WT 20-576

TEST OF THE SPACE-GENERAL NIKE-IROQUOIS MODEL IN THE JPL 20-INCH SUPERSONIC WIND TUNNEL

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TABLES

FIGURES

PLOTS

Plot No.	Run No.	Configuration		ϕ (deg)	Mach No.	q (psia)
1	120	B_1	F_2	0	3.0	4.0
↓	133	↓	F_3	↓	↓	↓
↓	143	↓	F_4	↓	↓	↓
↓	150	↓	F_5	↓	↓	↓
↓	103	↓	F_6	↓	↓	↓
2	144	↓	F_4	15.0	↓	↓
↓	151	↓	F_5	↓	↓	↓
↓	104	↓	F_6	↓	↓	↓
3	145	↓	F_4	22.5	↓	↓
↓	152	↓	F_5	↓	↓	↓
↓	105	↓	F_6	↓	↓	↓
4	146	↓	F_4	30.0	↓	↓
↓	153	↓	F_5	↓	↓	↓
↓	106	↓	F_6	↓	↓	↓
5	147	↓	F_4	37.5	↓	↓
↓	154	↓	F_5	↓	↓	↓
↓	107	↓	F_6	↓	↓	↓
6	148	↓	F_4	45.0	↓	↓
↓	155	↓	F_5	↓	↓	↓
↓	108	↓	F_6	↓	↓	↓
7	149	↓	F_4	60.0	↓	↓
↓	156	↓	F_5	↓	↓	↓
↓	109	↓	F_6	↓	↓	↓

I. INTRODUCTION

Wind-tunnel Test 20-576 was a test of the Space-General Corporation (El Monte) Nike-Iroquois model. The purpose of the test was to obtain aerodynamic characteristics and basic data in support of a theoretical investigation of the effects of interactions, between a body-shed vortex system and stabilizing surfaces, in producing induced vehicle rolling moments at higher Mach numbers. The approximate aerodynamic parameters for the test were Mach No. 1.4 to 3.0 and Reynolds No./in. from 0.27×10^6 to 0.11×10^6. The test variables and ranges were angle of attack from -4 to +16 deg and angle of roll from 0 to +60 deg.

The model configuration comprised a 29.4-in.-long centerbody with a 20-deg included-angle conical nose and six different afterbodies differing in the planform geometry of the attached stabilizing fins and, in one case, having a slight flare at the rear of the afterbody. Forces and moments were obtained for the complete configuration.

The test* was conducted at the Jet Propulsion Laboratory (JPL) from November 11 through November 15, 1963, with the Space-General Corporation represented by Mr. J.P. Taylor.

II. MODEL DESCRIPTION

The model is shown in Fig. 1. A more detailed description of the model and components is contained in Ref. 1.

III. WIND TUNNEL AND INSTRUMENTATION

Reference 2 describes the construction and operating conditions of the 20-in. supersonic wind tunnel. The wind tunnel has a nominal test-section size of 20 in. square, a Mach range from 1.3 to 5.0, a flexible-plate nozzle, and operates with continuous flow. Table 1 presents representative values of the test-section flow parameters for the Mach numbers at which this test was conducted.

*Symbols used in this Report are defined in the Nomenclature Section.

A six-component, internal, strain-gage balance was used to measure force-and-moment data.

IV. TEST PROCEDURE

Prior to actual test operations, measurements were made to determine the position of the model, the deflection constants, and the balance tares. During the test, data points were obtained at successive values of angle of attack. These data points were plotted vs load, and any data which appeared questionable were checked before the conclusion of the run. At least one data point was checked even if all data appeared correct.

V. DATA REDUCTION

The force-and-moment data were reduced to dimensionless coefficients in coordinates specified by the Space-General Corporation. The coefficients were obtained as follows:

$$\text{force coefficient} = \frac{\text{force}}{q\,A}$$

$$\text{moment coefficient} = \frac{\text{moment}}{q\,Ad}$$

where

q = free-stream dynamic pressure (psi)

A = reference area = 1.327 (in.^2)

d = reference length = 1.300 (in.)

and the point about which the moments were measured was 14.393 in. from the model base, on the model centerline.

The chord-force coefficient was corrected to eliminate the base-drag increment due to the differential between base pressure and free-stream static pressure. The coefficients were obtained on a digital computer by a standardized series of formulas as indicated in Ref. 3. The repeatability of the coefficient data is indicated in Table 2.

The coefficients are defined in the Nomenclature, and the coefficient sign conventions are shown in Fig. 2.

VI. RESULTS

The results of this test have been reduced to dimensionless coefficients and are presented in Plot Series 1 a-f through 7 a-f.* No attempt was made in this Report to interpret the results. The aerodynamic measurements obtained at Mach 1.4 and 2.4 are not presented in this Report. Shock-wave reflections from the walls were intersecting the model at these low Mach numbers. These data were no longer representative of free-flight conditions.

*Also numbered from 1 through 42 in the lower left-hand corner of the ozalid plot pages.

NOMENCLATURE

Model

A_1	afterbody section; straight cylindrical section, 1.300 in. diam. and 6.559 in. long
B_1	vehicle-body designation; composed of N_1 (nose), S_1 (spacer), C_1 (centerbody), and A_1 (afterbody)
C_1	centerbody section; a straight cylindrical section, 1.300 in. diam. and 13.734 in. long; mounting pad for Space-General Corporation 0.75-in. task Mark III; water-cooled balance system is an integral part of C_1 centerbody.
F_1	fin designation; a 9.32%-thick, blunted wedge section, aspect ratio (on exposed area and exposed span of two panels) of 2.644; span of 3.136 in., root chord of 3.250 in., taper ratio of 0.460, leading edge sweep of 48.7 deg, leading edge diam. to base thickness of 16.5%
F_2	fin designation; similar to F_1 fin, except leading-edge sweep angle is 38.0 deg.
F_3	fin designation; similar to F_1 fin, except root chord is 3.900 in., tip chord is 1.794 in., aspect ratio is 2.205.
F_4	fin designation; similar to F_1 fin, except span is increased to 3.786 in., aspect ratio is 3.192.
F_5	fin designation; similar to F_1 fin, except span is reduced to 2.486 in.; aspect ratio is 2.099.
F_6	fin designation; similar to F_1 fin, except used with A_2 (flared) afterbody
N_1	nose section; a 10-deg semivertex angle cone, blunted to a hemispherical tip, followed by a straight cylindrical section; diam. of hemispherical tip = 0.084 in.; over-all length 6.304 in.; base diam. = 1.300 in.
S_1	body-spacer section; a straight cylindrical section, 1.300 in. in diam. and 2.600 in. long

