted (Less Base)	10,345 ft^2	16.877 in^2
Base		

MODEL COMPONENT: WING (W)

GENERAL DESCRIPTION: Clipped Delta Wing for H-33 Orbiter (0.003366 Scale)

DRAWING NUMBER:

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area		
Planform	4840 ft^2	7.896 in^2
Wetted		
Span (equivalent)	94.5 ft	3.817 in
Aspect Ratio	1.846	1.846
Rate of Taper		
Taper Ratio	0.178	0.178
Diehedral Angle, degrees	5°	5°
Incidence Angle, degrees	2°	2°
Aerodynamic Twist, degrees	-5°	-5°
Toe-In Angle		
Cant Angle		
Sweep Back Angles, degrees		
Leading Edge	55°	55°
Trailing Edge		
0.25 Element Line		
Chords:		
Root (Wing Sta. 0.0)	1043.52 in	3.5125 in
Tip, (equivalent)	185.76 in	0.625 in
MAC	714.0 in	2.4033 in
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		
Airfoil Section		
Root	t/c = 9.5% Camberred	t/c = 9.5% Camberred
Tip	t/c = 9.5% Camberred	t/c = 9/5% Camberred
EXPOSED DATA		
Area	2900 ft^2	4.7313 in^2
Span, (equivalent)	94.5 ft	3.817
Aspect Ratio	1.846	1.846
Taper Ratio	0.178	0.178
Chords		
Root	815.76 in	2.7458 in
Tip	185.76 in	0.625 in
MAC	714.0 in	2.4033 in
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

MODEL COMPONENT: VERTICAL STABILIZER (V)

GENERAL DESCRIPTION: Centerline Vertical Stabilizer for H-33 Orbiter (0.003366 Scale)

DRAWING NUMBER: _____

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area		
Planform		
Wetted		
Span (equivalent)		
Aspect Ratio		
Rate of Taper		
Taper Ratio		
Diehedral Angle, degrees		
Incidence Angle, degrees		
Aerodynamic Twist, degrees		
Toe-In Angle		
Cant Angle		
Sweep Back Angles, degrees		
Leading Edge	47°	47°
Trailing Edge		
0.25 Element Line		
Chords:		
Root (Wing Sta. 0.0)		
Tip, (equivalent)		
MAC		
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		
Airfoil Section		
Root	NACA 64A010	NACA 64A010
Tip	NACA 64A010	NACA 64A010
EXPOSED DATA		
Area	855 ft^2	1.395 in^2
Span, (equivalent)	405 in	1.363 in
Aspect Ratio	1.33	1.33
Taper Ratio	0.38	0.38
Chords		
Root	439.92 in	1.48 in
Tip	168.0 in	0.5655 in
MAC	324.0 in	1.09 in
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

NASA-MSFC-MA

MODEL COMPONENT: DROP TANKS (T)

GENERAL DESCRIPTION: Orbiter Externally Mounted Drop Tanks (0.003366 Scale)

DRAWING NUMBER: _____

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length	102.17 ft	4.127 in
Max. Width DIA	14.854 ft	0.60 in
Max. Depth	14.854 ft	0.60 in
Fineness Ratio	6.878	6.878
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

NOMENCLATURE

(General)

SYMBOL	SADSAC SYMBOL	DEFINITION
α	ALPHA	angle of attack, angle between the projection of the wind X_w-axis on the body X, Z-plane and the body X-axis; degrees
β	BETA	sideslip angle, angle between the wind X_w-axis and the projection of this axis on the body X-Z-plane; degrees
ψ	PSI	yaw angle, angle of rotation about the body Z-axis, positive when the positive X-axis is rotated toward the positive Y-axis; degrees
ϕ	PHI	roll angle, angle of rotation about the body X-axis, positive when the positive Y-axis is rotated toward the positive Z-axis; degrees
ρ		air density; K_g/m^3, slugs/ft^3
a		speed of sound; m/sec, ft/sec
V		speed of vehicle relative to surrounding atmosphere; m/sec, ft/sec
q	Q(PSI) Q(PSF)	dynamic pressure; $1/2\rho V^2$, psi, psf
M	MACH	Mach number; V/a
RN/L	RN/L	Reynolds number per unit length; million/ft
p		static pressure; psi
P		total pressure; psi
C_p	CP	pressure coefficient; $(p-p_\infty)/q$

NOMENCLATURE (Continued)

Body & Stability Axis System

SYMBOL	SADSAC SYMBOL	DEFINITION
		Body Axis System
C_N	CN	normal force coefficient; F_N/qS
C_A	CA	axial force coefficient; F_A/qS
C_{A_b}	CAB	base axial force coefficient; $\left[-1\right] \left[(p_b - p_\infty)/q\right] (A_b/S)$
C_{A_f}	CAF	forebody axial force coefficient; $C_A - C_{A_b}$
C_n	CYN	yawing moment coefficient; $M_Z/qS\ b_{ref}$
C_ℓ	CBL	rolling moment coefficient; $M_X/qS\ b_{ref}$
		Common to Both Axis Systems
C_m	CLM	pitching moment coefficient; $M_Y/qS\ \ell_{ref}$
C_y	CY	side force coefficient; F_Y/qS
		Stability Axis System
C_L	CL	lift force coefficient; F_L/qS
C_D	CD	drag force coefficient; F_D/qS
C_{D_b}	CDB	base drag coefficient
C_{D_f}	CDF	forebody drag coefficient; $C_D - C_{D_b}$
C_n	CLN	yawing moment coefficient; $M_{Z,s}/qS\ b_{ref}$
C_ℓ	CSL	rolling moment coefficient; $M_{X,s}/qS\ b_{ref}$
L/D	L/D	lift-to-drag ratio; C_L/C_D
L/D_f	L/DF	lift to forebody drag ratio; C_L/C_{D_f}

NOMENCLATURE (Continued)

Axis System General

SYMBOL	DEFINITION
F	force; F, lbs
M	moment; M, in-lb

Subscript	Definition
N	normal force
A	axial force
L	lift force
D	drag force
Y	force or moment about the Y axis
Z	moment about the Z axis
X	moment about the X axis
s	stability axis system
w	wind axis system
ref	reference conditions
∞	free stream conditions
t	total conditions
b	base

NOMENCLATURE (Continued)

Reference & C. G. Definitions

SYMBOL	SADSAC SYMBOL	DEFINITION
S		wing area; m^2, ft^2
S	SREF	reference area; m^2, ft^2
$\bar{c}$		wing mean aerodynamic chord or reference chord; m, ft, in (see ℓ_{ref} or LREF)
ℓ_{ref}	LREF	reference length; m, ft, in.; (see $\bar{c}$)
b_{ref}	BREF	wing span or reference span; m, ft, in
A_b		base area; m^2, ft^2, in^2
c. g.		center of gravity
MRP	MRP	abbreviation for moment reference point
	XMRP	abbreviation for moment reference point on X-axis
	YMRP	abbreviation for moment reference point on Y-axis
	ZMRP	abbreviation for moment reference point on Z-axis

ADDITIONS TO GENERAL NOMENCLATURE

SYMBOL	DEFINITION
A_{BO}	orbiter base area, in.^{2}
A_{BS}	solid propellant booster motors total base area, in.^{2}
A_C	model strain balance cavity area, in.^{2}
C_{ABO}	orbiter base axial force coefficient
C_{ABS}	solid propellant booster motors base axial force coefficient
C_{AC}	model strain gage cavity axial force coefficient
CNAAFO	zero angle of attack normal force coefficient gradient
CMAAFO	zero angle of attack pitching moment coefficient gradient
CAFAFO	zero angle of attack forebody axial force coefficient
CDAFO	zero angle of attack drag force coefficient
DCMLO	zero angle of attack center of pressure
CYBO	zero sideslip angle side force gradient
CYNBO	zero sideslip angle yawing moment gradient
CBLBO	zero sideslip angle rolling moment gradient
DCYNOL	zero sideslip angle center of pressure

TABULATED DATA LISTING

A tabulated data listing, consisting of all aero data sets, both original and those created in arriving at the plotted material to be presented subsequently, is available as an addendum to this report. The tabular listing is made up in two sections:

(a) a brief summary list of all data sets containing the identifier, the descriptor, and the resident dependent variables.

(b) a full list of all data sets containing all resident or selected aerodynamic coefficients of the data sets as well as the above mentioned information.

The listing is currently sent on limited distribution to the following organizations:

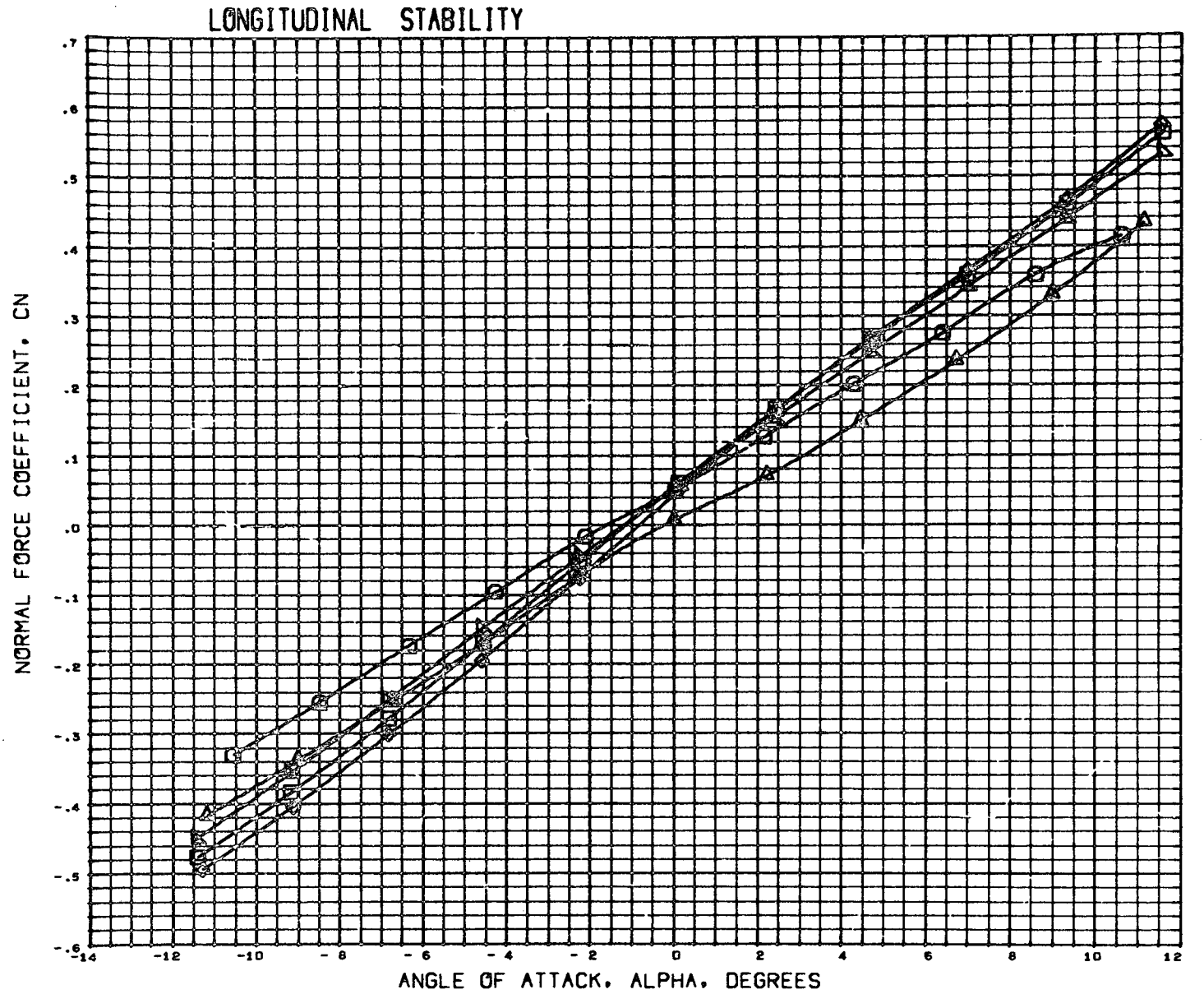
NASA AMES	Mr. V. Stevens
NASA MSFC	Mr. J. Weaver

If copies of this listing are desired, please contact the above or the cognizant SADSAC personnel who, for this data, is:

Mr. J. R. Ziler
Department 2780
Chrysler Corporation Space Division
New Orleans, La. 70129

(504) 255-2304

P L O T T E D D A T A



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△	0.898		
◇	1.001		
□	1.099		
◺	1.196		

REFERENCE FILE S-E-AERO-AA-

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LREF	6.4950	IN.
BREF	3.9300	IN.
XMRP	3.2300	IN.
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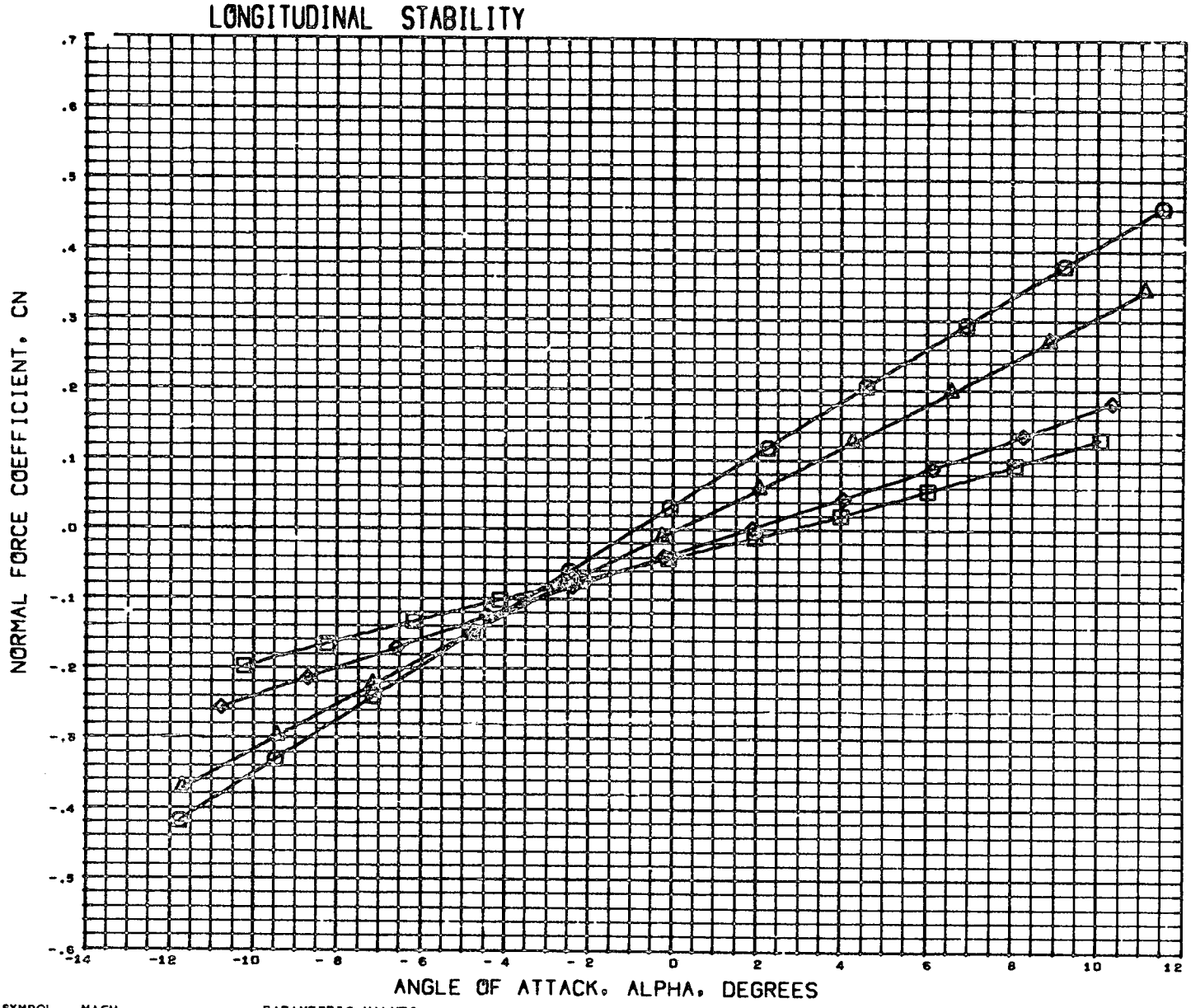
SCALE	0.3366	PERCEN

MSFC 504 GRUMMAN H33 ORB.+DROP TANKS 01 (A46011) 16 OCT 71 PAGE 1



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□	4.959		

REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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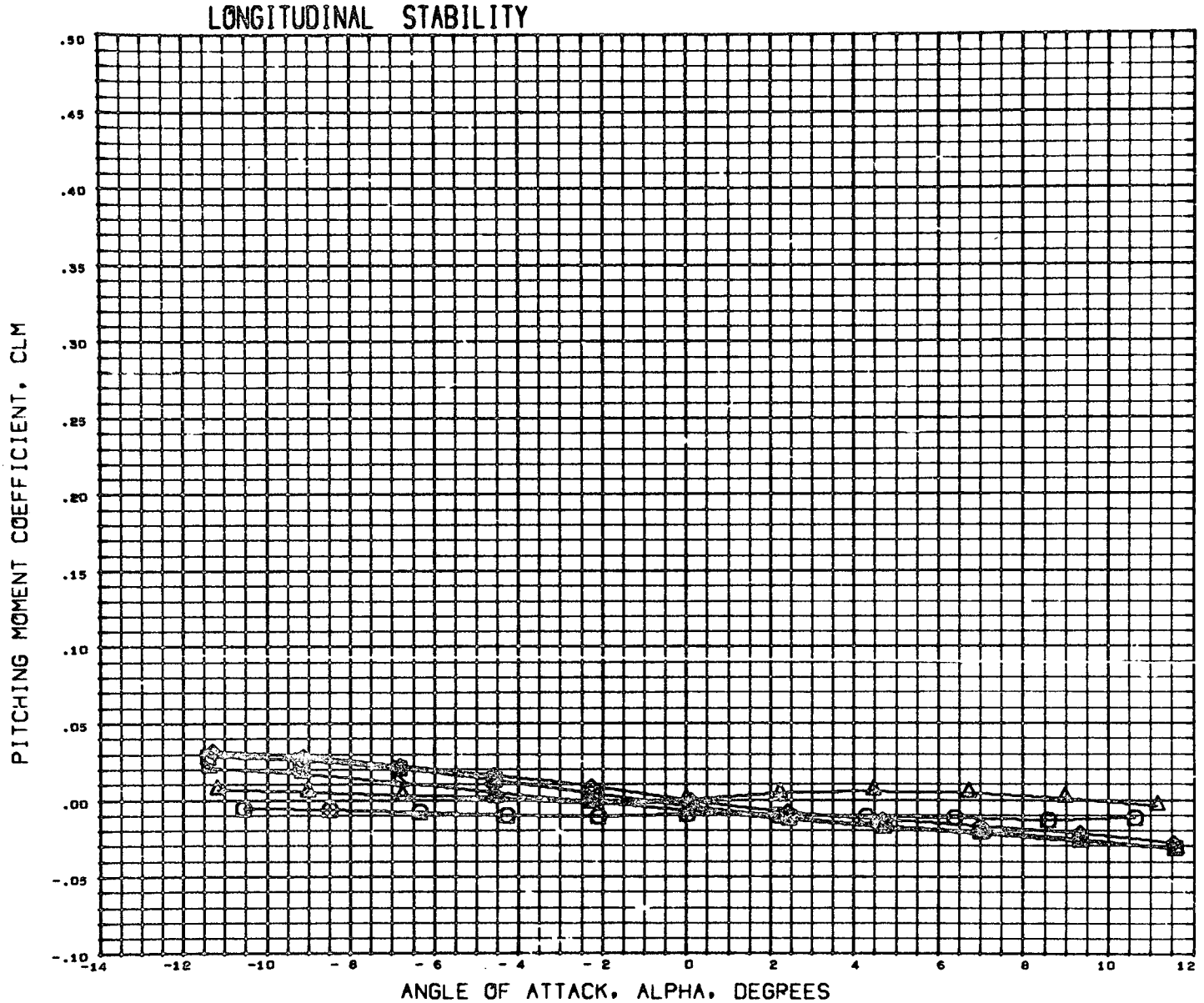

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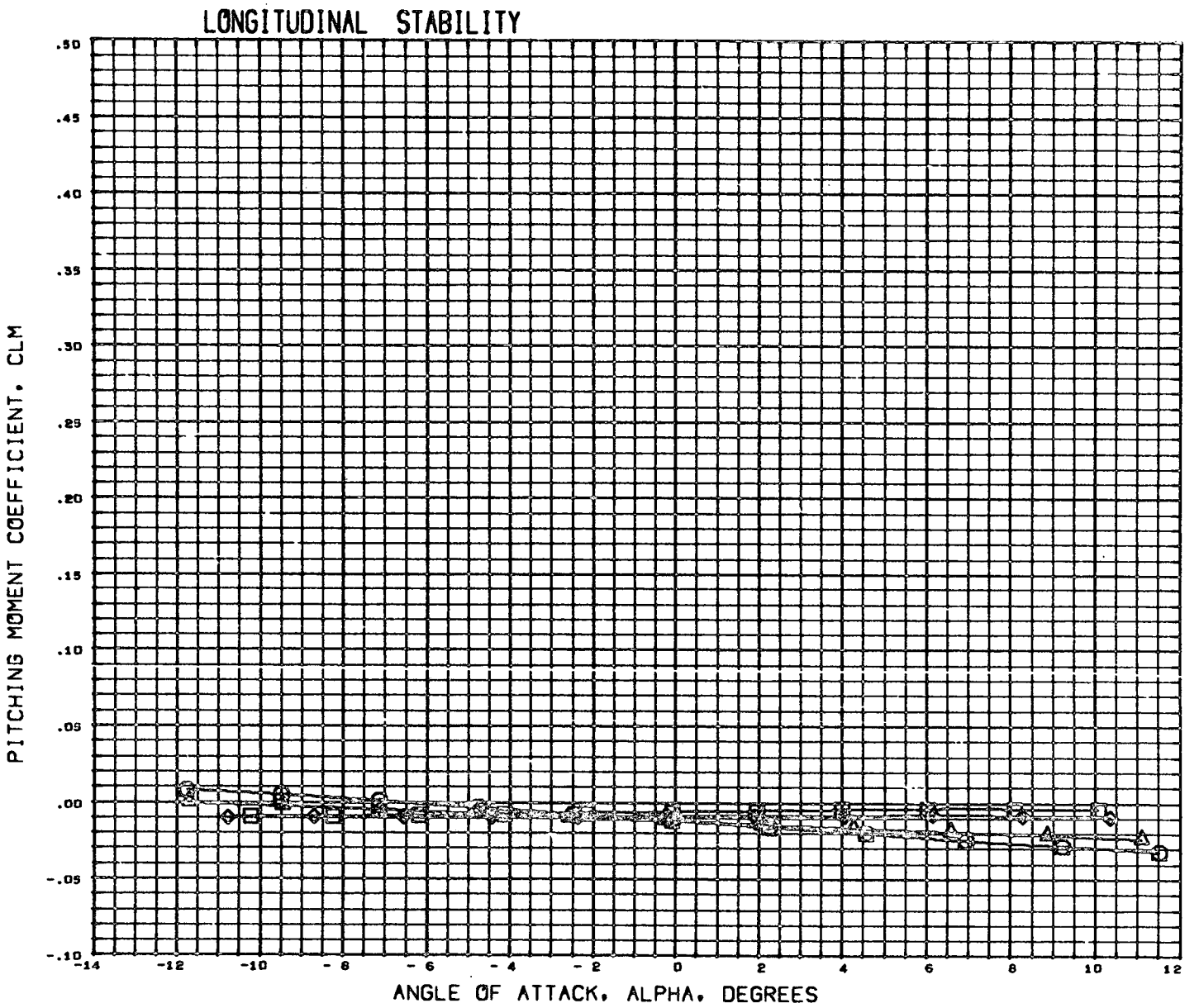

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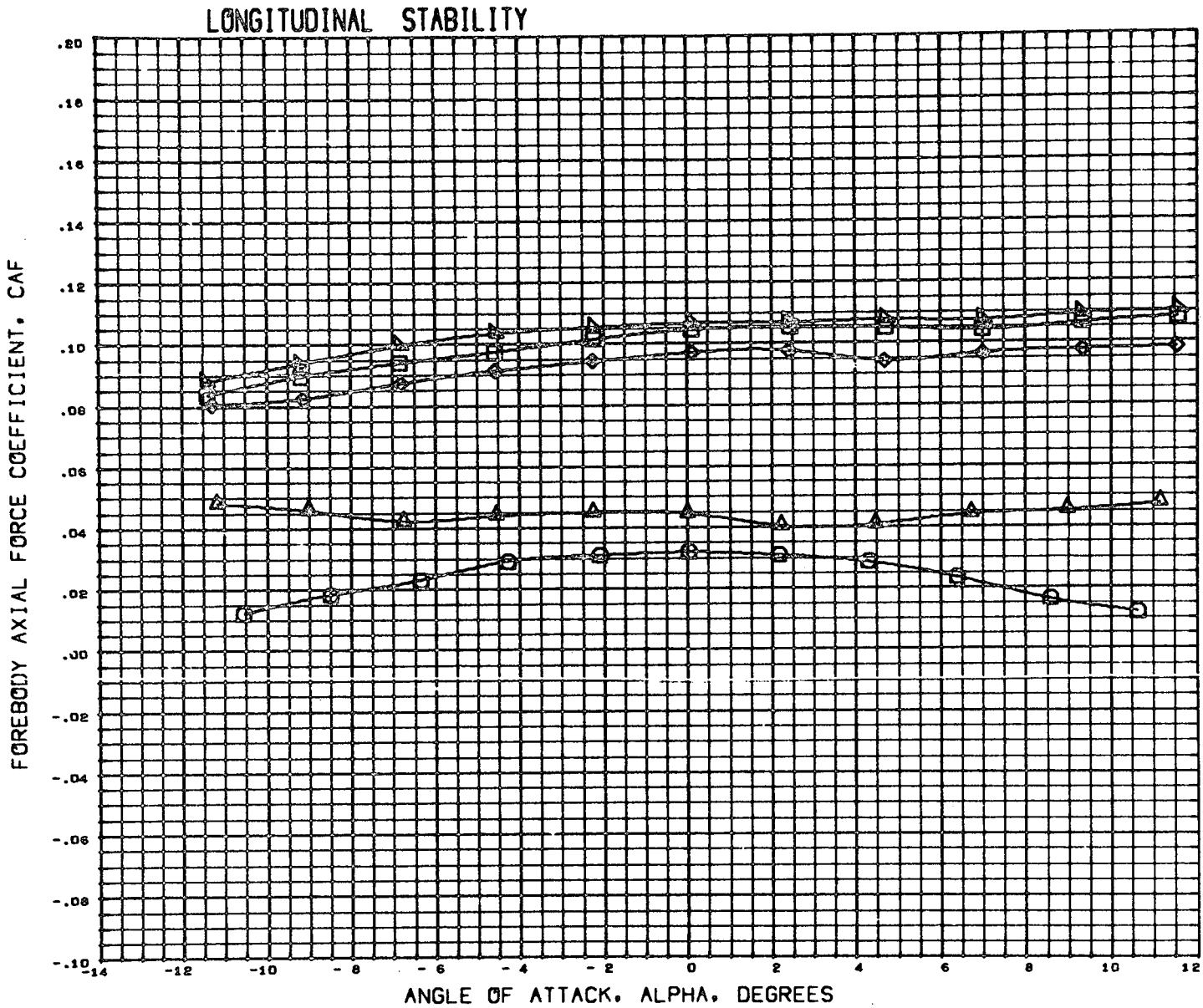

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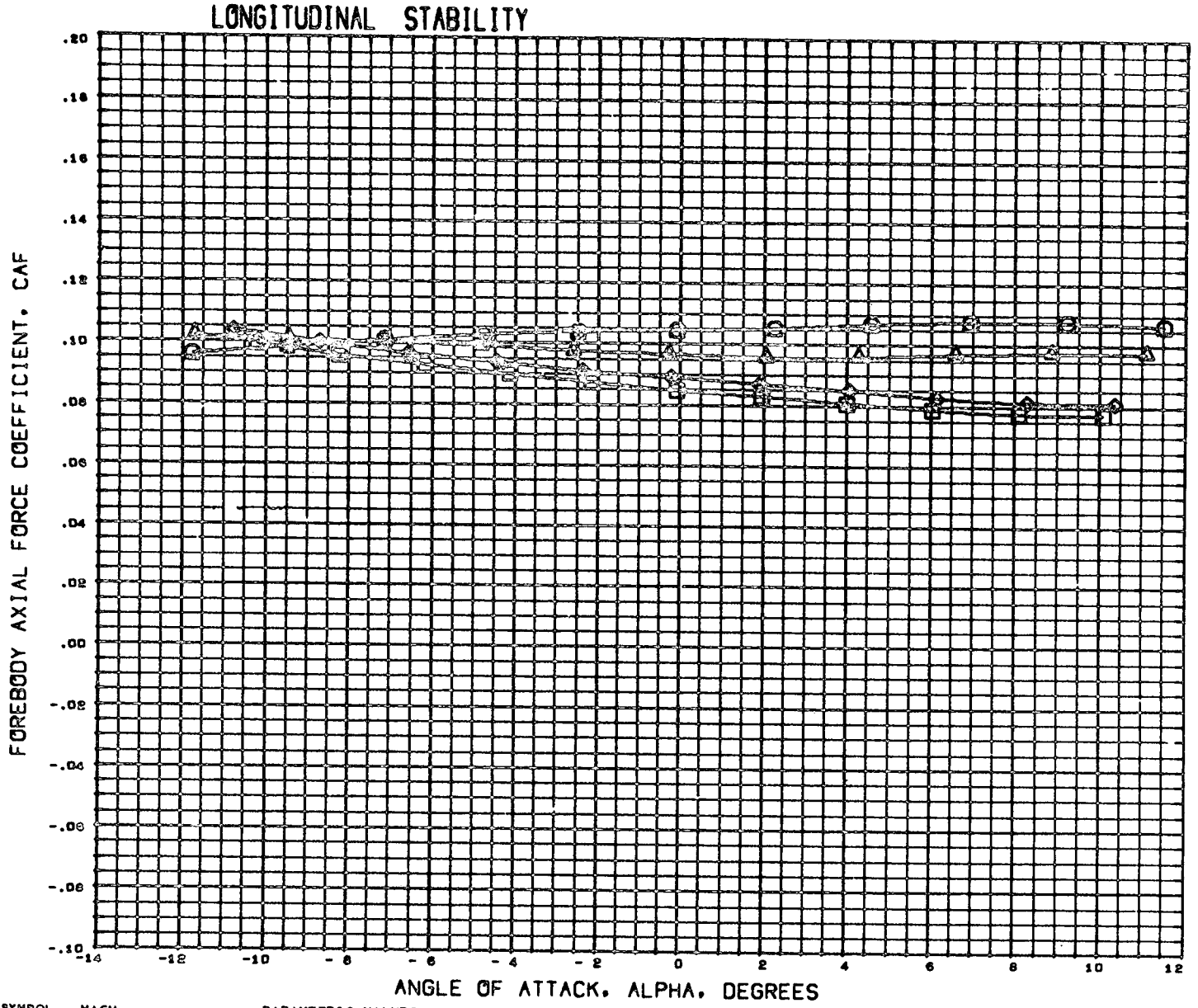

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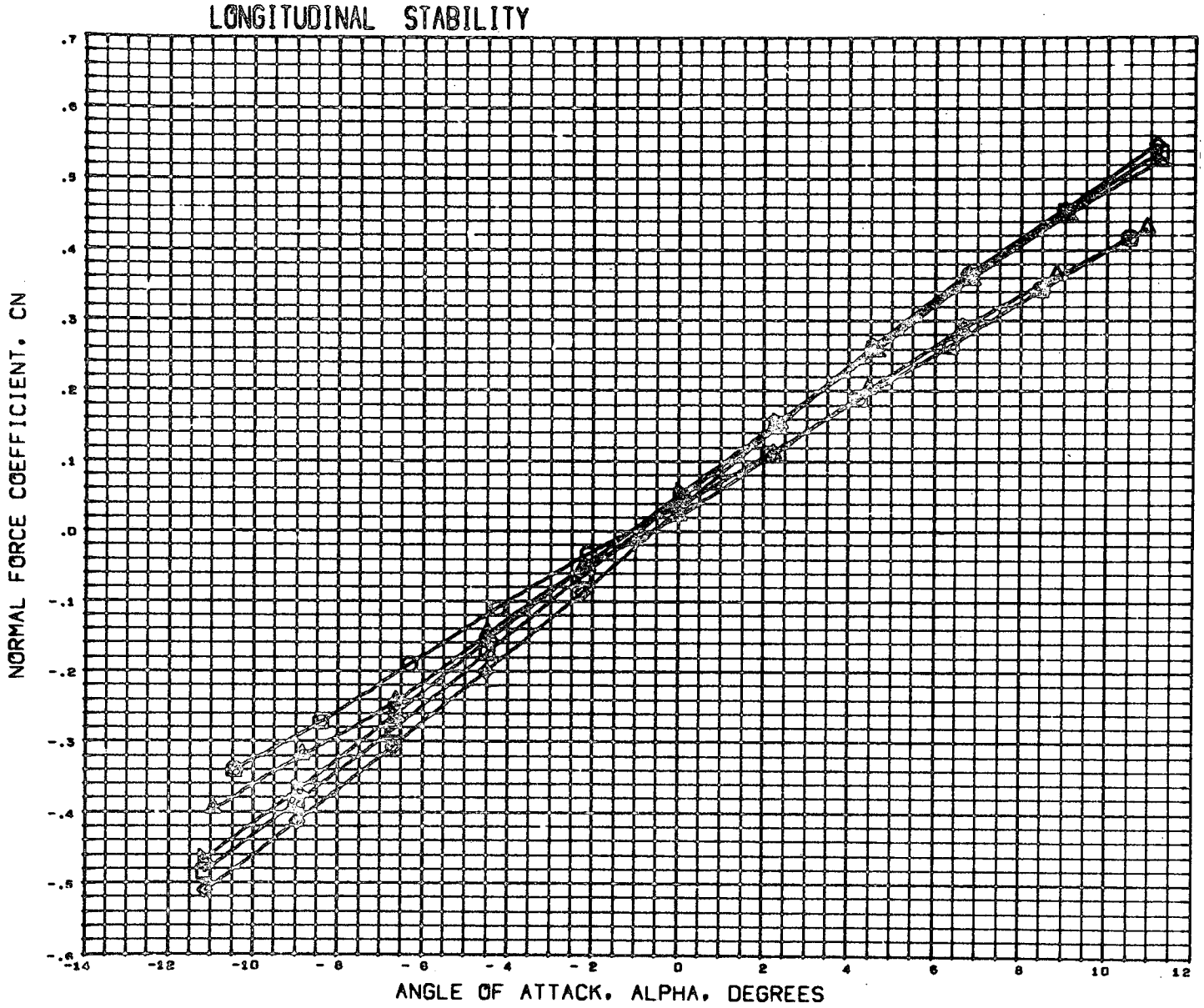
REFERENCE FILE S-E-AERO-AA-



