DMS-DR-2127

(LA35)

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REYNOLDS NUMBER EFFECTS ON HYPERSONIC CHARACTERISTICS OF A 0.010-SCALE MODEL OF THE 139-B SHUTTLE ORBITER

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16. Abstract

Longitudinal and lateral-directional stability characteristics of the Rockwell International 139-B orbiter (model 32-0) were obtained in the NASA/Langley Continuous Flow Hypersonic Tunnel (CFHT) at Mach 10.3. Tests were made at Reynolds numbers of 1.04×10^6 and 2.17×10^6 (based on body length) over an angle of attack range of 12^o to 36^o at sideslip angles of 0^o and -5^o. Data were obtained at three elevon/body flap settings; $\delta_e = -40^o$, $\delta_{BF} = -14.25^o$; $\delta_e = 0^o$, $\delta_{BF} = 0^o$; and $\delta_e = 15^o$, $\delta_{BF} = 13.75^o$.

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REYNOLDS NUMBER EFFECTS ON HYPERSONIC CHARACTERISTICS OF A 0.010-SCALE MODEL OF THE 139-B SHUTTLE ORBITER (LA35)

By

Peter T. Bernot, NASA/LaRC

SUMMARY

Longitudinal and lateral-directional stability characteristics of the Rockwell International 139-B orbiter (model 32-0) were obtained in the NASA/Langley Continuous Flow Hypersonic Tunnel (CFHT) at Mach 10.3. Tests were made at Reynolds numbers of 1.04×10^6 and 2.17×10^6 (based on body length) over an angle of attack range of 12° to 36° at sideslip angles of 0° and -5°. Data were obtained at three elevon/body flap settings, $\delta_e = -40^\circ$, $\delta_{BF} = -14.25^\circ$; $\delta_e = 0^\circ$, $\delta_{BF} = 0^\circ$; and $\delta_e = 15^\circ$, $\delta_{BF} = 13.75^\circ$.

INTRODUCTION

This report presents the results of Mach 10.3 tests of a 0.010-scale model of the 139-B orbiter configuration in the Langley Continuous Flow Hypersonic Tunnel. These data serve as part of the overall aerodynamic evaluation of the space shuttle orbiter. Longitudinal and lateral-directional characteristics were determined over an angle of attack range of 12^{o} to 36^{o} at Reynolds numbers of 1.04×10^{6} and 2.17×10^{6} based on fuselage length. Tests were conducted at elevon and body flap deflections corresponding to the maximum positive and negative design values as well as 0 degrees. As the prime shuttle contractor, Rockwell International supplied the model; data plots and tables were prepared by Chrysler Corporation under NASA contract. For this investigation, designated CFHT Test No. 102 (LA-35), the tunnel occupancy time was 16 hours.

NOMENCLATURE

General

SYMBOL	DATAMAN SYMBOL	DEFINITION
M	MACH	Mach Number
q	Q(NSM)	dynamic pressure, $1/2\ \rho V^2$
RN	RN	Reynolds number based on body length, $\times 10^{6}$
V		velocity
α	ALPHA	angle of attack, degrees
β	BETA	angle of side slip, degrees
ρ		mass density
		Reference Definitions
b	BREF	wing span
$\bar{c}$	LREF	wing mean aerodynamic chord
S	SREF	total wing planform area
	MRP	moment reference point
		Body-Axis System
C_N	CN	normal-force coefficient, $\frac{\text{normal force}}{qS}$
C_A	CA	axial-force coefficient, $\frac{\text{axial force}}{qS}$

NOMENCLATURE (Continued)

Body-Axis System

SYMBOL	DATAMAN SYMBOL	DEFINITION
C_Y	CY	side-force coefficient, $\frac{\text{side force}}{qS}$
C_m	CLM	pitching-moment coefficient, $\frac{\text{pitching moment}}{qS\bar{c}}$
C_n	CYN	yawing-moment coefficient, $\frac{\text{yawing moment}}{qSb}$
C_ℓ	CBL	rolling-moment coefficient, $\frac{\text{rolling moment}}{qSb}$
		Stability-Axis System
C_L	CL	lift coefficient, $\frac{\text{lift}}{qS}$
C_D	CD	drag coefficient, $\frac{\text{drag}}{qS}$
L/D	L/D	lift-to-drag ratio, C_L/C_D
		Additions to Standard List
C_{Y_β}	DCY/DB	side force coefficient derivative with respect to beta, per degree
C_{n_β}	DCYNDB	yawing moment coefficient derivative with respect to beta, per degree
C_{ℓ_β}	DCBLDB	rolling moment coefficient derivative, with respect to beta, per degree
δ_a	AILRON	aileron deflection for roll control, positive deflection left trailing panel down, $(\delta_{e_L} - \delta_{e_R})/2$, degrees
δ_e	ELEVTR	elevon deflection for pitch control, positive deflection trailing edge down, $(\delta_{e_L} + \delta_{e_R})/2$, degrees
δ_{BF}	BDFLAP	body flap deflection angle, positive deflection trailing edge down, degrees

NOMENCLATURE (Concluded)

Additions to Standard List

SYMBOL	DATAMAN SYMBOL	DEFINITION
δ_{SB}	RUDFLR	split rudder flare angle, positive deflection trailing edges outward, degrees

SUBSCRIPTS

L	left
R	right

MODEL

The test configuration was a 0.010-scale model of the RI-139B orbiter (designated model No. 32-0). See figure 1. The various model components are as follows:

B19 - Fuselage
C7 - Canopy
W107 - Wing
E23 - Elevon
V7 - Vertical tail
M4 - OMS pod
F5 - Body flap
N39 - Main propulsion system (2 bottom nozzles on)
R5 - Rudder

Each component is described in the dimensional data sheets in Table I.

FACILITY AND TESTS

The Mach 10 nozzle of the NASA/Langley CFHT is designed to operate at stagnation pressures of 1.519 MN/m^2 (15 atmospheres) to 15.19 MN/m^2 (150 atmospheres) at temperatures up to 1089^{o} K (1960^{o} R). Air is preheated electrically by passing it through a multi-tube heater. The nozzle has a 0.78 m (31-inch) square test section and incorporates a movable second minimum. Continuous operation is achieved by passing the air through a series of compressors. Additional information on this facility can be found in reference 1.

Model forces and moments were measured by a six-component, water-cooled, strain-gage balance (HCF-09) which was mounted on a 20^{o} bent sting (No. 11). See figure 2. Tests were conducted at stagnation pressures of 5.17 MN/m^2 (750 psia) and 10.82 MN/m^2 (1570 psia) at Reynolds numbers of about 1.04×10^6 and 2.17×10^6, respectively. The Mach number was 10.32 for the lower pressure and 10.37 for the higher pressure. The angle of attack range was from 12^{o} to 36^{o} at sideslip angle of 0^{o} and -5^{o}. All tests were made with a speed brake deflection of 55^{o}. Model base pressures were not measured in this investigation. The complete test program is presented in Table II.

DATA REDUCTION

Aerodynamic coefficients based on body-axis and stability-axis systems (figure 3) were calculated using the following reference values:

S = total wing planform area = .025 m^2 (.2690 ft^2)
$\bar{c}$ = wing mean aerodynamic chord = .12 m (4.748 in)
b = wing span = .238 m (9.367 in)

All moment coefficients were referenced about the nominal 65 percent center of gravity which corresponds to a location .213 m (8.417 in) aft of the nose and .025 m (1.01 in) below the fuselage top surface.

Estimated inaccuracies in the body-axis coefficients are based on 0.5 percent of the design loads for the HCF-09 balance. These inaccuracies expressed in coefficient form are:

	M = 10.32 q = 6890 N/m^2 (1.0 psia)	M = 10.37 q = 14800 N/m^2 (2.15 psia)
C_N	.015	.007
C_A	.0039	.0018
C_m	.0033	.0015
C_ℓ	.0002	.0001
C_n	.0003	.0002
C_Y	.0032	.0015

PRESENTATION OF RESULTS

The longitudinal characteristics at $\beta = 0^{o}$ are presented in figure 4 for Reynolds numbers of 1.04×10^{6} and 2.17×10^{6}. In figure 5, the longitudinal characteristics are presented in the same manner for $\beta = -5^{o}$. The lateral-directional characteristics at both Reynolds numbers are shown in figures 6(a), 6(b), and 6(c) for the elevon/body flap deflections of $0^{o}/0^{o}$, $15^{o}/13.75^{o}$, and $-40^{o}/-14.25^{o}$, respectively. Tabulations of body and stability-axis coefficients are presented in the Appendix.

These data indicate no major performance anomalies and are presented without further analysis as a part of the overall data base.

REFERENCES

1. Schaefer, William T., Jr.: Characteristics of Major Active Wind Tunnels at the Langley Research Center. NASA TM X-1130, 1965.

TABLE I

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Body - B-19

GENERAL DESCRIPTION : Fuselage

Model Scale = 0.010

DRAWING NUMBER : VL70-000139B

DIMENSIONS :	FULL SCALE	
Length	32.7 m	1290.3 in.
Max Width	6.7 m	267.6 in.
Max Depth	6.2 m	244.5 in.
Fineness Ratio	4.82	
Area		
Max. Cross-Sectional	35.9 m^2	386.67 ft^2
Planform		
Wetted		
Base		

TABLE I (Continued)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Canopy - C7

GENERAL DESCRIPTION :

Model Scale = 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	
Length	6.02 m	237.0 in.
Max Width		
Max Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE I (Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT: Wing - W107

GENERAL DESCRIPTION: Configuration 3A

Model Scale = 0.010

DRAWING NUMBER: VL70-000139B

DIMENSIONS:	FULL-SCALE	
TOTAL DATA		
Area		
Planform	249.9 m^2	2690 ft^2
Wetted	-	-
Span (equivalent)	23.79 m	936.68 in.
Aspect Ratio	2.26	
Rate of Taper	1.17	
Taper Ratio	0.200	
Dihedral Angle, degrees	3.50	
Incidence Angle, degrees	0.50	
Aerodynamic Twist, degrees	3.00	
Toe-In Angle	-	
Cant Angle	-	
Sweep Back Angles, degrees		
Leading Edge	45.00	
Trailing Edge	-10.24	
0.25 Element Line	35.21	
Chords:		
Root (Wing Sta. 0.0)	17.50 m	689.24 in.
Tip, (equivalent)	3.50 m	137.85 in.
MAC	12.06 m	474.8 in.
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		
Airfoil Section (RI-Mod. NASA		
Root XXXX-64	0.10	
Tip	0.12	
EXPOSED DATA		
Area	162.79 m^2	1752.29 ft^2
Span, (equivalent)	18.30 m	720.68 in.
Aspect Ratio	2.05	
Taper Ratio	0.245	
Chords		
Root	14.28 m	562.4 in.
Tip	3.50 m	137.85 in.
MAC	9.98 m	393.03 in.
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

TABLE I (Continued)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Elevon - E23

GENERAL DESCRIPTION : Data for (1) of (2) sides

Model Scale = 0.010

DRAWING NUMBER VL70-000139B

DIMENSIONS	FULL SCALE	
Area	19.09 m^2	205.52 ft^2
Span (equivalent)	8.97 m	353.34 in.
Inb'd equivalent chord	2.91 m	114.78 in.
Outb'd equivalent chord	1.39 m	55.0 in.
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	.208	
At Outb'd equiv. chord	.400	
Sweep Back Angles, degrees		
Leading Edge	0	
Trailing Edge	-10.24	
Hingeline	0	
Area Moment (Normal to hinge line)	43.83 m^3	1548.07 ft^3

TABLE I (Continued)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : OMS Pod - M4

GENERAL DESCRIPTION : Lightweight configuration - with nozzles removed.

Model Scale = 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	
Length	8.3 m	327.0 in.
Max Width	2.7 m	108.0 in.
Max Depth	2.8 m	113.0 in.
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE I (Continued)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Body Flap - F5

GENERAL DESCRIPTION :

Model Scale = 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	
Length	2.1 m	84.7 in.
Max Width	6.7 m	267.6 in.
Max Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform	13.2 m^2	142.5 ft^2
Wetted		
Base		

TABLE I (Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT: MPS Nozzles - N39

GENERAL DESCRIPTION: Configuration 3A MPS Nozzles

Model Scale = 0.010

DIMENSIONS		FULL SCALE	
Length			
Gimbal Point to Exit Plane		3.9 m	157 in.
Throat to Exit Plane		2.5 m	99.2 in.
Diameter			
Exit		2.3 m	94 in.
Throat		1.09 m	43 in.
Inlet		-	-
Area			
Exit		4.4 m^2	48.193 ft^2
Throat		-	-
Gimbal Point (station)			
Upper Nozzle			
X	NOT USED	—	—
Y		—	—
Z		—	—
Lower Nozzles			
X		37.1 m	1462 in.
Y	BOTH NOZZLES USED	±1.3 m	±53 in.
Z		8.7 m	342.7 in.
Null Position			
Upper Nozzle			
Pitch	NOT USED	—	—
Yaw		—	—
Lower Nozzles			
Pitch		10°	-
Yaw		3.5°	-

TABLE I (Continued)
MODEL DIMENSIONAL DATA

MODEL COMPONENT: Vertical Tail - V7

GENERAL DESCRIPTION: Centerline tail, double-wedge airfoil with rounded leading edge.