NOMENCLATURE (Cont'd)

Data

CA	axial-force coefficient
CL	rolling-moment coefficient
CMCG	pitching-moment coefficient
CN	normal-force coefficient
CNCG	yawing-moment coefficient
CY	side-force coefficient
M_0	free-stream Mach number
q	free-stream dynamic pressure (psi)
ALPHA	angle of attack (deg)
ϕ	angle of roll (deg)

REFERENCES

1. Space-General Corporation. Pre-Test Report for the Jet Propulsion Laboratory 21-Inch Hypersonic Wind Tunnel, J. P. Taylor. El Monte, California, Space-General Corporation, Sept. 27, 1963. UNCLASSIFIED

2. Jet Propulsion Laboratory, California Institute of Technology. Wind-Tunnel Facilities at the Jet Propulsion Laboratory, Wind-Tunnel Staff. Pasadena, California, JPL, April 18, 1961. (Technical Release No. 34-257) UNCLASSIFIED

3. Jet Propulsion Laboratory, California Institute of Technology. Equations for Wind-Tunnel-Force Data Reduction. Pasadena, California, JPL, April 19, 1957. (Internal Memorandum SWT G-T3) UNCLASSIFIED

Table 1. Average aerodynamic parameters

Parameter	Mach No.
	3.0
Static pressure (psia)	0.63
Stagnation pressure (psia)	23.50
Dynamic pressure (psia)	4.00
Reynolds number (per in. x 10^{-6})	0.27

Table 2. Coefficient repeatability

Mach No.	Coefficient*					
	CN	CMCG	CY	CNCG	CA	CL
3.0	0.014	0.045	0.067	0.068	0.023	0.005

*Based upon the following reference area and length: A = 1.327 and d = 1.300.