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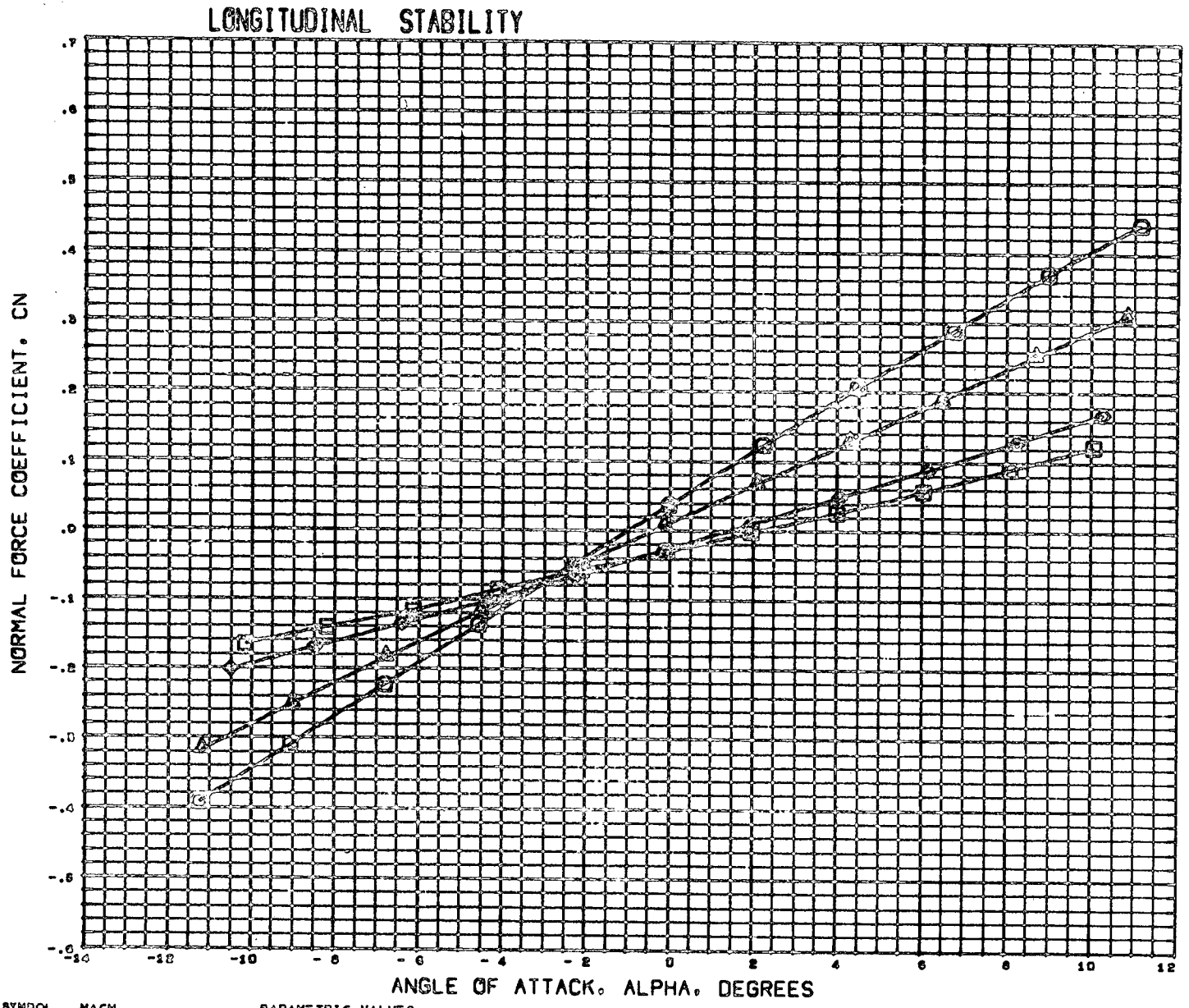

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REFERENCE FILE S-E-AERO-AA-

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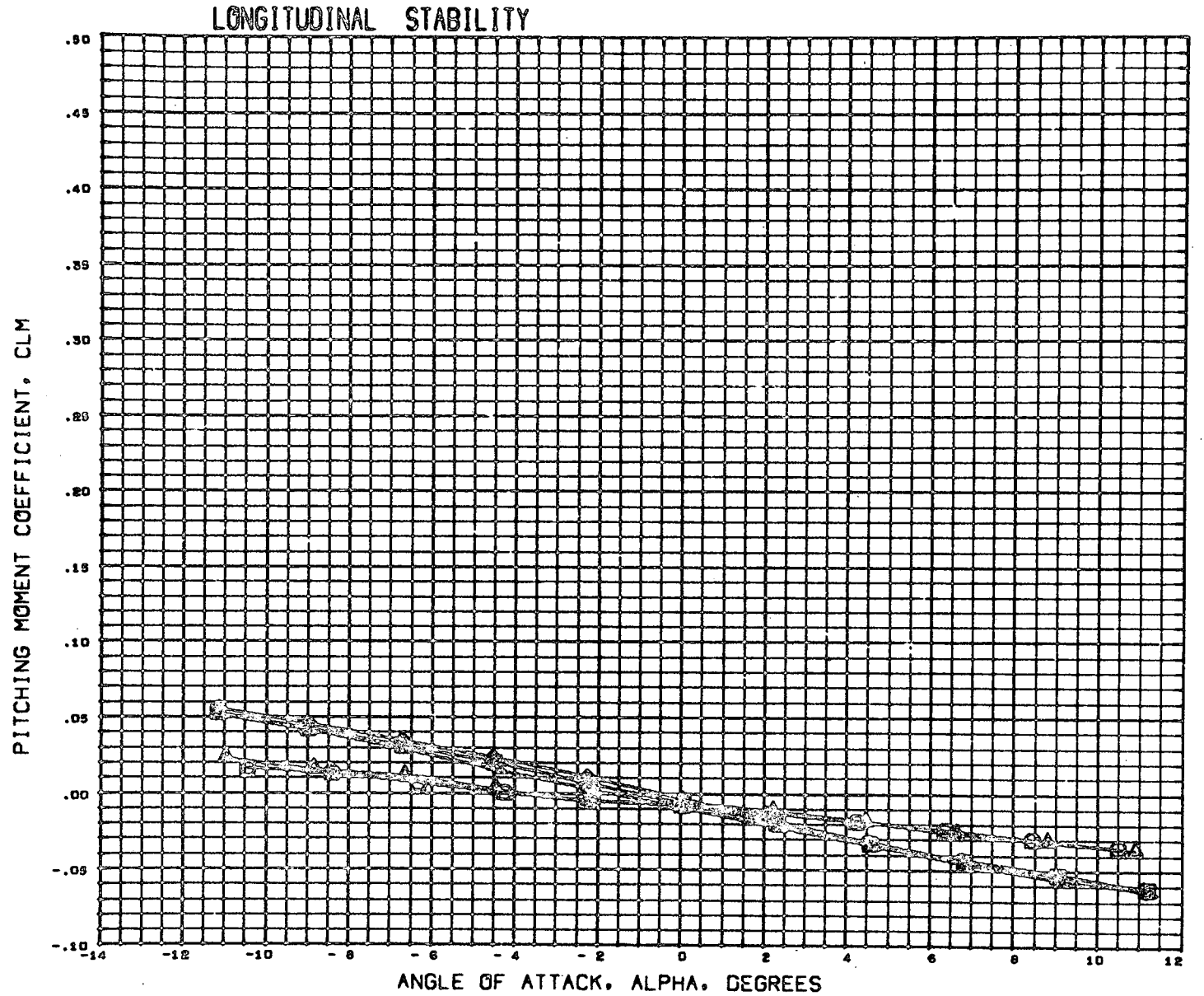

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REFERENCE FILE S-E-AERO-AA-

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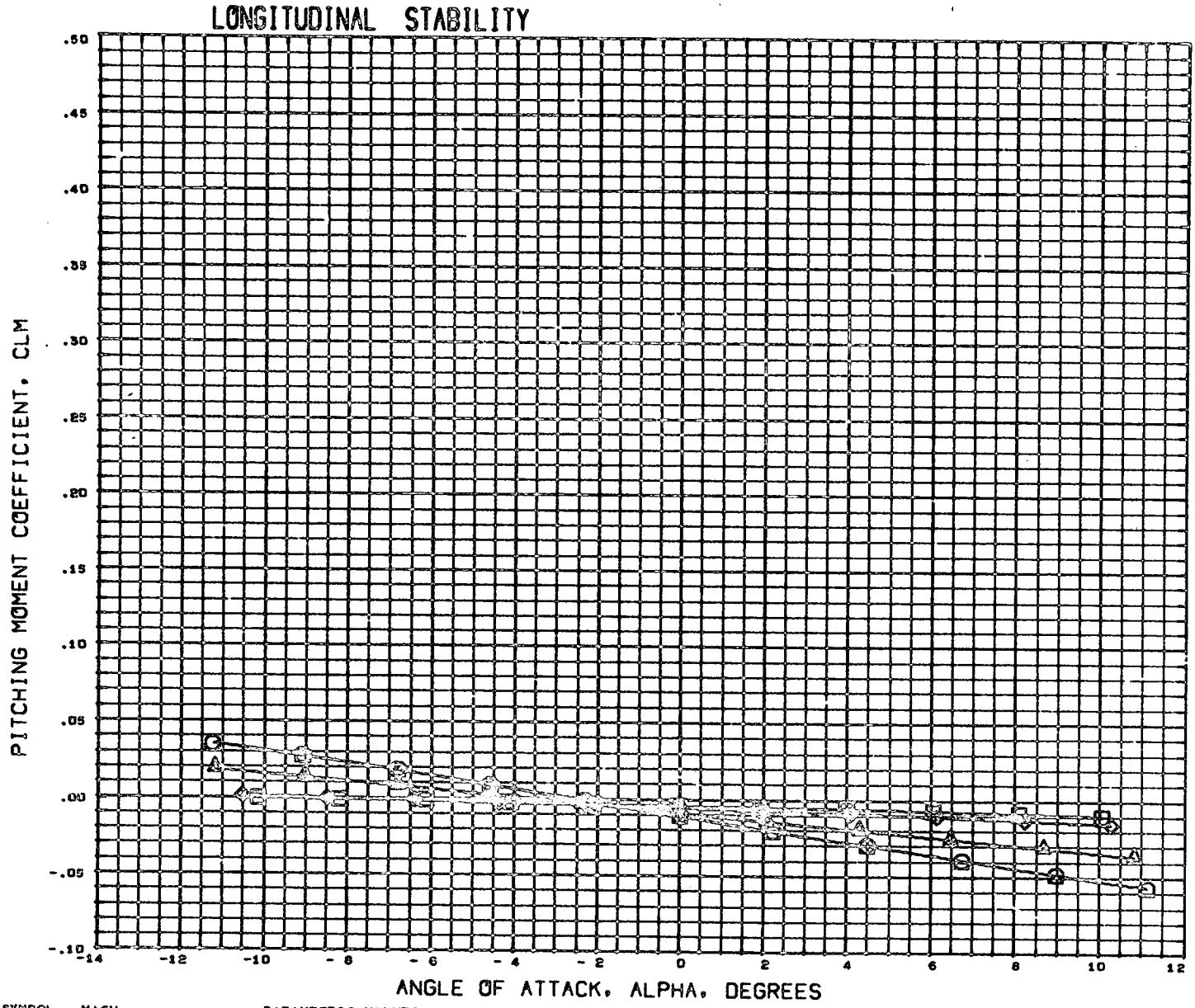

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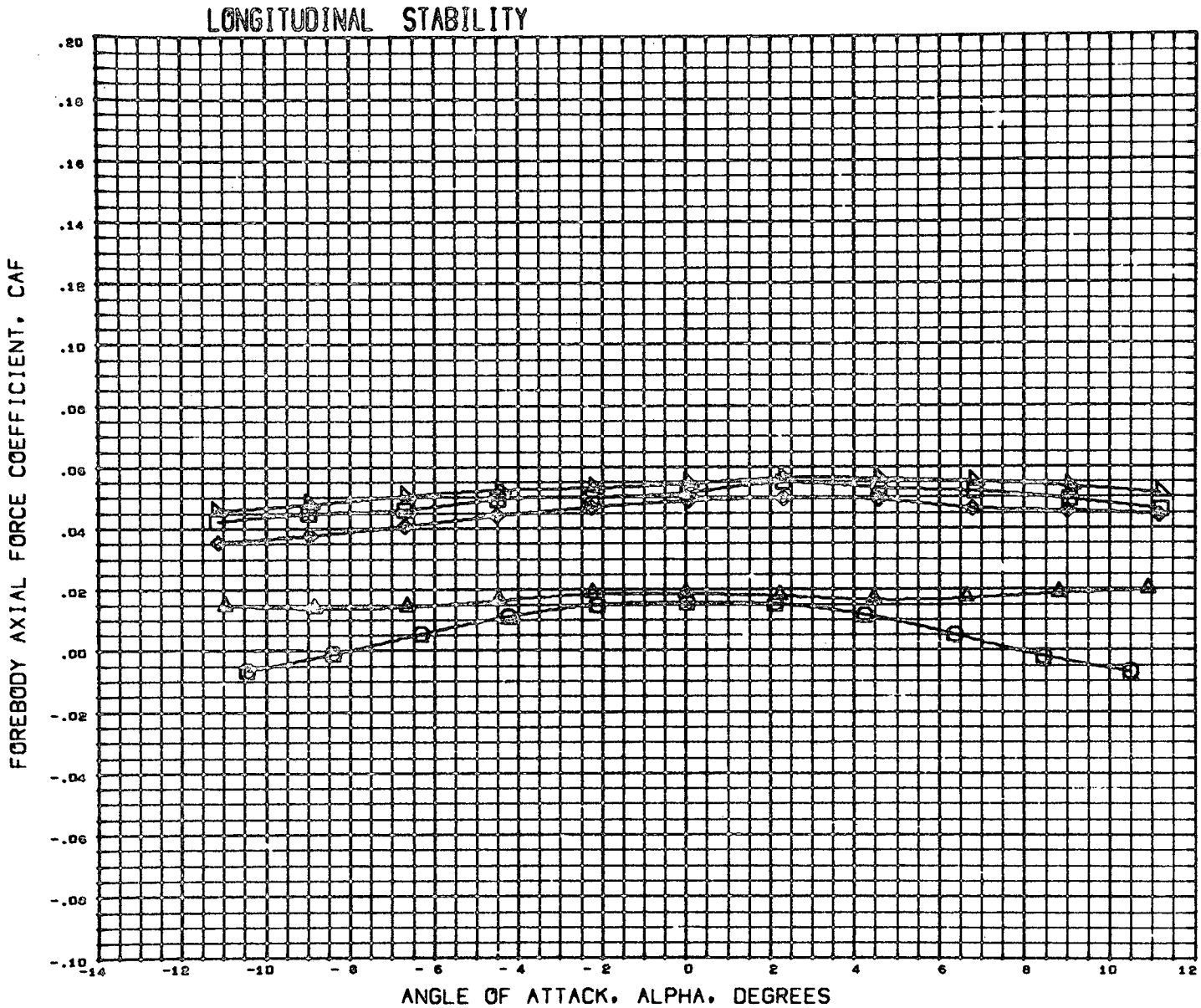

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□	1.096		
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REFERENCE FILE S-E-AERO-AA-

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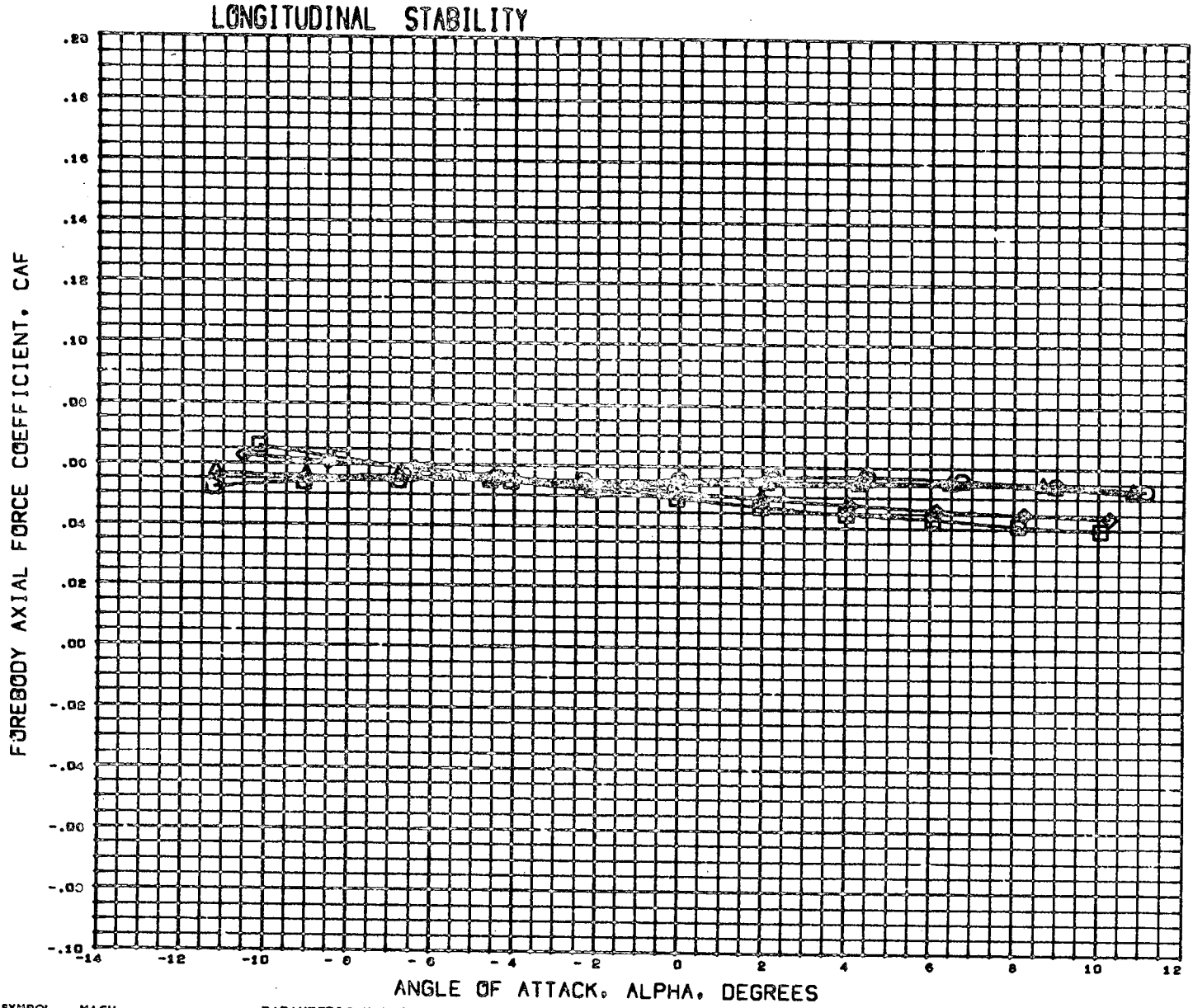

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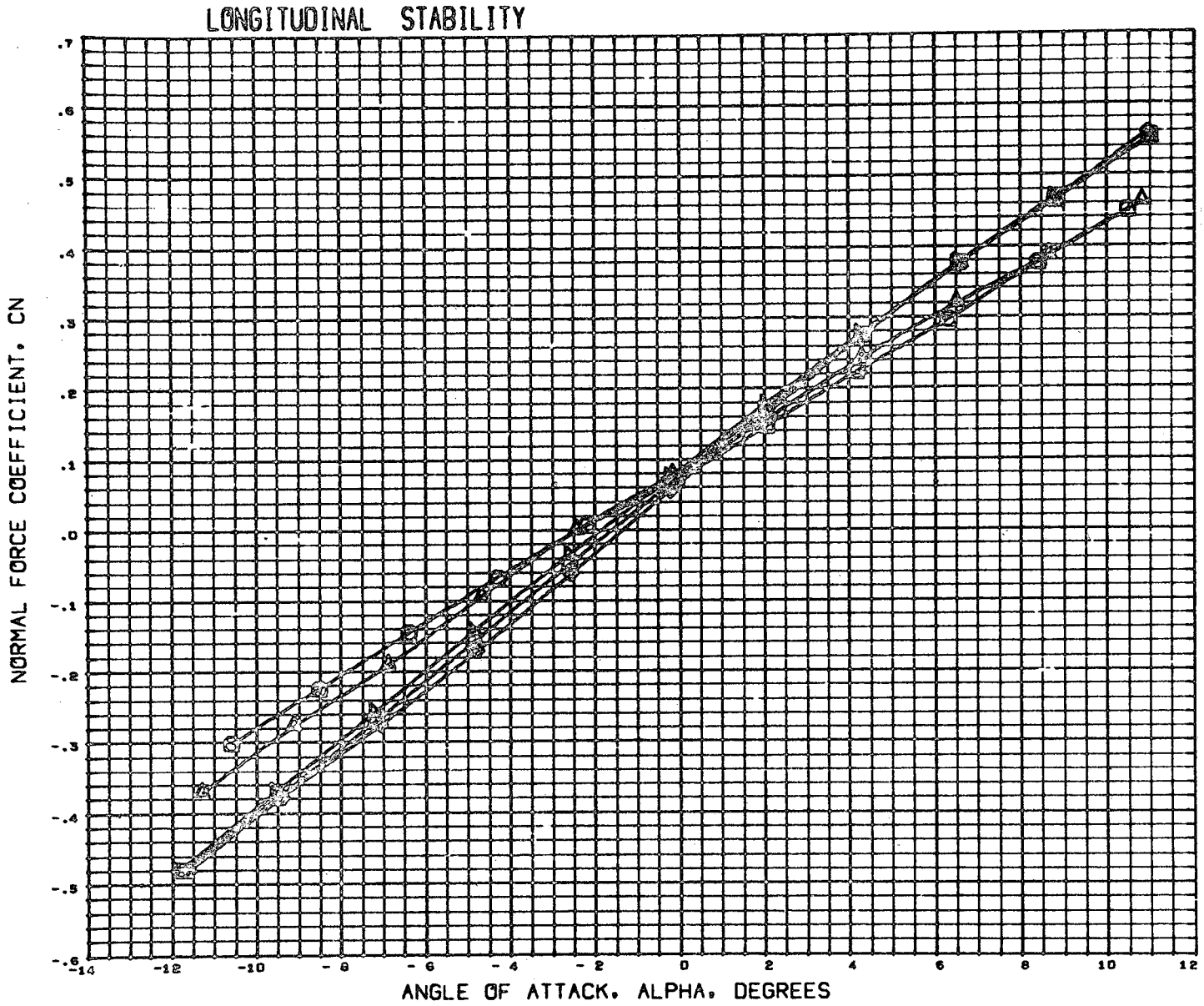
REFERENCE FILE S-E-AERO-AA-



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REFERENCE FILE S-E-AERO-AA-

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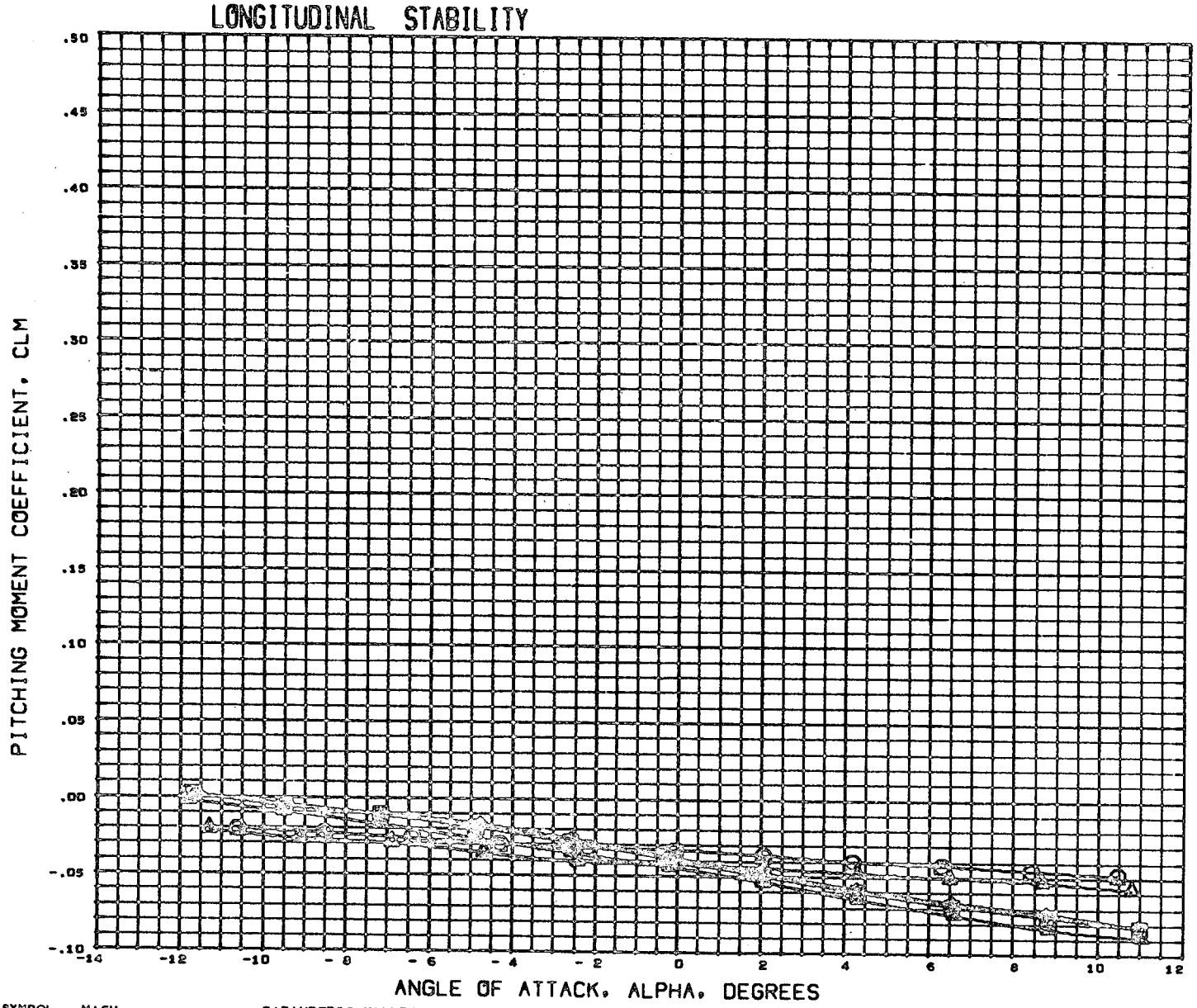

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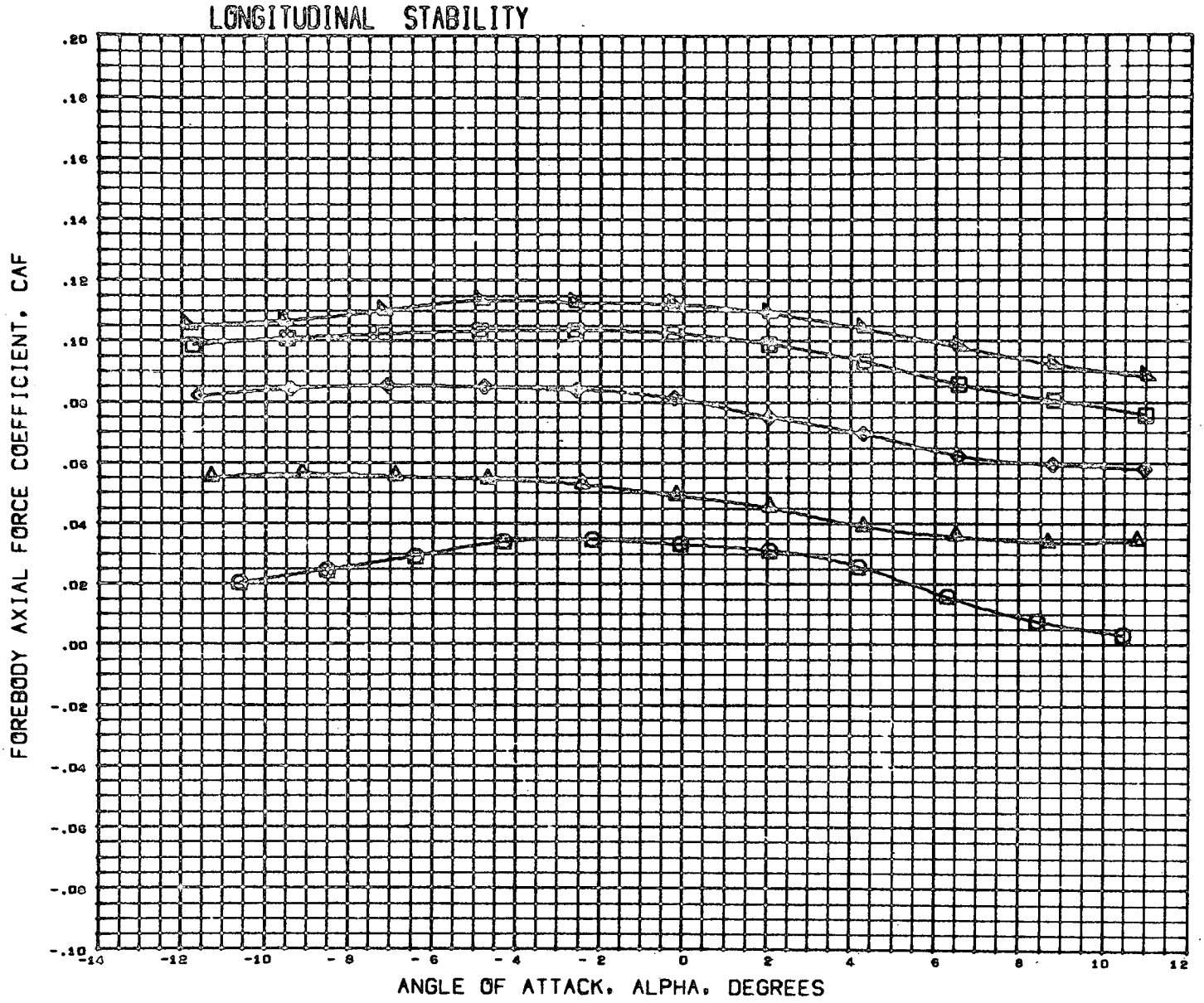

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REFERENCE FILE S-E-AERO-AA-

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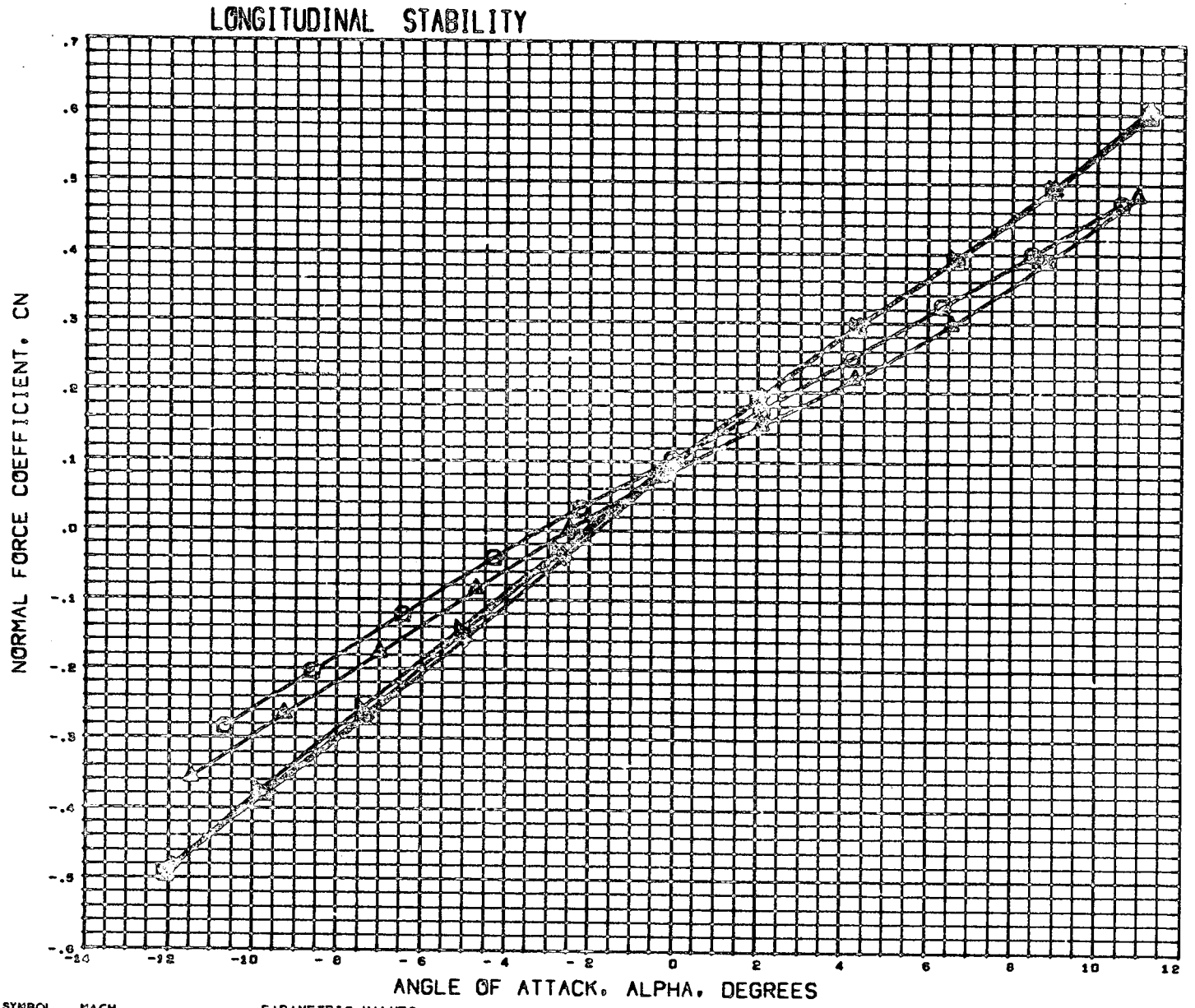
MSFC 504 GRUMMAN H33 ORB.+BOOST.-DROP TANKS (A46041) 16 OCT 71 PAGE 15



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REFERENCE FILE S-E-AERO-AA-

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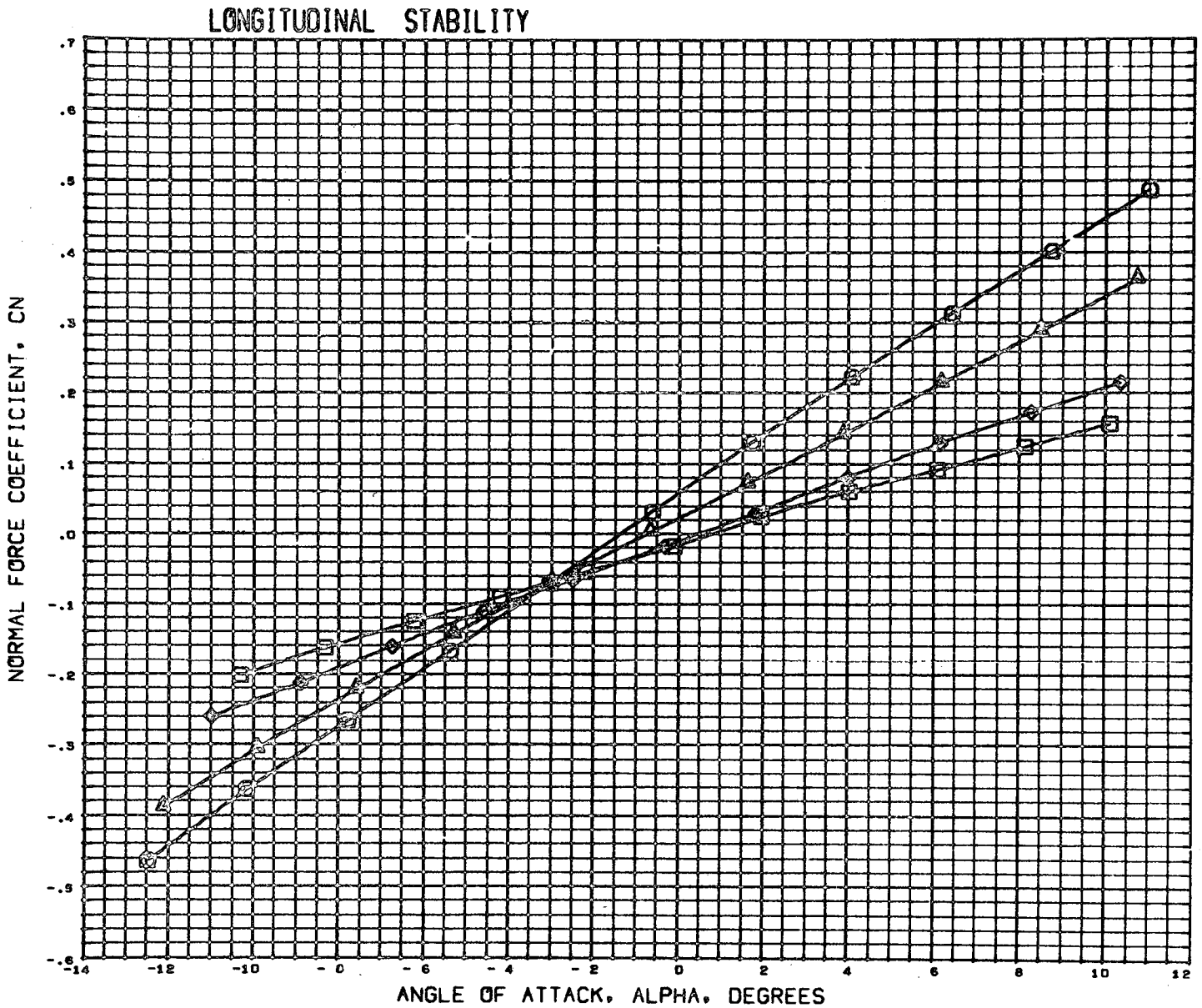