Model Scale = 0.010

DRAWING NUMBER: VL70-000139

DIMENSIONS:	FULL-SCALE	
TOTAL DATA		
Area		
Planform	39.57 m^2	425.92 ft^2
Wetted	-	-
Span (equivalent)	8.01 m	315.72 in.
Aspect Ratio	1.67	
Rate of Taper	0.507	
Taper Ratio	0.404	
Dihedral Angle, degrees		
Incidence Angle, degrees		
Aerodynamic Twist, degrees		
Toe-In Angle		
Cant Angle		
Sweep Back Angles, degrees		
Leading Edge	45.0	
Trailing Edge	26.249	
0.25 Element Line	41.13	
Chords:		
Root (Wing Sta. 0.0)	6.82 m	268.50 in.
Tip, (equivalent)	2.75 m	108.47 in.
MAC	5.07 m	199.81 in.
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		
Airfoil Section		
Leading Wedge Angle, deg.	10.0	
Trailing Wedge Angle, deg.	14.92	
EXPOSED DATA		
Area		
Span, (equivalent)		
Aspect Ratio		
Taper Ratio		
Chords		
Root		
Tip		
MAC		
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

TABLE I (Concluded)

MODEL DIMENSIONAL DATA

MODEL COMPONENT : Rudder - R5

GENERAL DESCRIPTION

Model Scale = 0.010

DRAWING NUMBER VL70-000095

DIMENSIONS	FULL SCALE	
Area	9.88 m^2	106.38 ft^2
Span (equivalent)	5.10 m	201.0 in.
Inb'd equivalent chord	2.32 m	91.585 in.
Outb'd equivalent chord	1.29 m	50.83 in.
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	
At Outb'd equiv. chord	0.400	
Sweep Back Angles, degrees		
Leading Edge	34.83	
Trailing Edge	26.25	
Hingeline	34.83	
Area Moment (Normal to hinge line)	14.89 m^3	526.13 ft^3

TABLE II

TEST : CFHT 102 (LA-35) — DATA SET/RUN NUMBER COLLATION SUMMARY — DATE : 12/73

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	SCHD. β	PARAMETERS/VALUES δ_e	δ_a	δ_{BF}	δ_{SB}	RN	NO. OF RUNS	MACH NUMBERS 10.3	TEST RUN NUMBERS
RQUO01	RI-139B Orb.	A	0	0	0	0	55	1.04		3	
2			-5					1.04		4	
3			0					2.18		9	
4			-5					2.18		10	
5			0	15	0	13.75		1.06		15	
6			-5					1.06		16	
7			0					2.19		17	
8			-5					2.19		18	
9			0	-40	0	-14.25		1.02		11	
10			-5					1.02		12	
11			0					2.22		13	
12			-5					2.22		14	

1 7 13 19 25 31 37 43 49 55 61 67 75 76

α OR β SCHEDULES: A: 12° to 36°, Δα = 4°

COEFFICENTS

IDVAR(1) IDVAR(2) NDV

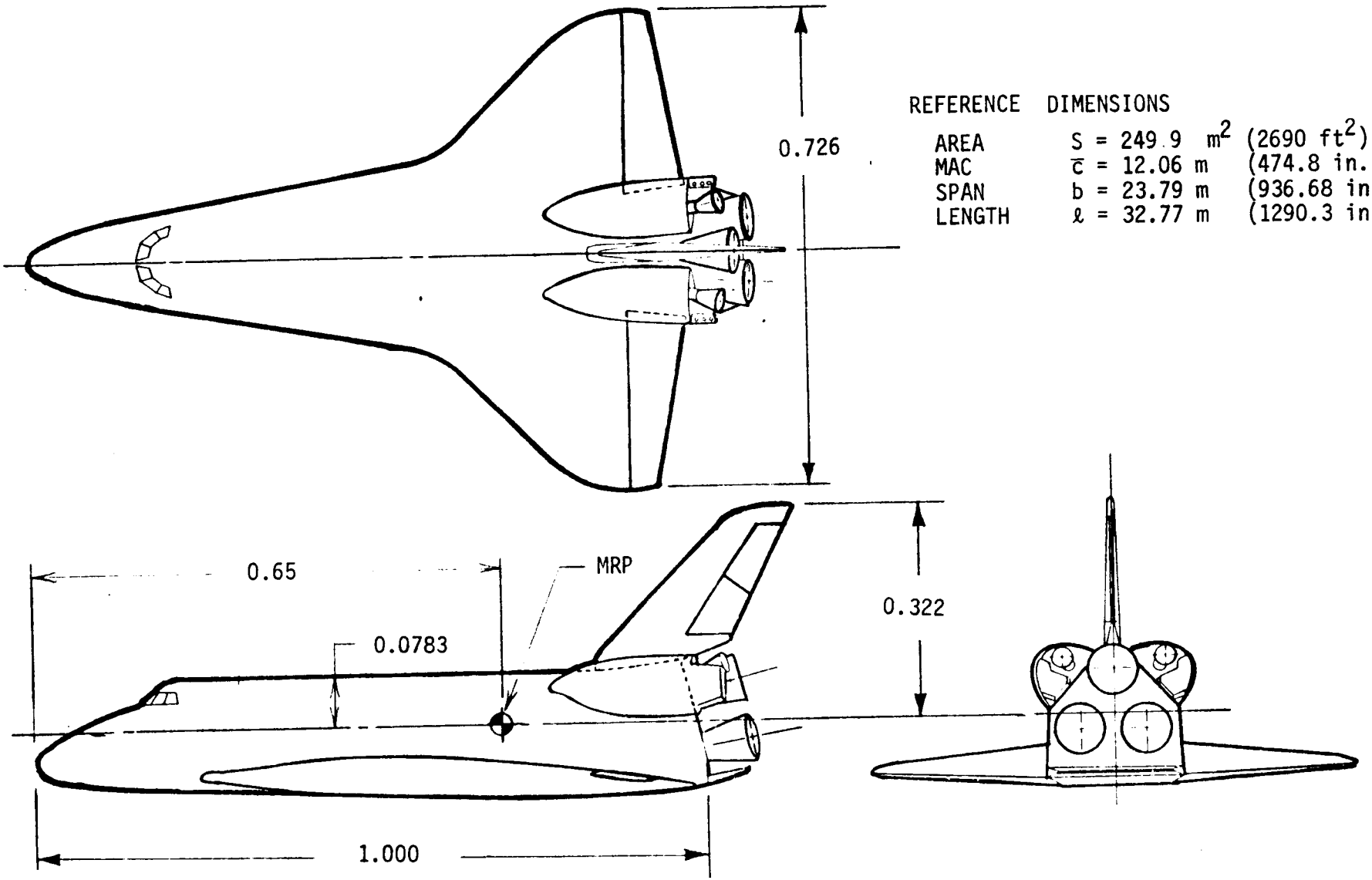


Figure 1.- Layout of 139-B Orbiter. All dimensions are normalized by reference length, ℓ.

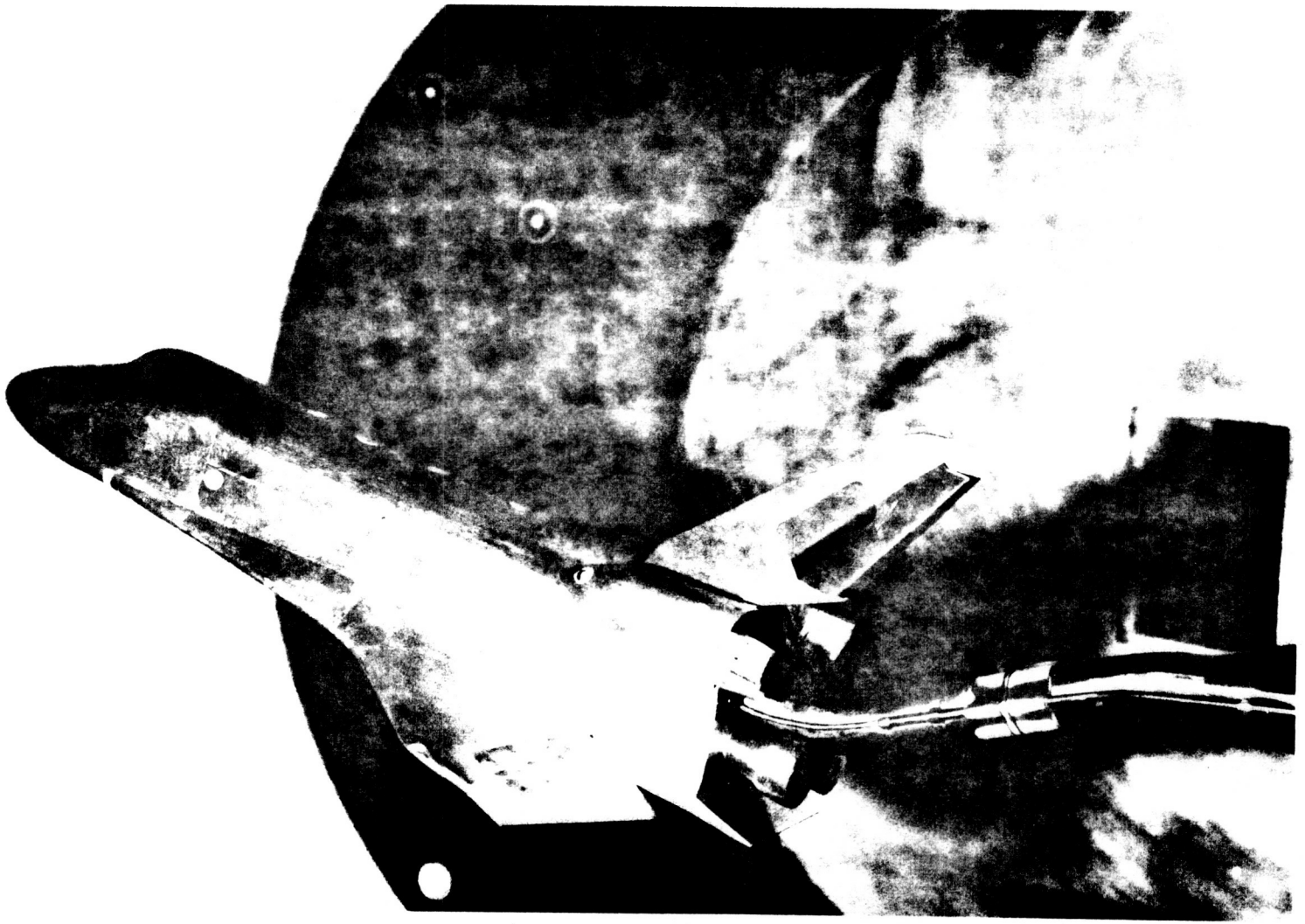


Figure 2.- 139-B Orbiter and 20-deg. Bent Sting Setup in LaRC CFHT Mach 10 Tunnel

Notes:

1. Positive directions of force cofficients, moment coefficients, and angles are indicated by arrow
2. For clarity, origins of wind and stability axes have been displaced from the center of gravity