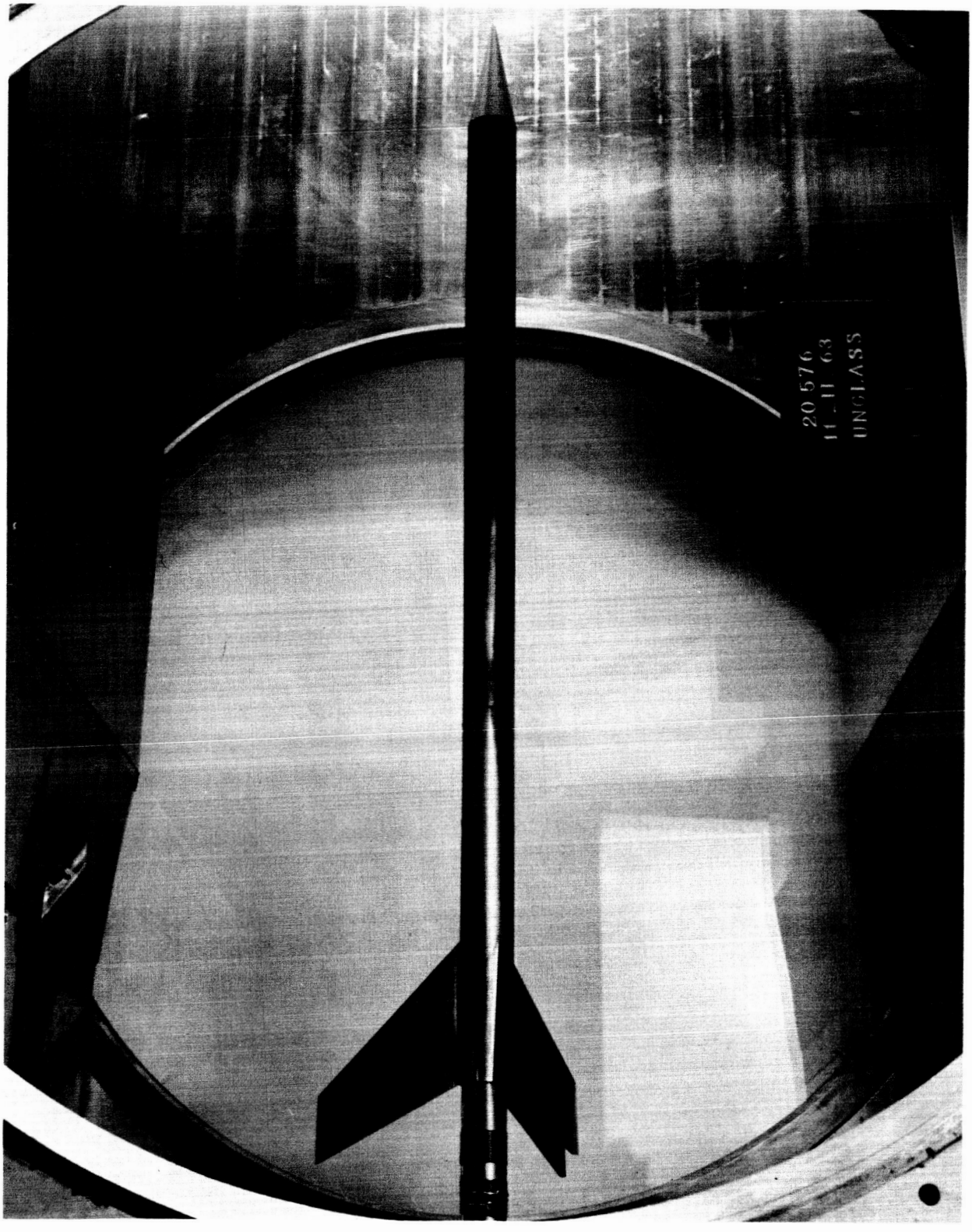
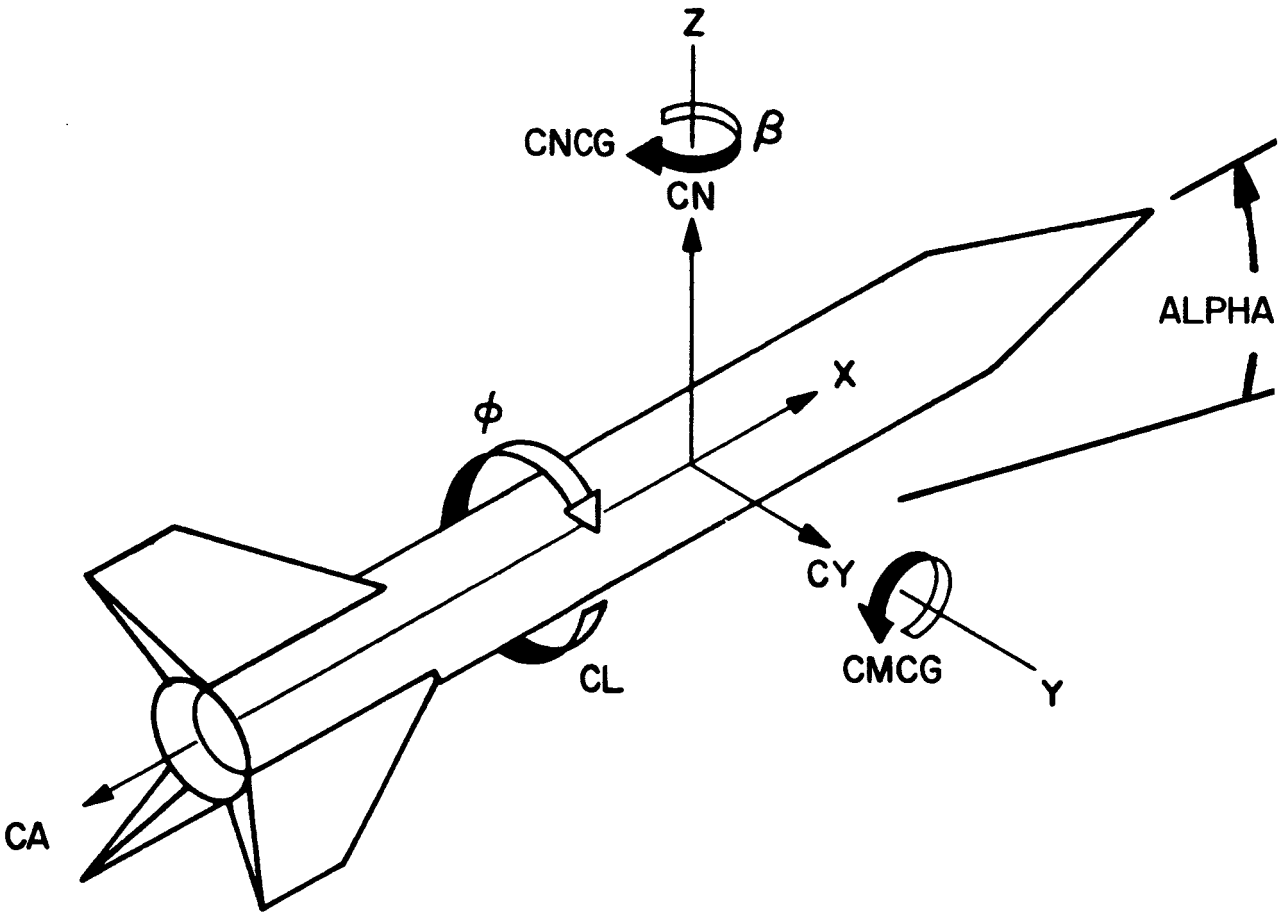