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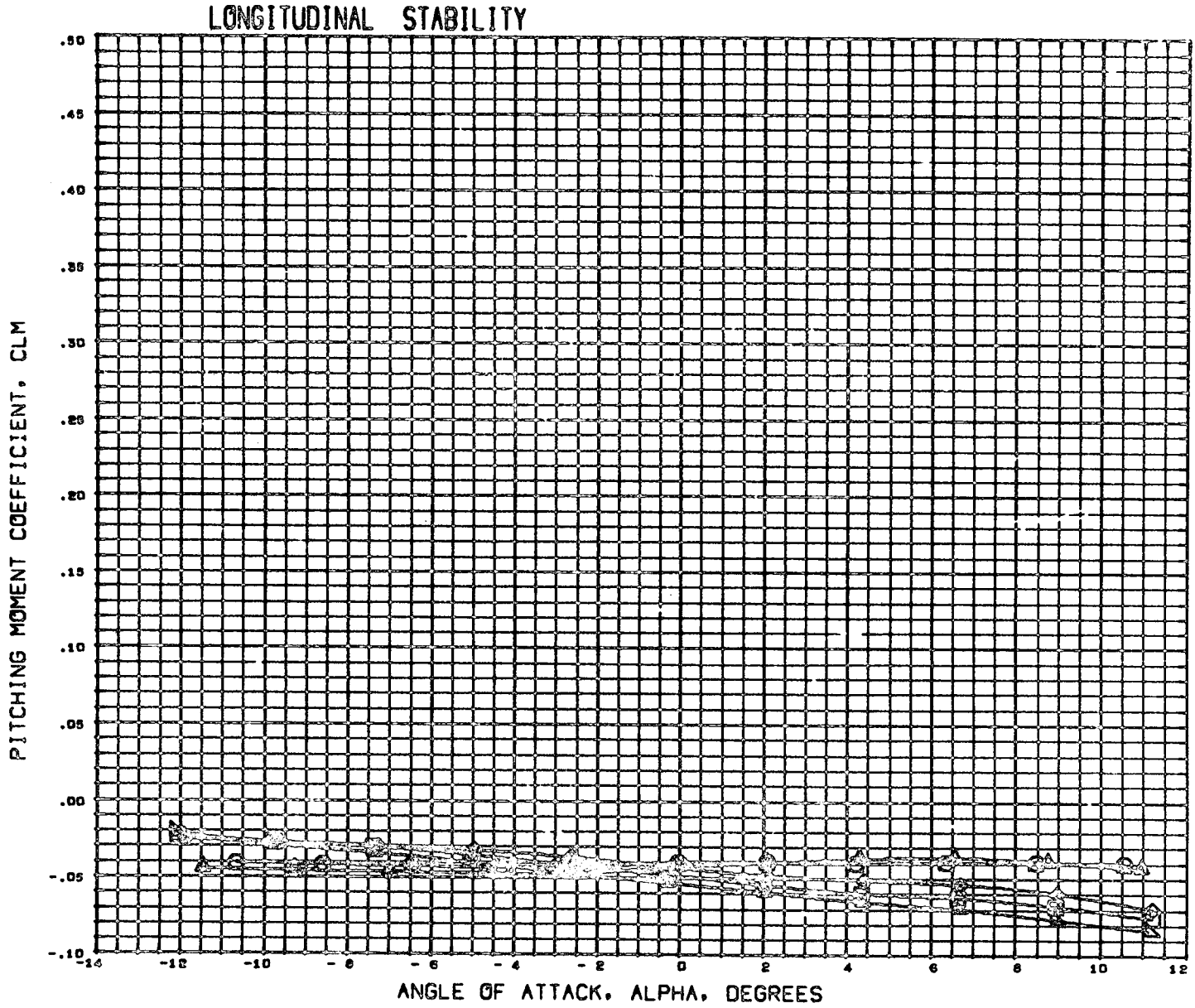

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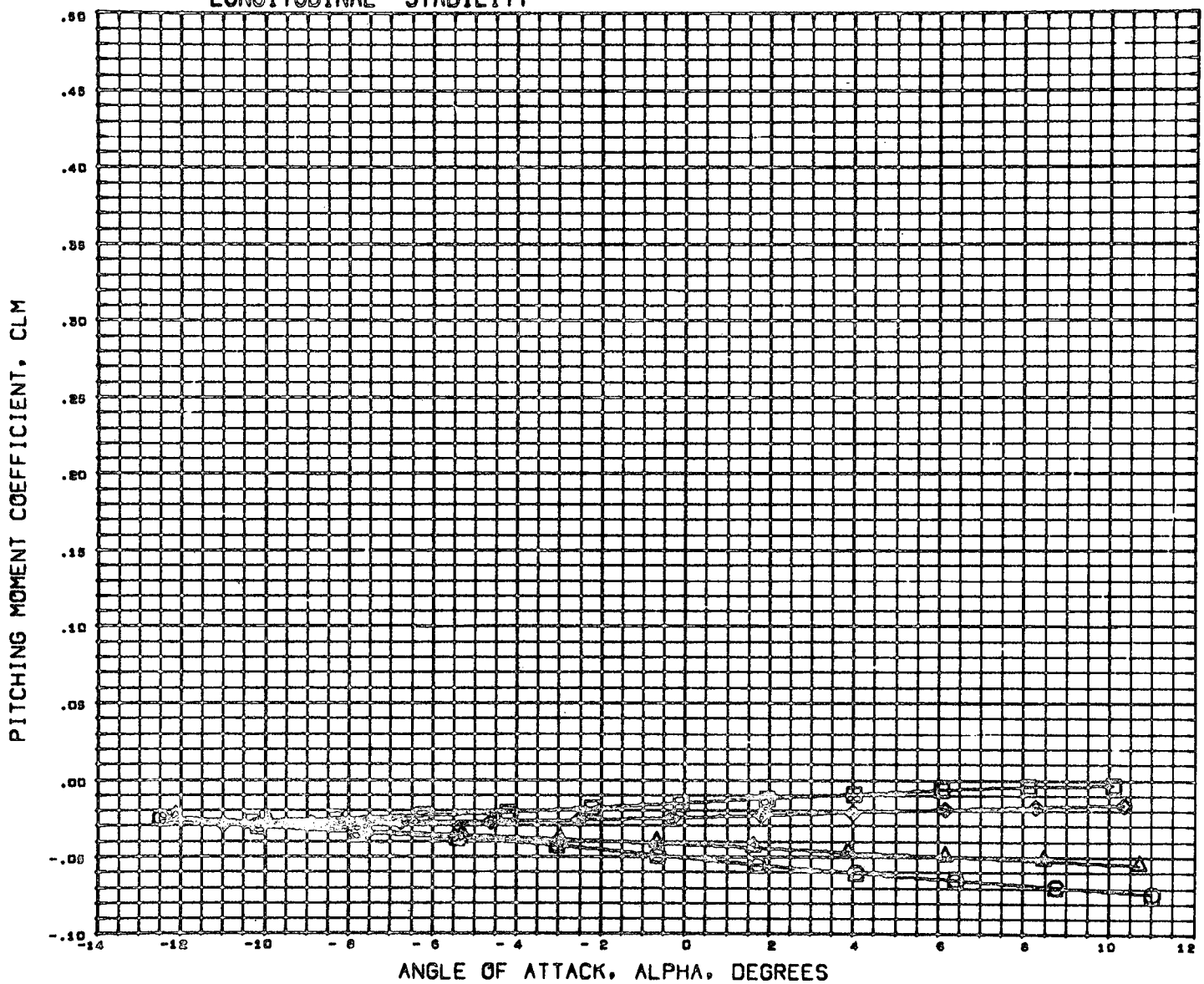
LONGITUDINAL STABILITY



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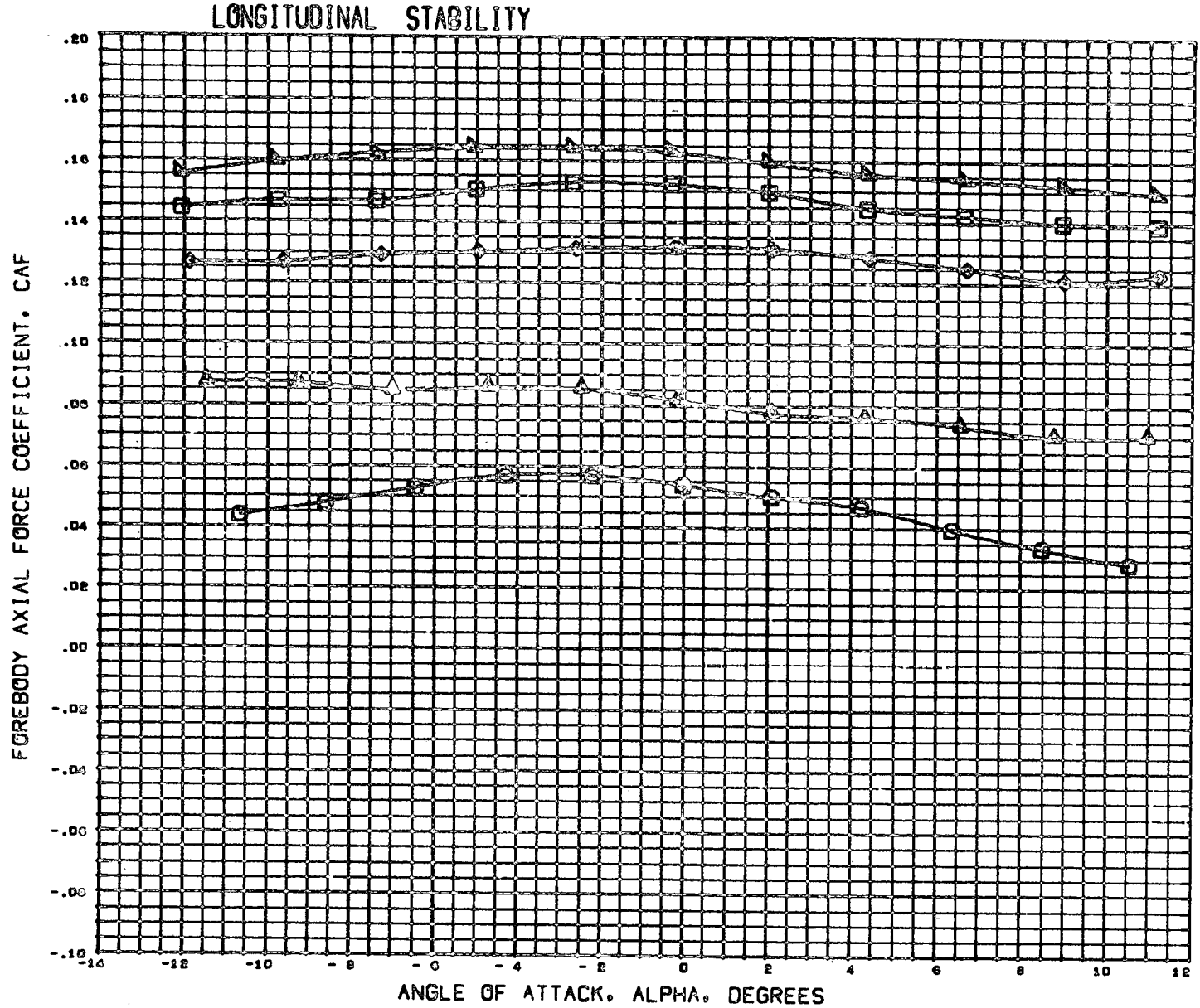

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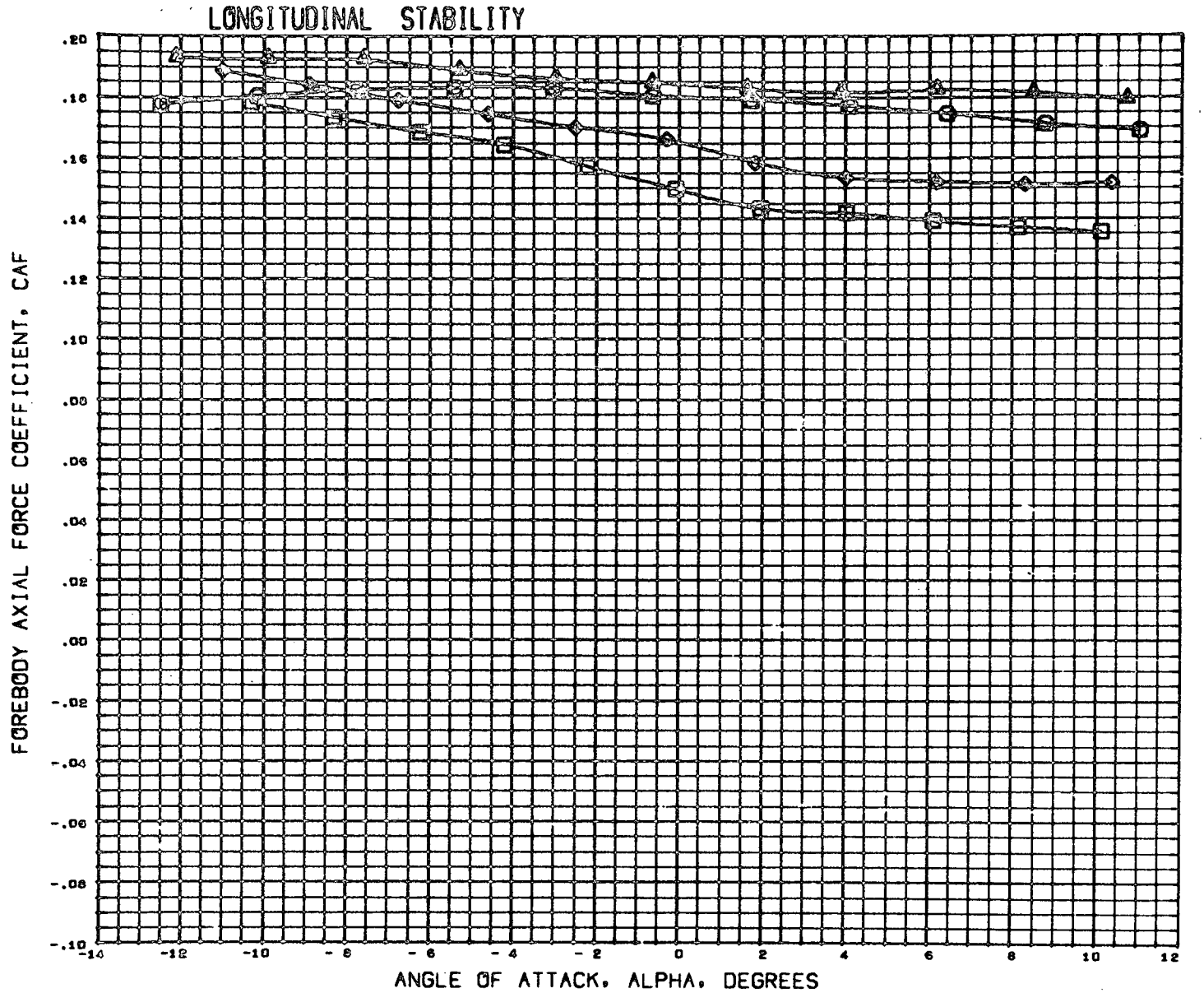

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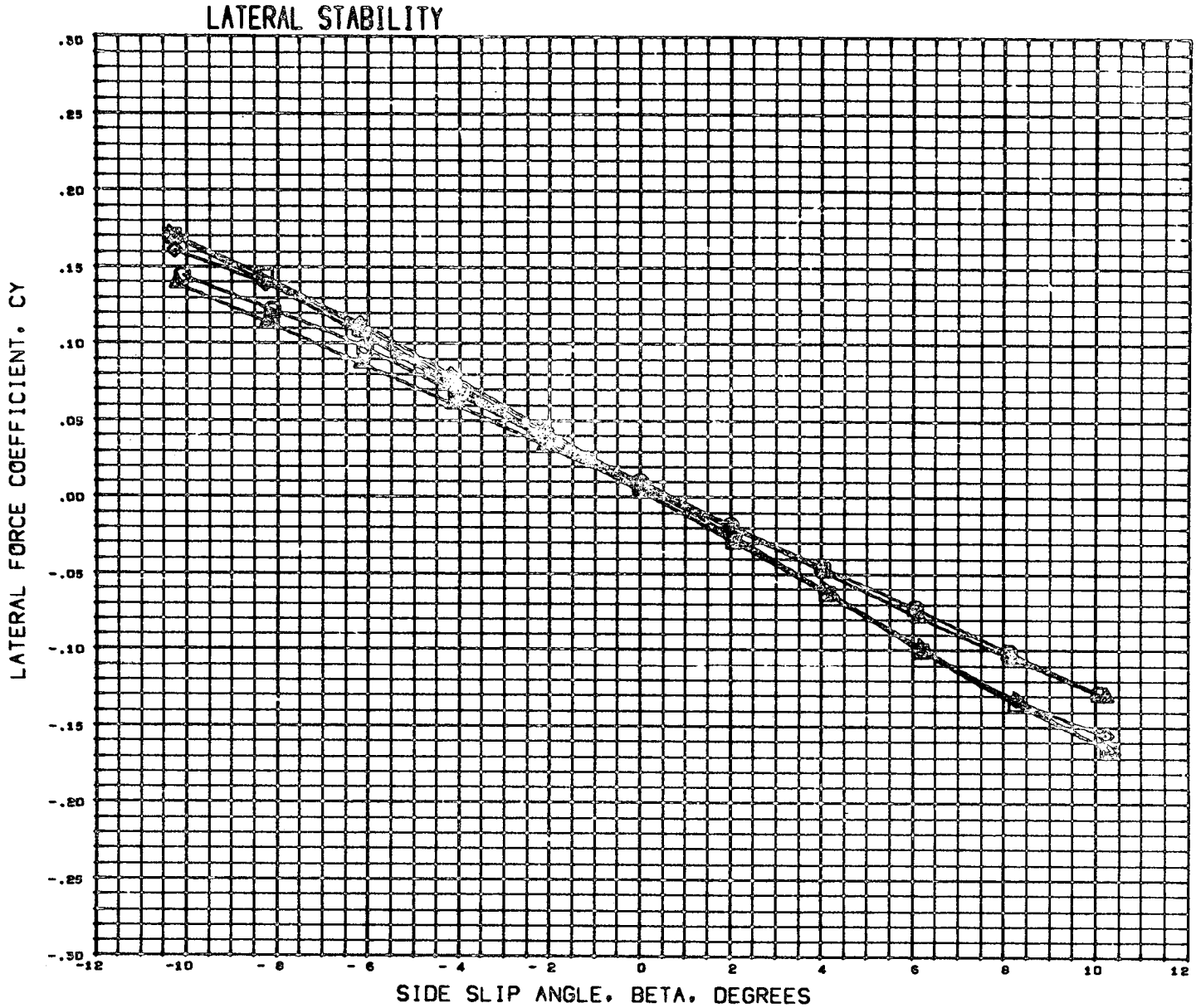

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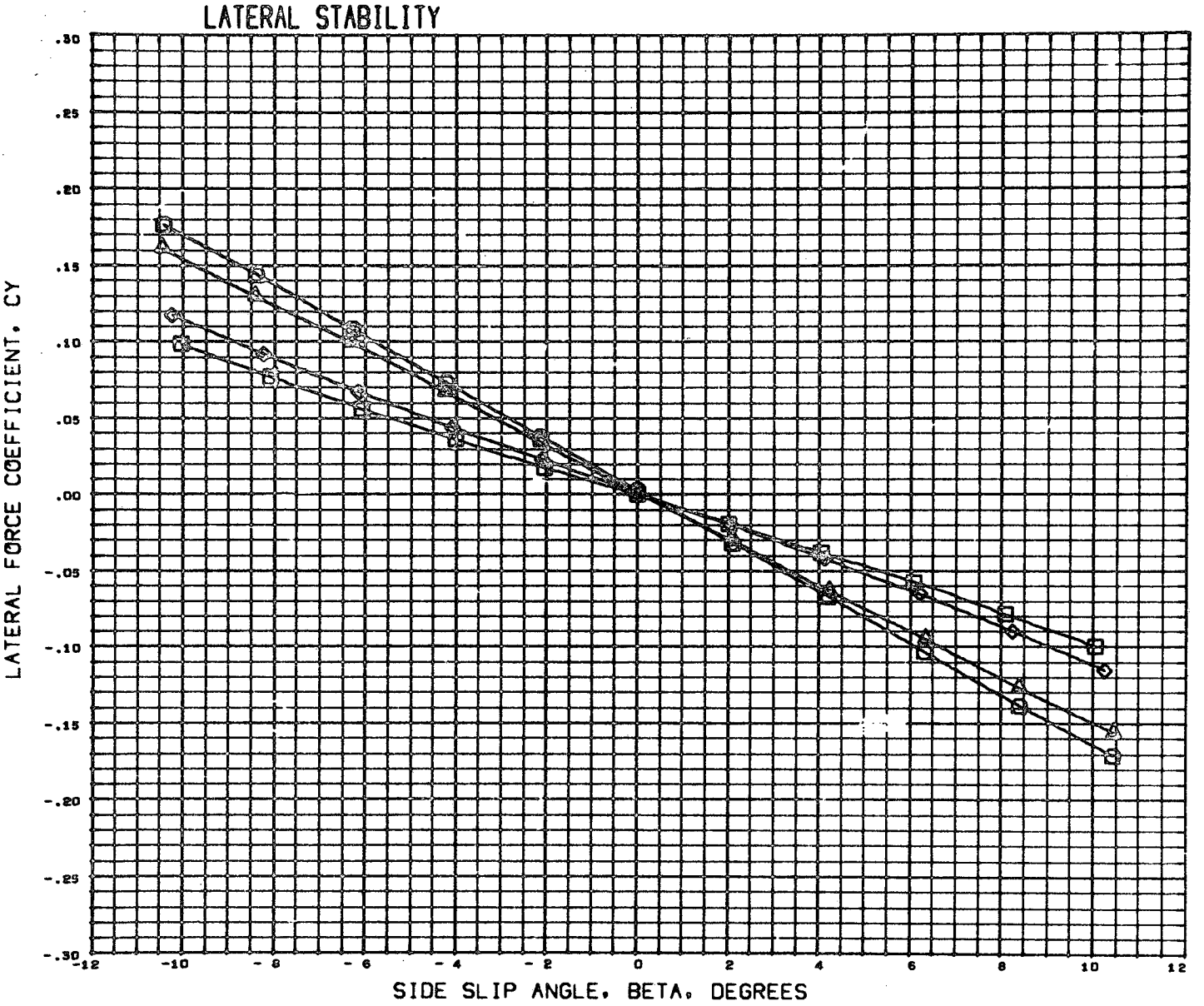

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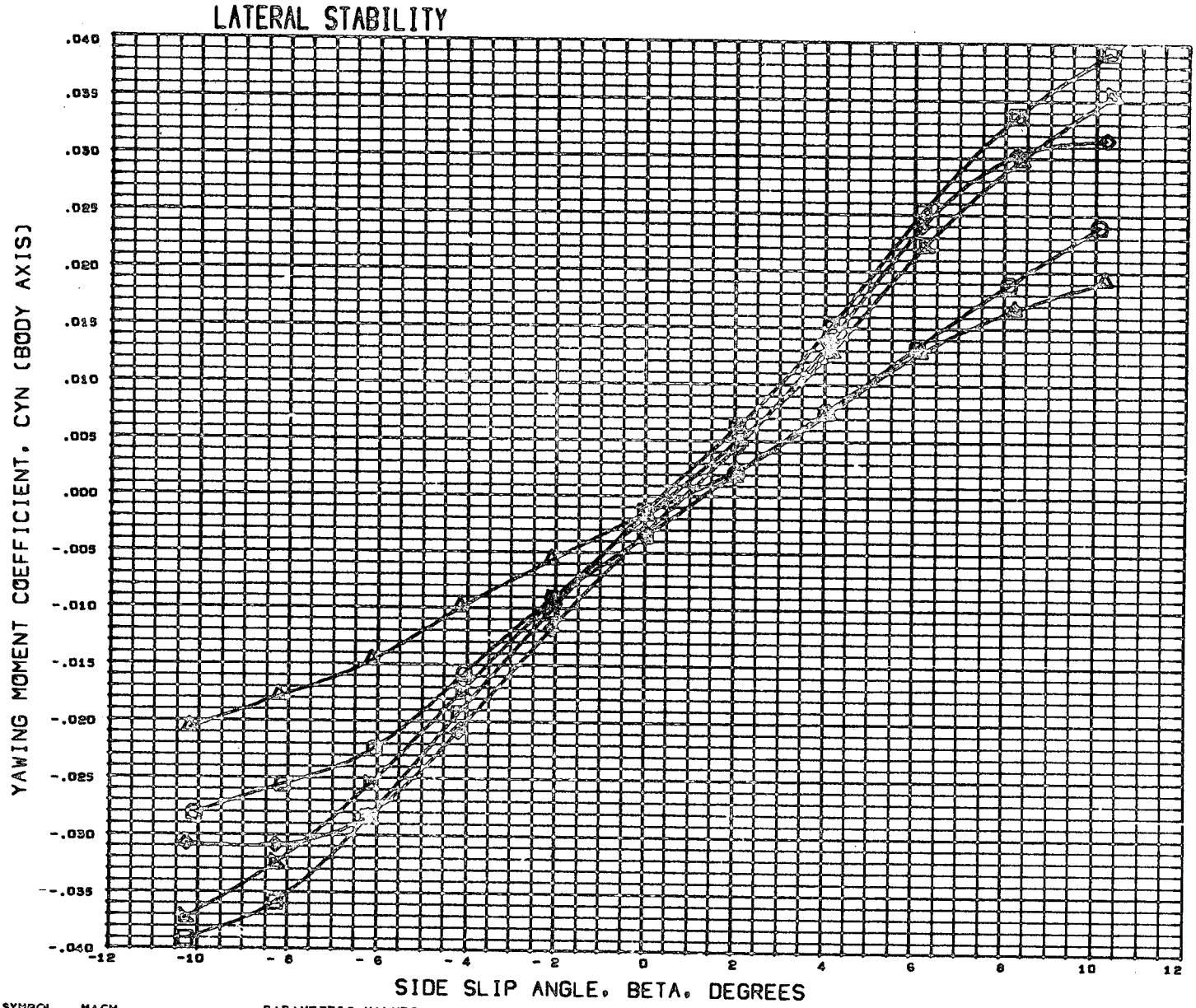

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◇	0.999
□	1.101
◺	1.200

PARAMETRIC VALUES

ALPHA 0.000

REFERENCE FILE S-E-AERO-AA-

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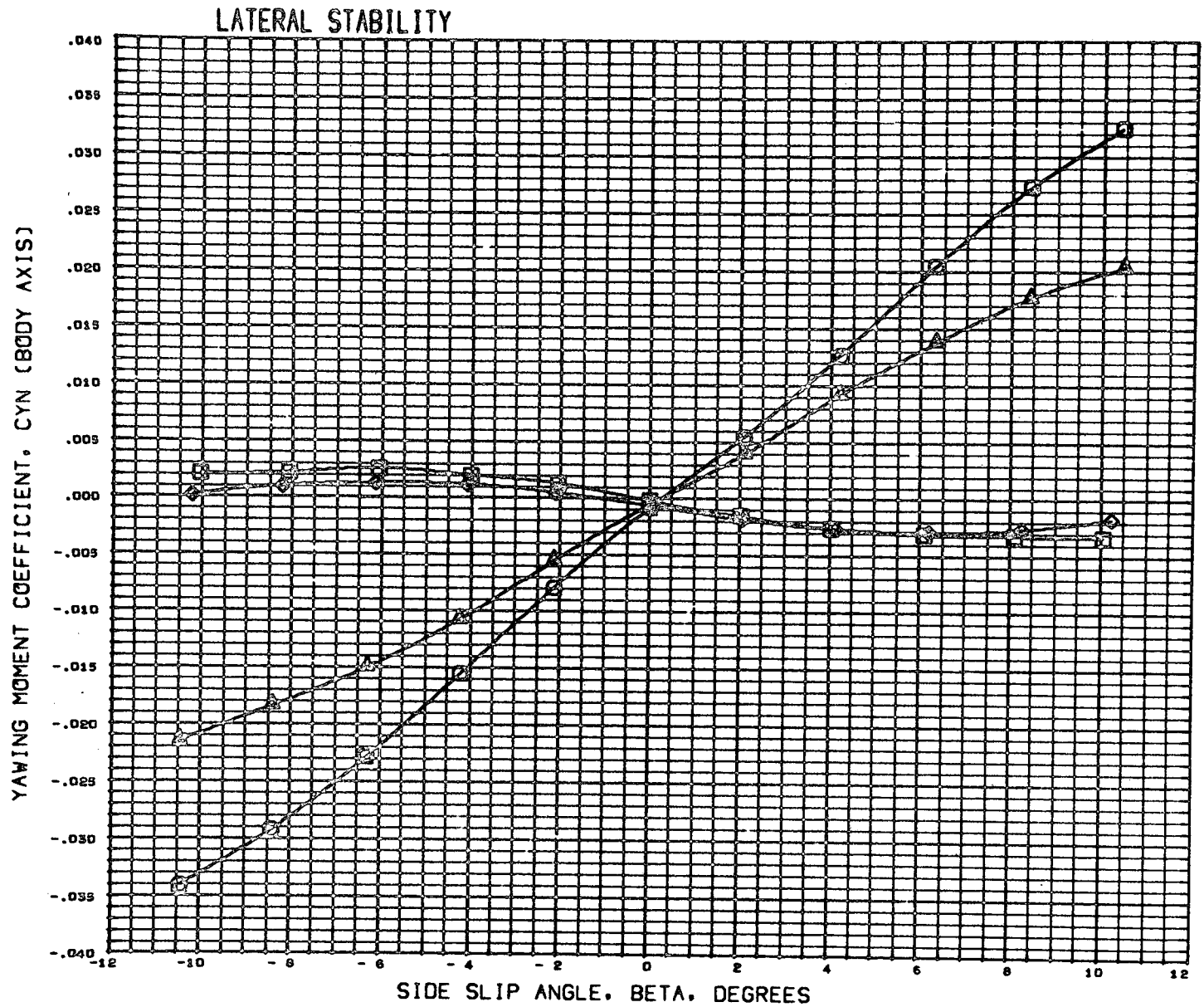

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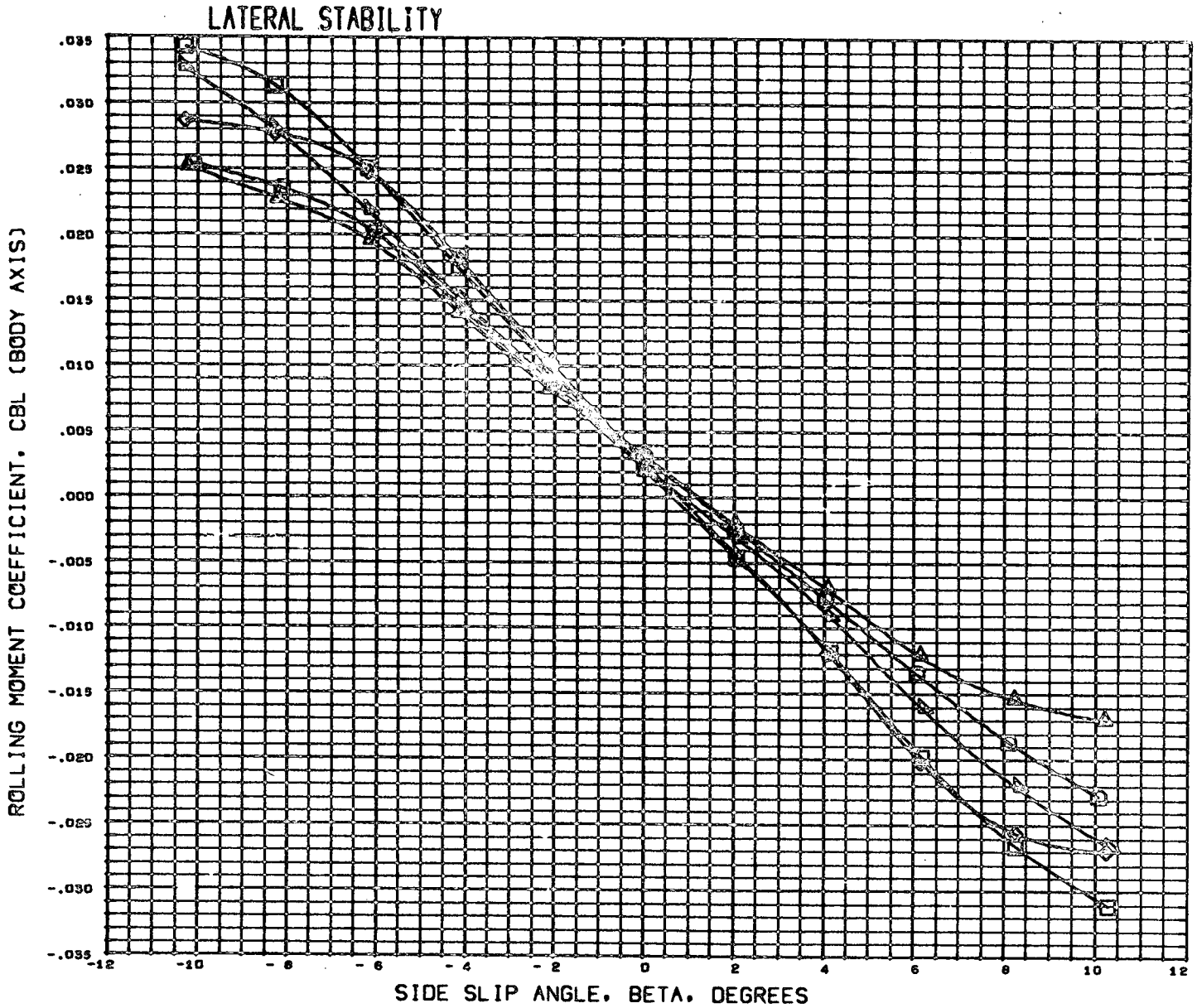