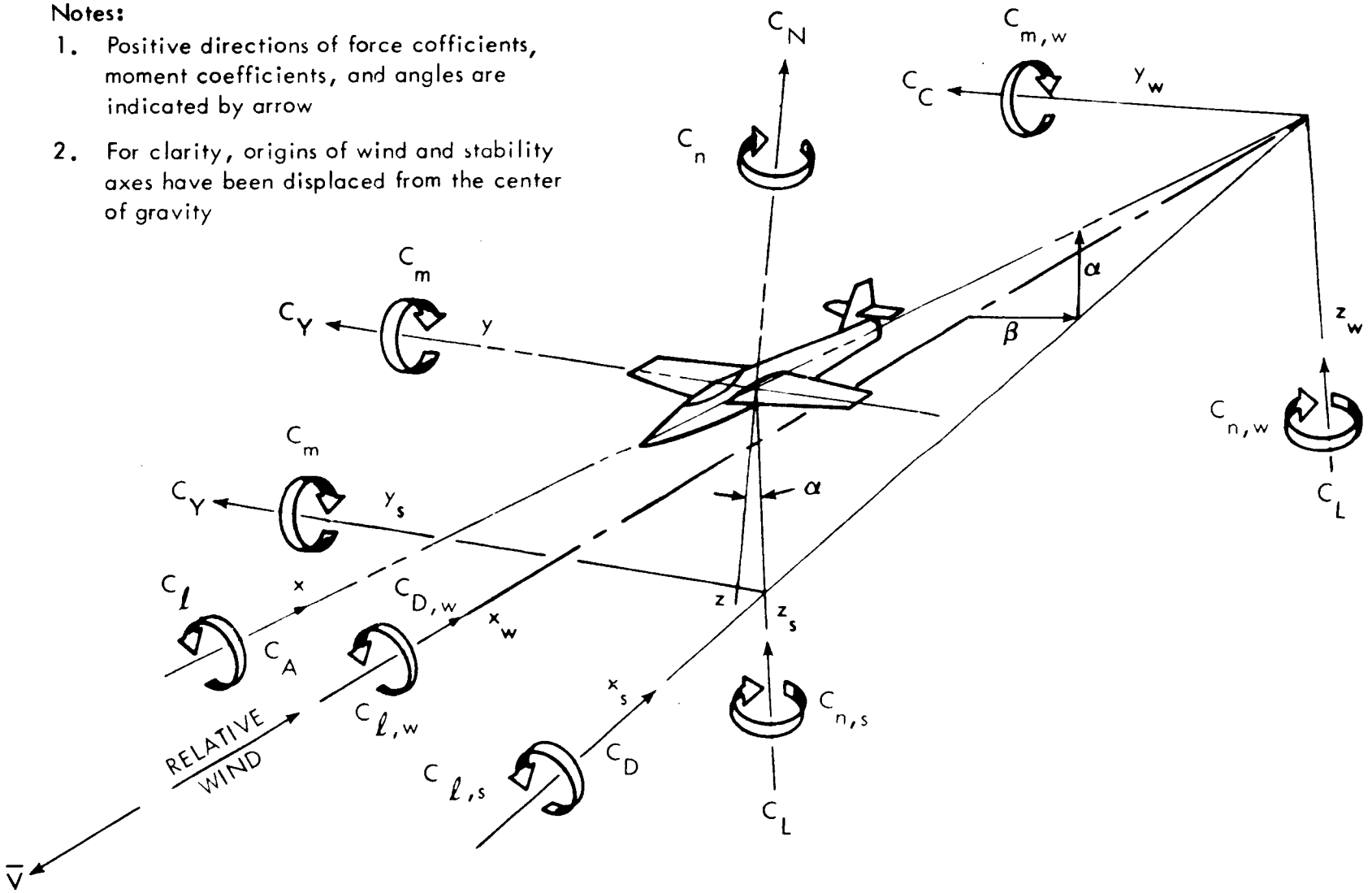
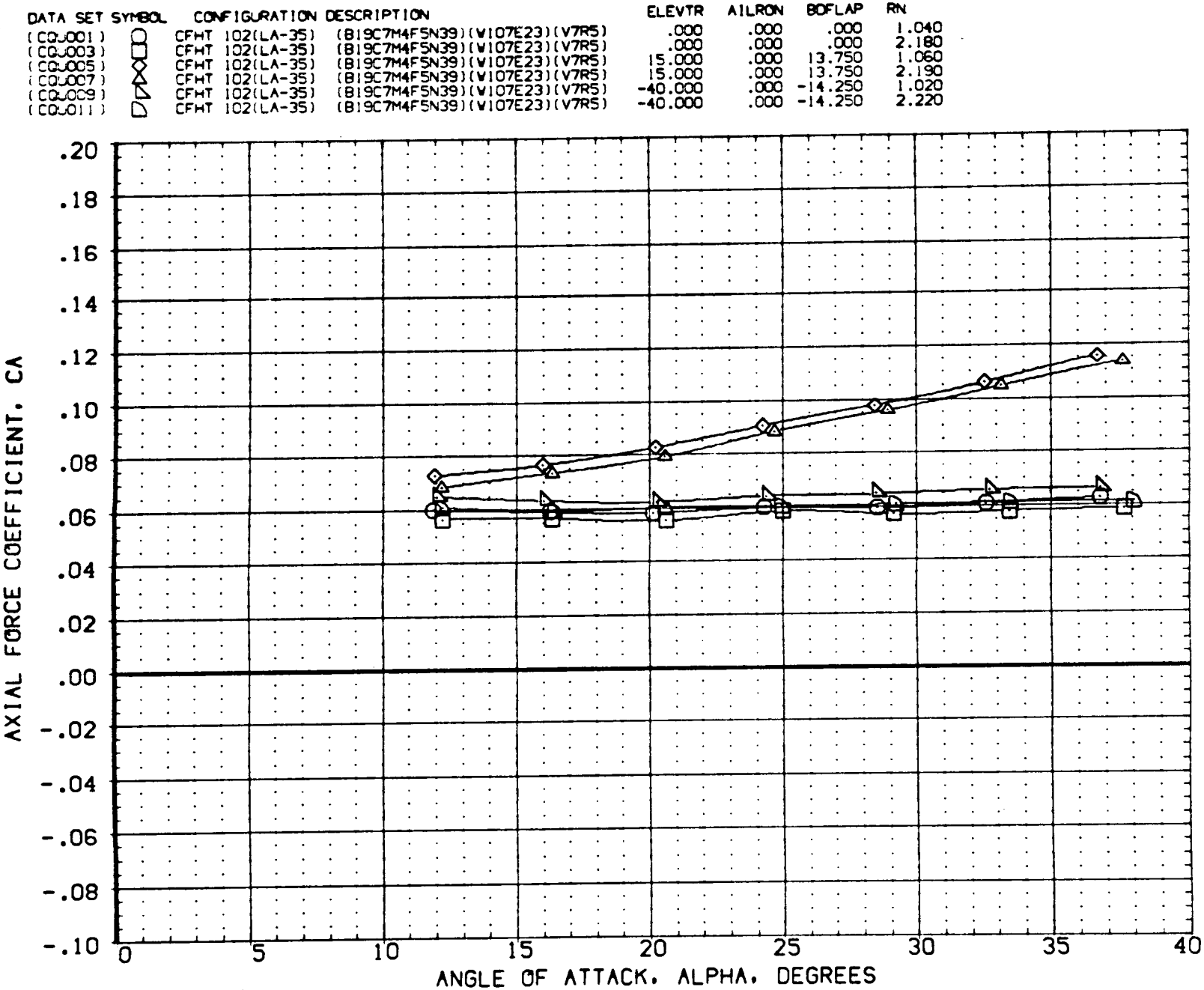
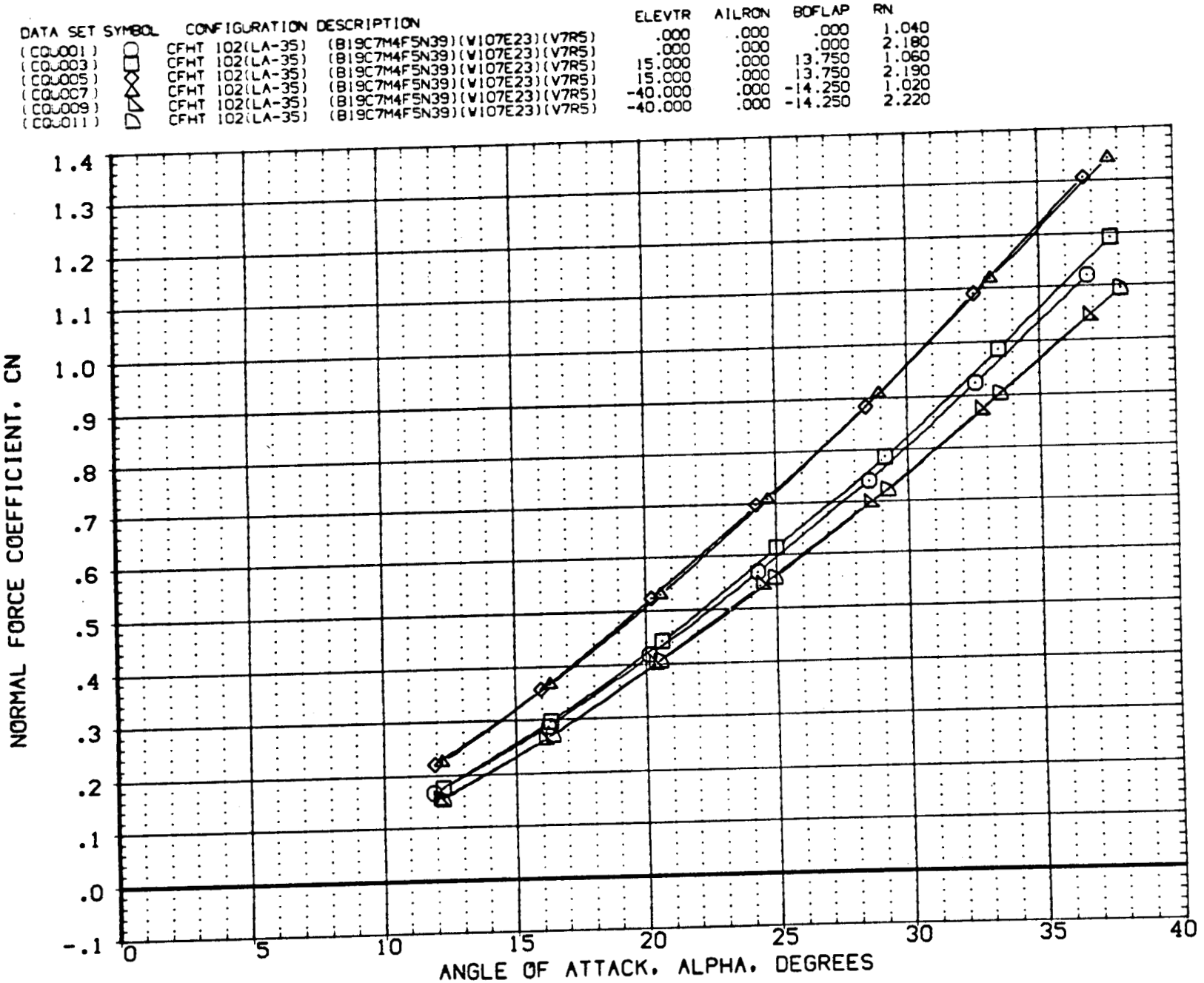


Figure 3.- Axis Systems.



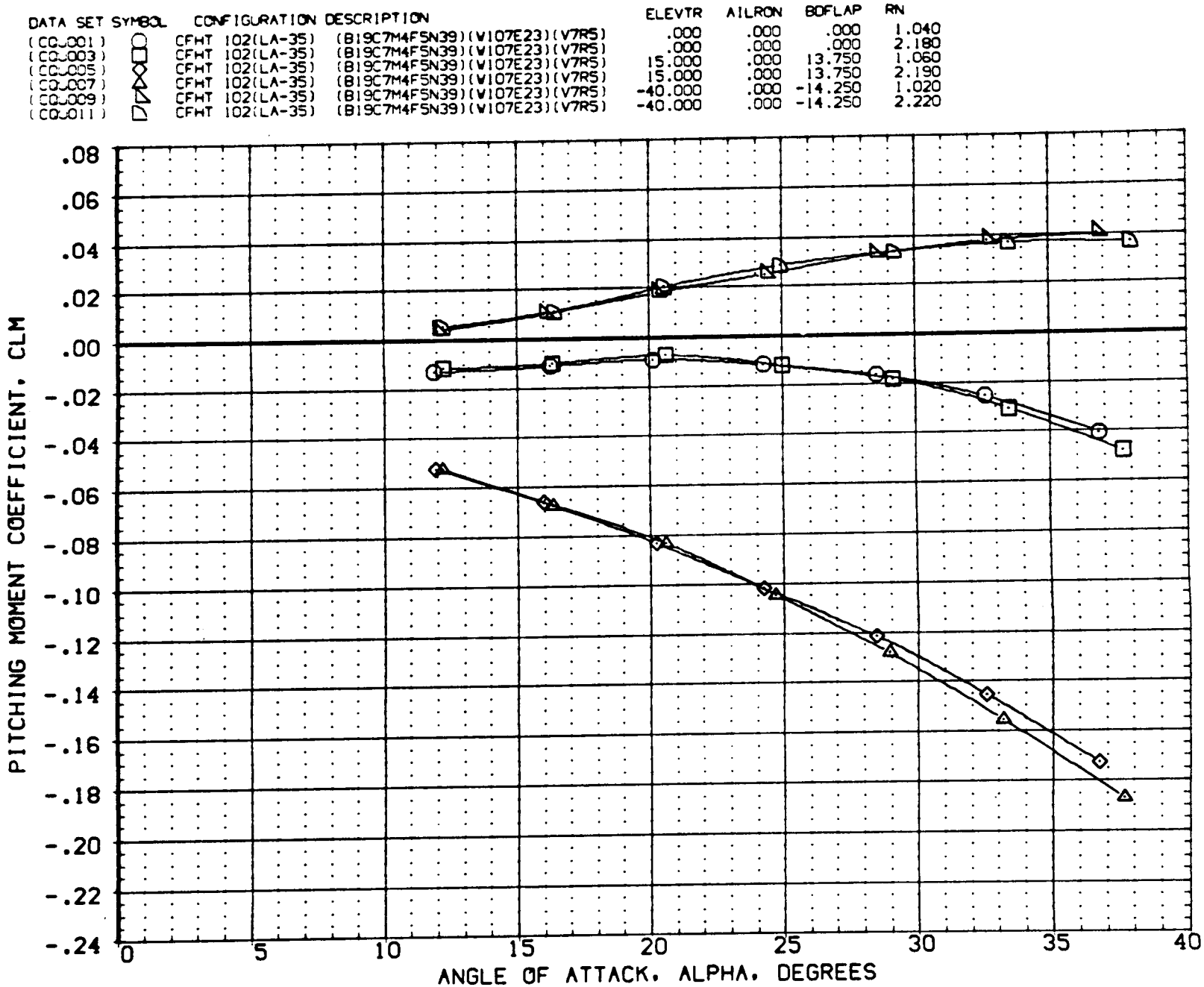
(a) Axial-force coefficient.

Figure 4.- Effect of Reynolus Number on longitudinal characteristics at $\beta = 0^{o}$. $\delta_{SB} = 55^{o}$.