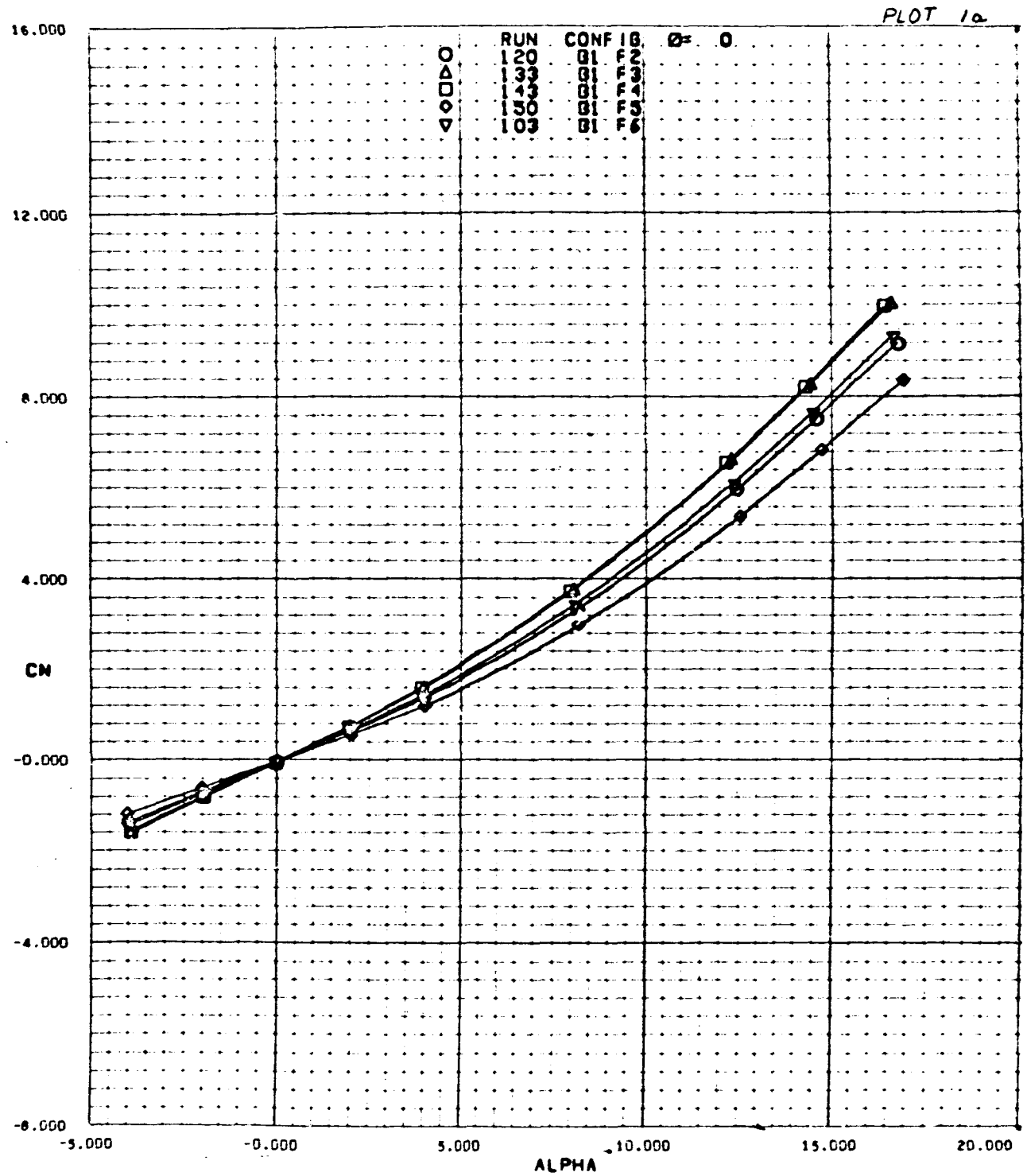