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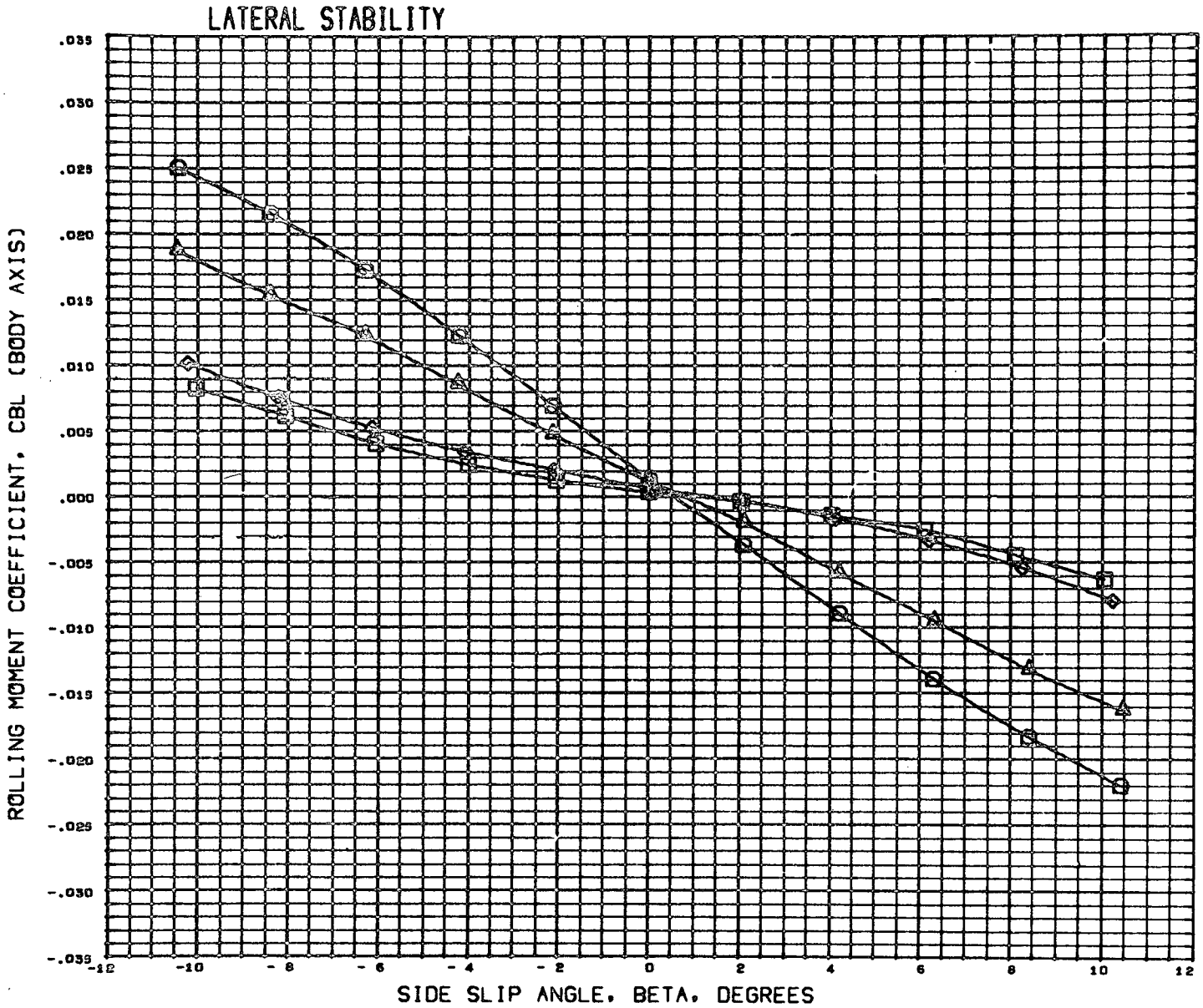
SCALE	0.3366	PERCEN



SYMBOL	MACH		PARAMETRIC VALUES
○	1.457	ALPHA	0.000
△	1.961		
◇	3.480		
□	4.959		

REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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BREF	3.9300	IN.
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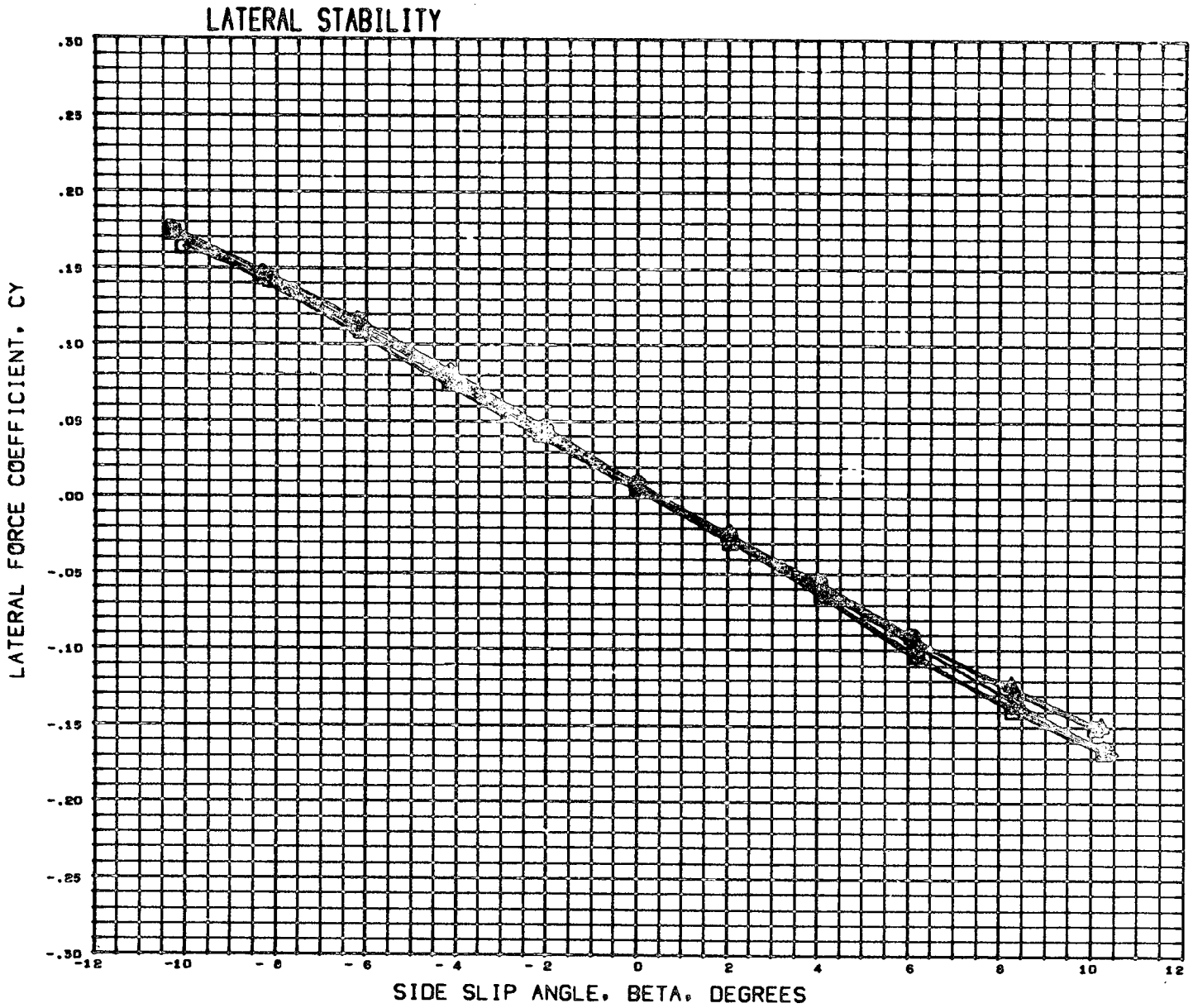
SCALE	0.3366	PERCEN



SYMBOL	MACH	PARAMETRIC VALUES	
○	0.600	ALPHA	0.000
△	0.903		
◇	1.001		
□	1.102		
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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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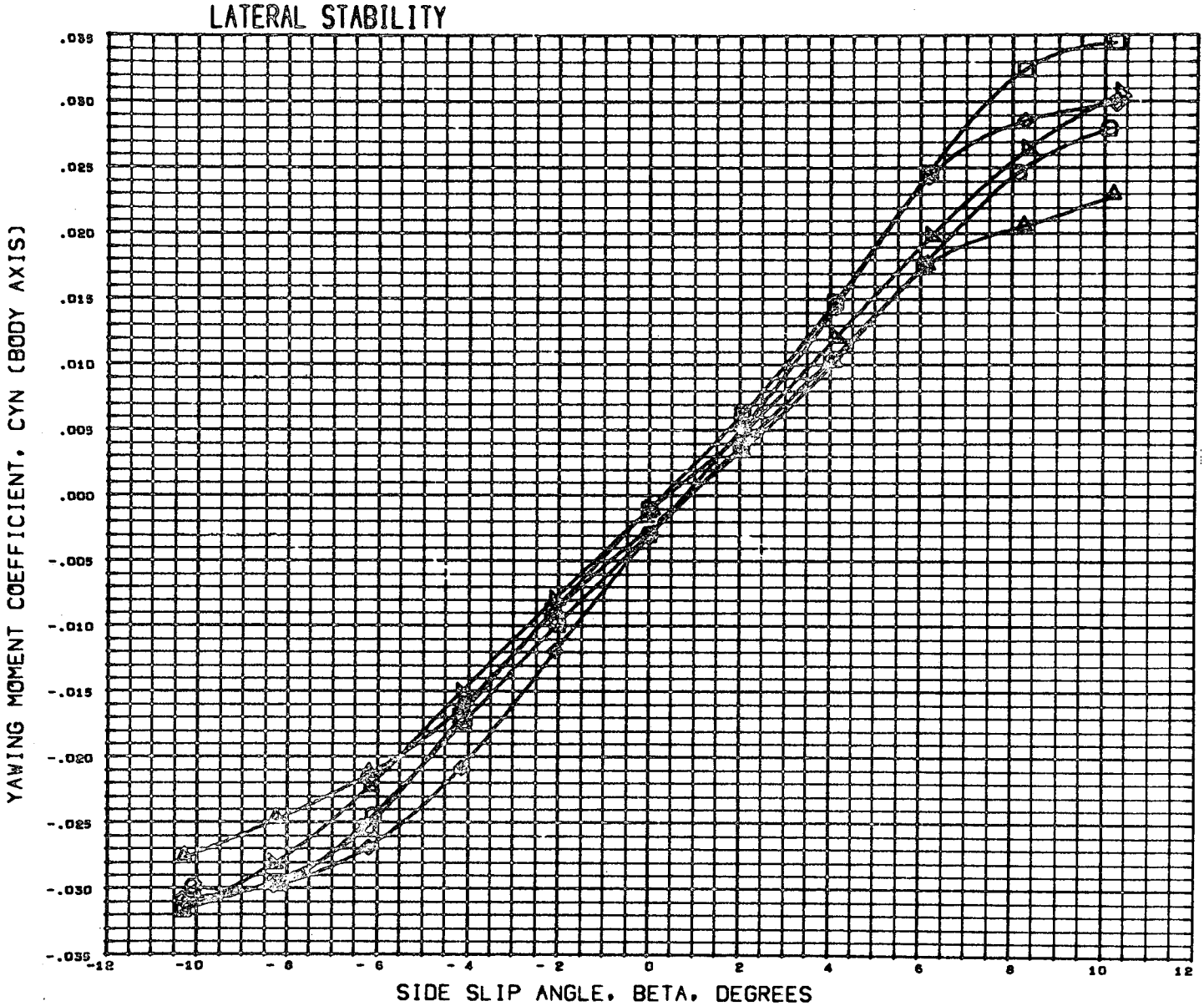
SCALE	0.3366	PERCEN



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○	0.600	ALPHA	0.000
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□	1.102		
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REFERENCE FILE S-E-AERO-AA-

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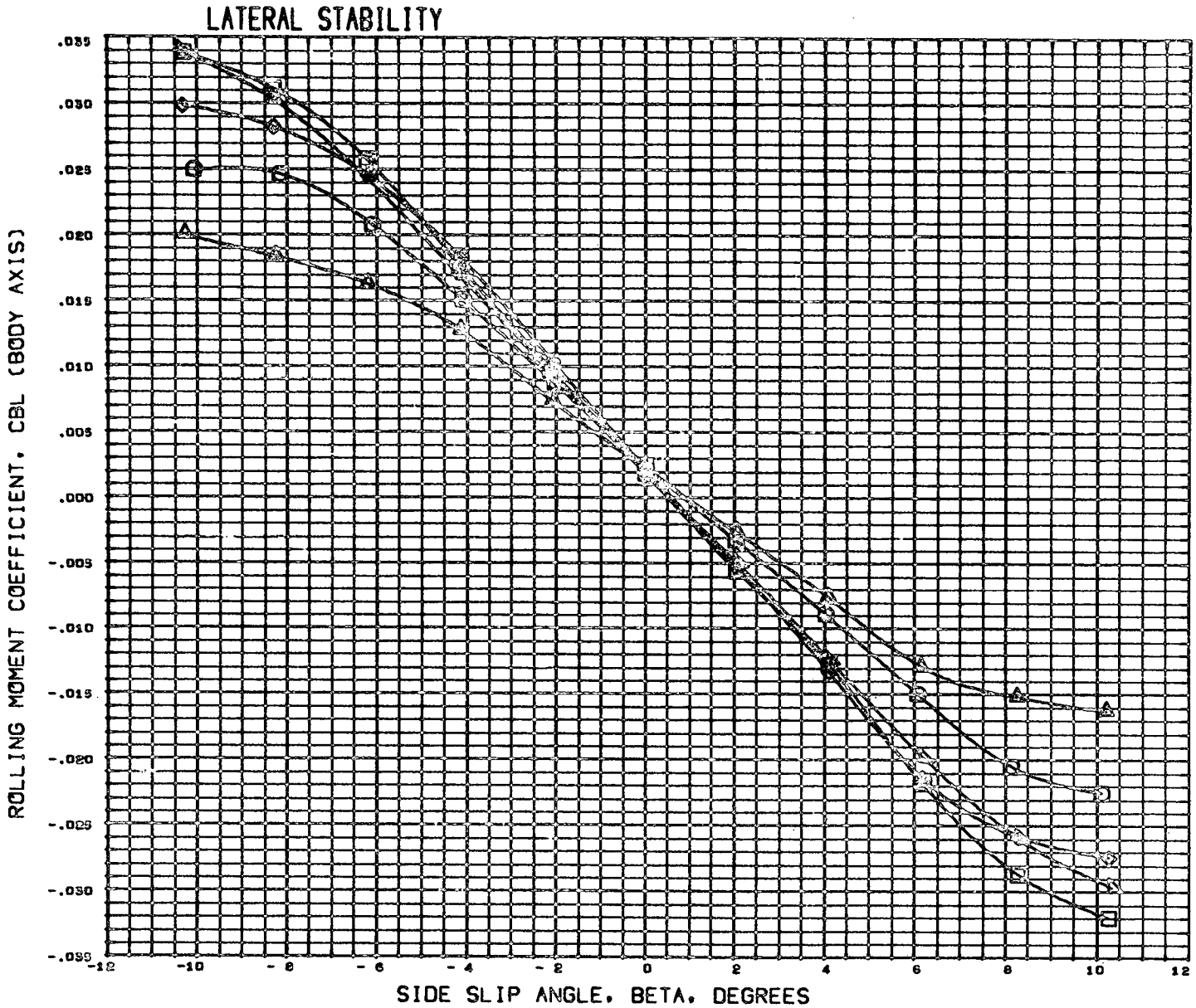

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□	1.102		
▷	1.201		

REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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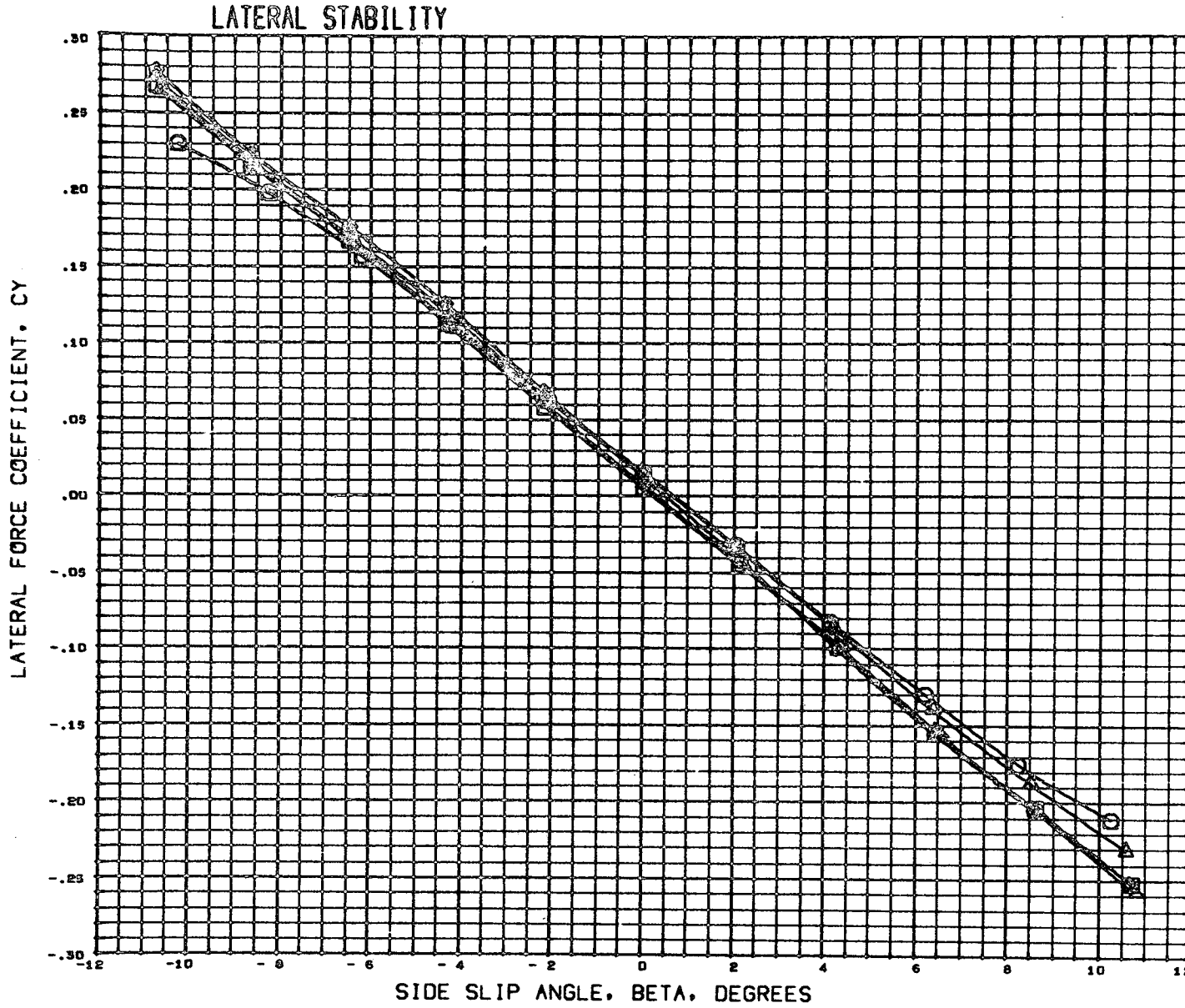

SYMBOL	MACH		PARAMETRIC VALUES
○	0.604	ALPHA	0.000
△	0.907		
◇	1.001		
□	1.109		
◪	1.196		

REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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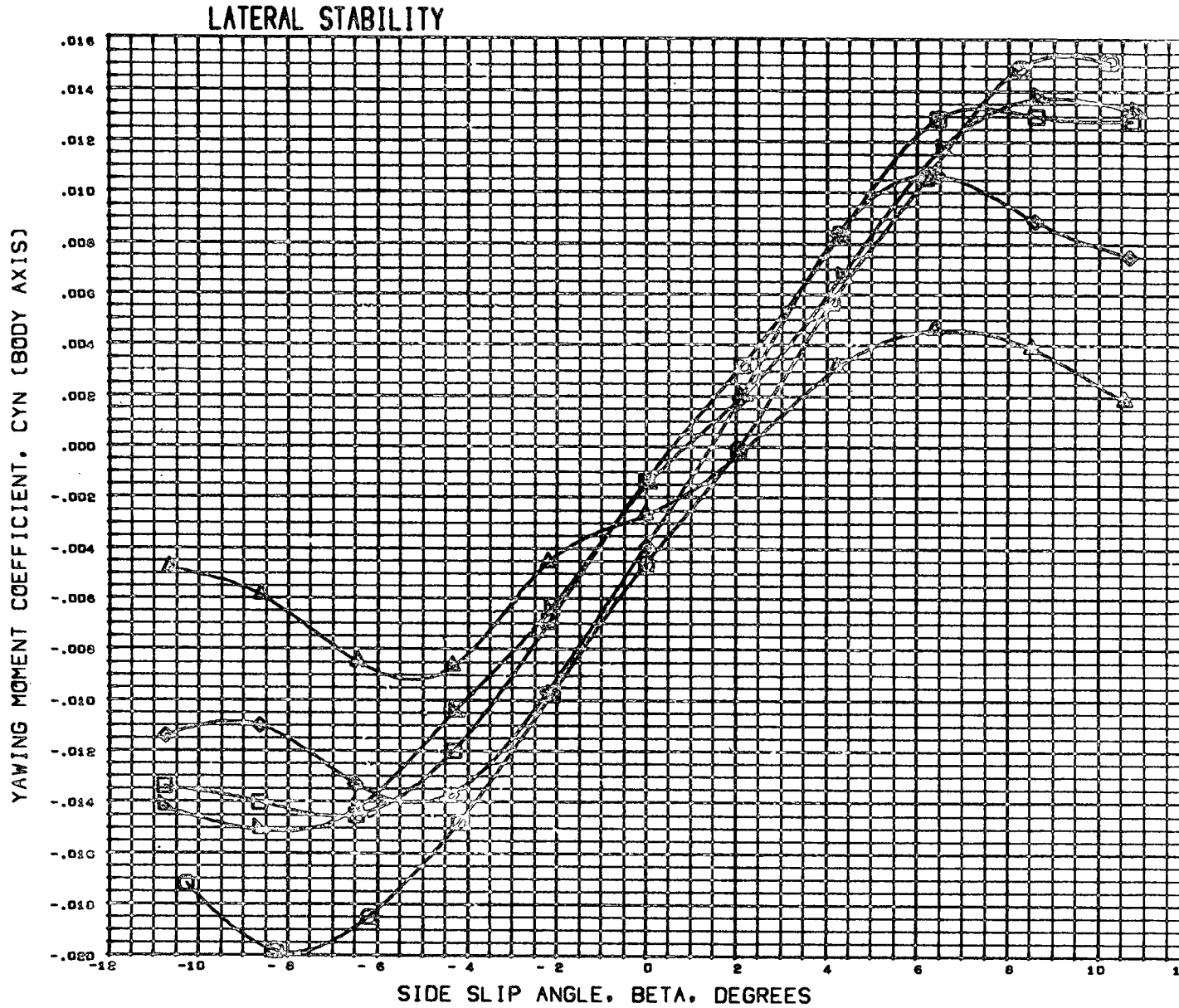

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○	0.604	ALPHA	0.000
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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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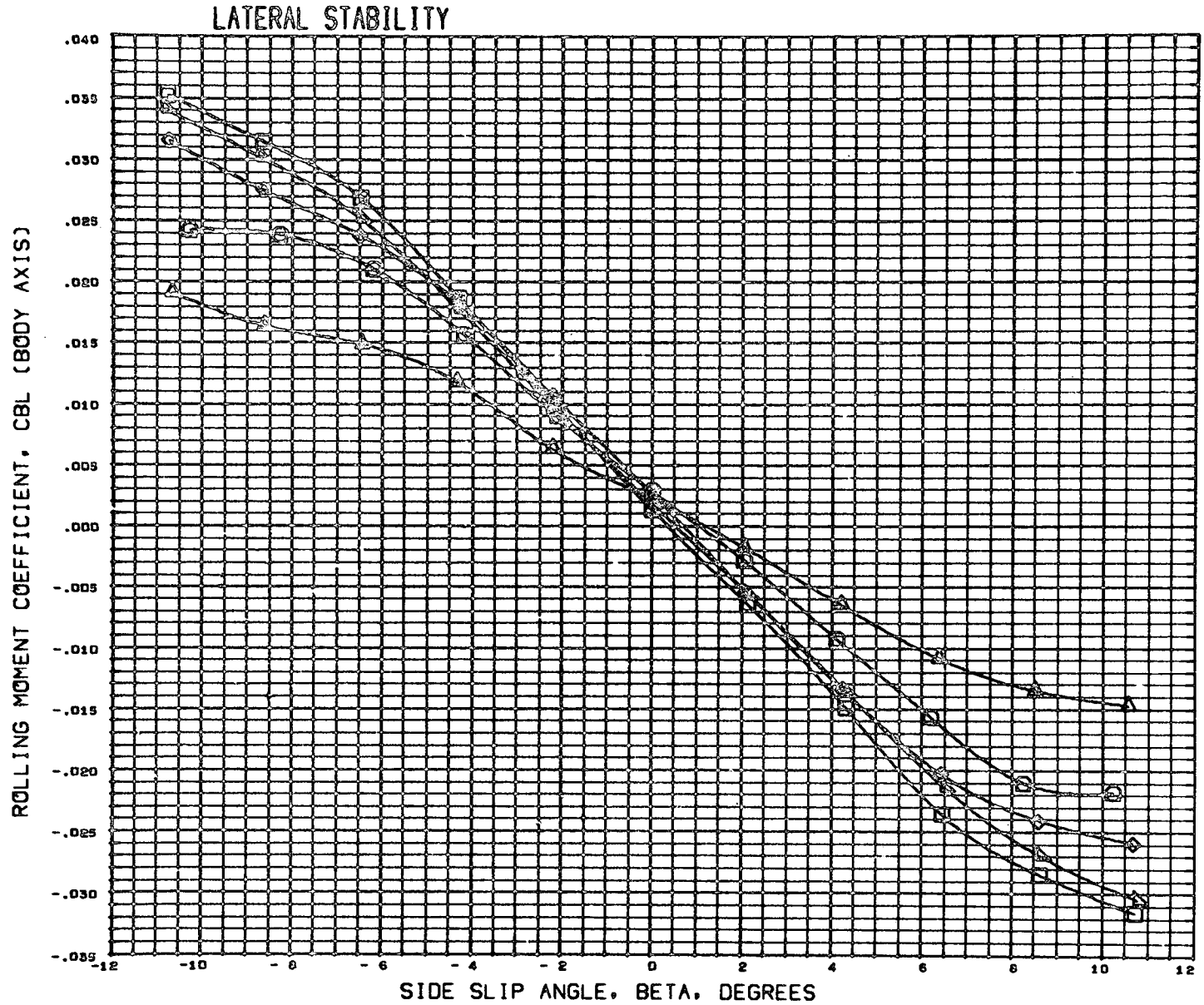

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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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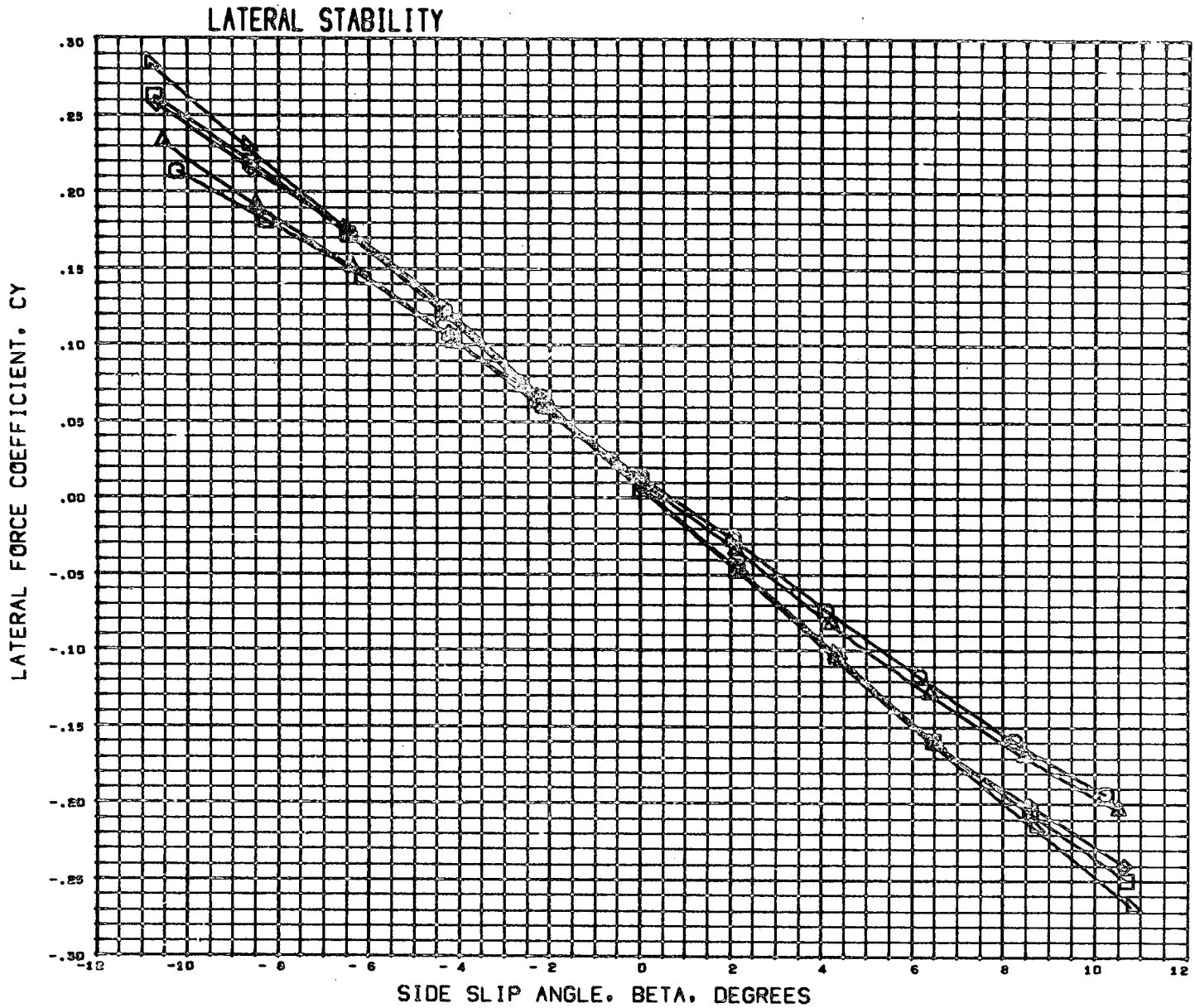

SYMBOL	MACH		PARAMETRIC VALUES
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△	0.898		
◇	0.999		
□	1.100		
▷	1.198		

REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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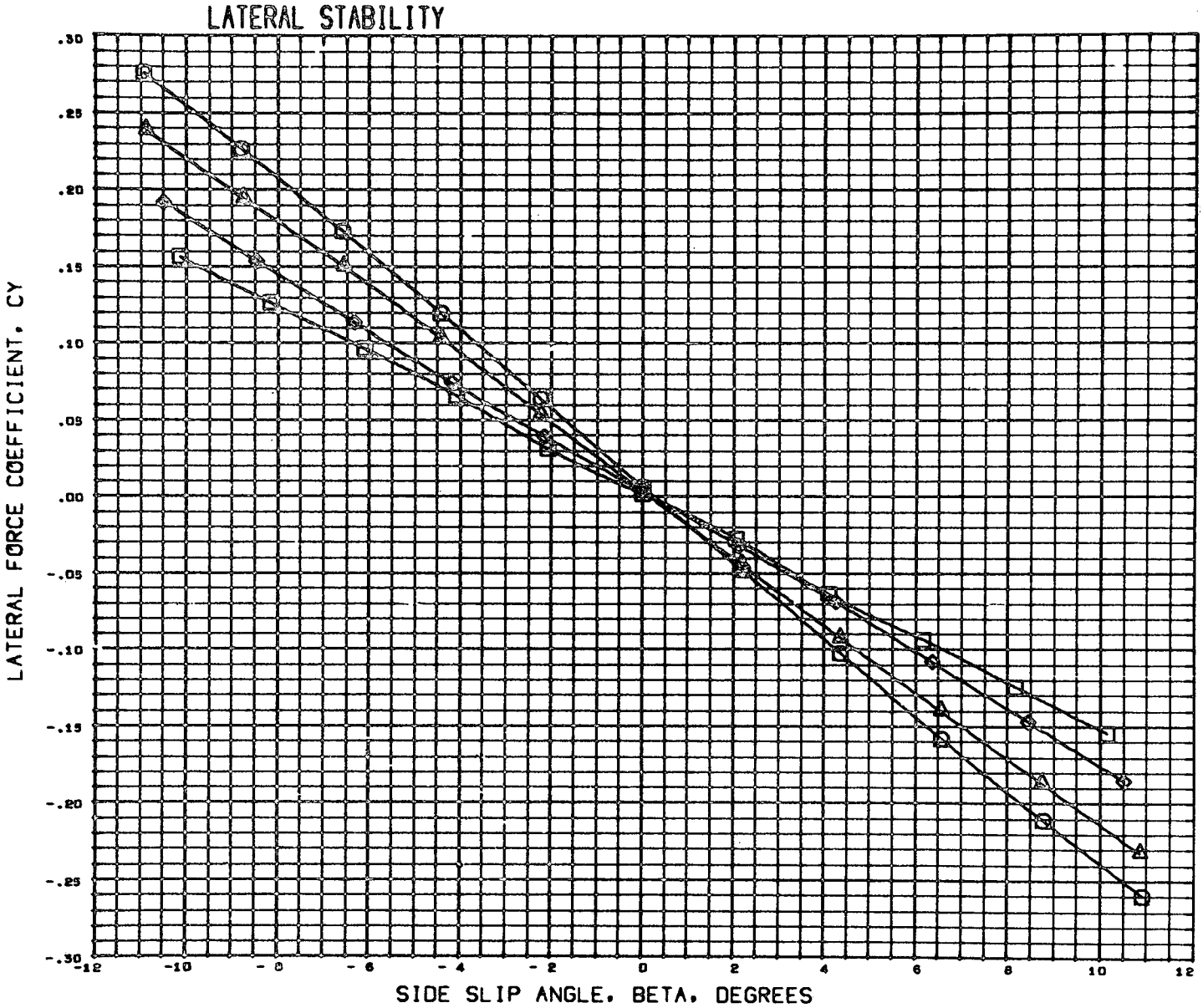

SYMBOL	MACH	PARAMETRIC VALUES	
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REFERENCE FILE S-E-AERO-AA-

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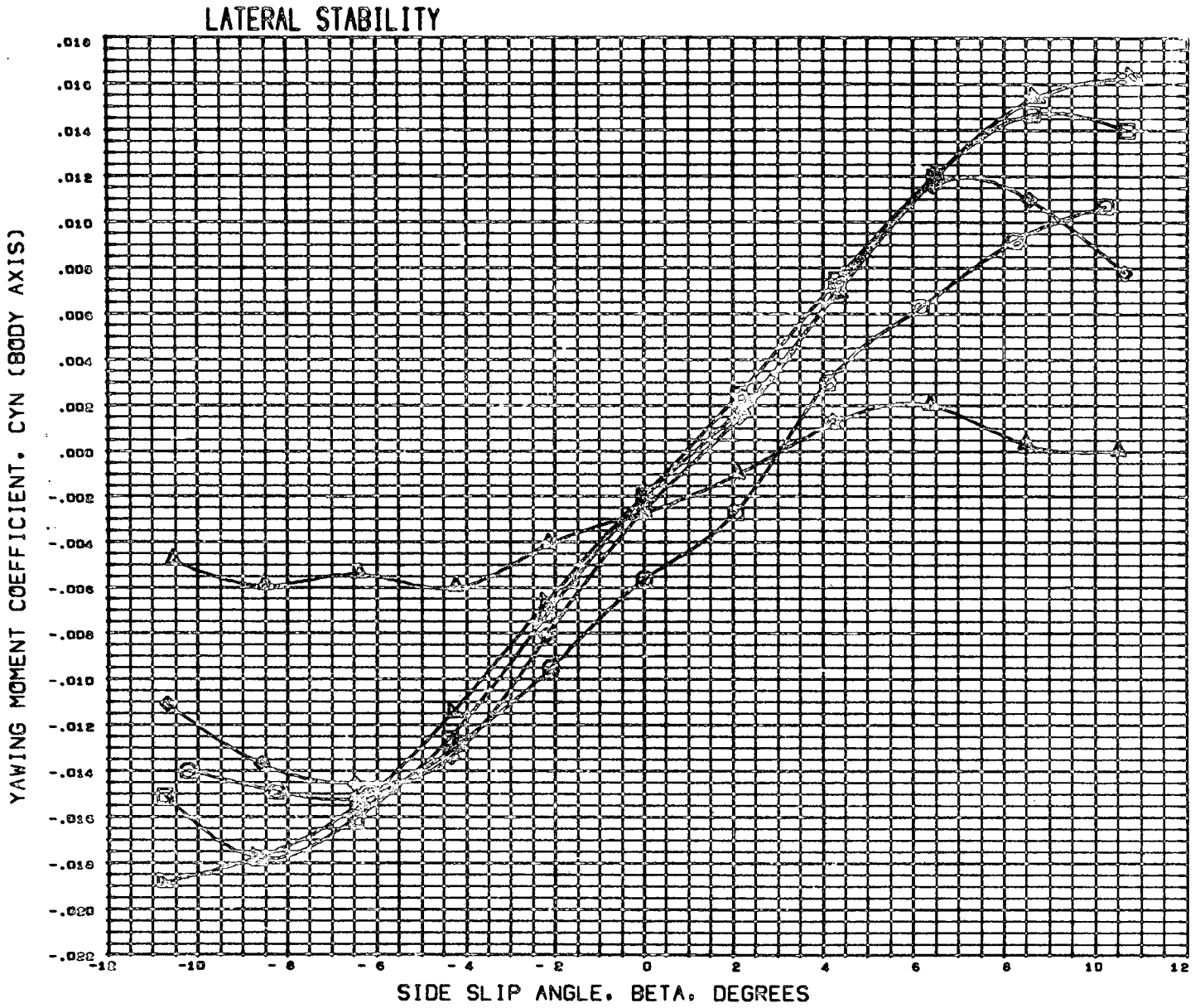