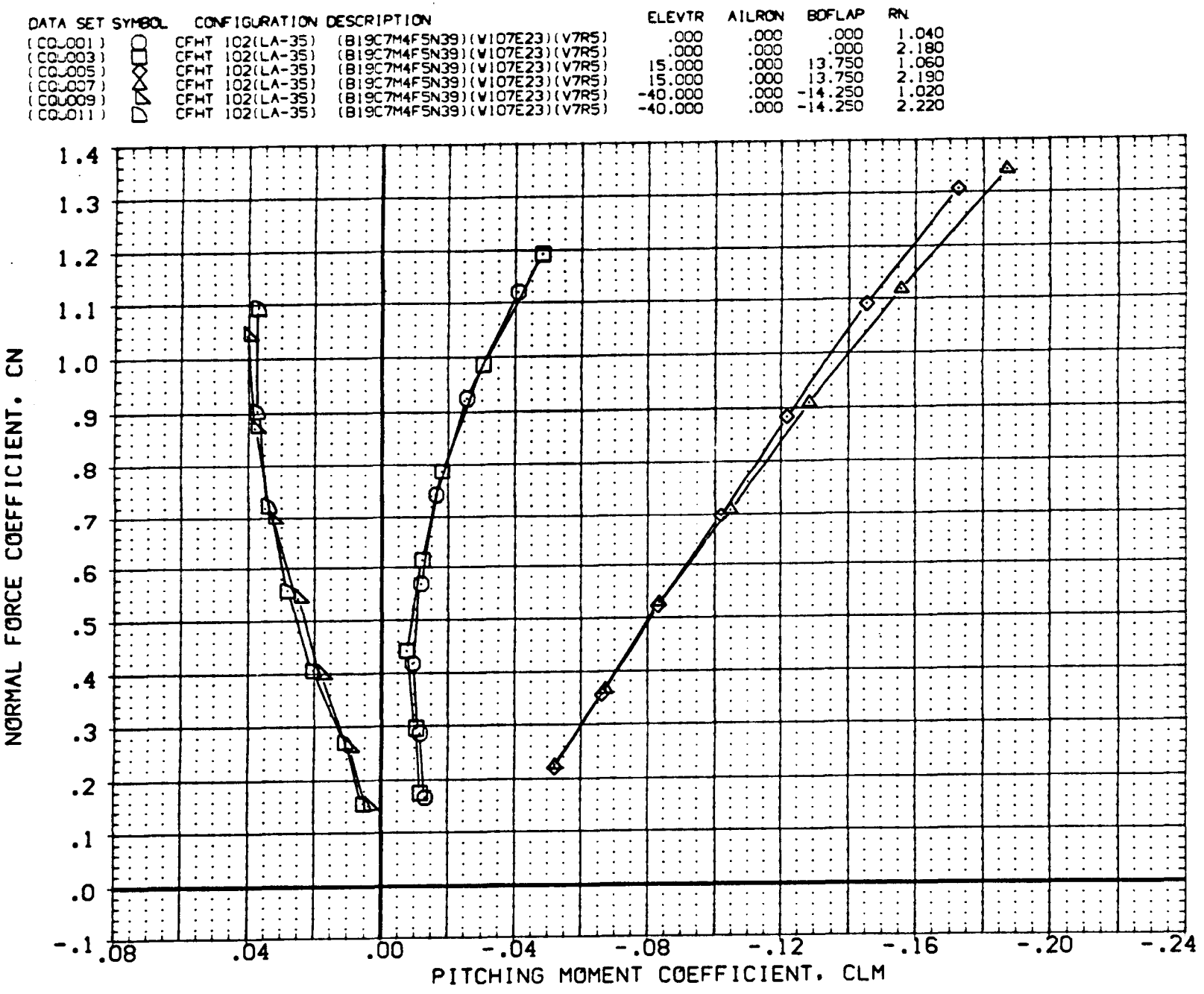
(b) Normal-force coefficient.

Figure 4.- Continued.



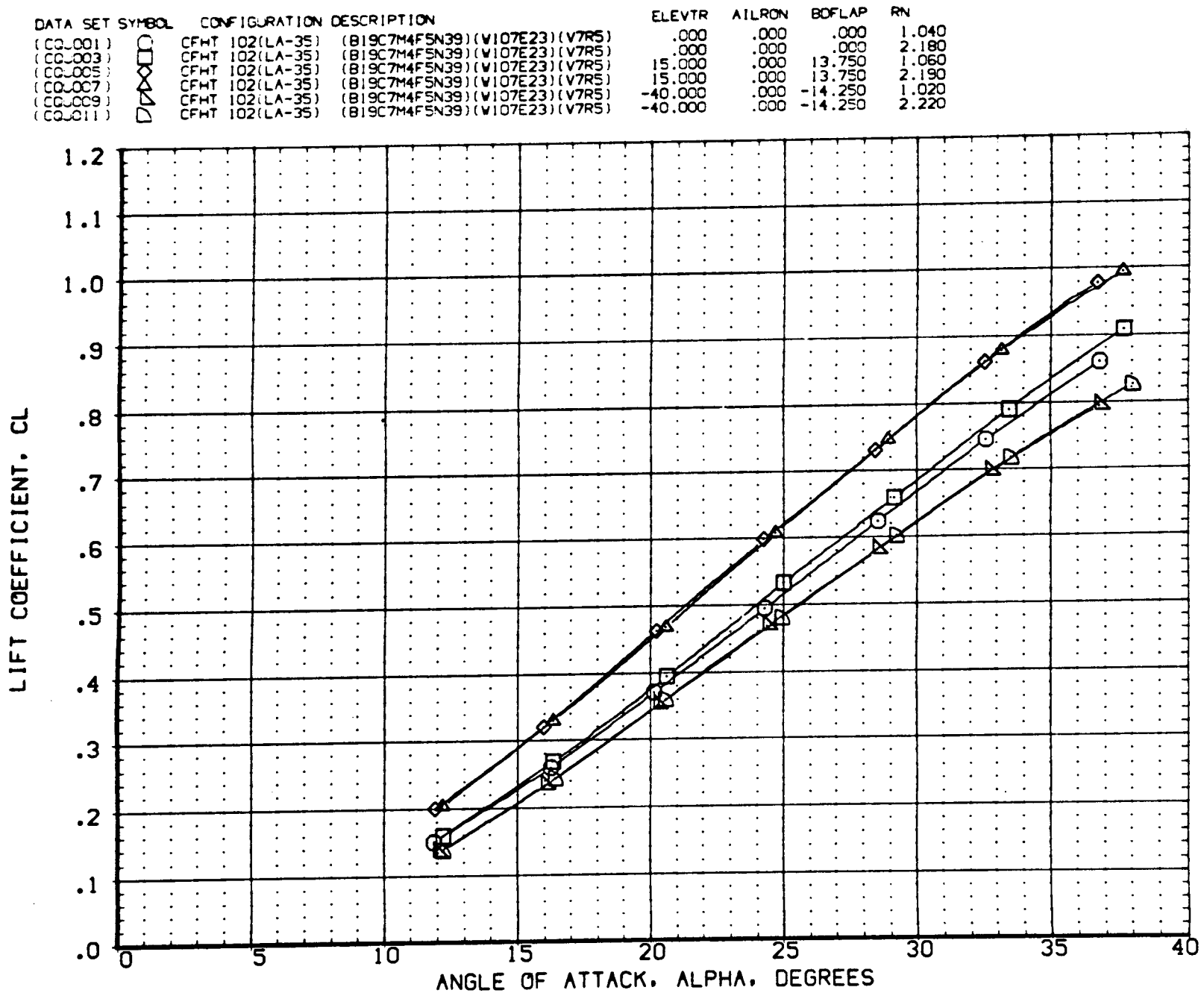
(c) Pitching-moment coefficient.

Figure 4.- Continued.



(d) Normal-force coefficient and pitching-moment coefficient.

Figure 4.- Continued.



(e) Lift coefficient.

Figure 4.- Continued.

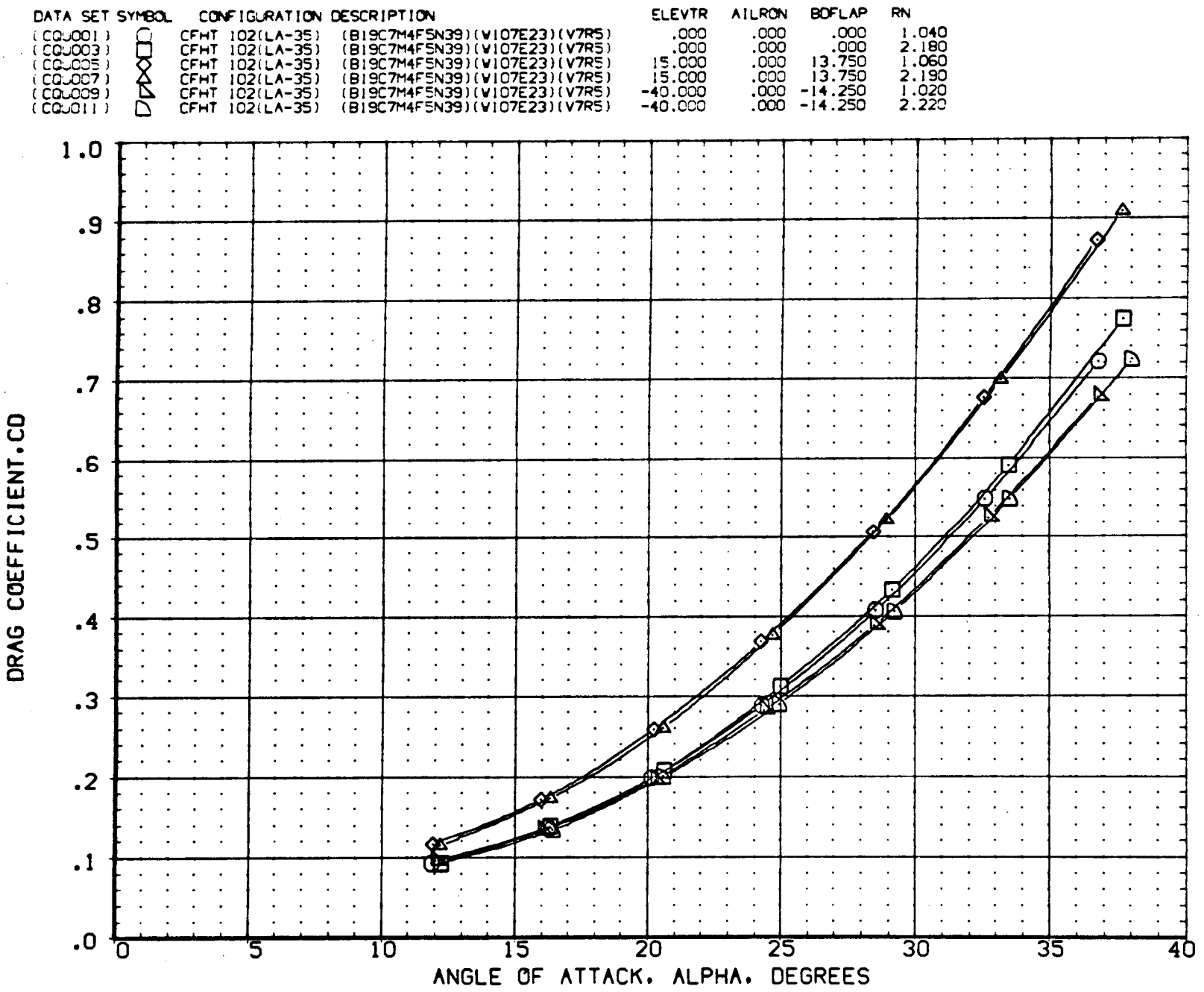
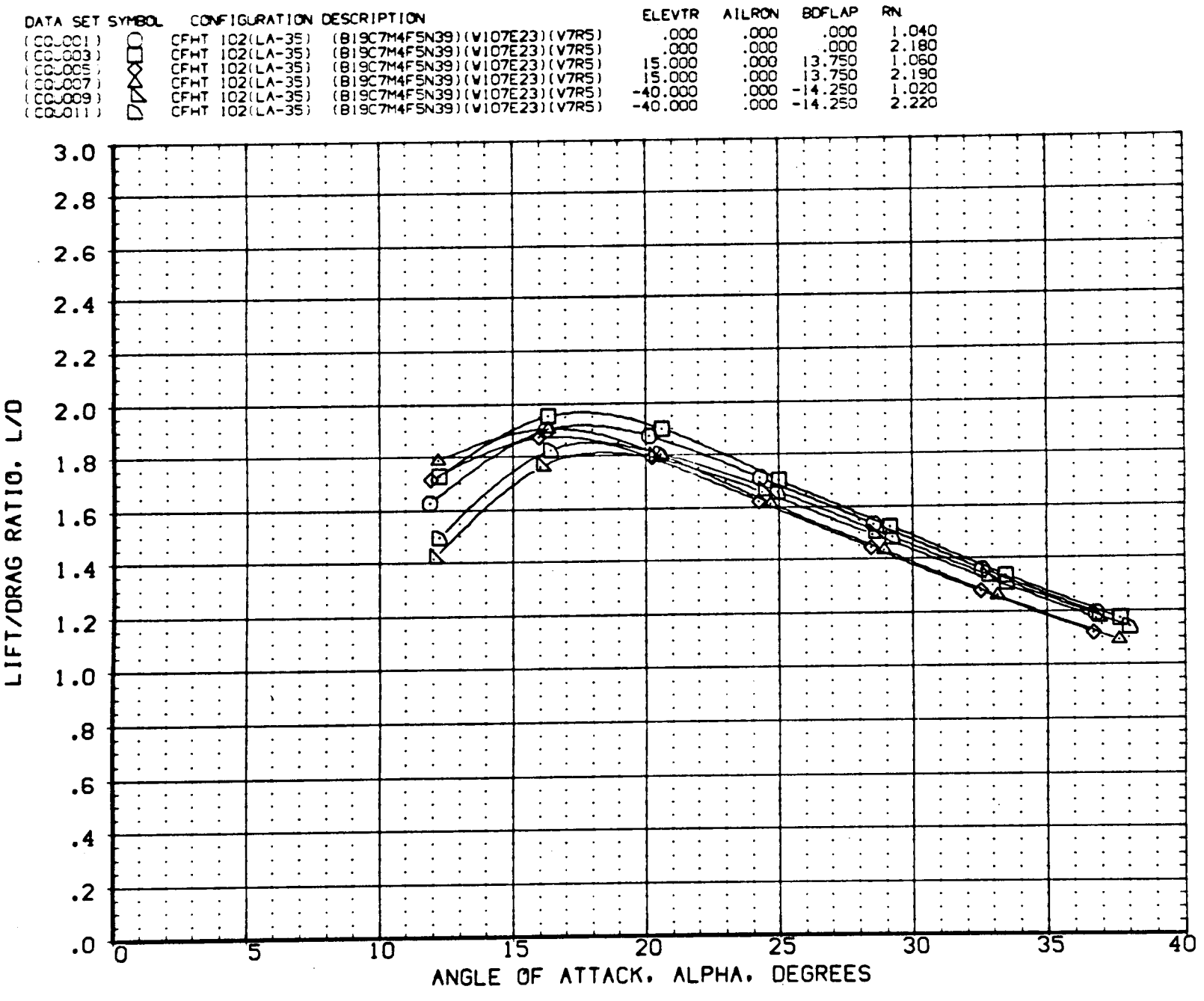