Fig. 1 Installation of Model in the 20-in SWT



NOTE:
ARROWS INDICATE POSITIVE DIRECTIONS OF ATTITUDE ANGLES, FORCES, AND MOMENTS

Fig. 2 Sign Conventions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143 B1 F4
150 B1 F5
103 B1 F6
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8.000
4.000
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CN
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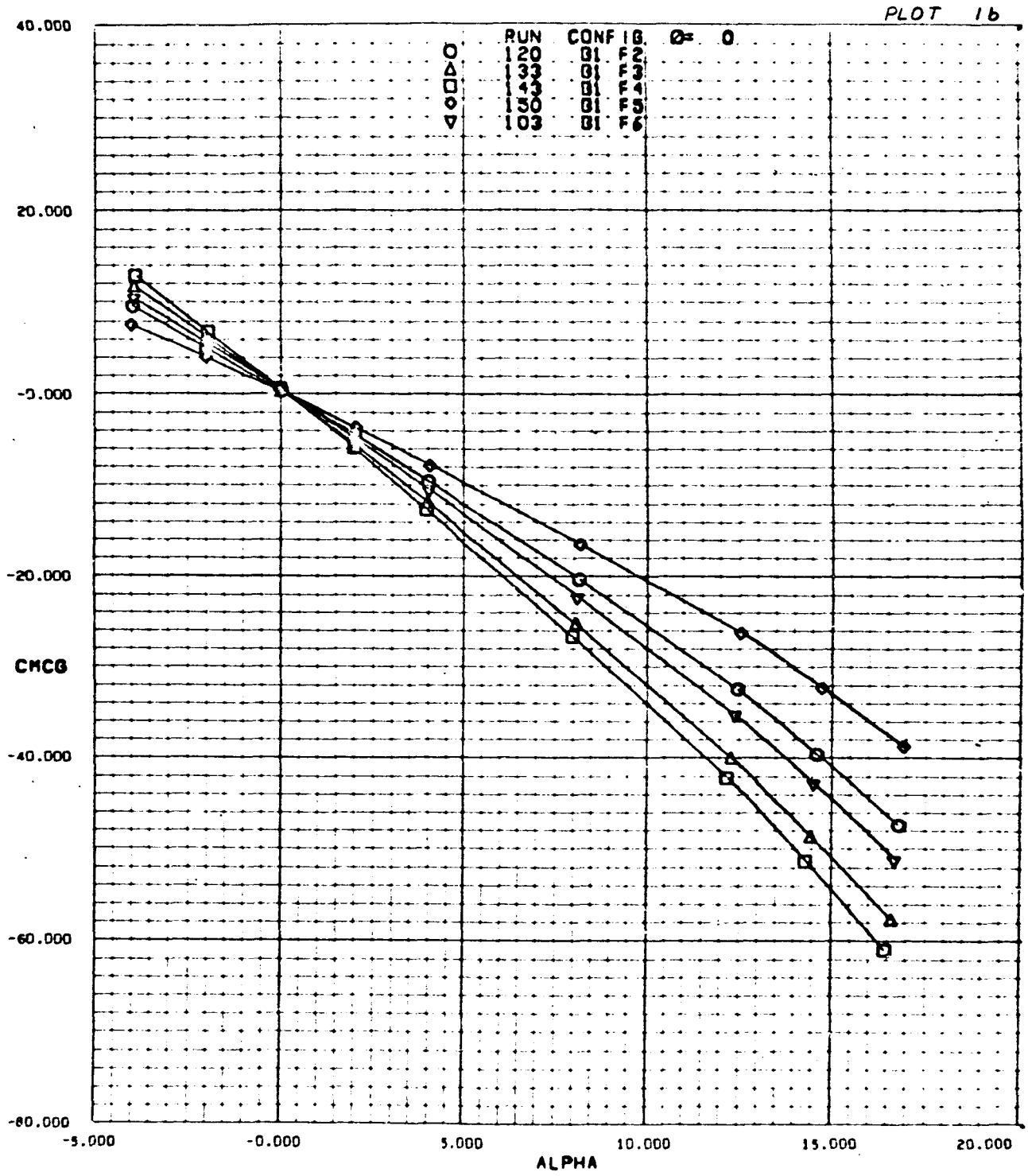
5.000
10.000
15.000
20.000
ALPHA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103 B1 F6
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-0.000
-20.000
CMCG
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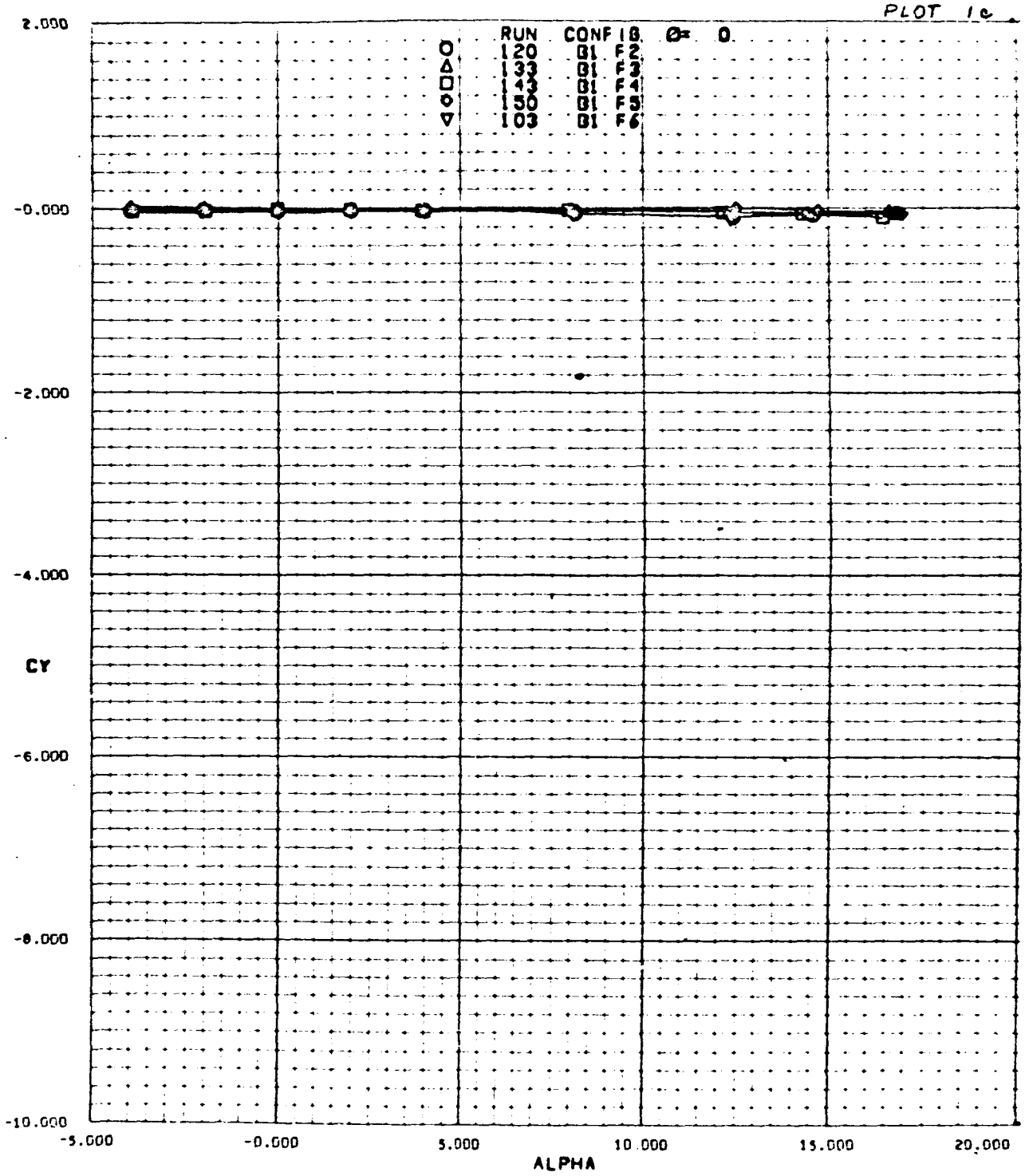
5.000
10.000
15.000
20.000
ALPHA