SYMBOL	MACH	PARAMETRIC VALUES	
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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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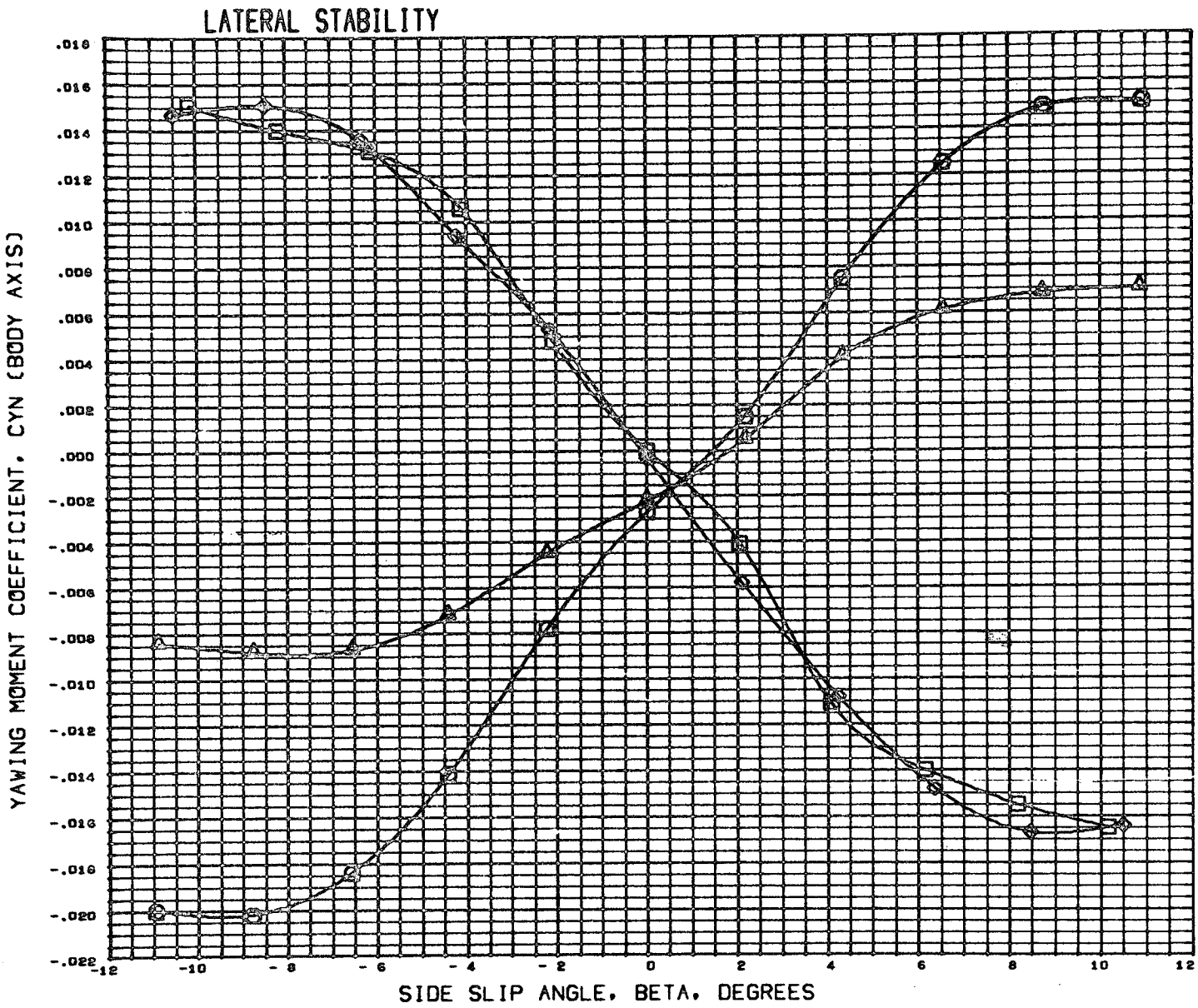
SCALE	0.3366	PERCEN

MSFC 504 GRUMMAN H33 ORB.+BOOST.+DROP TANKS (A46032) 16 OCT 71 PAGE 36



SYMBOL	MACH	PARAMETRIC VALUES	
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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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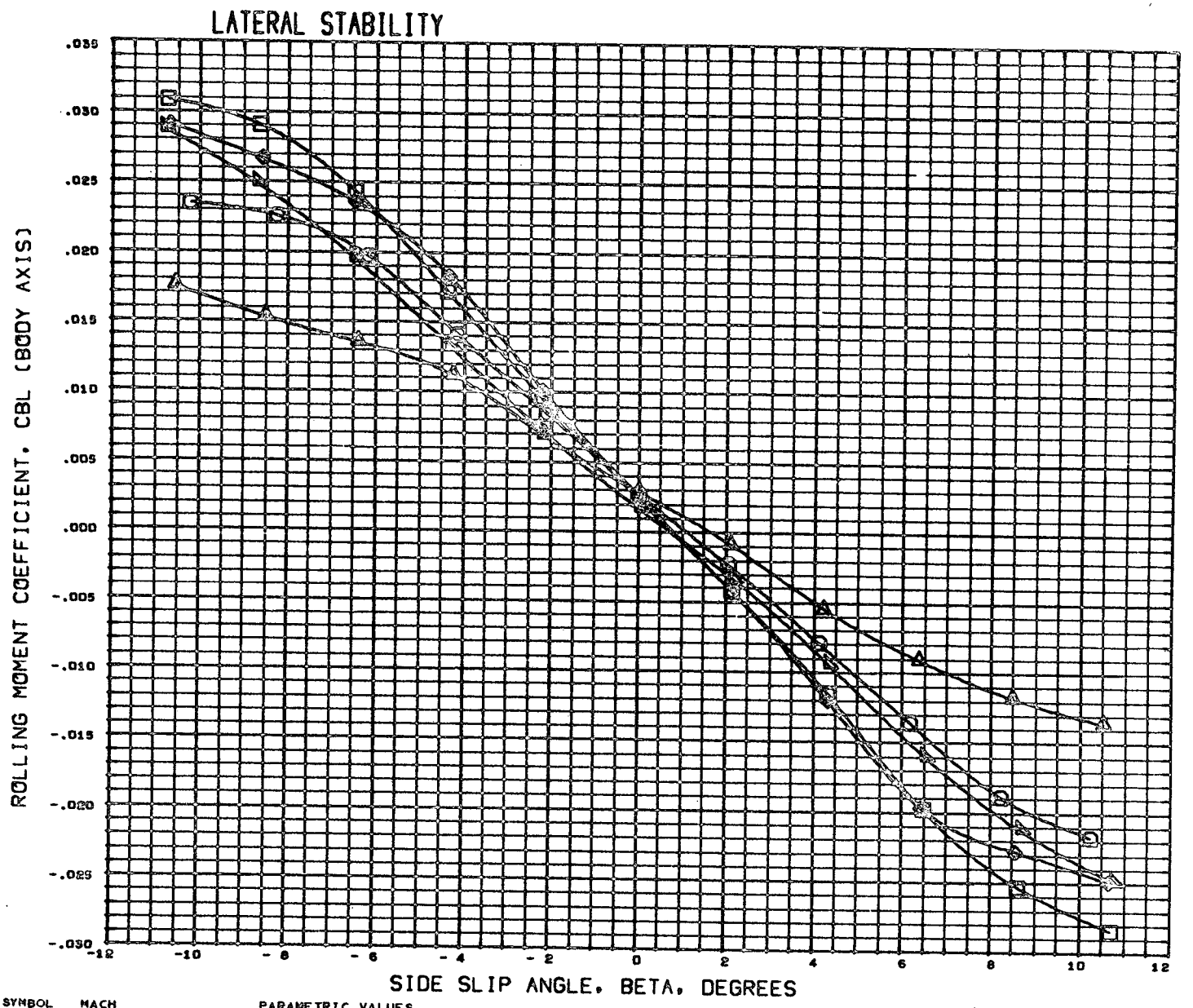

SYMBOL	MACH
○	0.595
△	0.898
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□	1.100
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PARAMETRIC VALUES

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REFERENCE FILE S-E-AERO-AA-

REFERENCE INFORMATION

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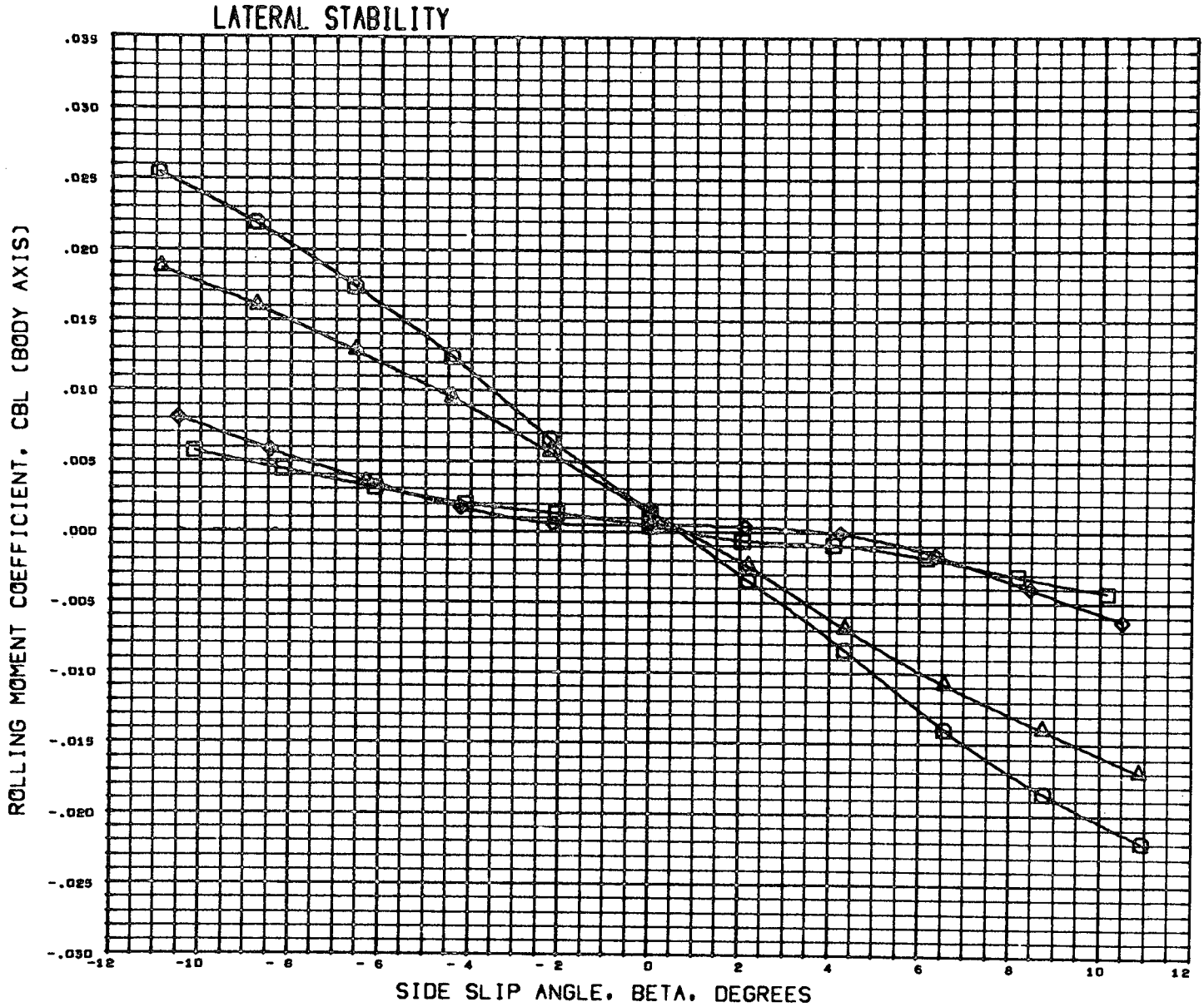

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REFERENCE FILE S-E-AERO-AA-

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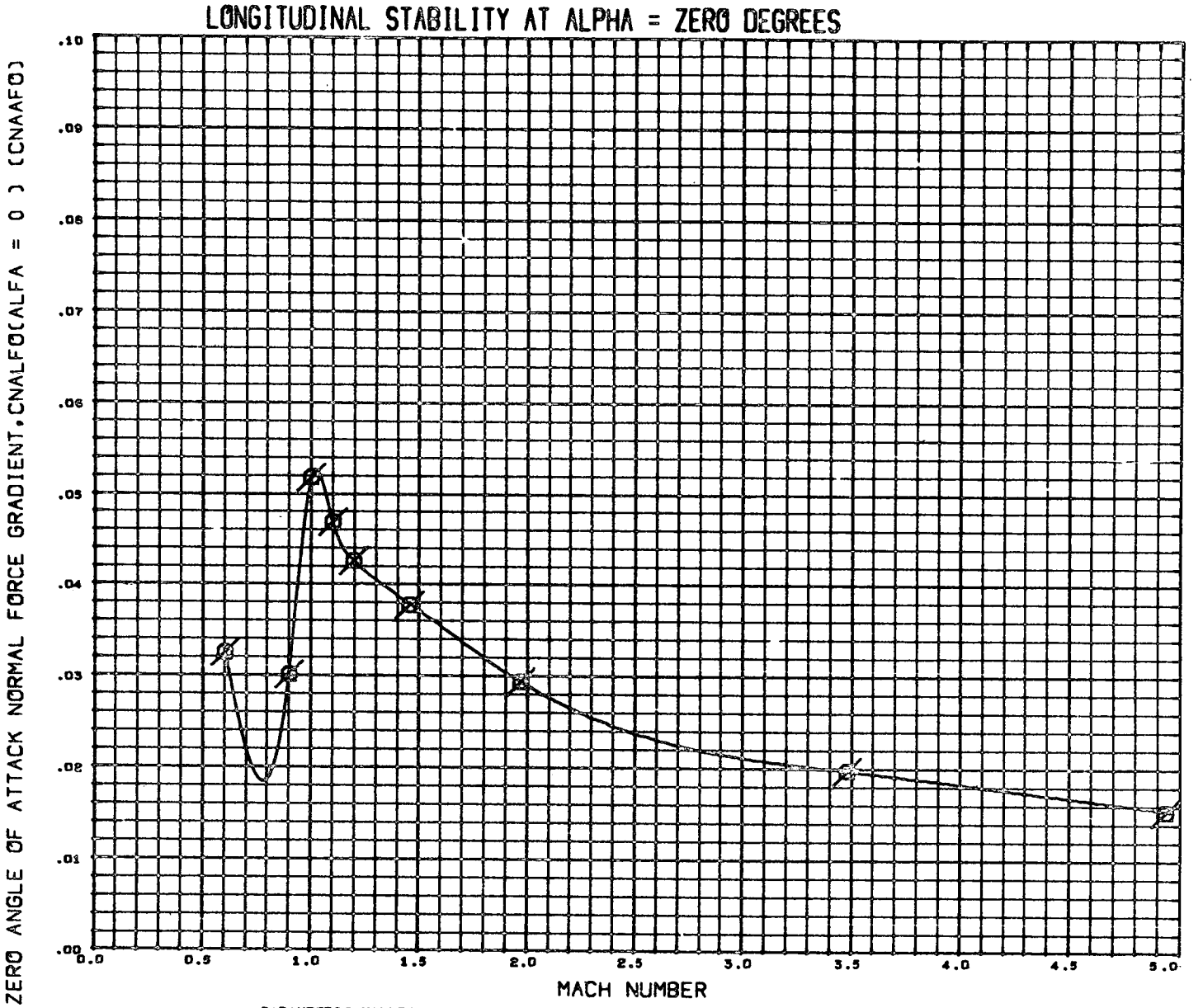

PARAMETRIC VALUES

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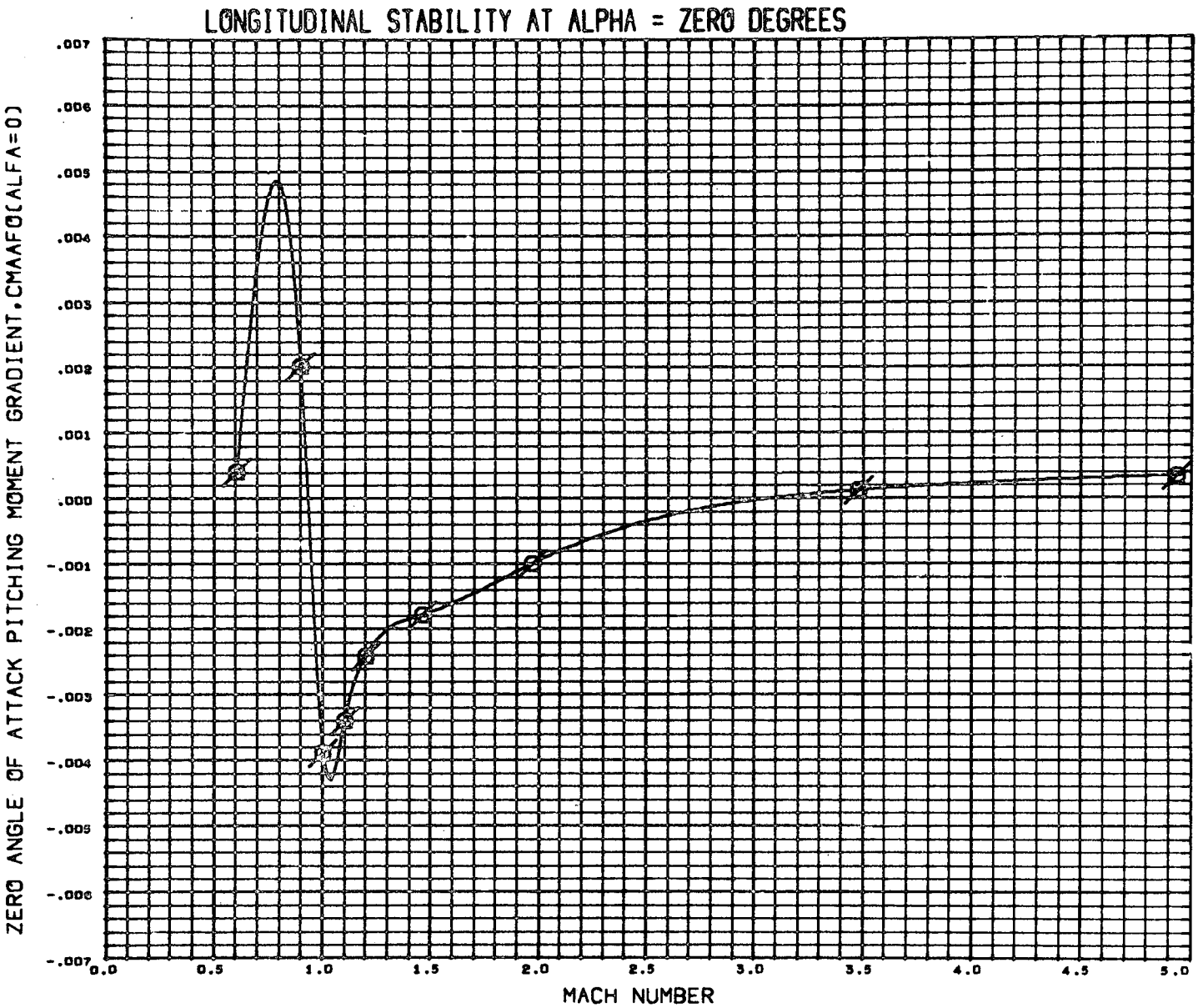
DATA HIST. CODE *EGF



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DATA HIST. CODE *EGF

REFERENCE INFORMATION

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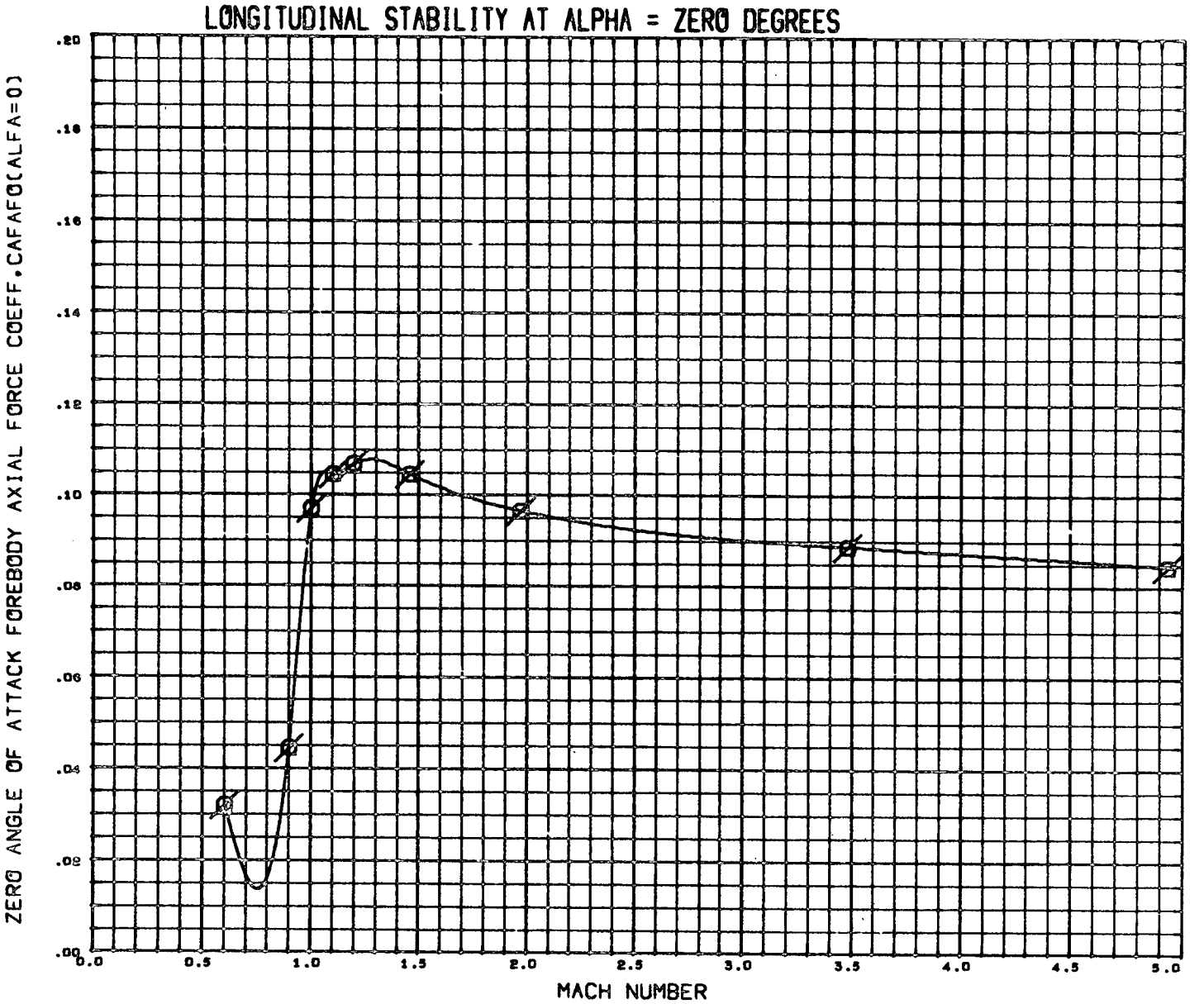

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REFERENCE INFORMATION

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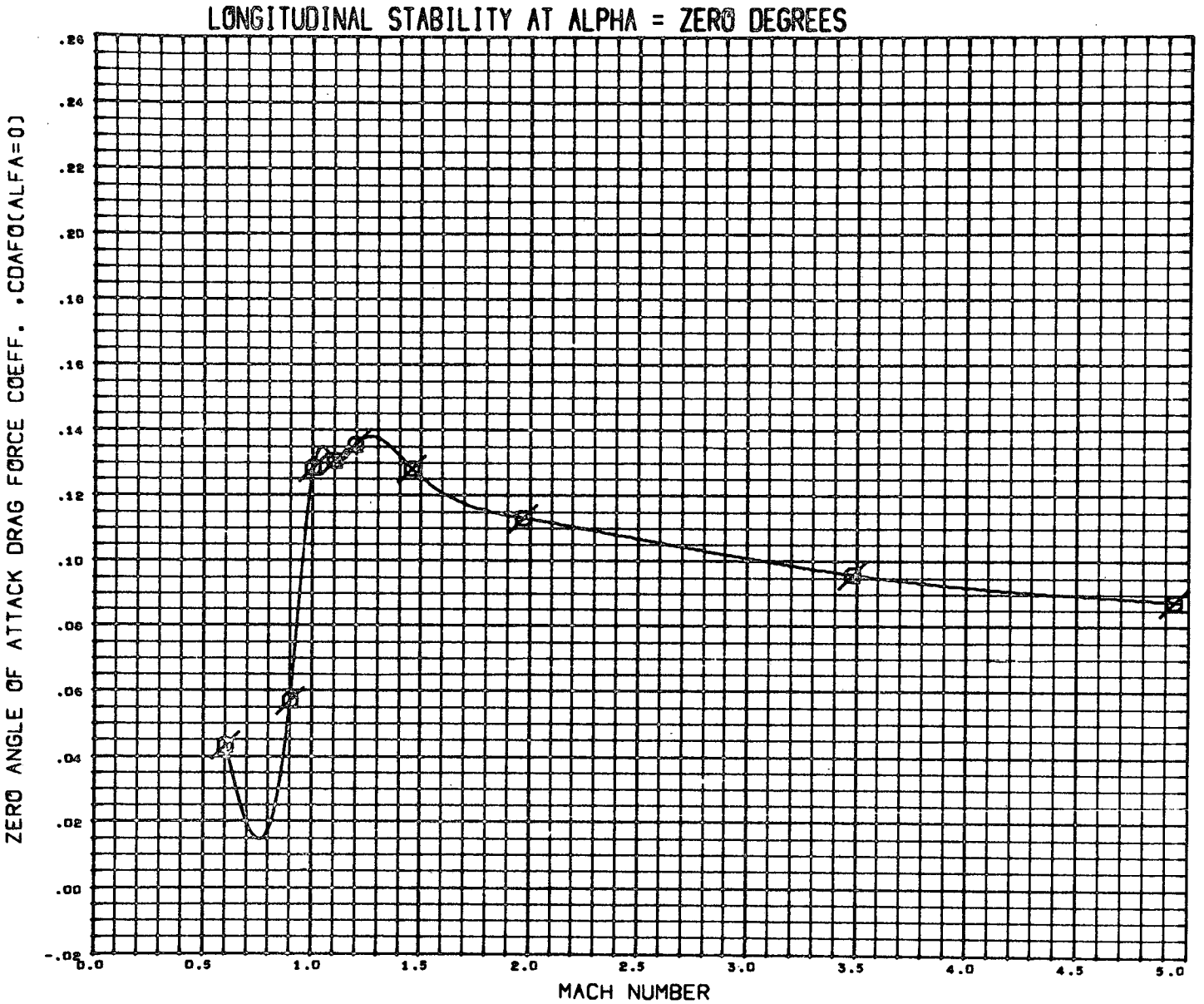
DATA HIST. CODE *EGF



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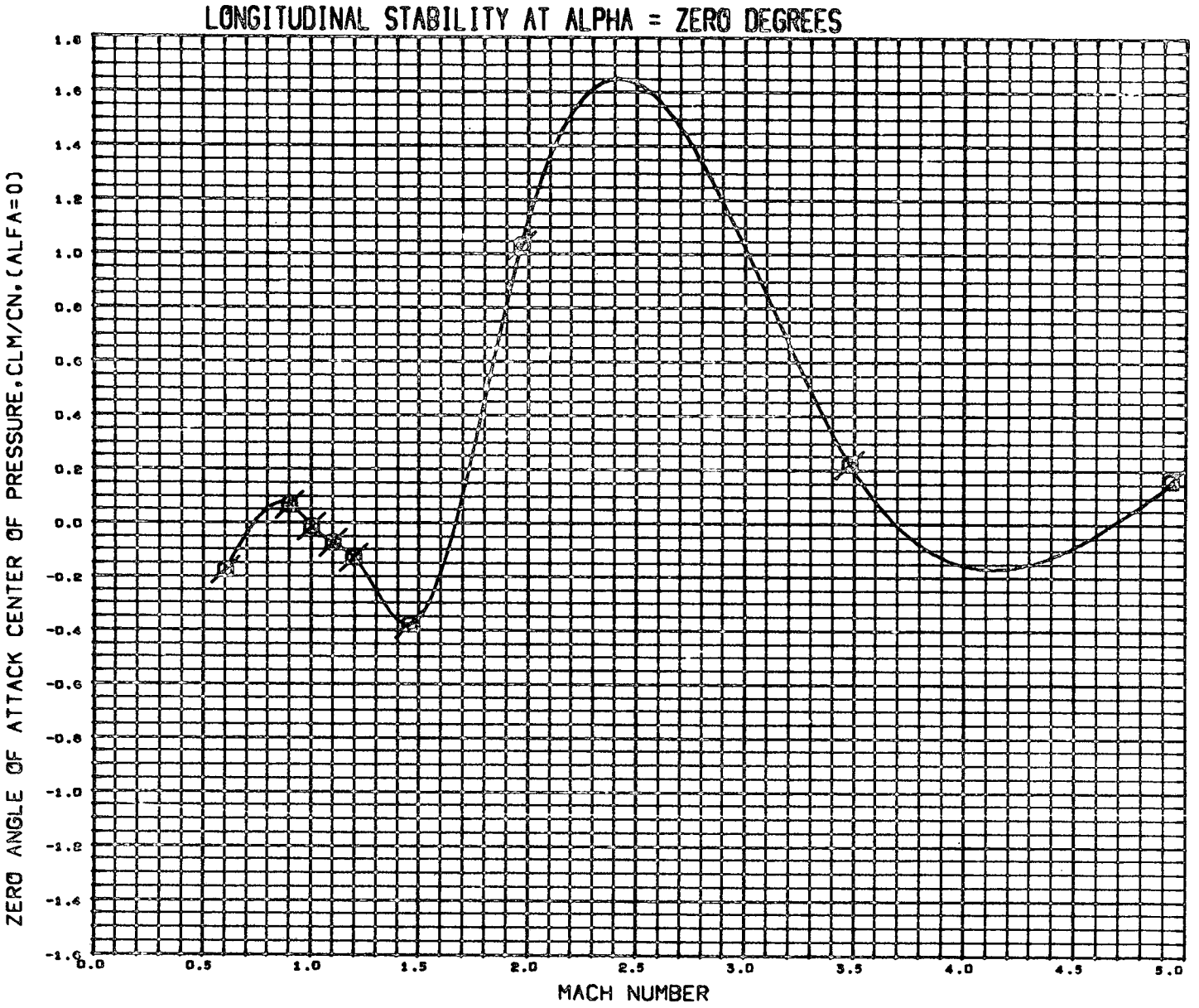
DATA HIST. CODE *EGF



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REFERENCE INFORMATION

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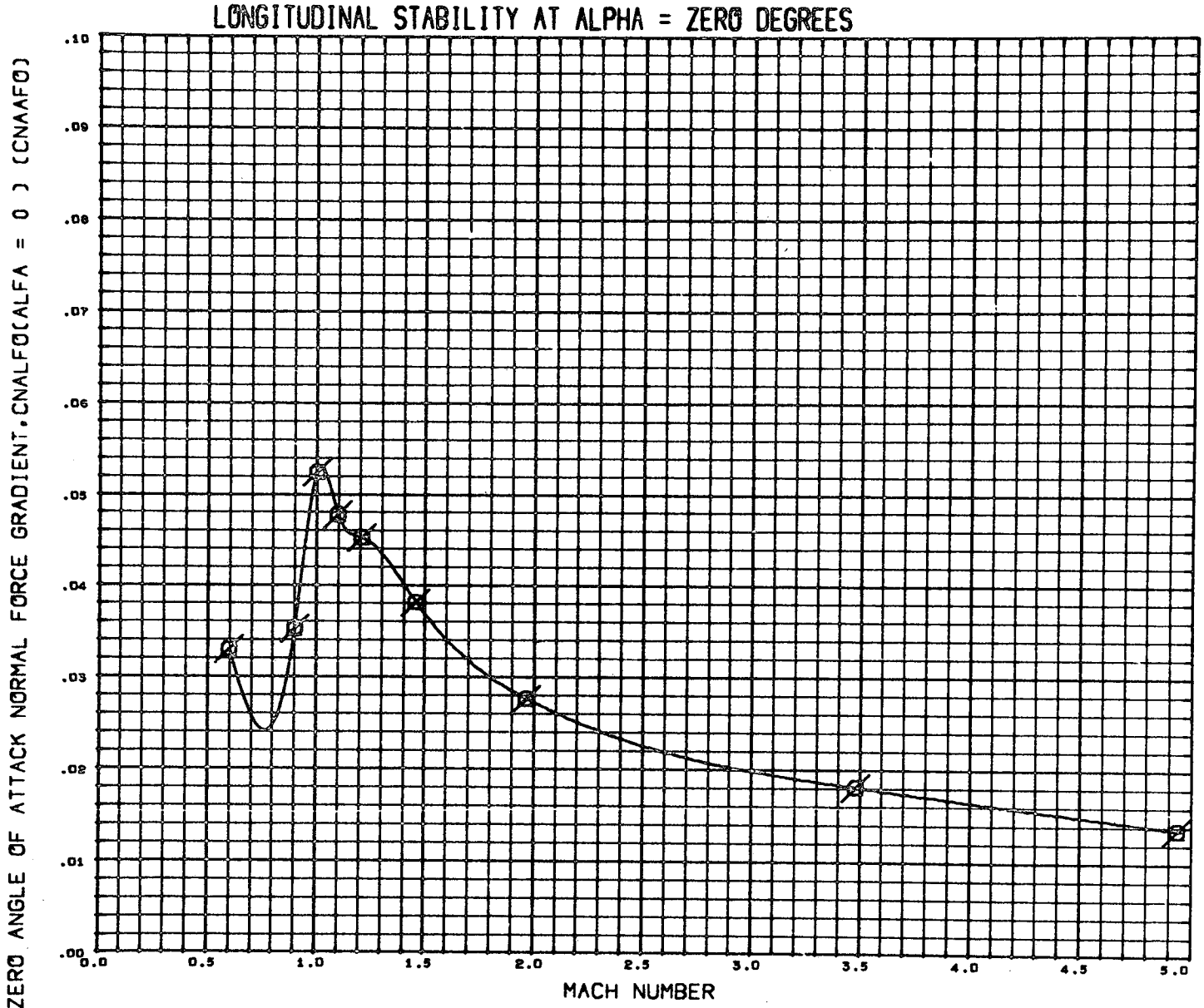