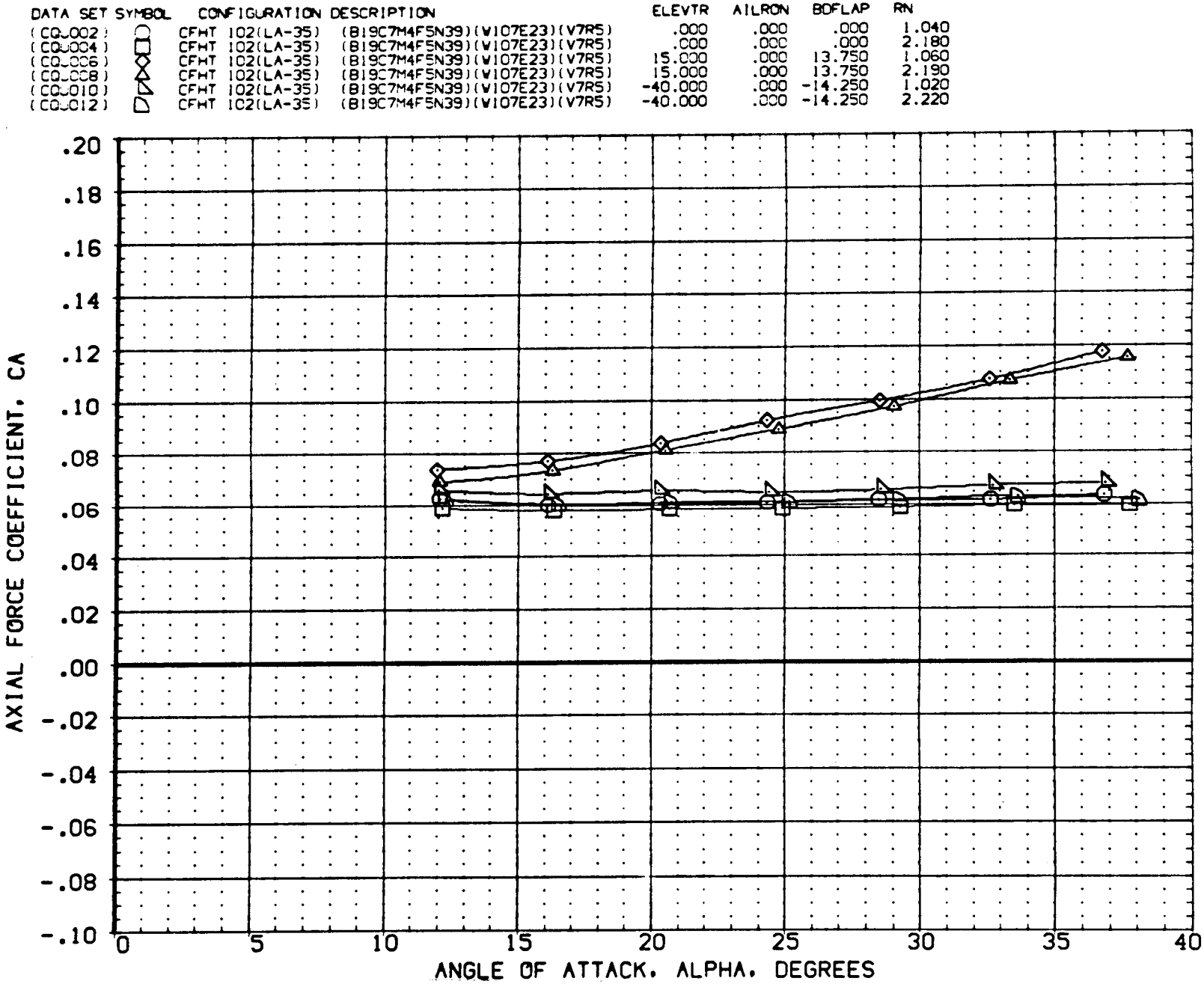
Figure 4.- Continued.

(f) Drag coefficient.



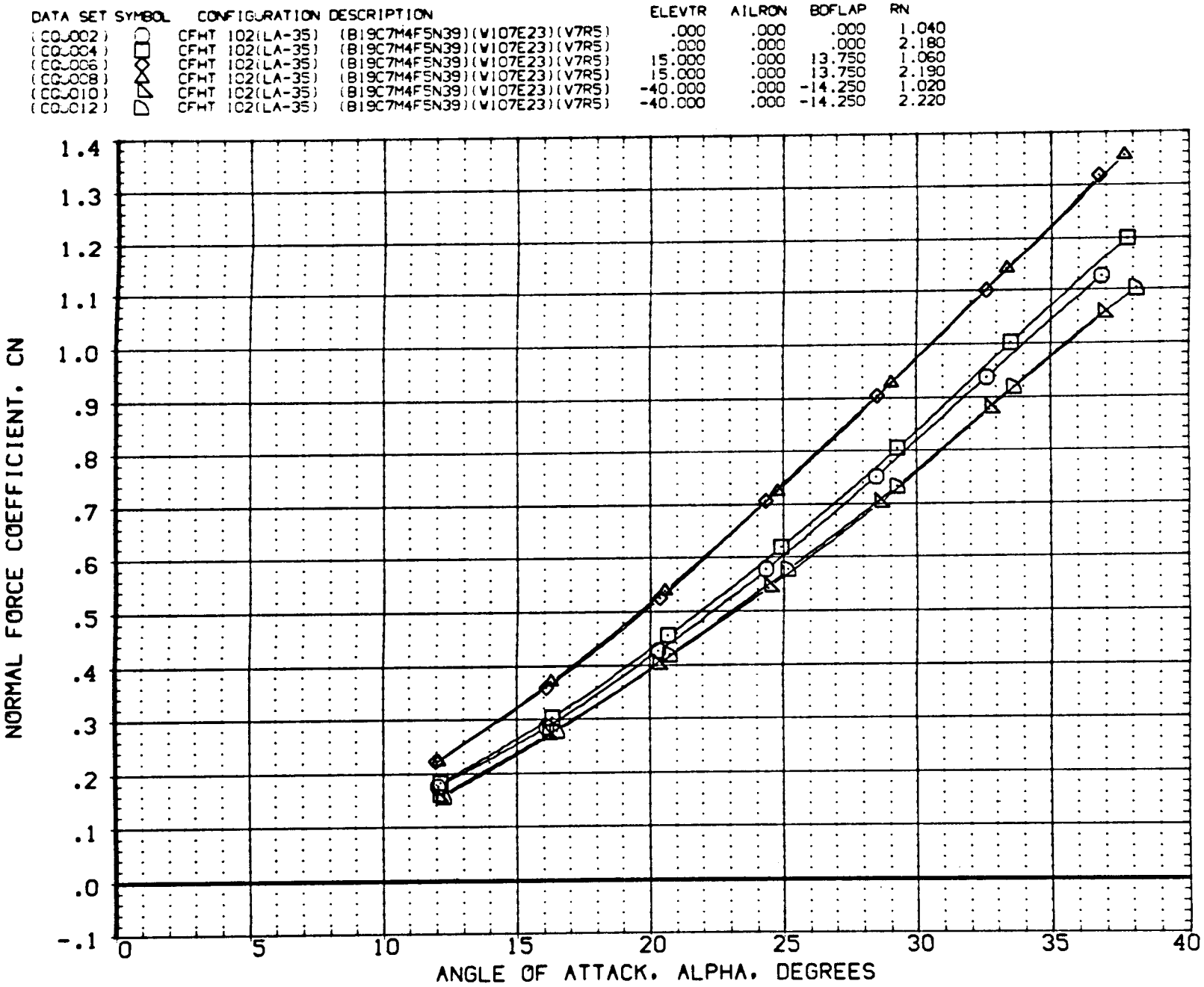
(g) Lift to drag ratio.

Figure 4.- Concluded.



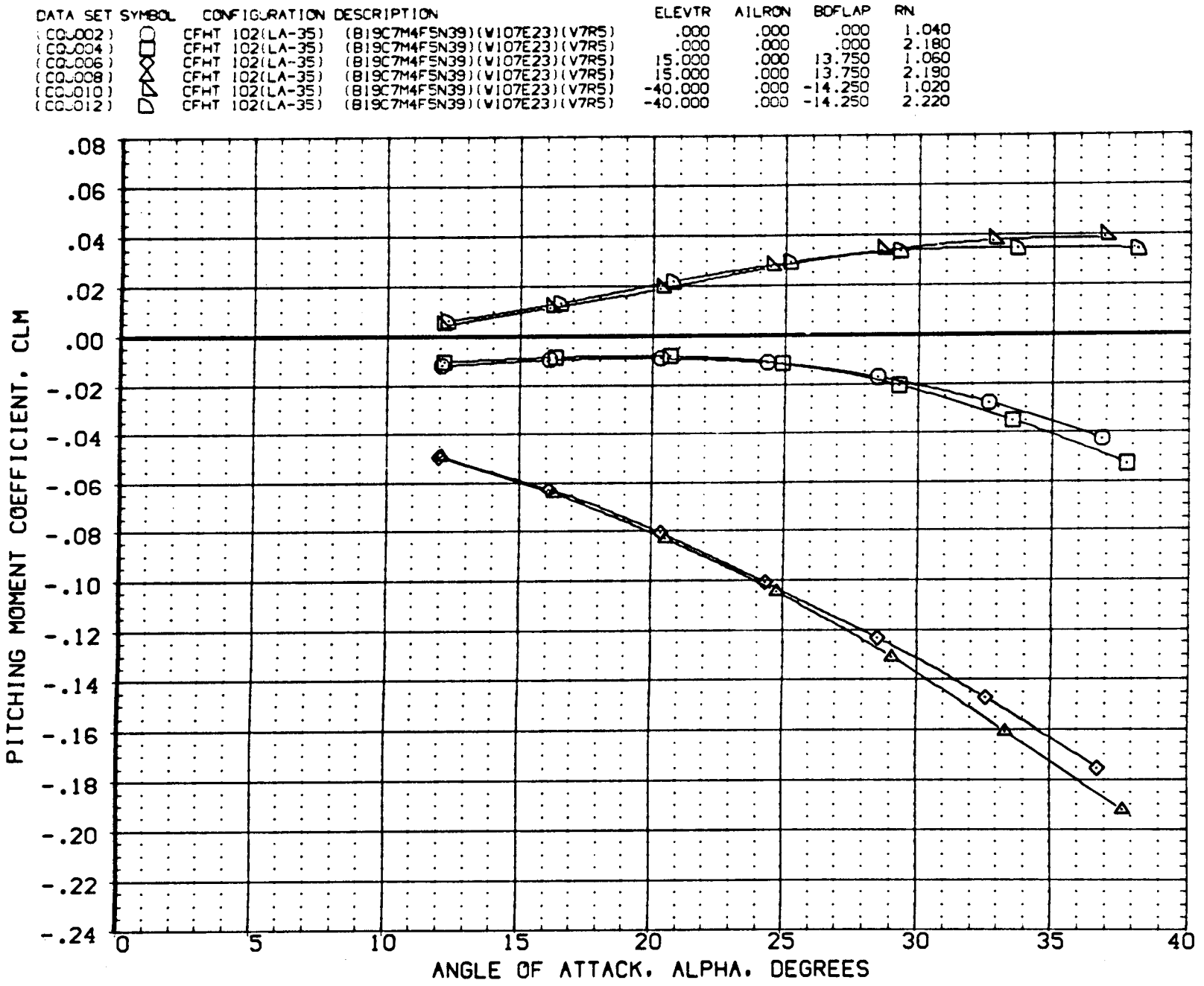
(a) Axial-force coefficient.

Figure 5.- Effect of Reynolds Number on longitudinal characteristics at $\beta = -5^{o}$. $\delta_{SB} = 55^{o}$.