2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-4.000
CY
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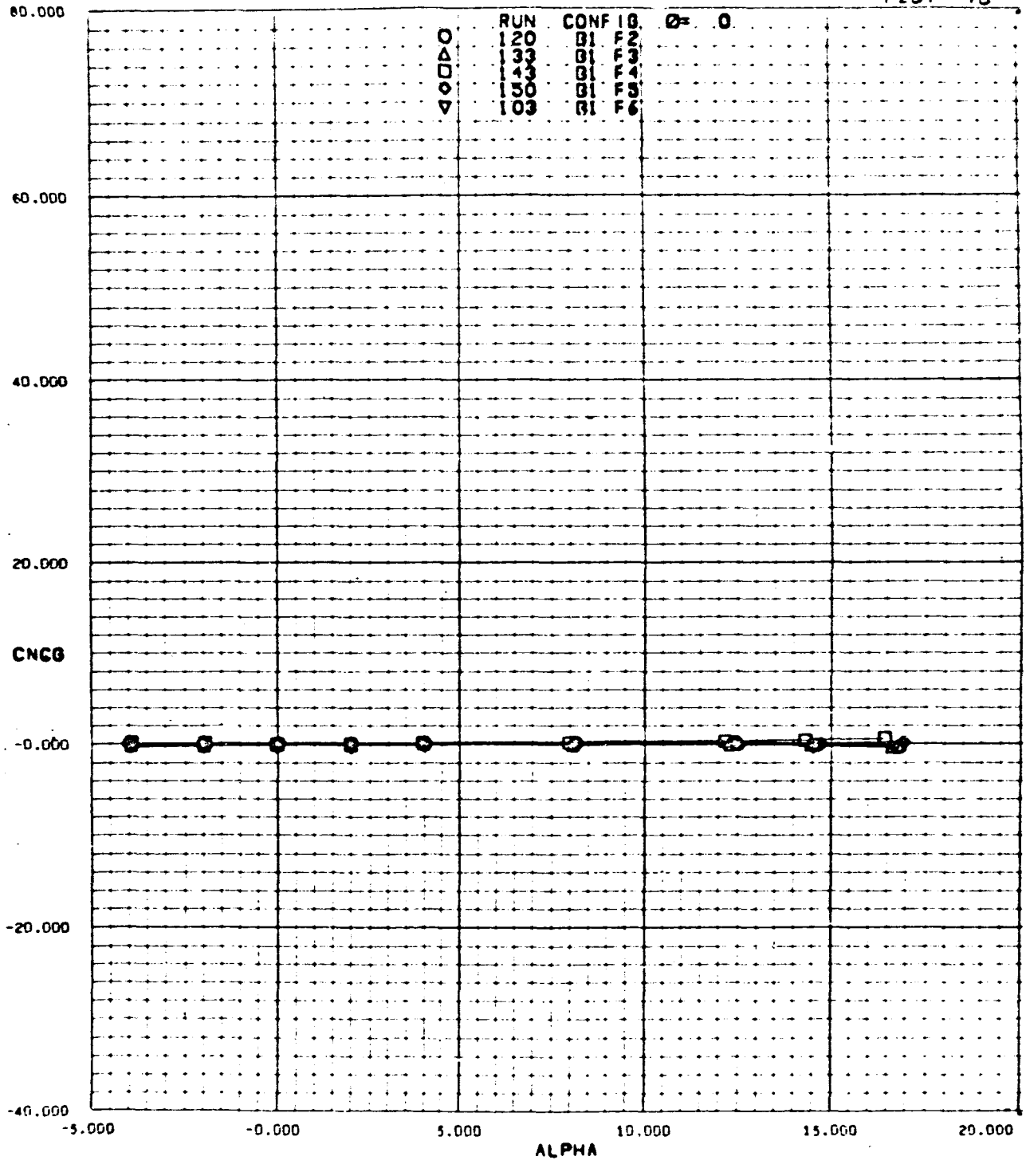
15.000
20.000
ALPHA

3

PLOT 1d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Δ 133 B1 F3
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◇ 150 B1 F5
▽ 103 B1 F6
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20.000
CNCB
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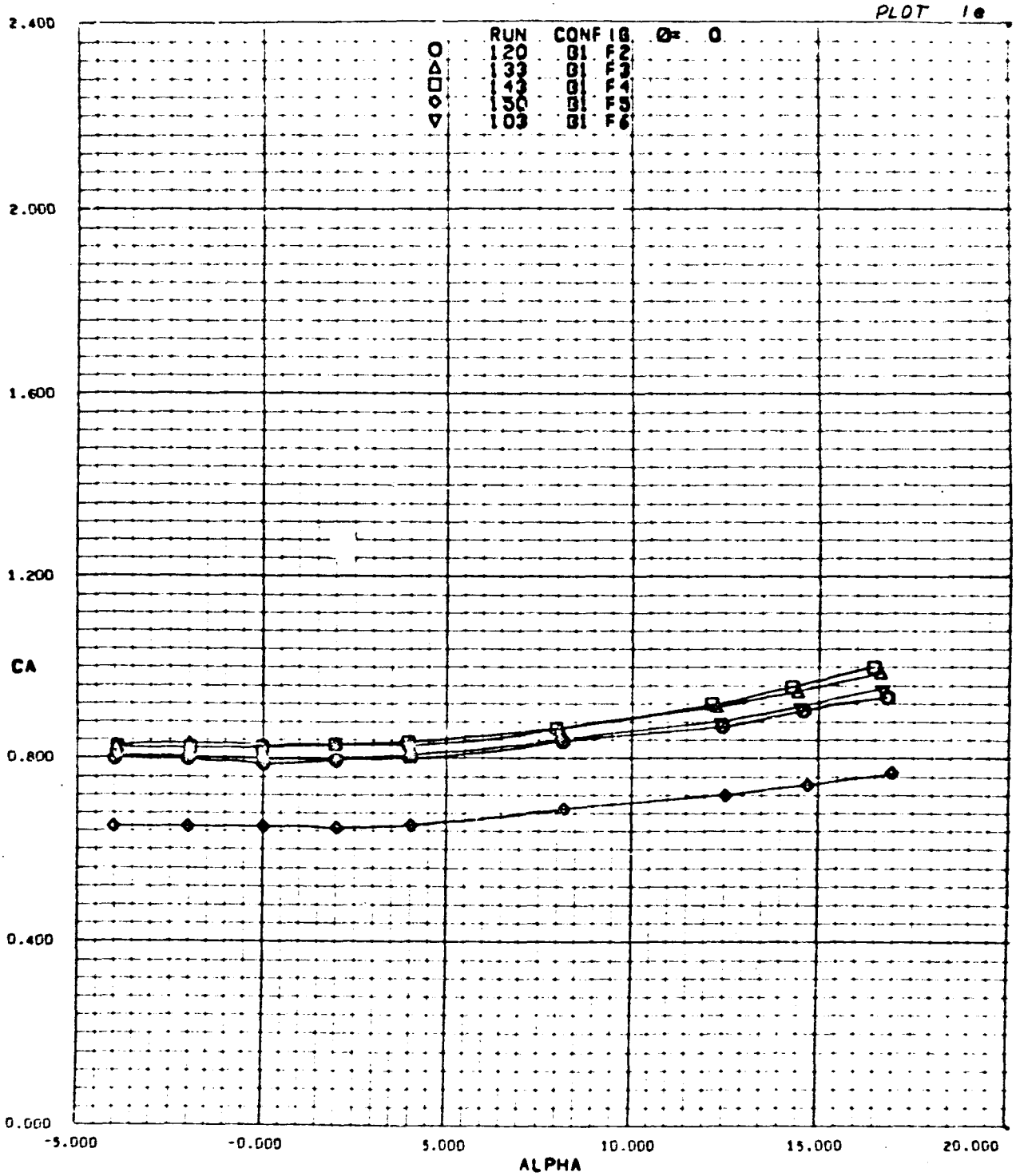
20.000
ALPHA