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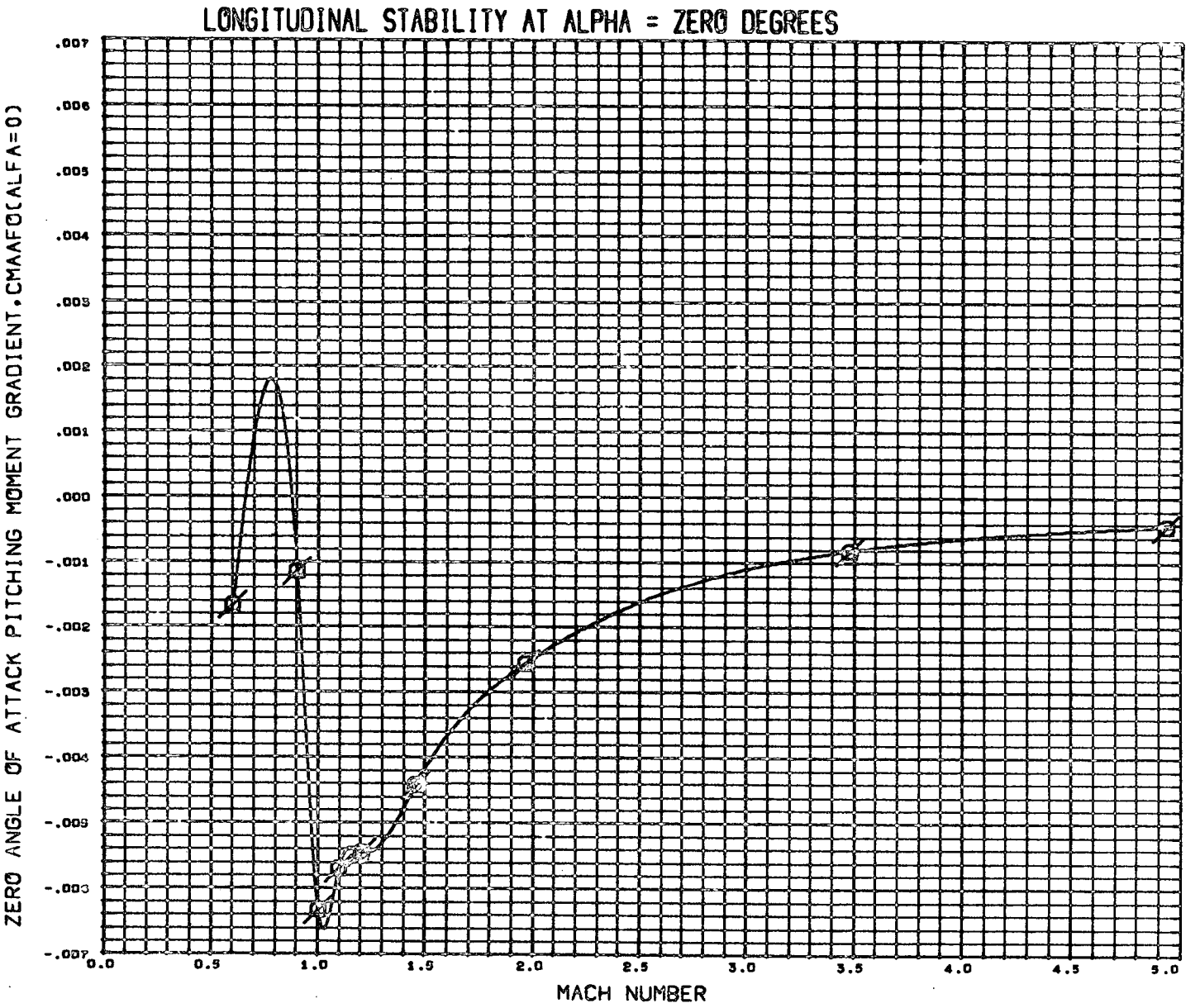
DATA HIST. CODE *EGF

LONGITUDINAL STABILITY AT ALPHA = ZERO DEGREES



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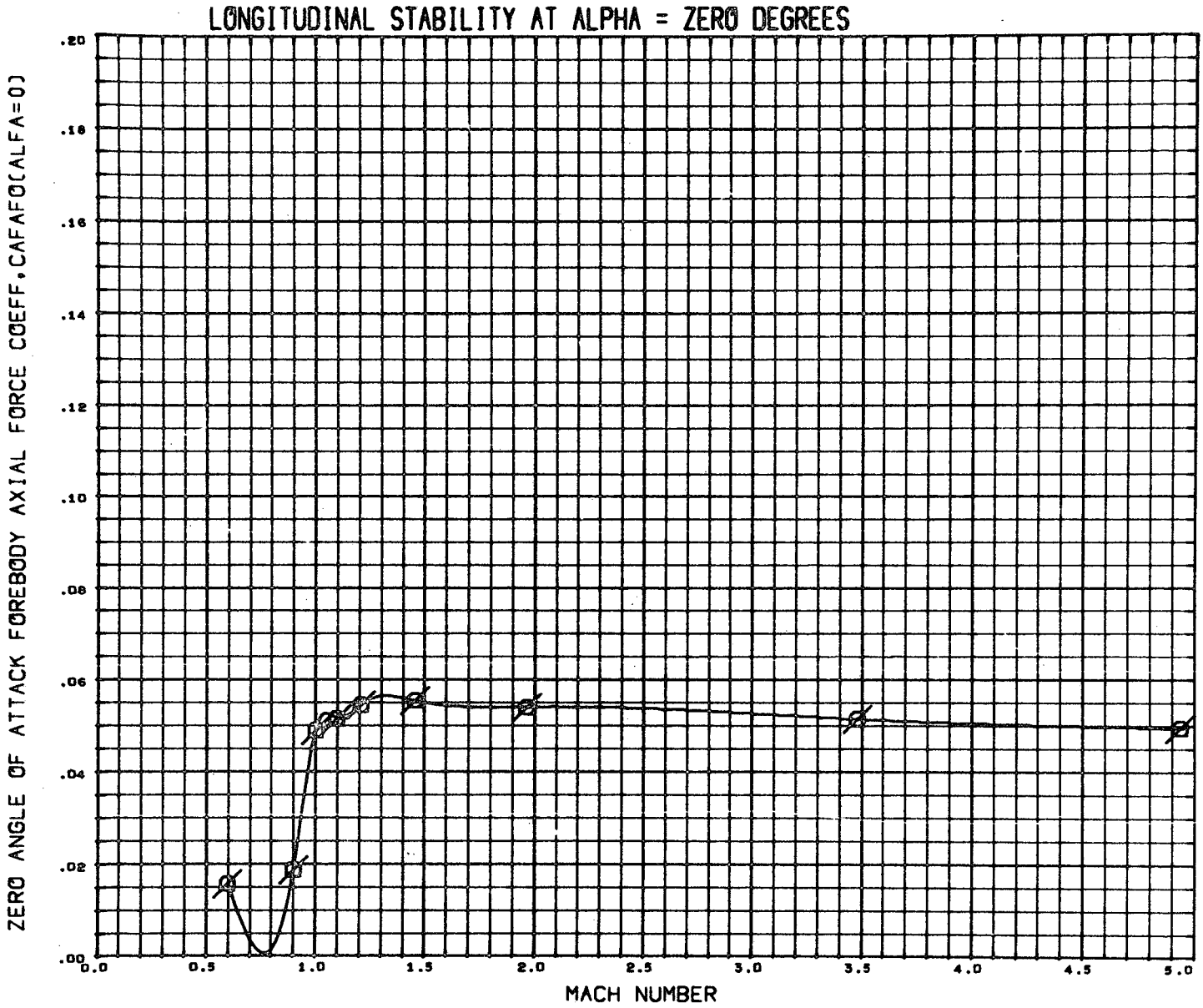

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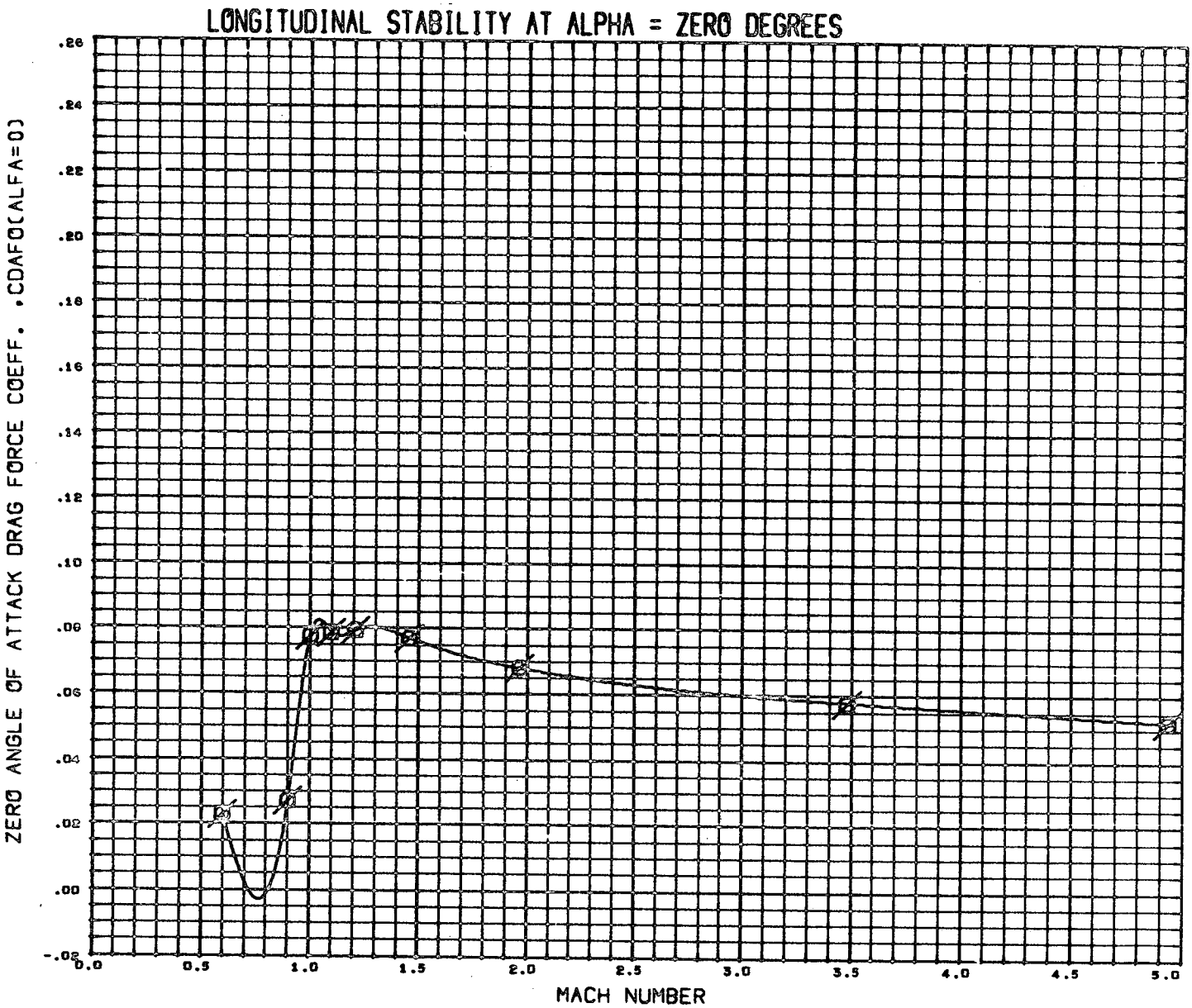

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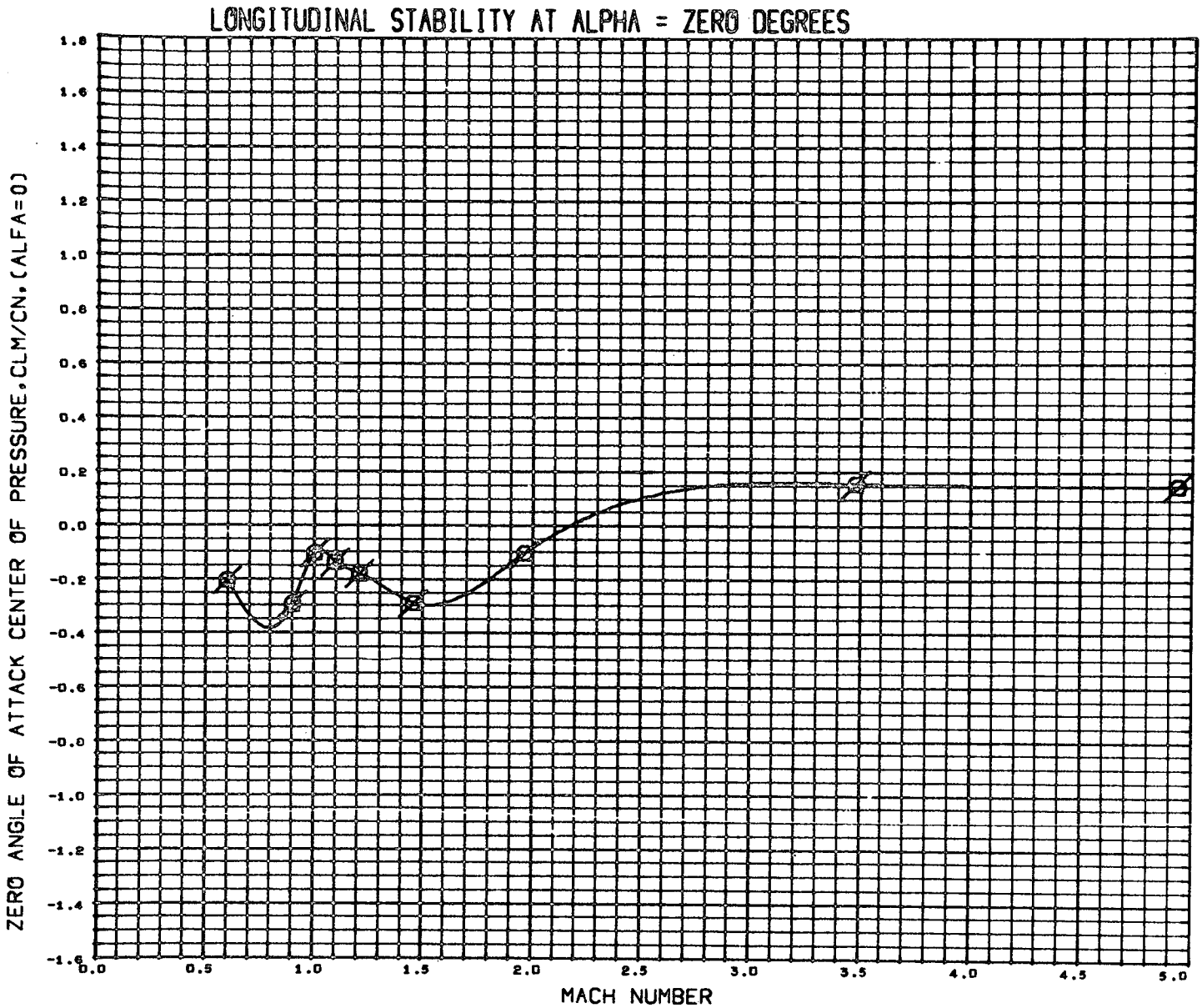
DATA HIST. CODE #EGF



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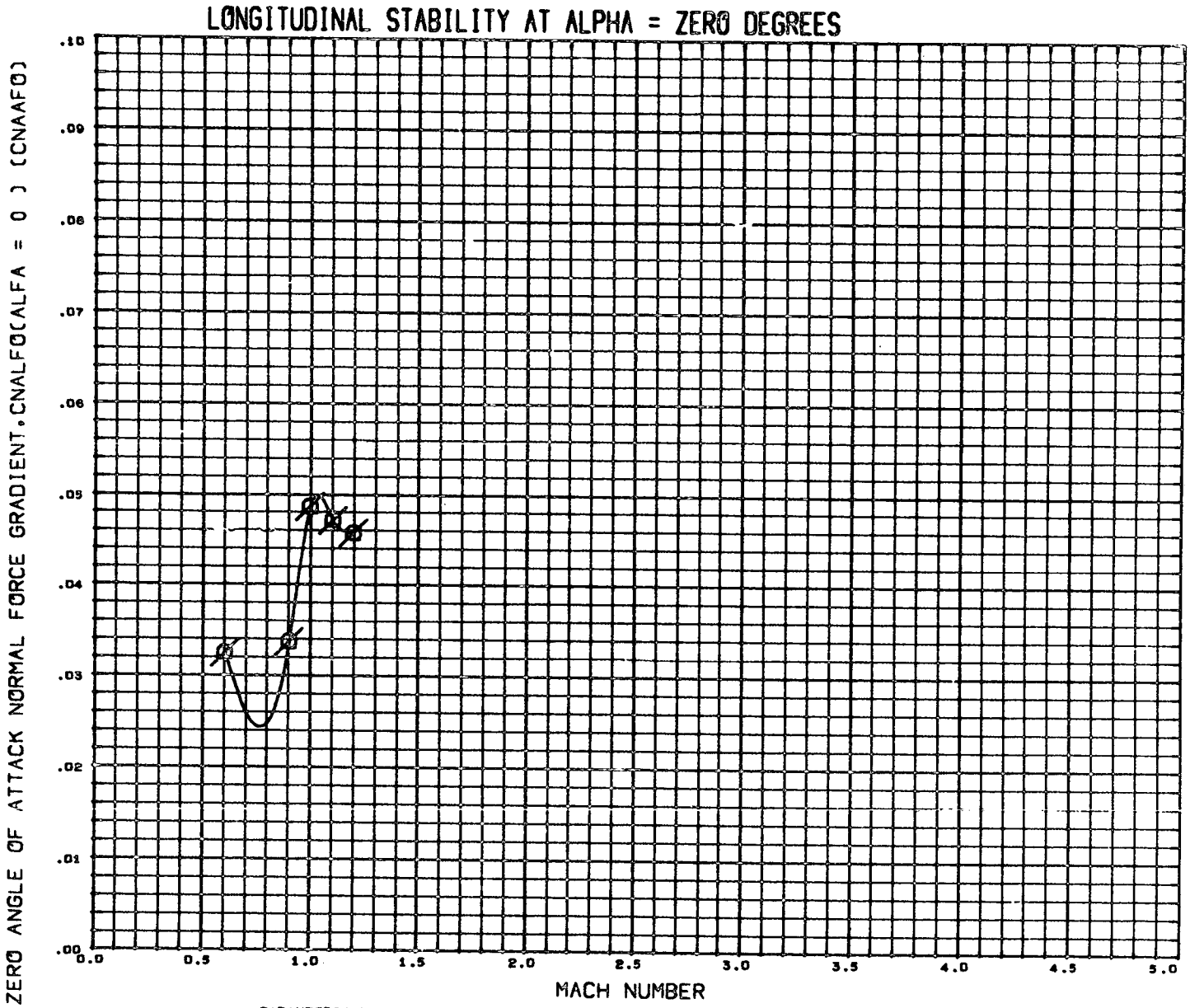
LONGITUDINAL STABILITY AT ALPHA = ZERO DEGREES



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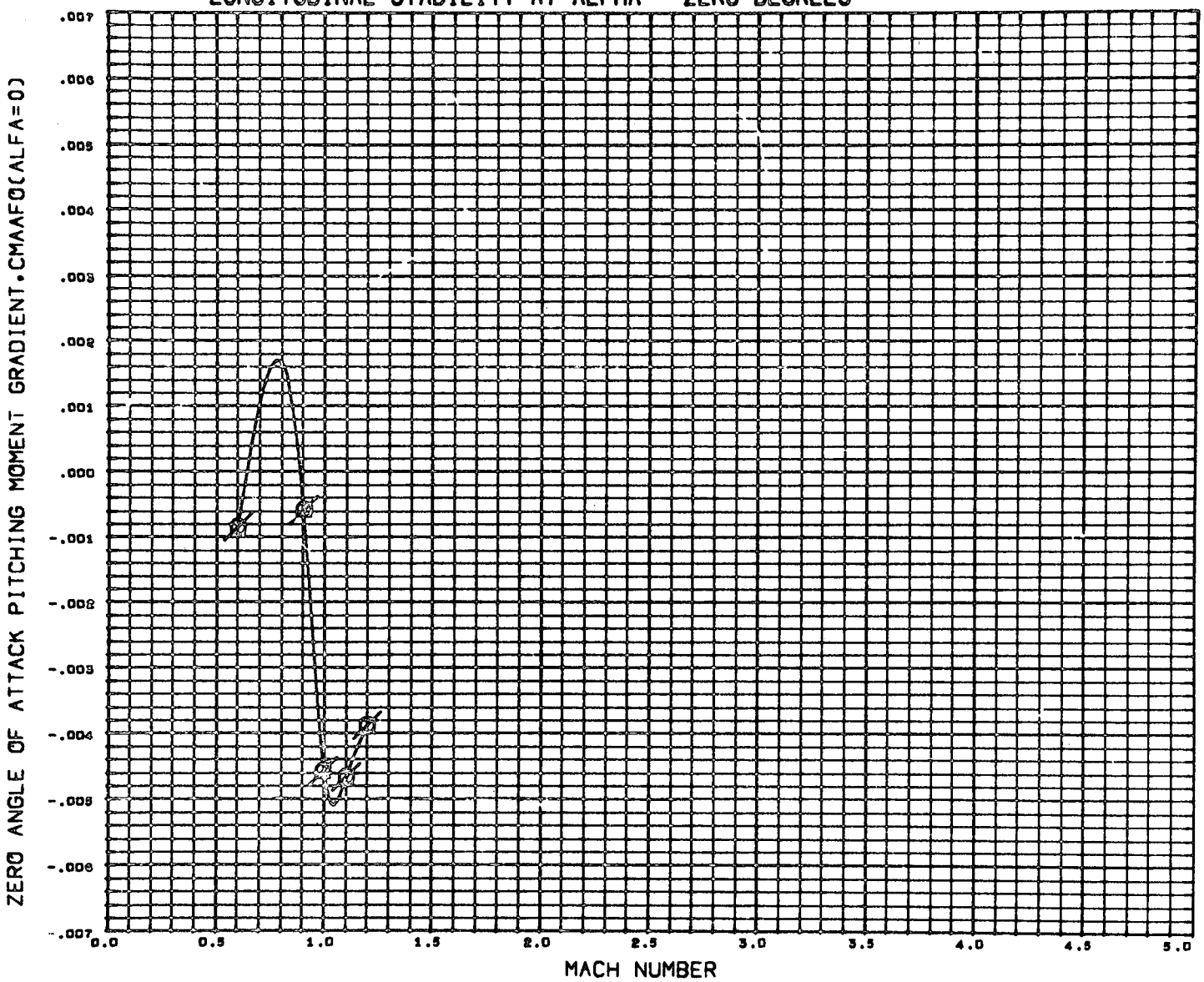
DATA HIST. CODE *EGF

LONGITUDINAL STABILITY AT ALPHA = ZERO DEGREES



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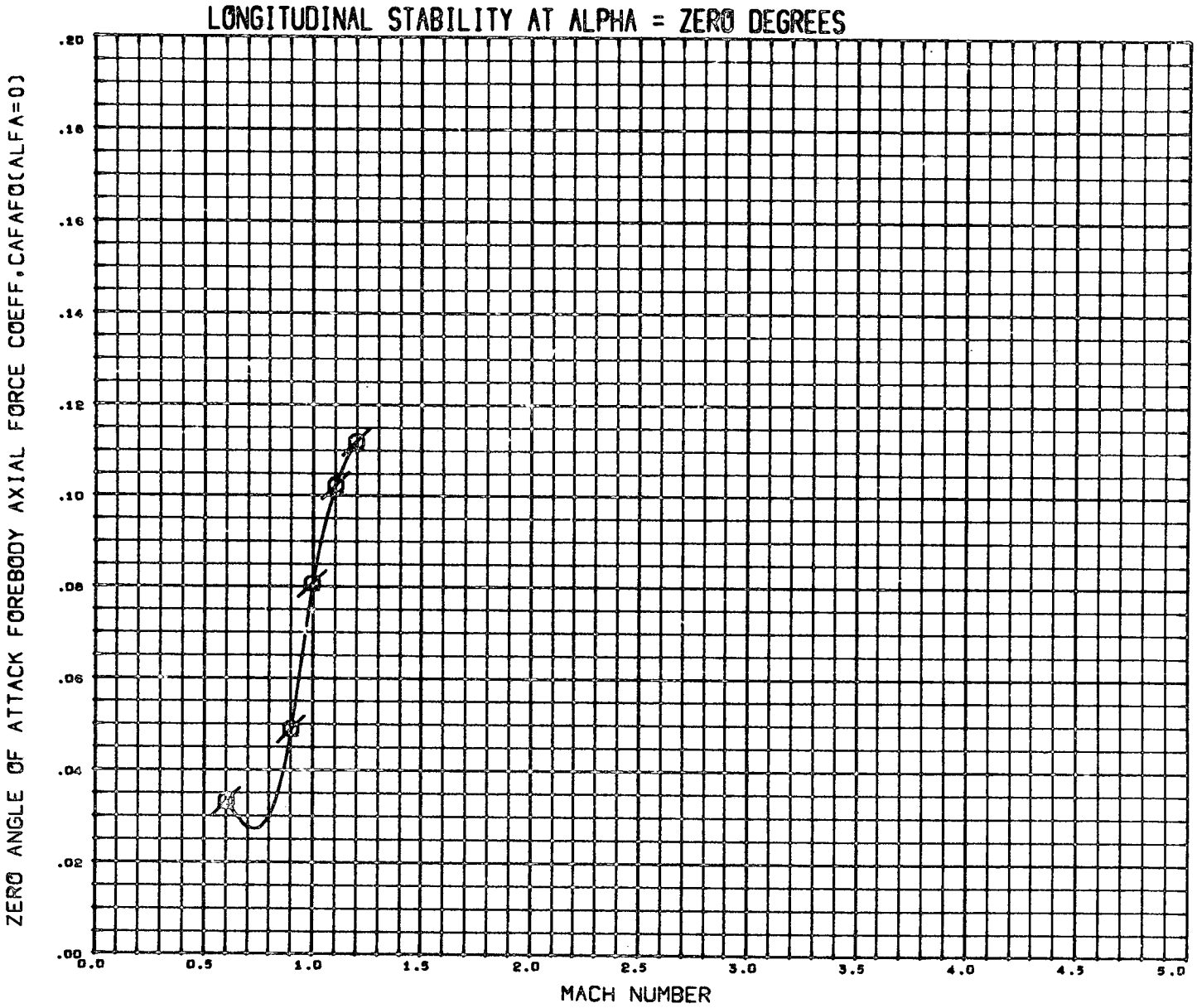

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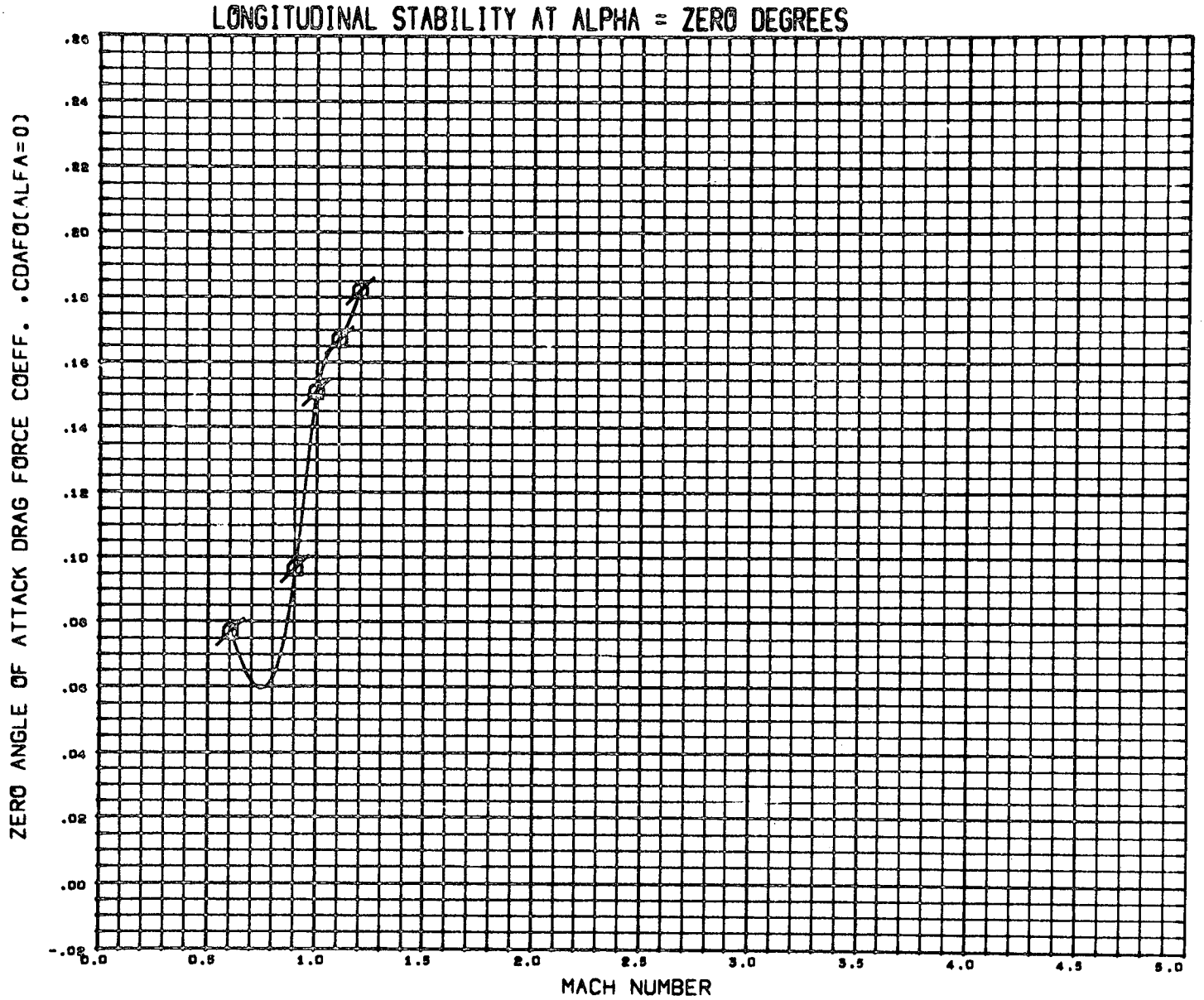
LONGITUDINAL STABILITY AT ALPHA = ZERO DEGREES



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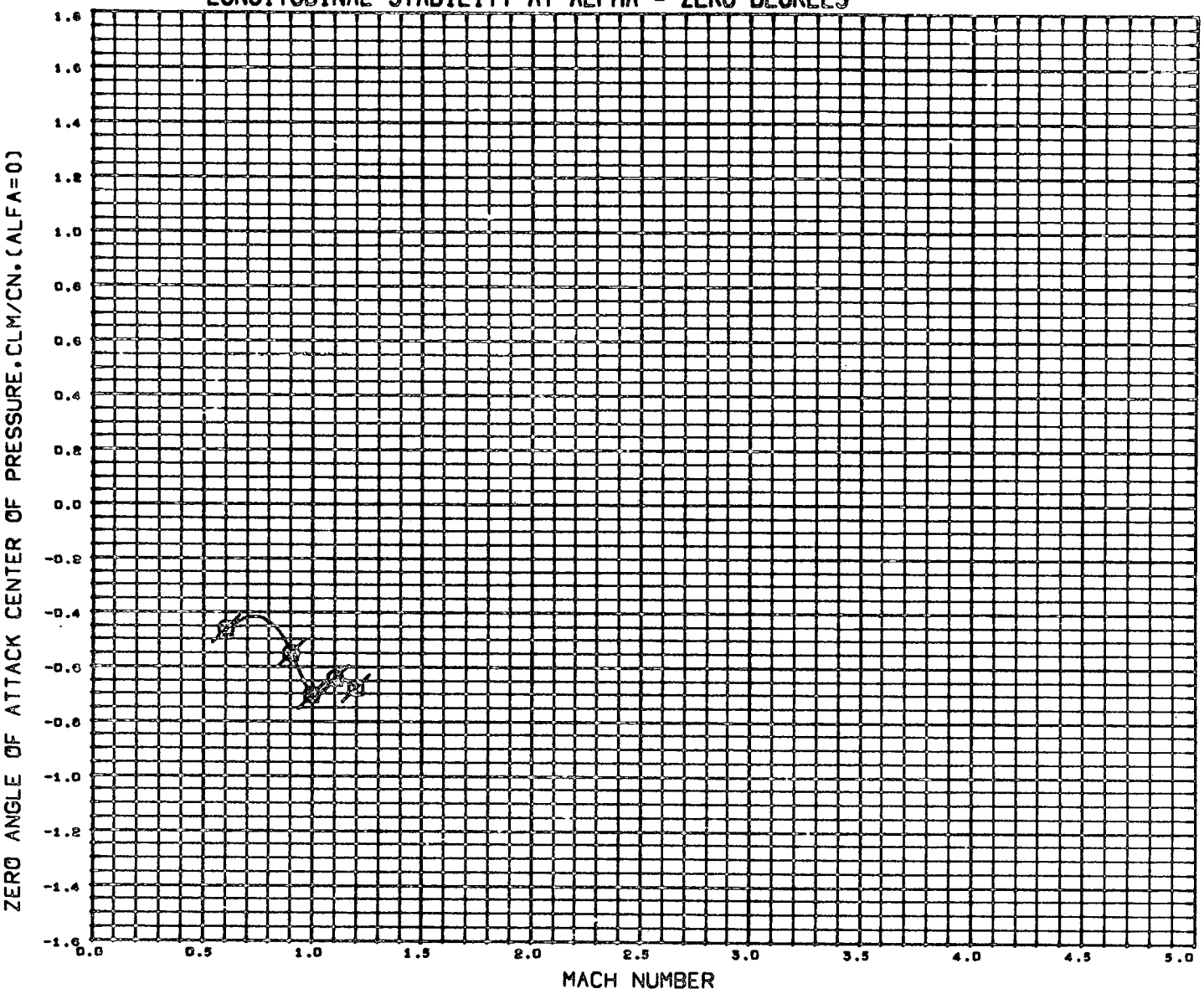
LONGITUDINAL STABILITY AT ALPHA = ZERO DEGREES



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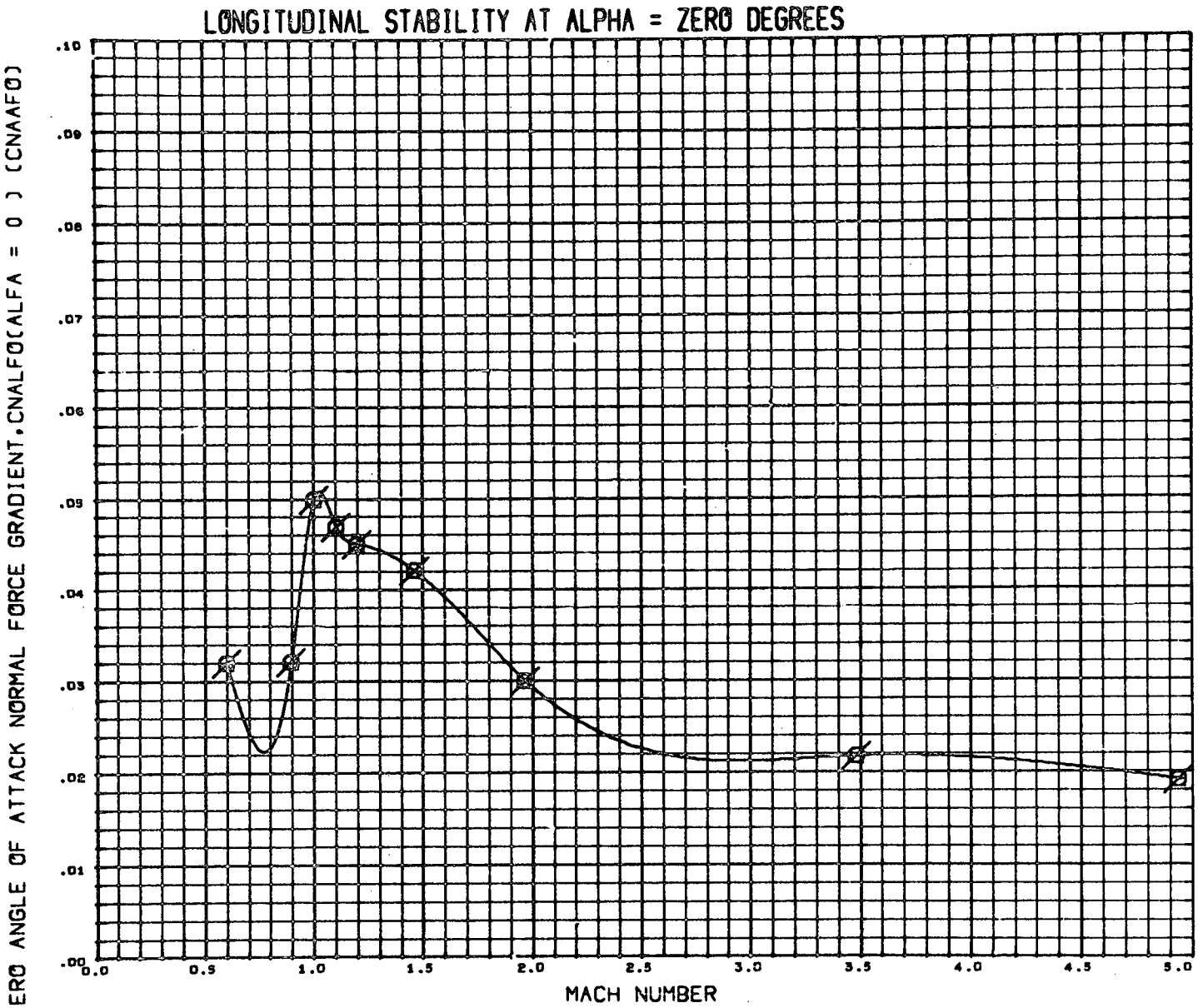