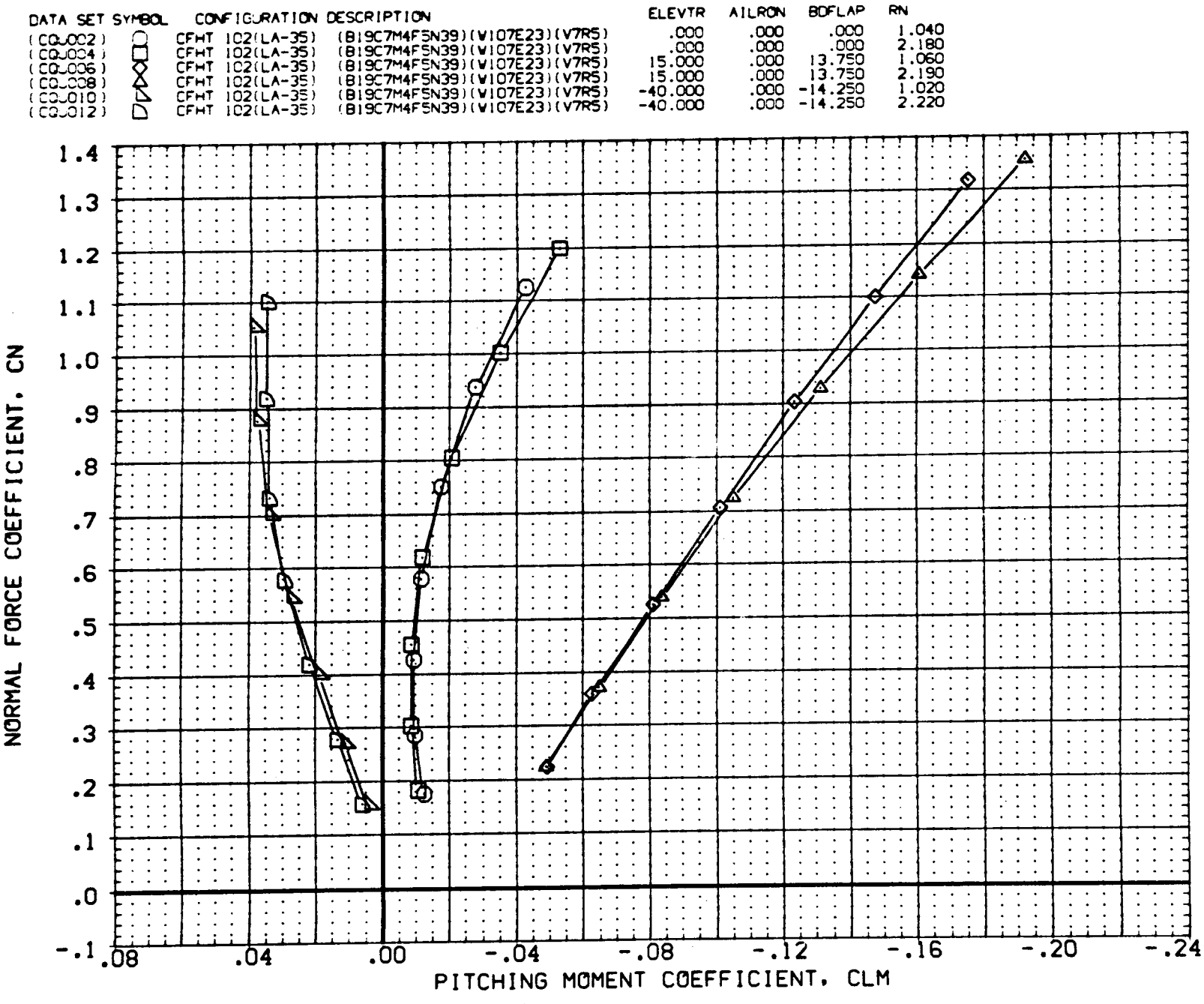
(b) Normal-force coefficient.

Figure 5.- Continued.



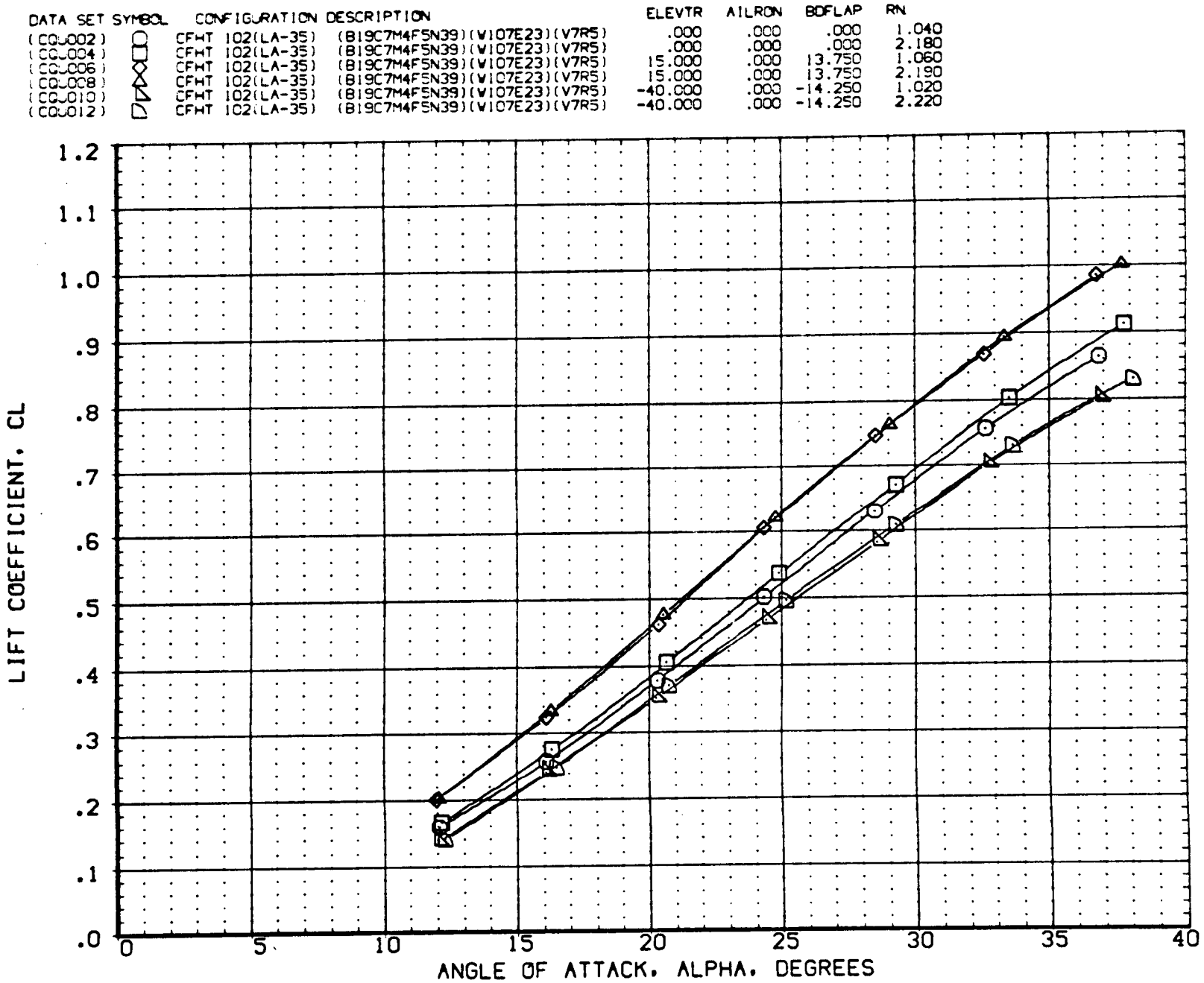
(c) Pitching-moment coefficient.

Figure 5.- Continued.



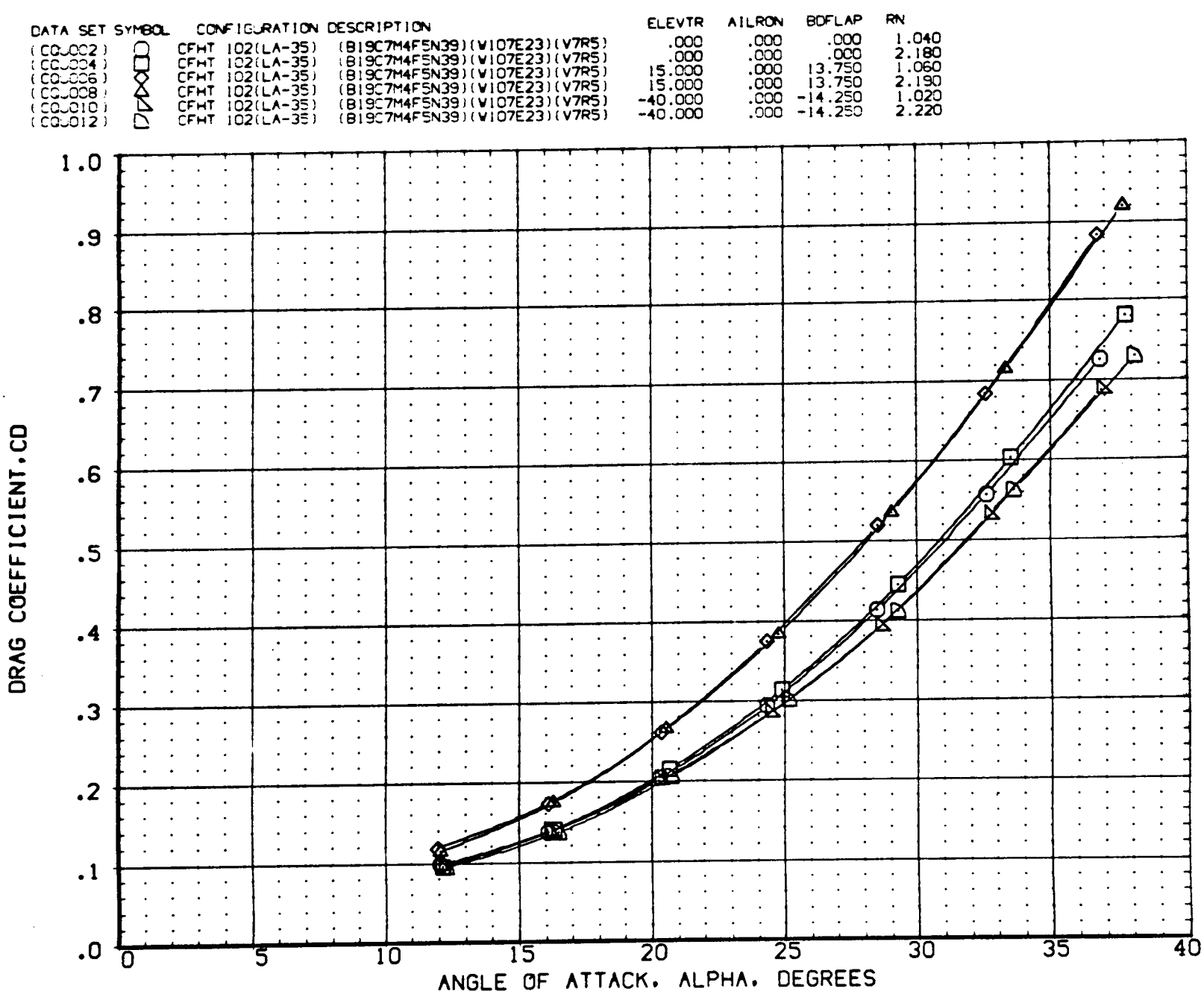
(d) Normal-force coefficient and pitching-moment coefficient.

Figure 5.- Continued.



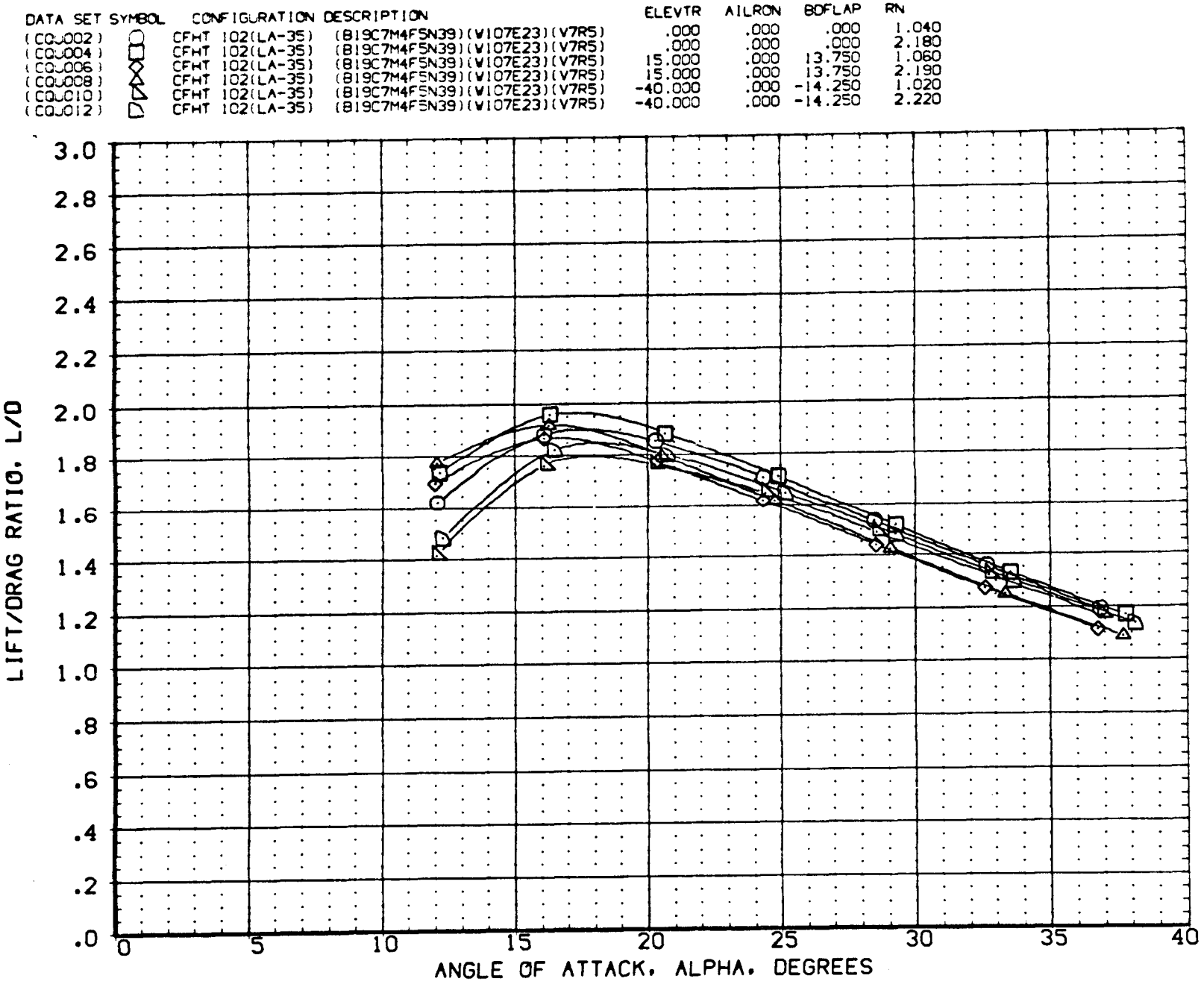
(e) Lift coefficient.