PLOT 1e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▽ 103 G1 F6
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2.000
1.600
1.200
CA
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15.000
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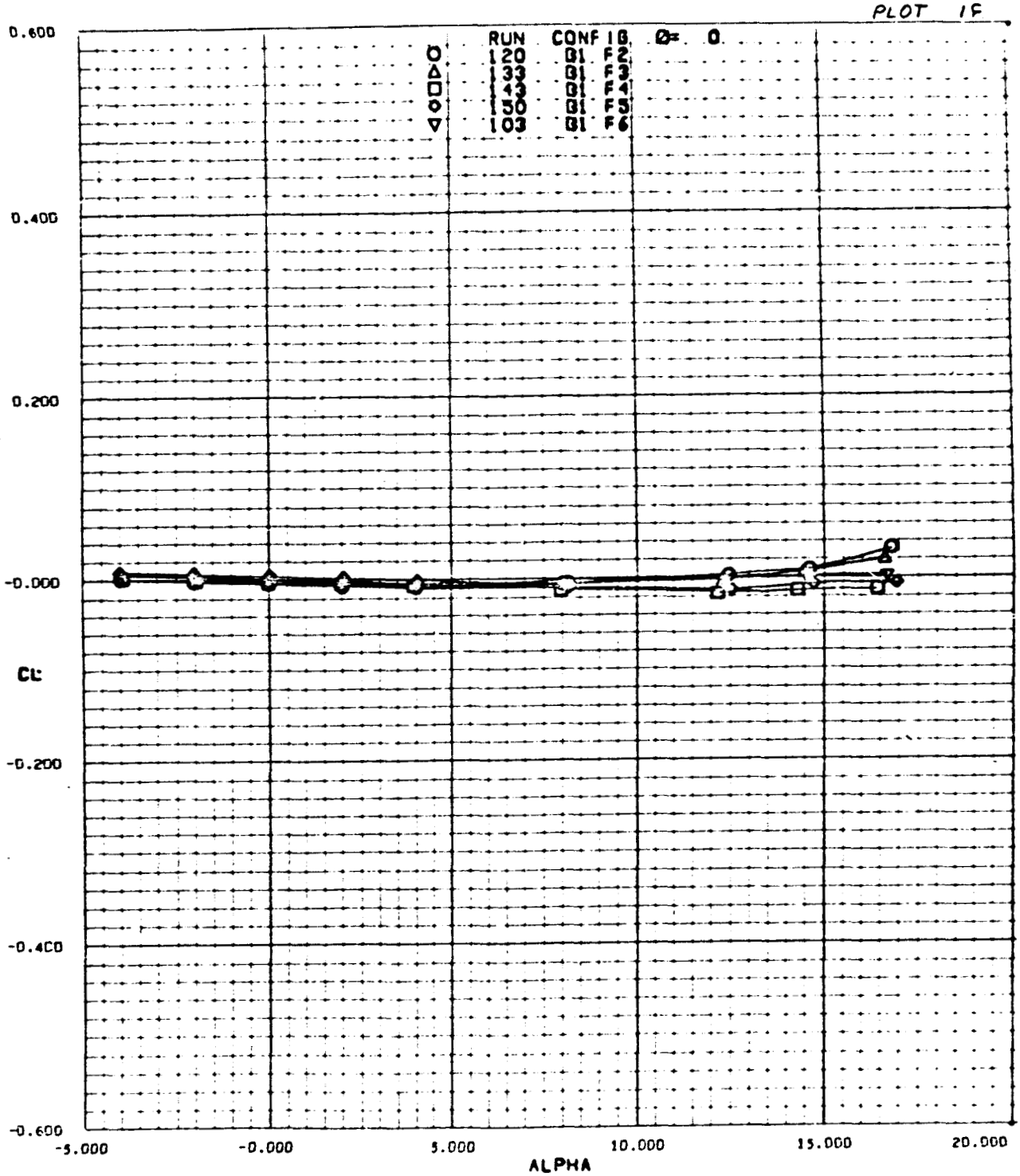
ALPHA