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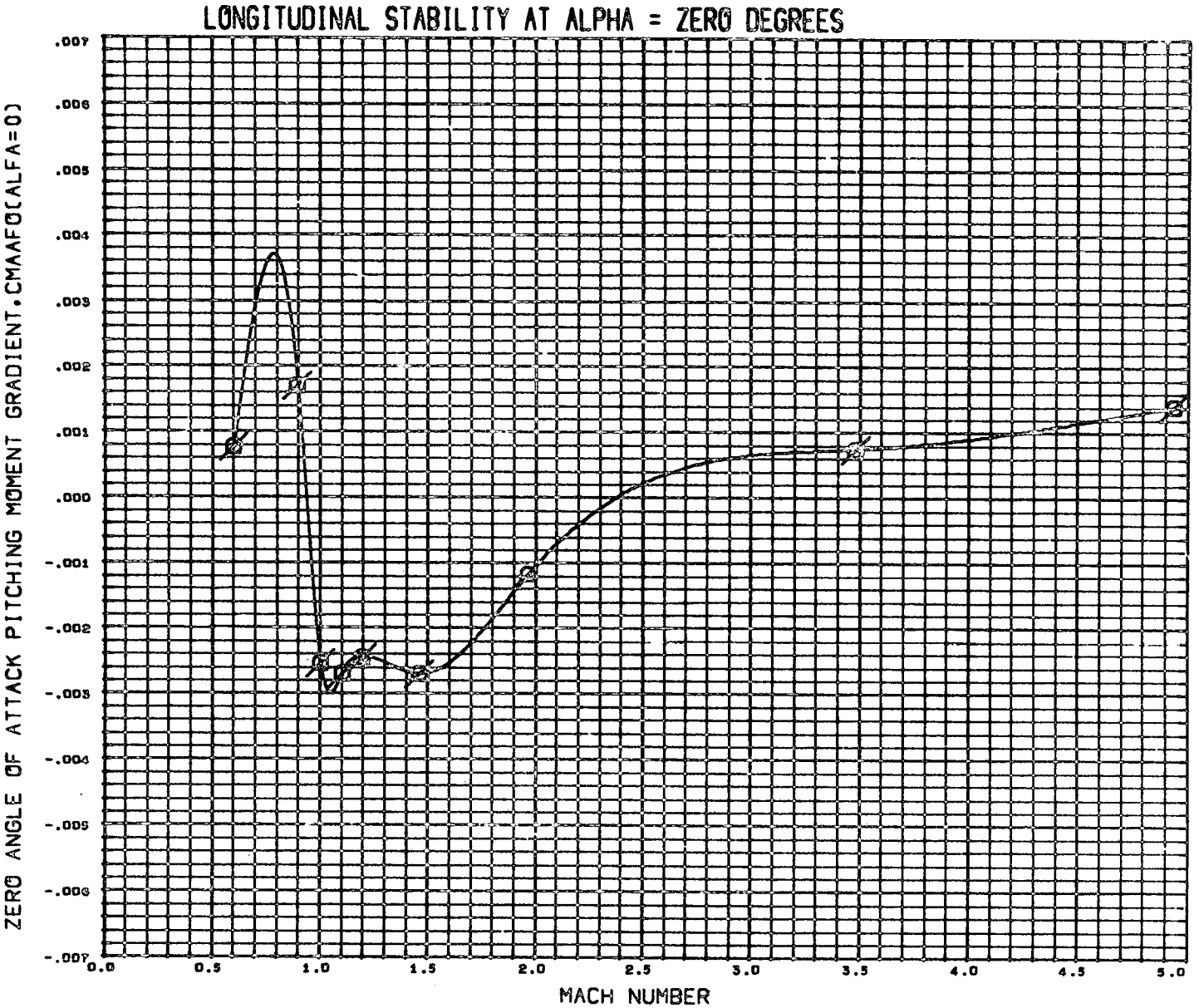

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DATA HIST. CODE #EGF

PARAMETRIC VALUES

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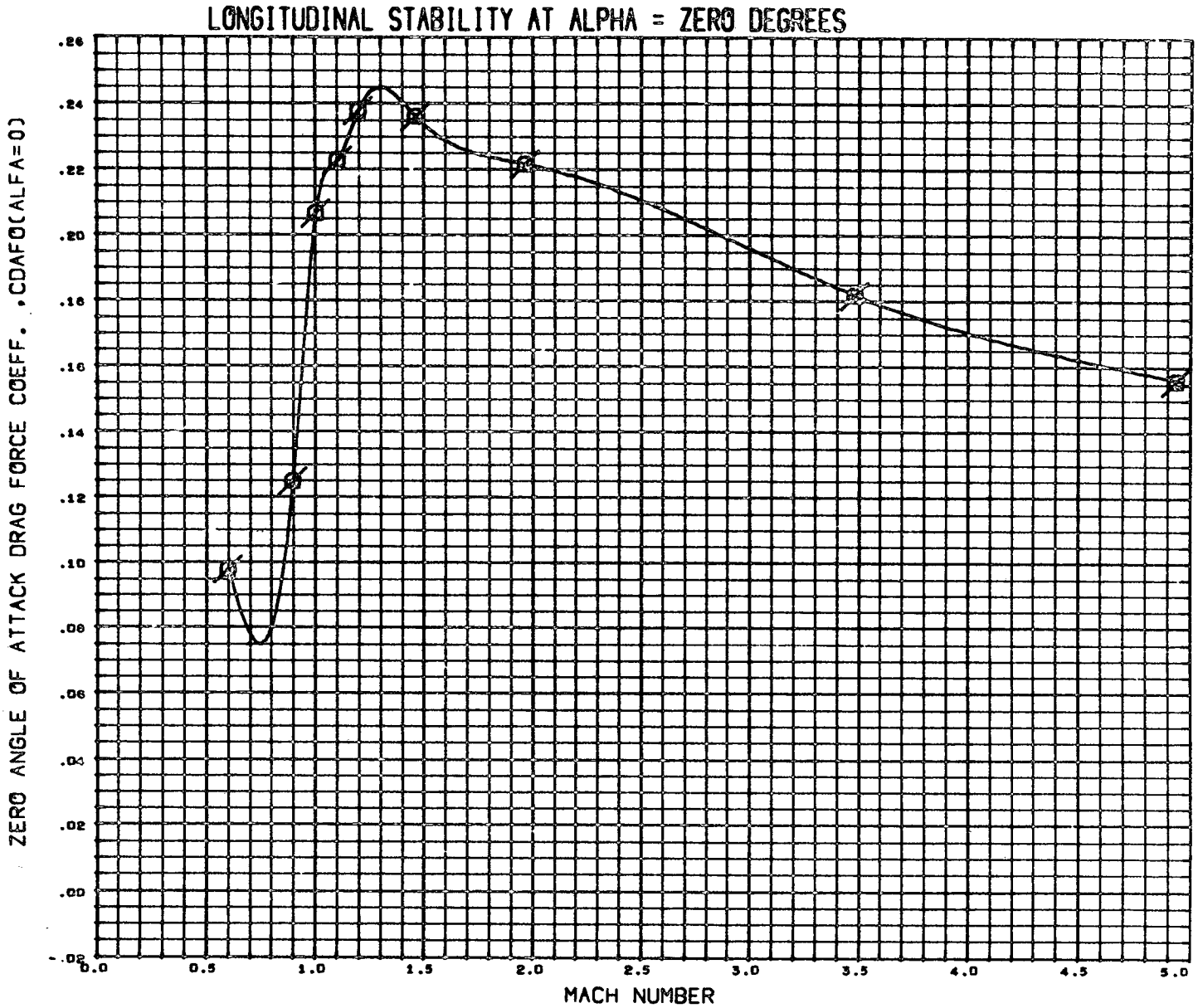

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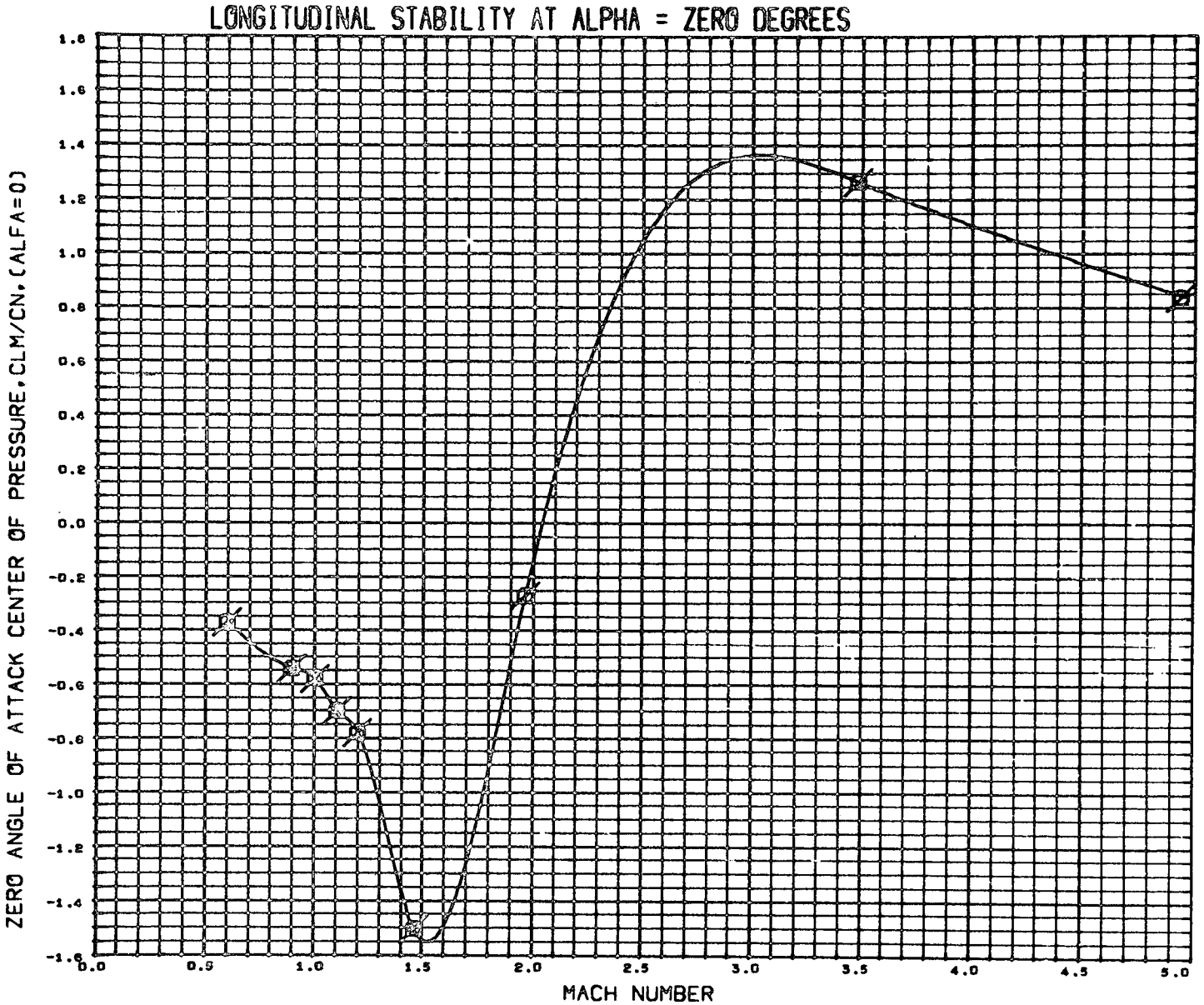

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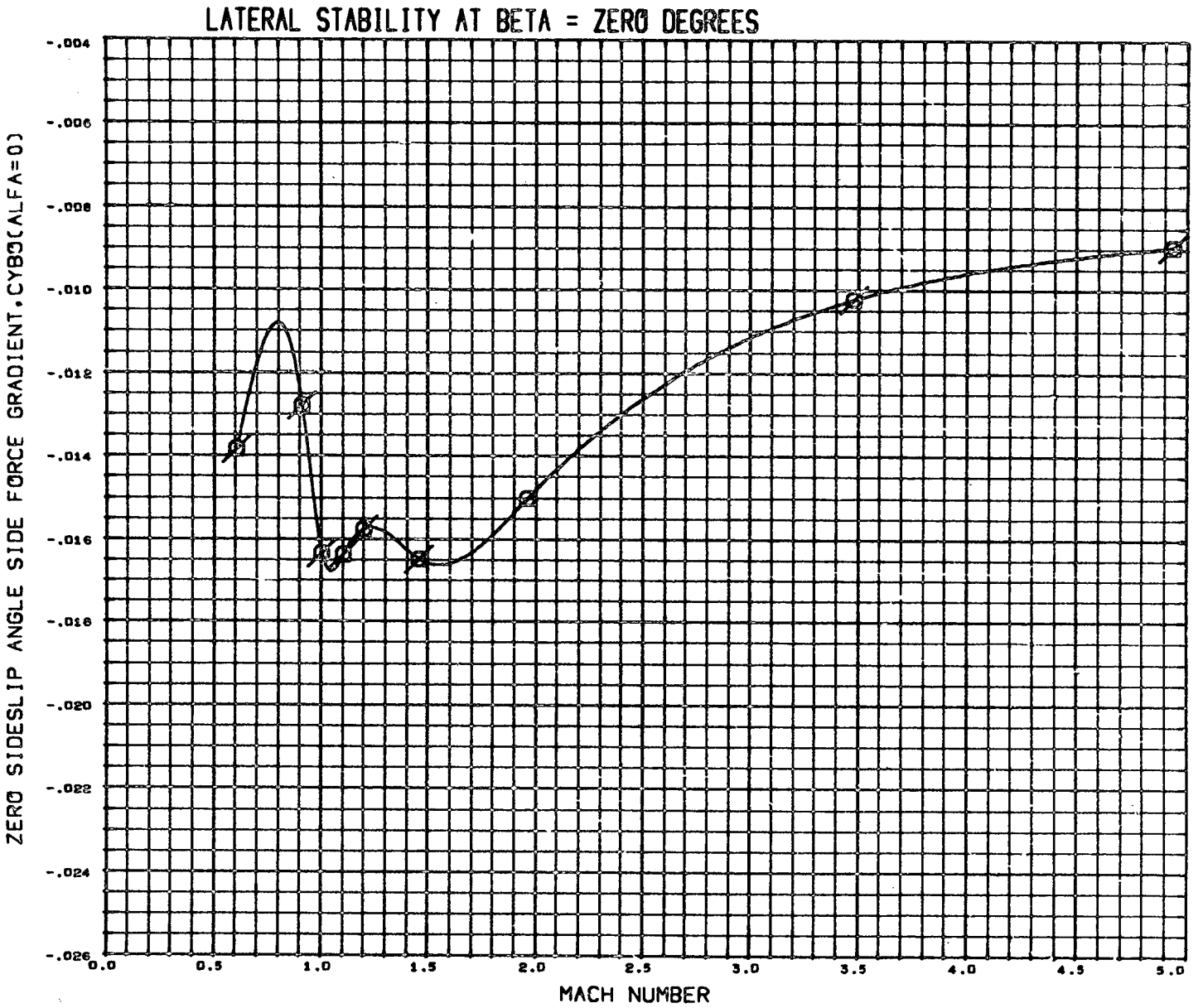

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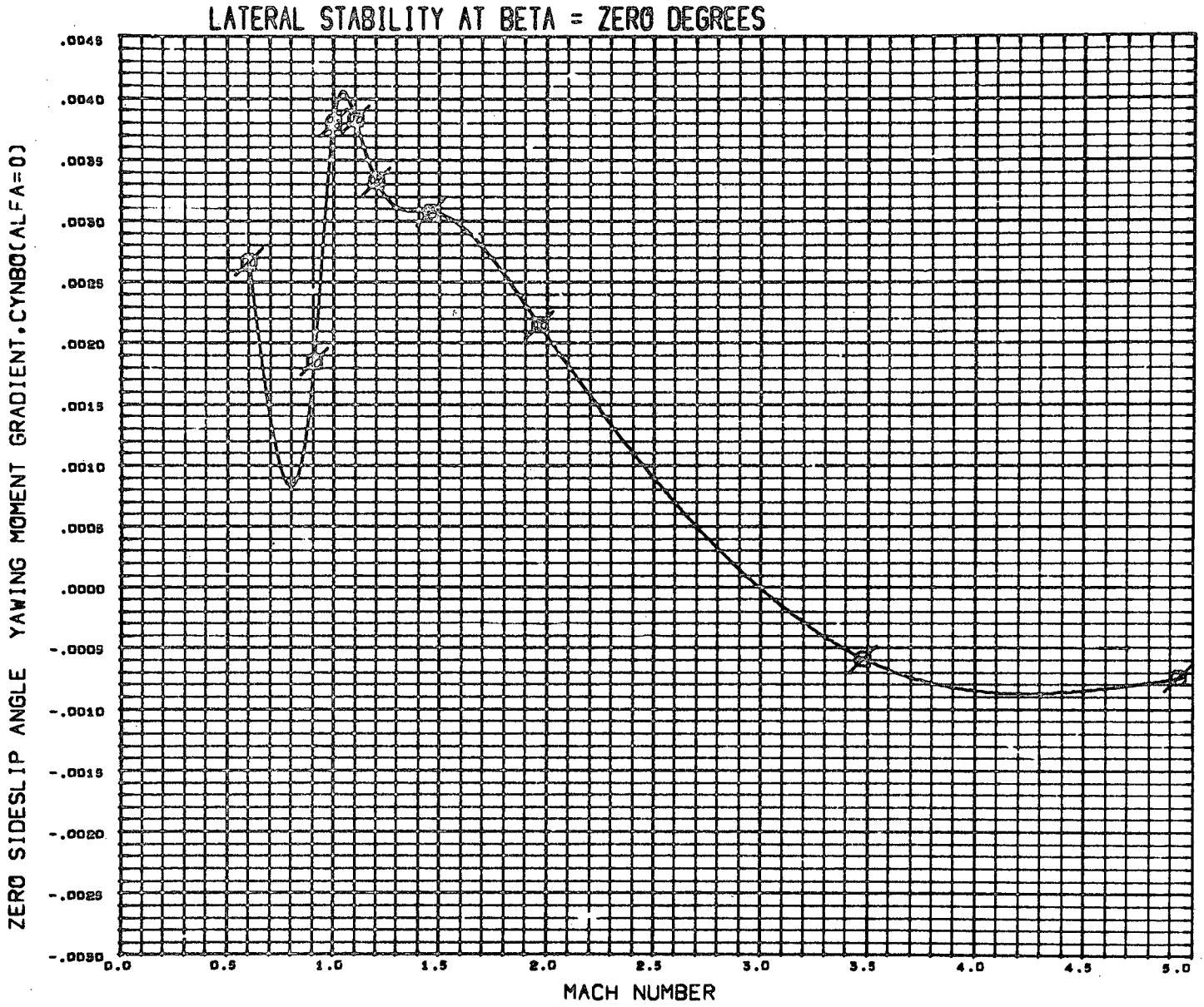

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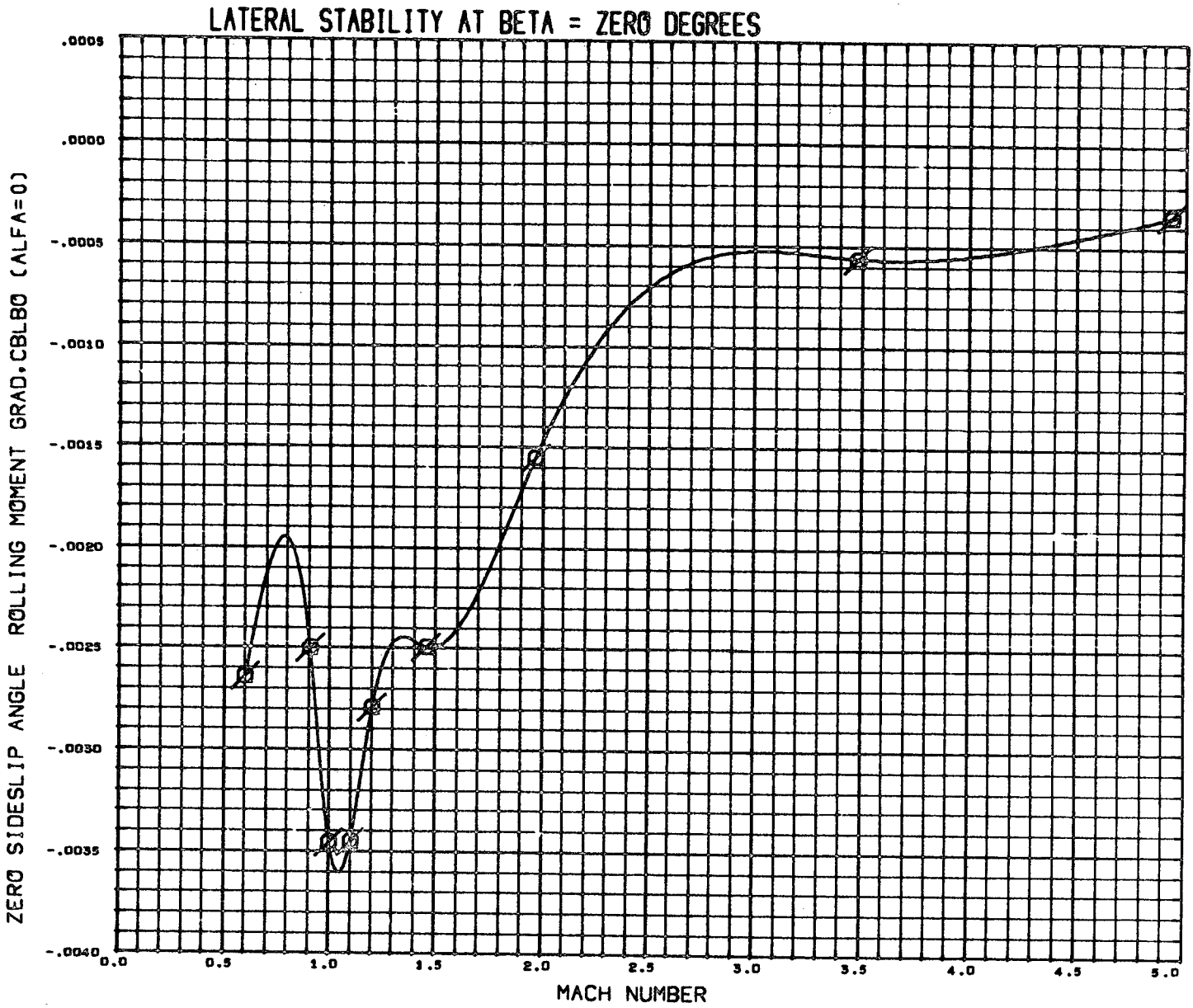

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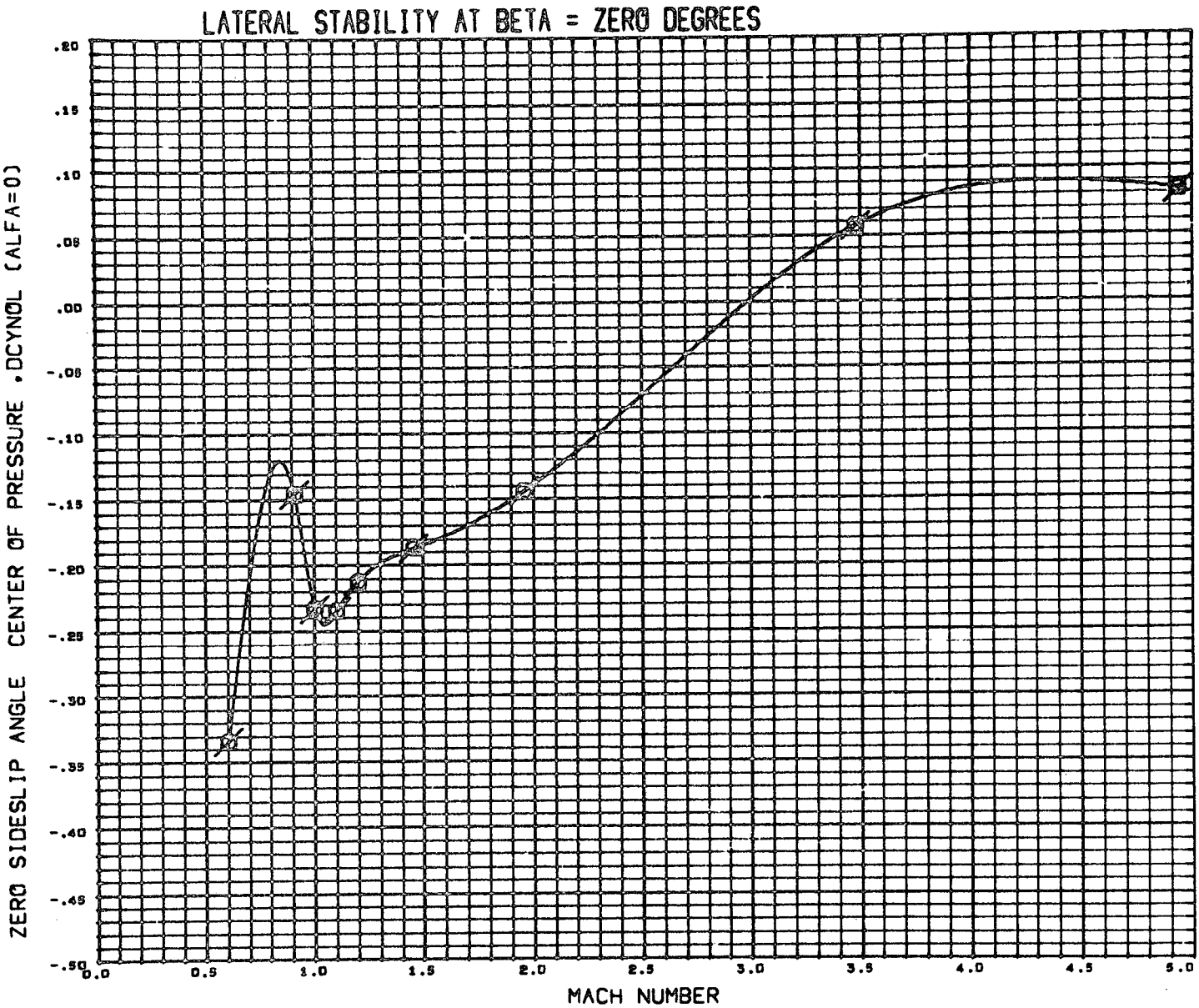

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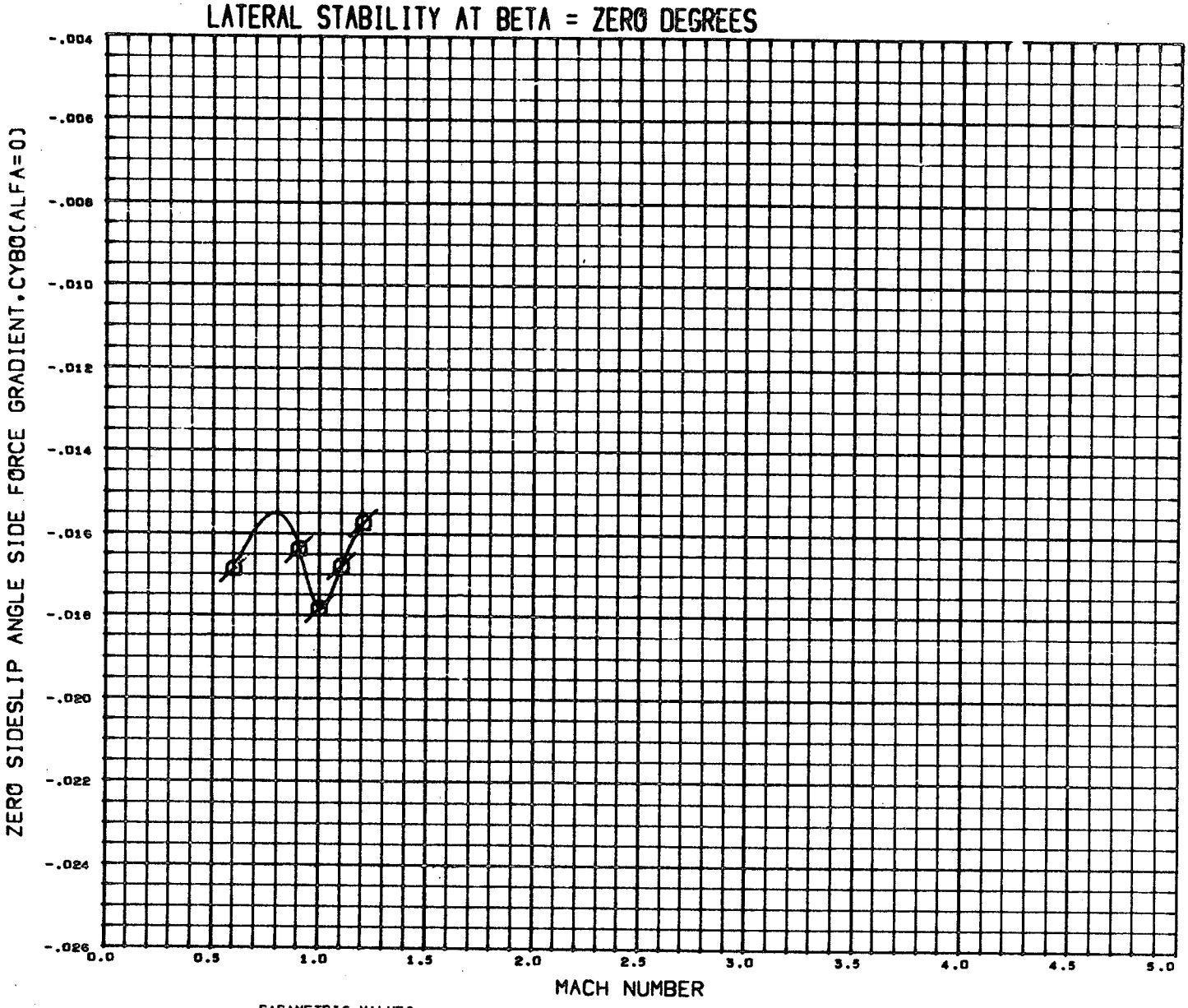

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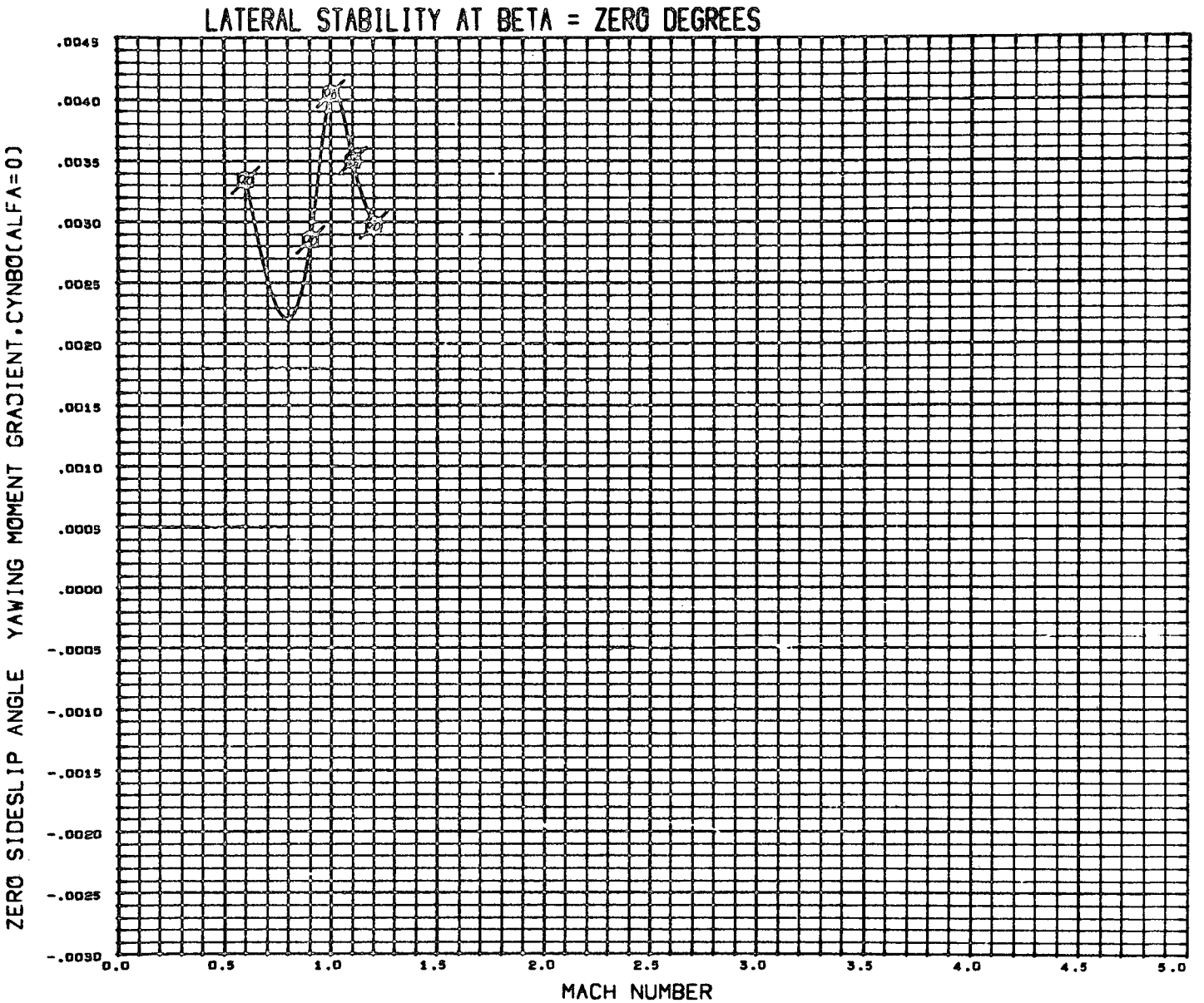
DATA HIST. CODE *EGF