Figure 5.- Continued.



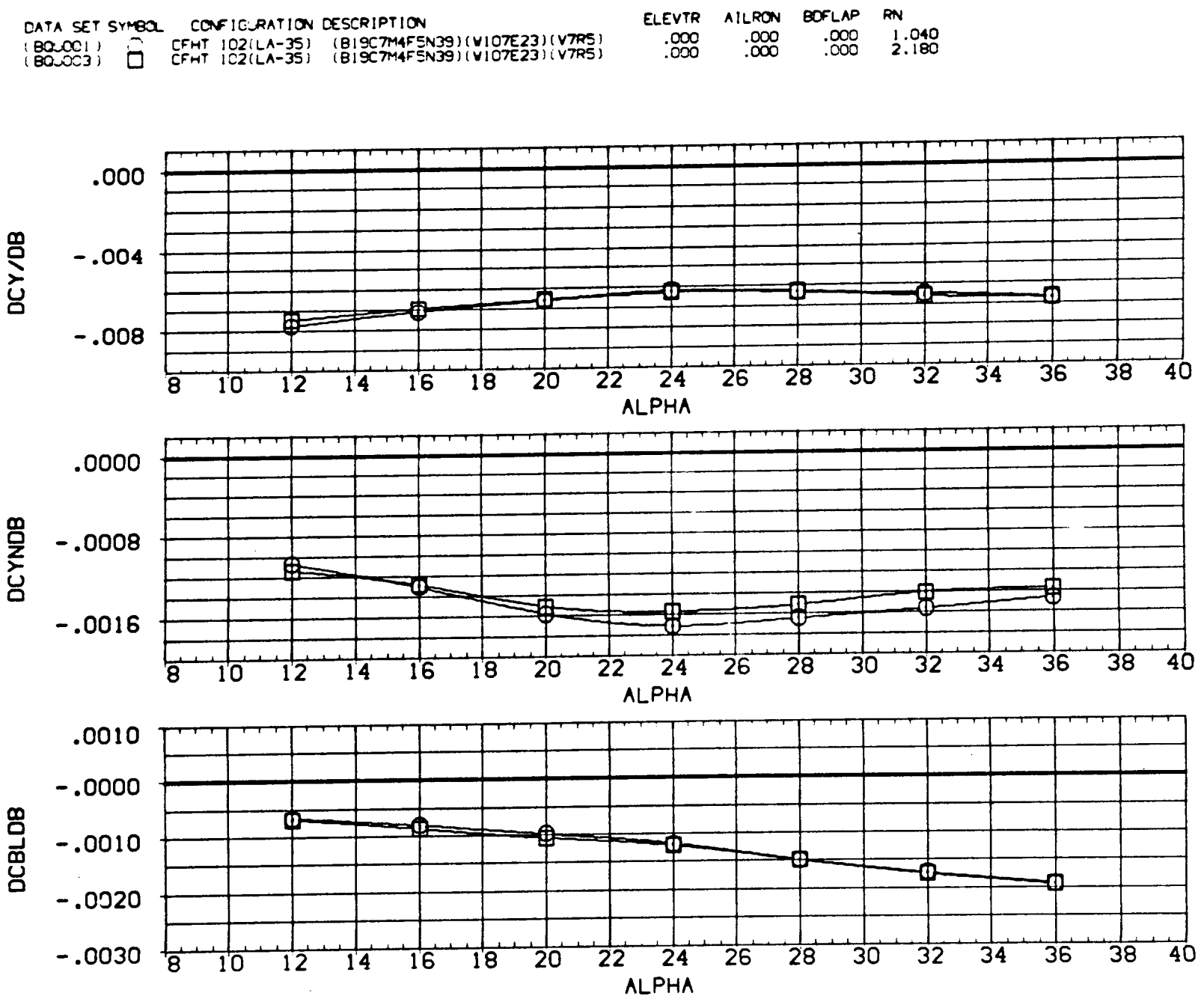
(f) Drag coefficient.

Figure 5.- Continued.



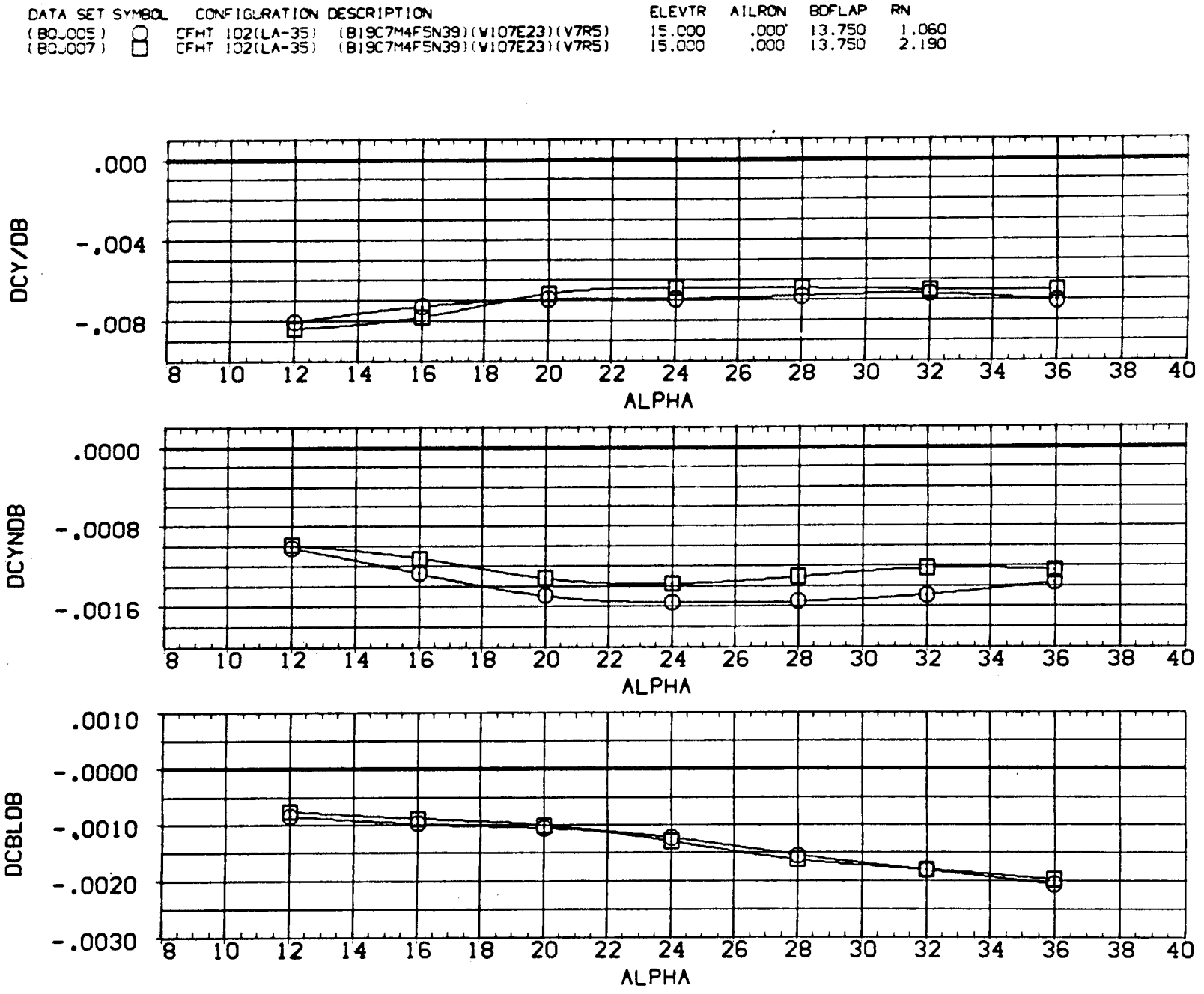
(g) Lift to drag ratio.

Figure 5.- Concluded.



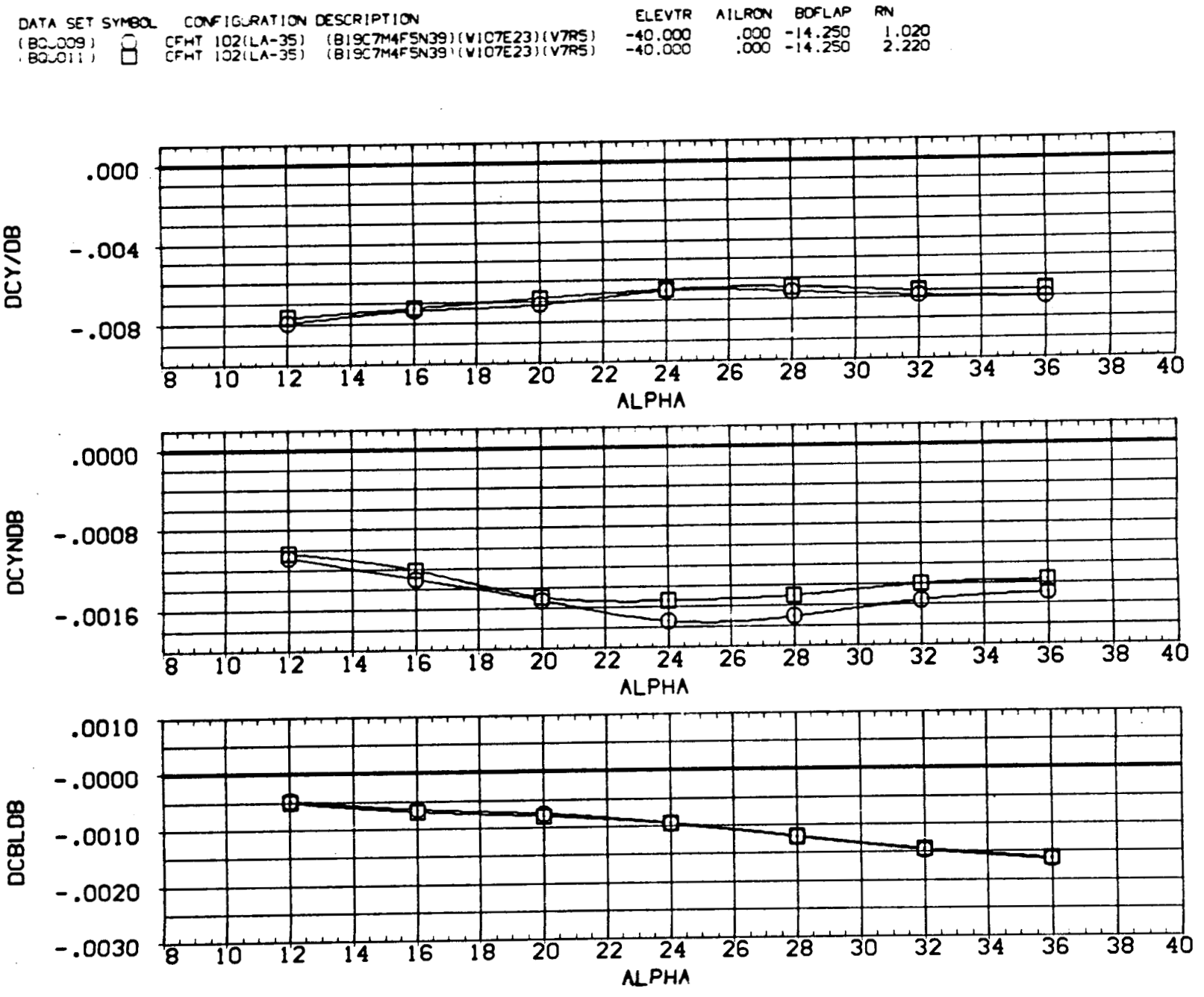
(a) $\delta_e = 0^o$, $\delta_{BF} = 0^o$

Figure 6.- Effect of Reynolds Number on lateral-directional characteristics. $\delta_{SB} = 55^o$.



(b) $\delta_e = 15^o$, $\delta_{BF} = 13.75^o$

Figure 6.- Continued.



(c) $\delta_e = -40^0$, δ_{BF} -14.25^0

Figure 6.- Concluded.

APPENDIX

TABULATED SOURCE DATA

Plotted data tabulations are
available from DMS on request.

DATE 20 MAR 74

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU001) (11 FEB 74)

Run No. 3

PARAMETRIC DATA

BETA =	.000	ELEVTR =	.000
AILRON =	.000	BDFLAP =	.000
RUDFLR =	55.000	RN =	1.040

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	11.869	-.00735	.16647	.05970	-.01307	.00009	-.00107	-.00411	.15063	.09266
10.320	16.227	.00098	.28735	.05880	-.01124	.00001	-.00118	-.00413	.25947	.13675
10.320	20.151	.00510	.41574	.05812	-.00912	-.00031	-.00130	-.00415	.37027	.19778
10.320	24.293	.00903	.56844	.05982	-.01178	-.00007	-.00131	-.00385	.49349	.28838
10.320	28.538	.01110	.74232	.05939	-.01651	-.00028	-.00137	-.00348	.62376	.40681
10.320	32.600	.01493	.92347	.06072	-.02568	-.00044	-.00146	-.00346	.74527	.54869
10.320	36.784	.01832	1.12038	.06258	-.04059	-.00052	-.00144	-.00353	.85983	.72100

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU002) (11 FEB 74)

Run No. 4

PARAMETRIC DATA

BETA =	-5.000	ELEVTR =	.000
AILRON =	.000	BDFLAP =	.000
RUDFLR =	55.000	RN. =	1.040

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	12.025	-5.01070	.17499	.06236	-.01231	.00345	.00427	.03456	.15816	.09745
10.320	16.094	-5.03963	.28473	.06007	-.00979	.00413	.00543	.03142	.25691	.13665
10.320	20.322	-5.04978	.42565	.06009	-.00940	.00475	.00676	.02870	.37828	.20417
10.320	24.349	-5.02838	.57735	.06067	-.01123	.00601	.00729	.02716	.50098	.29331
10.320	28.485	-4.97234	.75175	.06176	-.01744	.00736	.00676	.02800	.63128	.41282
10.320	32.632	-4.89266	.93736	.06180	-.02768	.00824	.00614	.02814	.75607	.55751
10.320	36.830	-4.77913	1.12587	.06351	-.04249	.00894	.00545	.02887	.86309	.72574

DATE 20 MAR 76

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU003) (11 FEB 74)

Run No. 9

PARAMETRIC DATA

BETA =	.000	ELEVTR =	.000
AILRON =	.000	BDFLAP =	.000
RUDFLR =	55.000	RN =	2.180

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.370	12.216	.03010	.17540	.05647	-.01159	-.00017	-.00116	-.00335	.15947	.09231
10.370	16.345	.03561	.29639	.05646	-.01017	-.00033	-.00113	-.00345	.26852	.13759
10.370	20.611	.04123	.44095	.05528	-.00736	-.00068	-.00120	-.00380	.39327	.20697
10.370	24.977	.04482	.61329	.05837	-.01212	-.00028	-.00130	-.00352	.53129	.31188
10.370	29.147	.04812	.78631	.05697	-.01828	-.00055	-.00124	-.00422	.65899	.43273
10.370	33.464	.05245	.98606	.05776	-.03058	-.00069	-.00132	-.00481	.79075	.59191
10.370	37.678	.05107	1.19259	.05845	-.04817	-.00092	-.00134	-.00526	.90816	.77519

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU004) (11 FEB 74)

Run No. 10

PARAMETRIC DATA

BETA =	-5.000	ELEVTR =	.000
AILRON =	.000	BDFLAP =	.000
RUDFLR =	55.000	RN =	2.180

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.370	12.137	-5.09074	.18198	.05848	-.01052	.00340	.00466	.03464	.16562	.09543
10.370	16.332	-5.12308	.30292	.05751	-.00870	.00425	.00556	.03199	.27452	.14037
10.370	20.685	-5.12600	.45385	.05799	-.00841	.00495	.00673	.02947	.40411	.21457
10.370	24.924	-5.08928	.61856	.05823	-.01165	.00620	.00671	.02831	.53642	.31347
10.370	29.290	-5.01437	.80371	.05865	-.02073	.00748	.00627	.02773	.67227	.44435
10.370	33.526	-4.90774	1.00172	.05941	-.03499	.00837	.00547	.02816	.80226	.60279
10.370	37.765	-4.77716	1.19919	.05928	-.05270	.00890	.00542	.02651	.91169	.78128

DATE 20 MAR 74

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU009) (11 FEB 74)

Run No. 11

PARAMETRIC DATA

BETA = .000 ELEVTR = -40.000
AILRON = .000 BDFLAP = -14.250
RUDFLR = 55.000 RN = 1.020

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	12.012	.01943	.15100	.06482	.00365	.00012	-.00078	-.00252	.13421	.09482
10.320	16.025	.02411	.26056	.06307	.00989	-.00001	-.00090	-.00265	.23303	.13255
10.320	20.270	.03088	.39659	.06225	.01803	-.00008	-.00105	-.00295	.35046	.19579
10.320	24.357	.03473	.54165	.06409	.02484	-.00008	-.00109	-.00322	.46701	.28178
10.320	28.502	.04030	.69454	.06460	.03267	-.00030	-.00109	-.00351	.57954	.38820
10.320	32.727	.04272	.86979	.06580	.03804	-.00047	-.00111	-.00396	.69615	.52559
10.320	36.804	.04467	1.04179	.06601	.04031	-.00050	-.00107	-.00439	.79461	.67696

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU010) (11 FEB 74)

Run No. 12

PARAMETRIC DATA

BETA = -5.000 ELEVTR = -40.000
AILRON = .000 BDFLAP = -14.250
RUDFLR = 55.000 RN = 1.020

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	12.021	-5.00949	.15418	.06616	.00405	.00255	.00461	.03727	.13702	.09682
10.320	16.090	-5.04196	.26894	.06450	.01136	.00331	.00568	.03456	.24053	.13651
10.320	20.280	-5.04873	.39886	.06561	.01885	.00381	.00676	.03302	.35139	.19979
10.320	24.430	-5.03065	.54343	.06483	.02739	.00486	.00776	.02947	.46796	.28378
10.320	28.561	-4.97615	.69832	.06557	.03375	.00596	.00736	.02979	.58199	.39146
10.320	32.710	-4.89129	.87674	.06717	.03776	.00695	.00648	.03002	.70140	.53030
10.320	36.892	-4.78180	1.05290	.06798	.03888	.00762	.00610	.02934	.80127	.68644

DATE 20 MAR 74

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7H4F5N39) (W107E23) (V7R5) (SQU011) (11 FEB 74)

Run No. 13

PARAMETRIC DATA

BETA =	.000	ELEVTR =	-40.000
AILRON =	.000	BDFLAP =	-14.250
RUDFLR =	55.000	RN =	2.220

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.370	12.204	.03032	.15393	.06085	.00505	.00001	-.00096	-.00365	.13758	.09201
10.370	16.406	.03626	.27104	.05925	.01104	-.00022	-.00103	-.00379	.24327	.13339
10.370	20.561	.04442	.40588	.06020	.02028	-.00026	-.00130	-.00390	.35888	.19891
10.370	24.929	.04587	.55740	.06014	.02836	-.00019	-.00125	-.00363	.48012	.28947
10.370	29.239	.05042	.72341	.06065	.03403	-.00043	-.00119	-.00448	.60161	.40628
10.370	33.538	.05441	.90241	.06110	.03723	-.00055	-.00121	-.00511	.71842	.54959
10.370	38.024	.05587	1.09622	.06133	.03715	-.00080	-.00139	-.00520	.82576	.72358

CFHT 102(LA-35) (B19C7H4F5N39) (W107E23) (V7R5) (SQU012) (11 FEB 74)

Run No. 14

PARAMETRIC DATA

BETA =	-5.000	ELEVTR =	-40.000
AILRON =	.000	BDFLAP =	-14.250
RUDFLR =	55.000	RN =	2.220

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.370	12.256	-5.11667	.15702	.06254	.00603	.00273	.00438	.03552	.14016	.09445
10.370	16.508	-5.15288	.27779	.06032	.01335	.00349	.00538	.03340	.24919	.13677
10.370	20.758	-5.18157	.41650	.06111	.02197	.00402	.00663	.03100	.36967	.20547
10.370	25.192	-5.12233	.57765	.06137	.02936	.00514	.00662	.02935	.49659	.30141
10.370	29.269	-5.05290	.73313	.06184	.03384	.00615	.00637	.02826	.60930	.41238
10.370	33.650	-4.94412	.91972	.06311	.03490	.00707	.00557	.02830	.73004	.56217
10.370	38.114	-4.81002	1.10352	.06159	.03448	.00749	.00547	.02620	.83023	.72957

DATE 20 MAR 74

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU005) (11 FEB 74)

Run No. 15

PARAMETRIC DATA

BETA =	.000	ELEVTR =	15.000
AILRON =	.000	BDFLAP =	13.750
RUDFLR =	55.000	RN =	1.060

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	11.925	.02609	.21993	.07269	-.05204	-.00012	-.00084	-.00237	.20016	.11656
10.320	15.992	.03134	.35544	.07644	-.06631	-.00016	-.00093	-.00275	.32062	.17141
10.320	20.205	.03726	.52268	.08264	-.08331	-.00023	-.00102	-.00328	.46197	.25808
10.320	24.261	.04248	.69597	.09045	-.10202	-.00021	-.00110	-.00299	.59734	.36843
10.320	28.433	.04502	.88330	.09770	-.12167	-.00042	-.00109	-.00337	.73023	.50648
10.320	32.567	.04920	1.09138	.10596	-.14555	-.00065	-.00108	-.00379	.86273	.67678
10.320	36.696	.05010	1.30683	.11563	-.17273	-.00081	-.00104	-.00439	.97874	.87363

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU006) (11 FEB 74)

Run No. 16

PARAMETRIC DATA

BETA =	-5.000	ELEVTR =	15.000
AILRON =	.000	BDFLAP =	13.750
RUDFLR =	55.000	RN =	1.060

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.320	11.964	-5.06902	.22072	.07389	-.04939	.00421	.00433	.03854	.20061	.11804
10.320	16.099	-5.10363	.35877	.07680	-.06275	.00492	.00560	.03437	.32340	.17327
10.320	20.366	-5.11058	.52468	.08374	-.08112	.00530	.00673	.03236	.46274	.26110
10.320	24.314	-5.08876	.70587	.09193	-.10113	.00622	.00692	.03241	.60541	.37441
10.320	28.523	-5.03222	.90394	.09950	-.12348	.00763	.00676	.03095	.74671	.51906
10.320	32.611	-4.94600	1.10076	.10730	-.14738	.00859	.00626	.02975	.86940	.68362
10.320	36.771	-4.83541	1.31875	.11792	-.17558	.00954	.00545	.03043	.98578	.88388

DATE 20 MAR 74

TABULATED SOURCE DATA LARC CFHT 102 (LA-35)

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU007) (11 FEB 74)

Run No. 17

PARAMETRIC DATA

BETA =	.000	ELEVTR =	15.000
AILRON =	.000	BDFLAP =	13.750
RUDFLR =	55.000	RN =	2.190

MACH	ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
10.370	12.169	.07556	.22332	.06849	-.05208	-.00024	-.00108	-.00639	.20387	.11403
10.370	16.327	.08194	.36522	.07351	-.06735	-.00057	-.00102	-.00682	.32983	.17322
10.370	20.553	.07993	.52964	.07916	-.08341	-.00035	-.00120	-.00256	.46814	.26006
10.370	24.691	.08073	.70917	.08834	-.10472	-.00068	-.00126	-.00228	.60743	.37651
10.370	28.930	.08180	.90678	.09559	-.12851	-.00116	-.00118	-.00253	.74738	.52230
10.370	33.170	.08999	1.11801	.10461	-.15567	-.00064	-.00128	-.00358	.87860	.69926
10.370	37.631	.08809	1.34343	.11338	-.18708	-.00107	-.00142	-.00384	.99471	.91006

CFHT 102(LA-35) (B19C7M4F5N39) (W107E23) (V7R5) (SQU008) (11 FEB 74)

Run No. 18

PARAMETRIC DATA

BETA =	-5.000	ELEVTR =	15.000
AILRON =	.000	BDFLAP =	13.750
RUDFLR =	55.000	RN =	2.190

MACH = 10.370

ALPHA	BETA	CN	CA	CLM	CBL	CYN	CY	CL	CD
12.059	-5.08326	.22158	.06915	-.04878	.00372	.00401	.03685	.20225	.11391
16.289	-5.11401	.36868	.07330	-.06463	.00409	.00486	.03325	.33332	.17377
20.527	-5.11525	.53806	.08107	-.08350	.00504	.00574	.03144	.47547	.26460
24.767	-5.08302	.72457	.08869	-.10496	.00636	.00578	.03066	.62077	.38407
29.061	-5.00968	.92695	.09711	-.13110	.00746	.00534	.03011	.76308	.53514
33.329	-4.90057	1.14017	.10684	-.16069	.00862	.00476	.02884	.89394	.71574
37.700	-4.76957	1.35609	.11533	-.19238	.00905	.00477	.02768	1.00245	.92054