LATERAL STABILITY AT BETA = ZERO DEGREES



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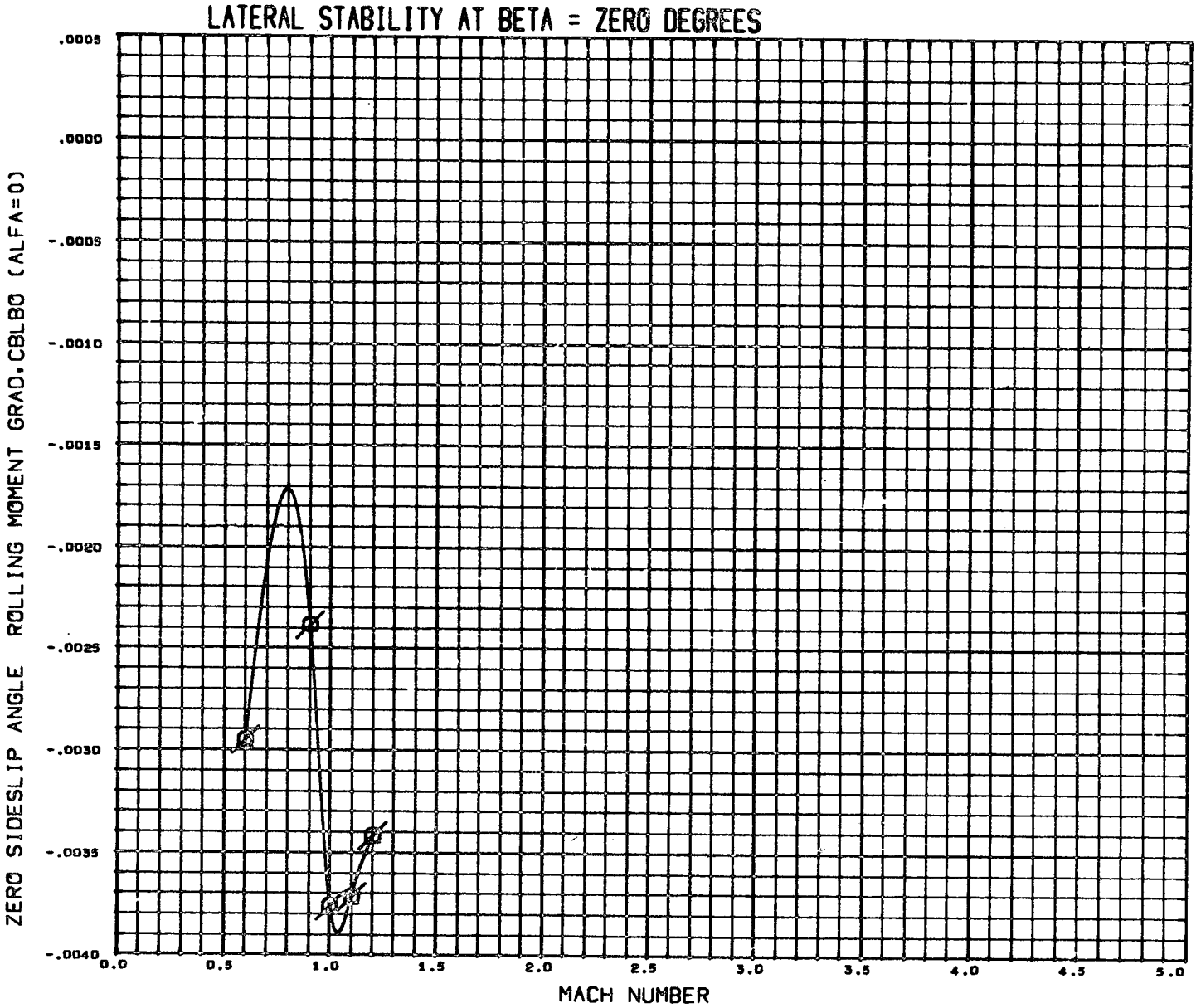

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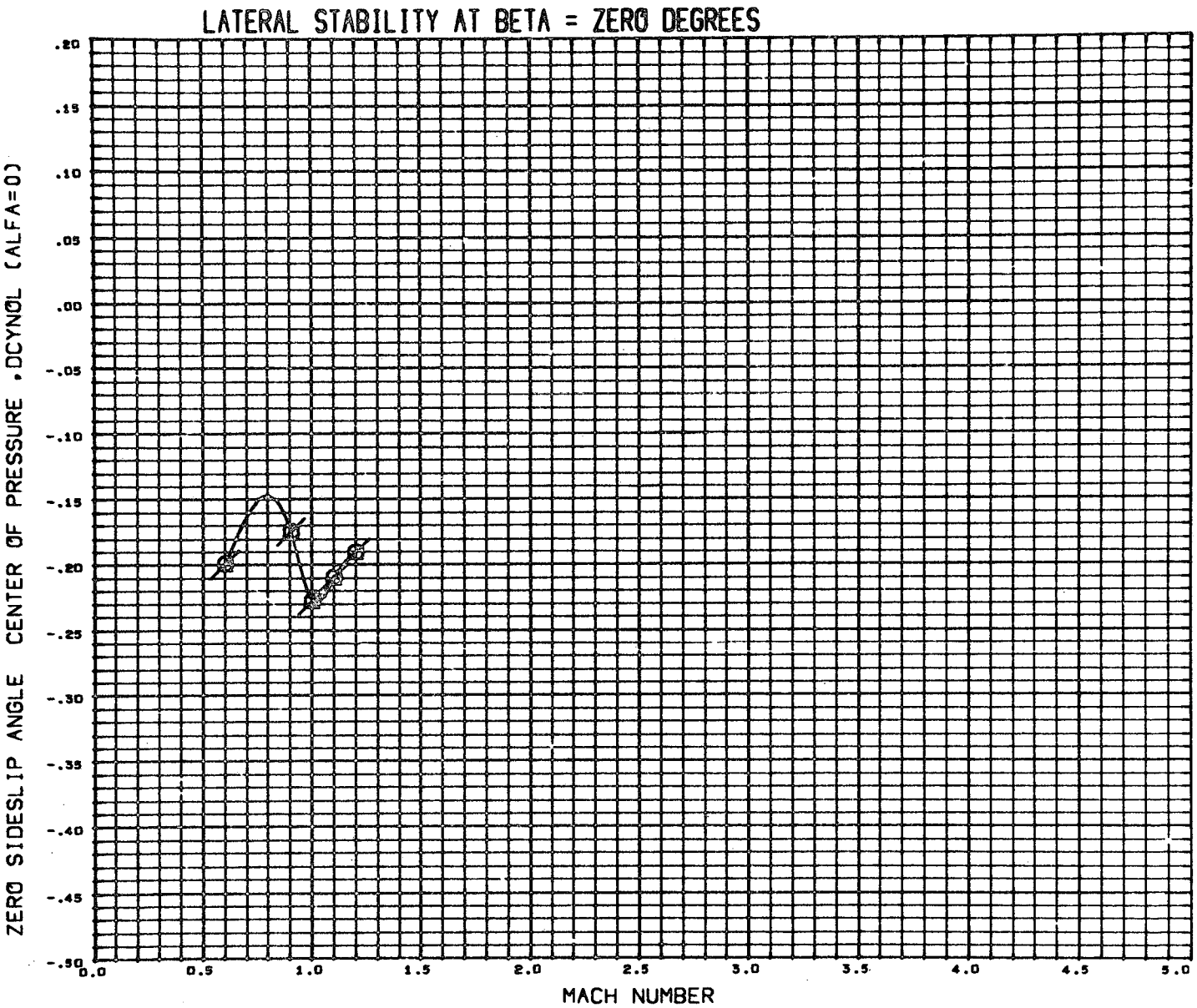

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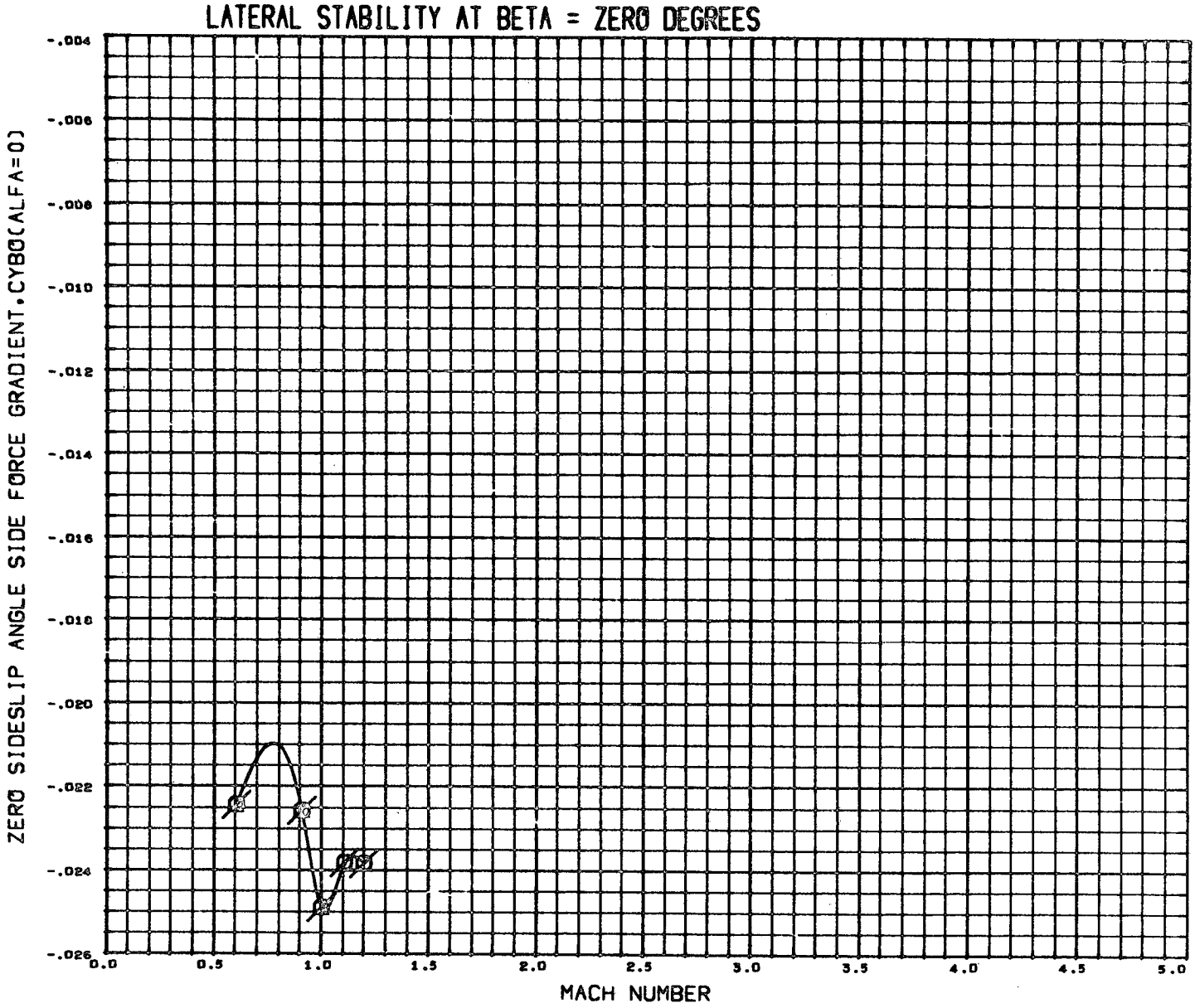

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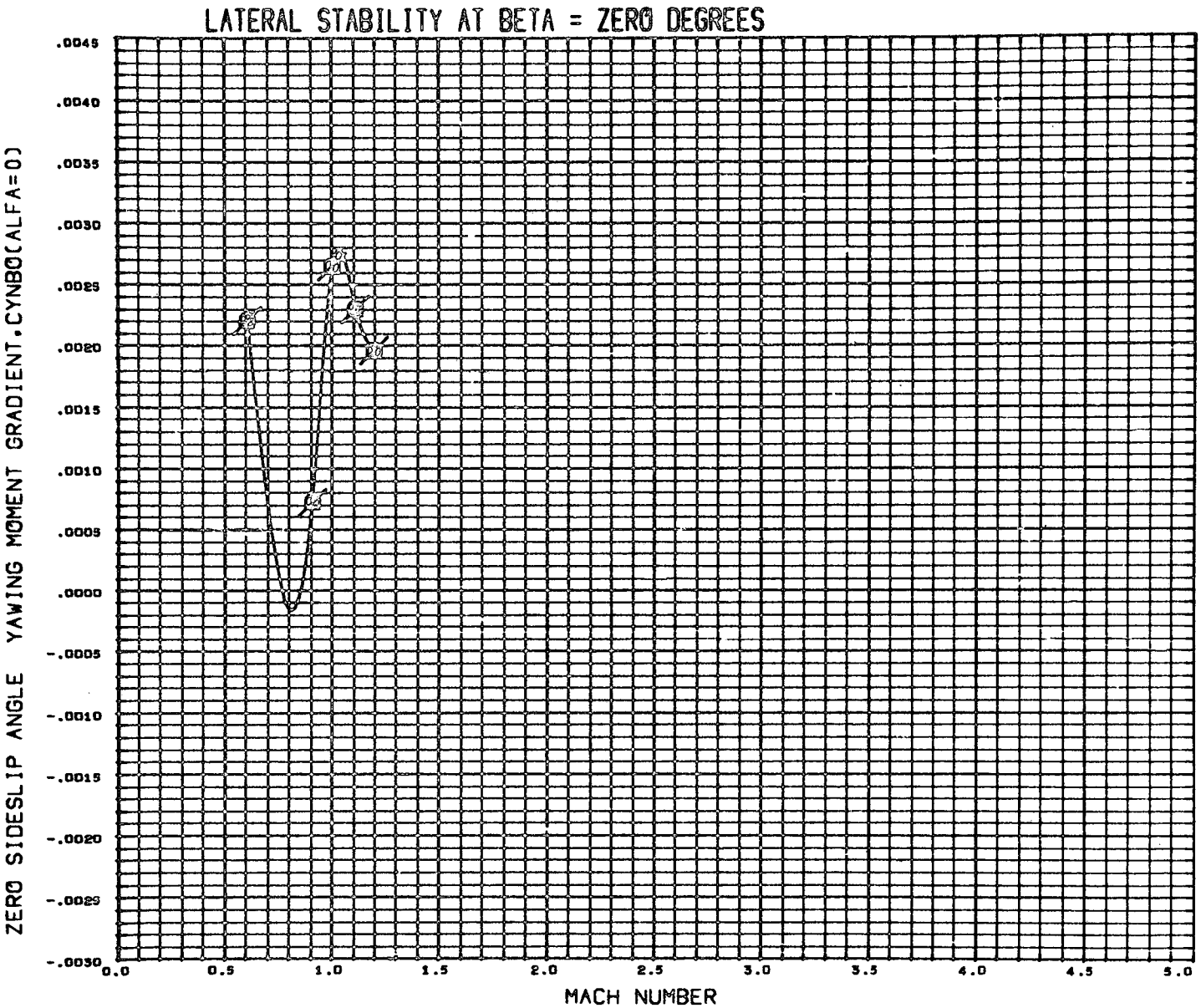
DATA HIST. CODE *EGF

LATERAL STABILITY AT BETA = ZERO DEGREES



PAR/METRIC VALUES

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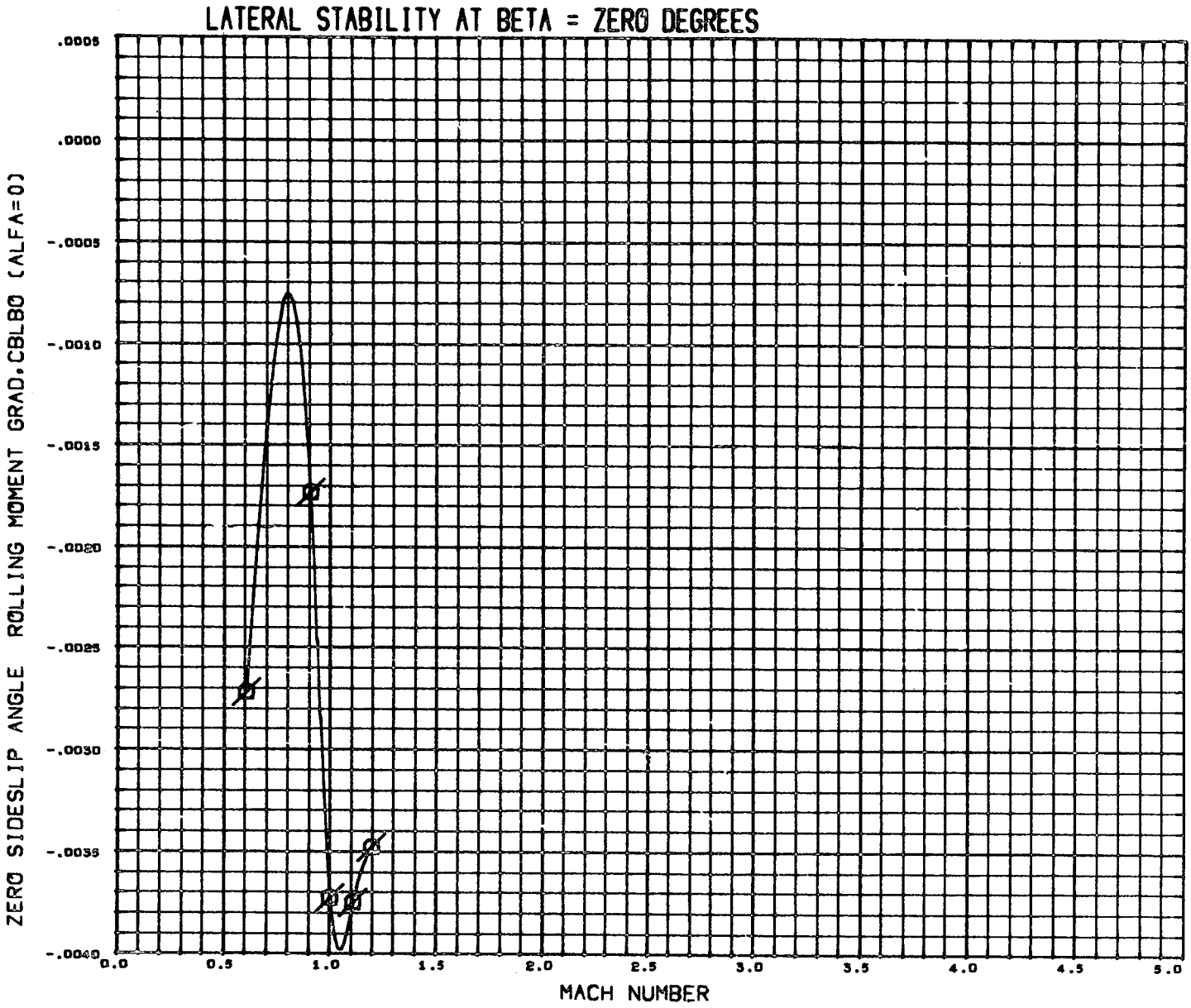

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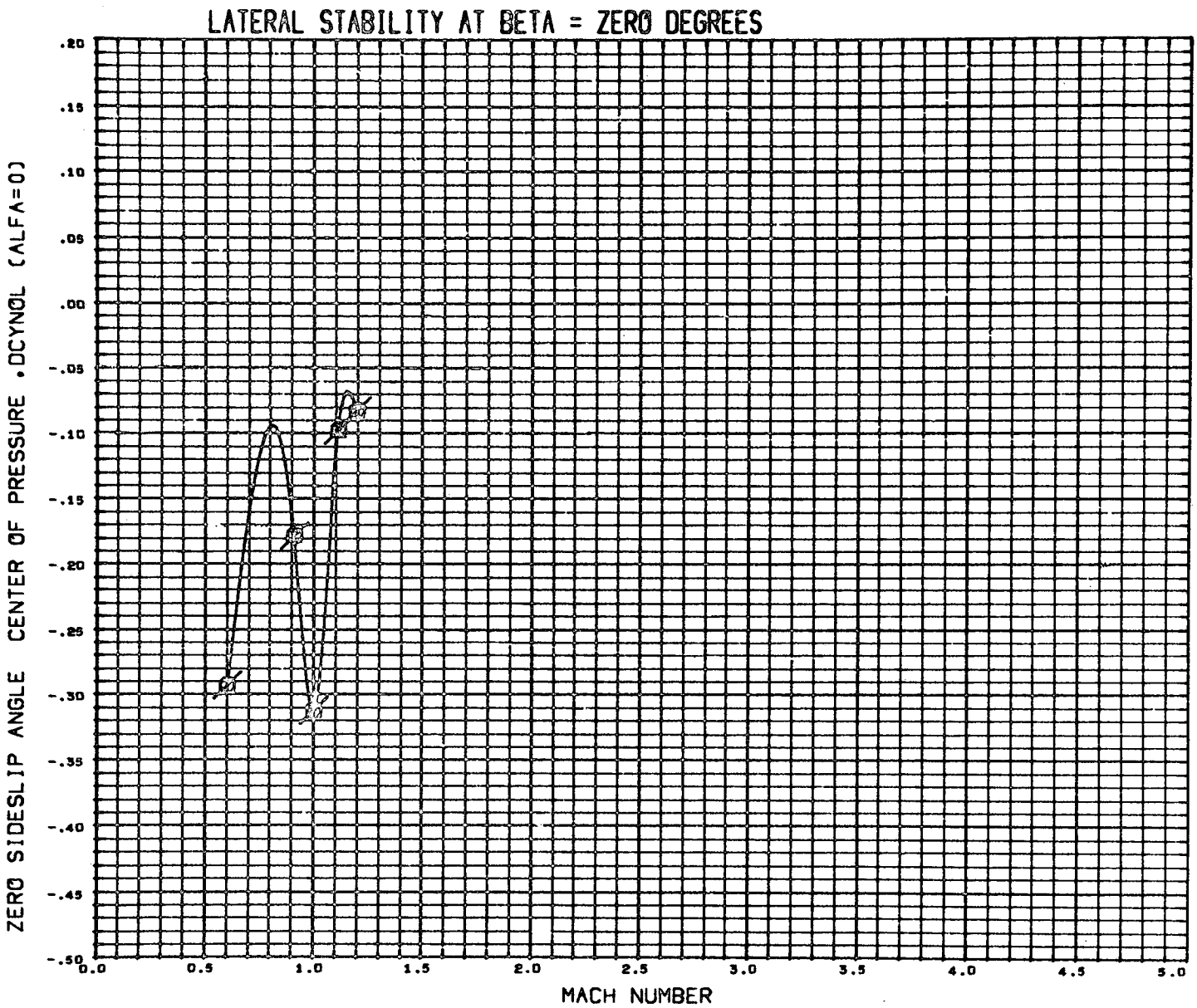

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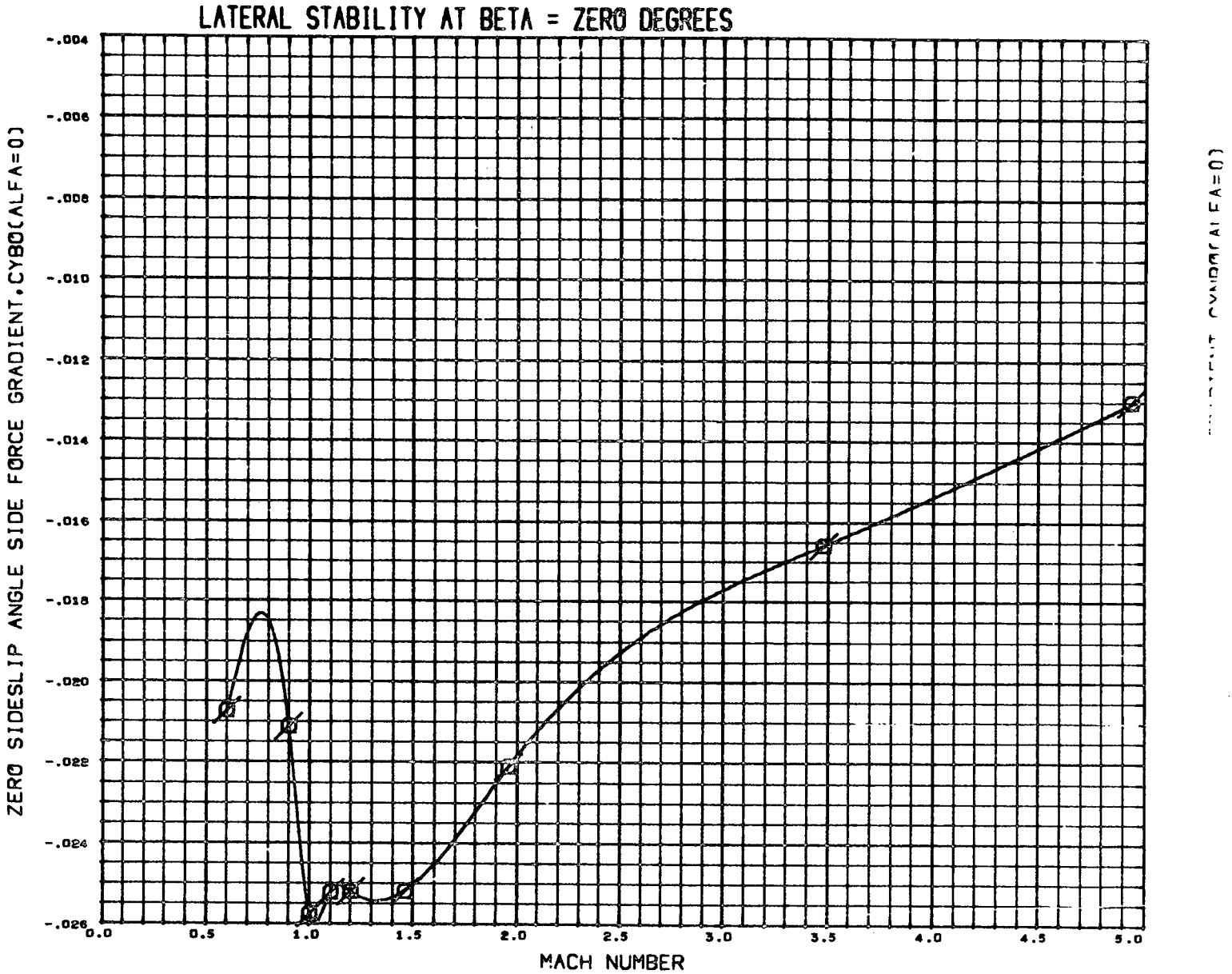

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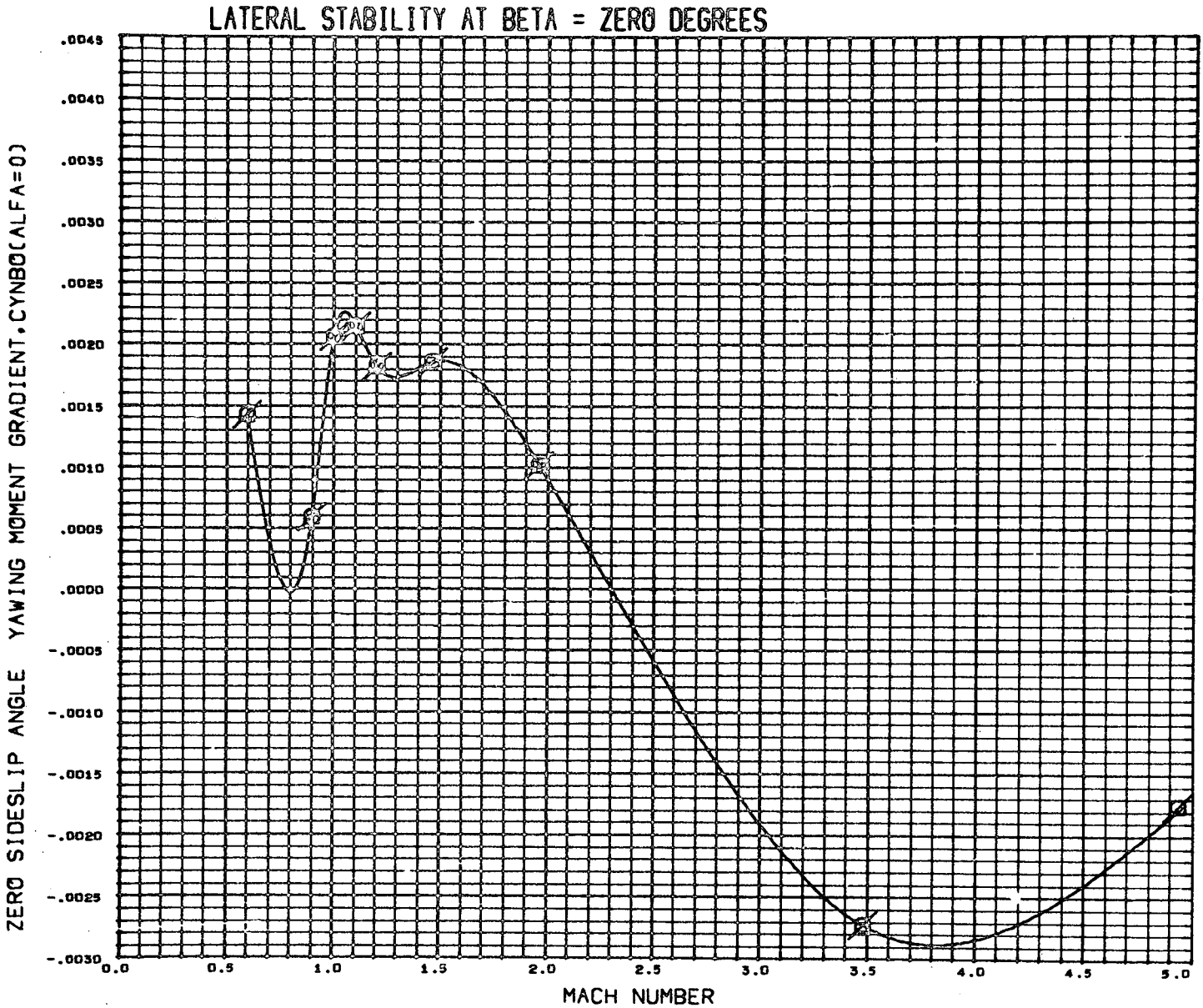

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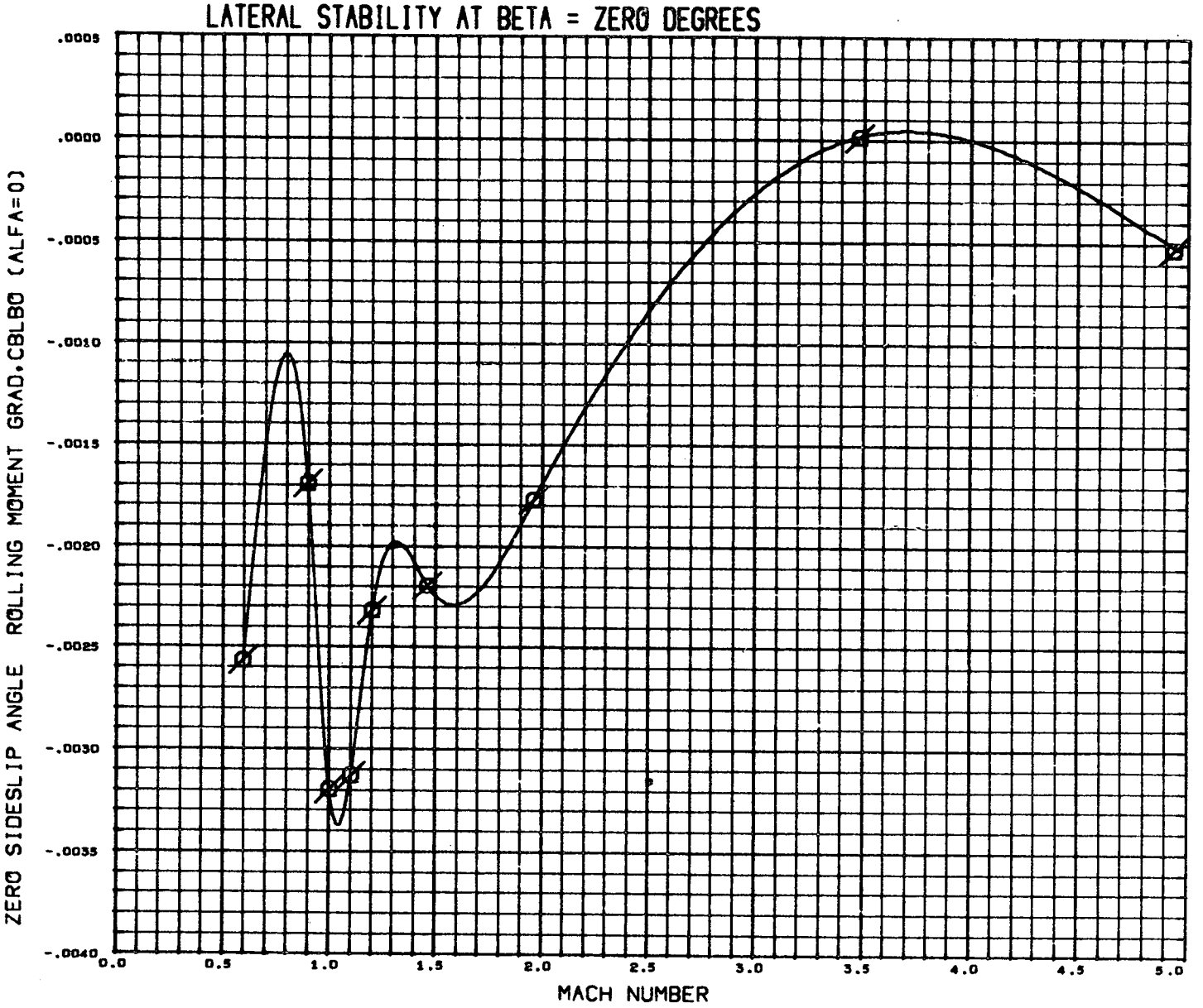

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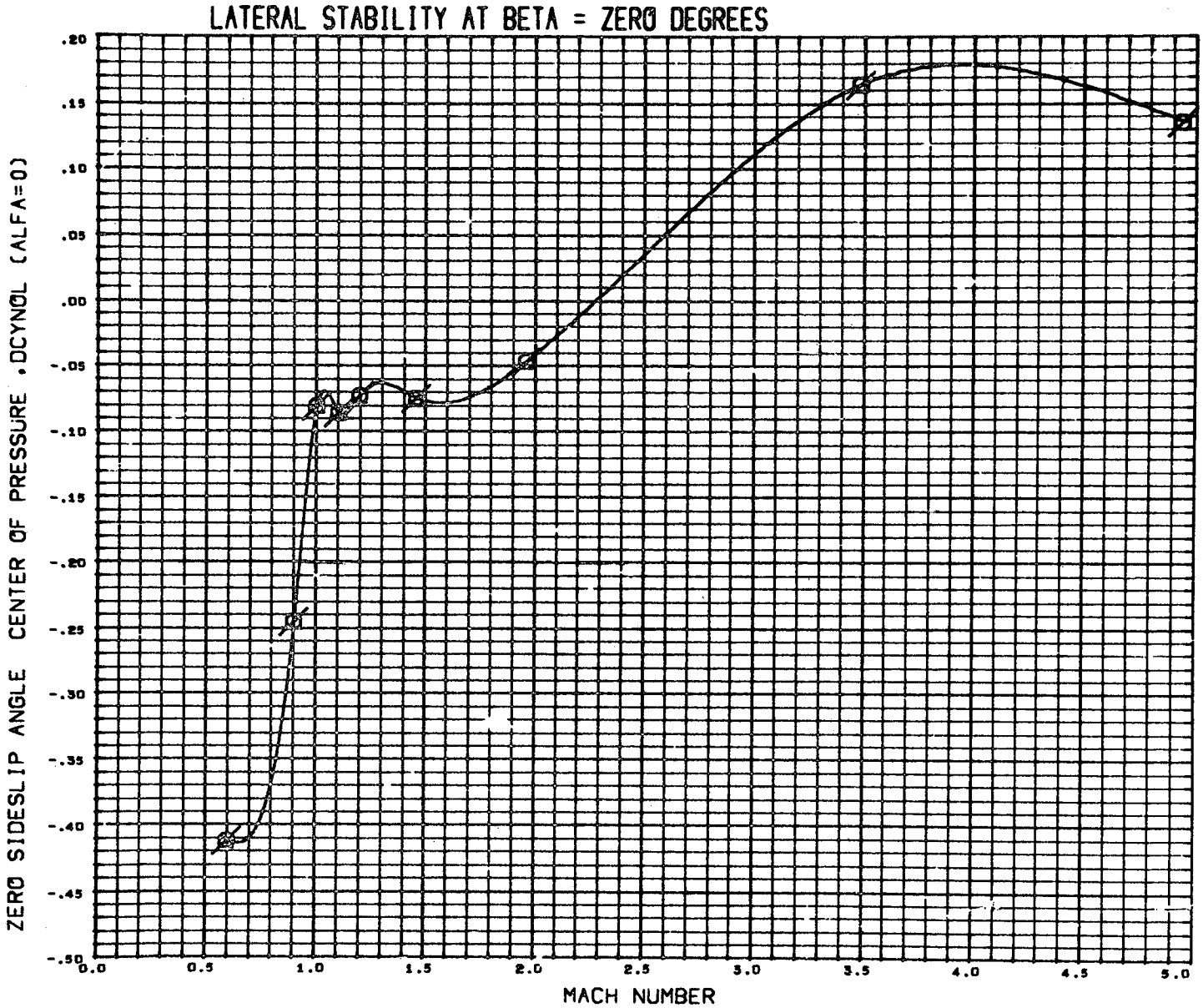

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