5

PLOT 1F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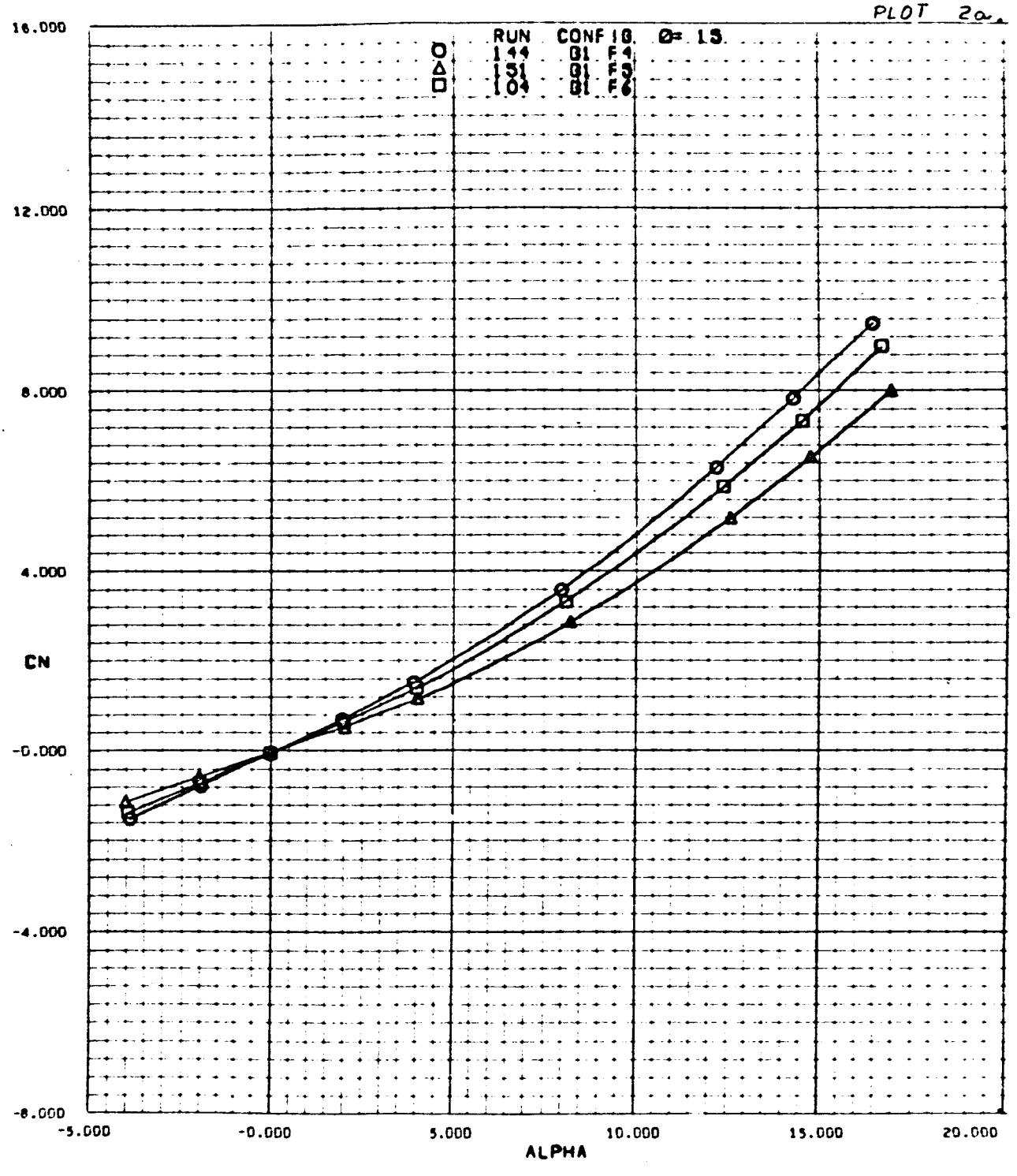
ALPHA

PLOT 2a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5.000
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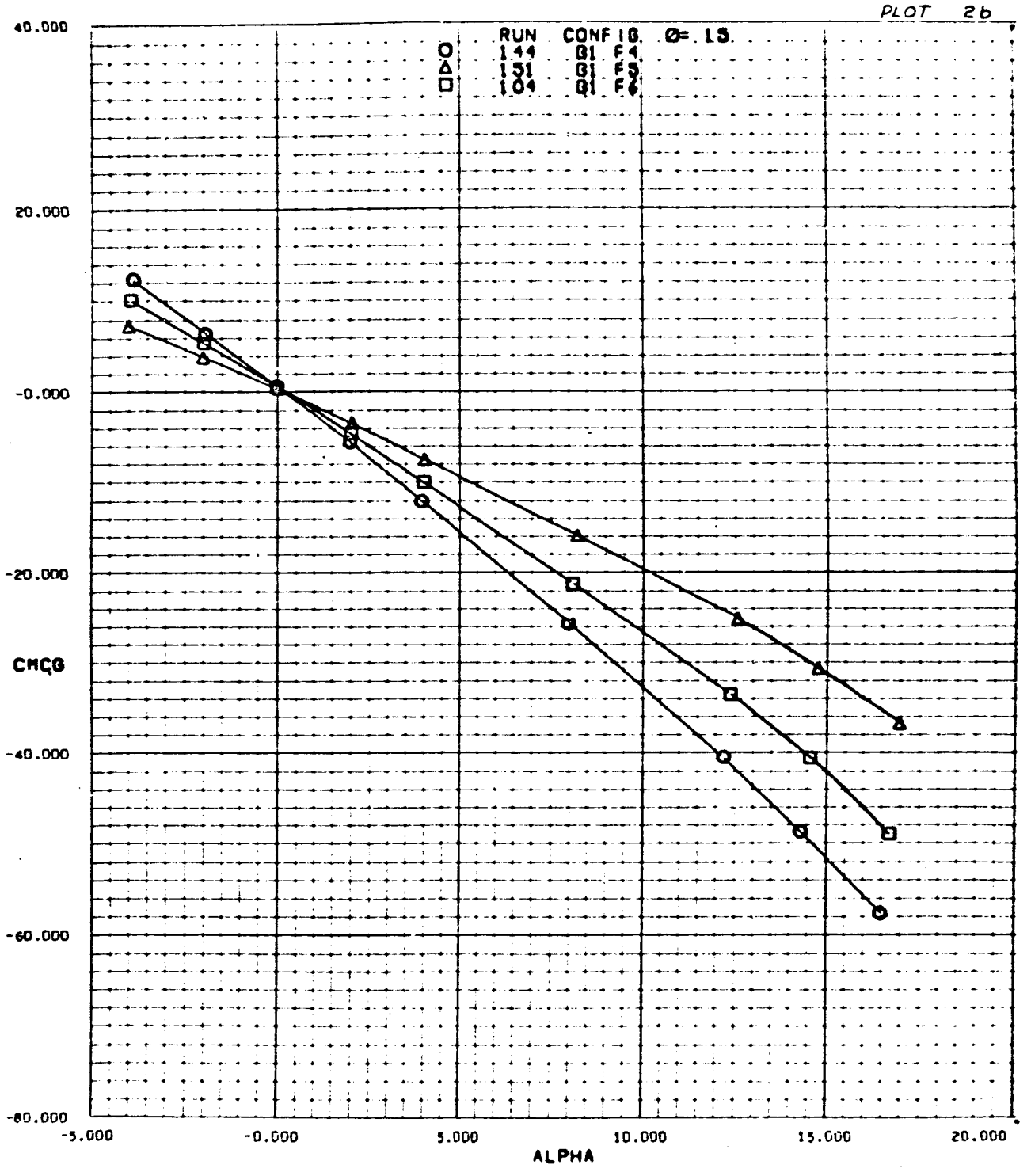
ALPHA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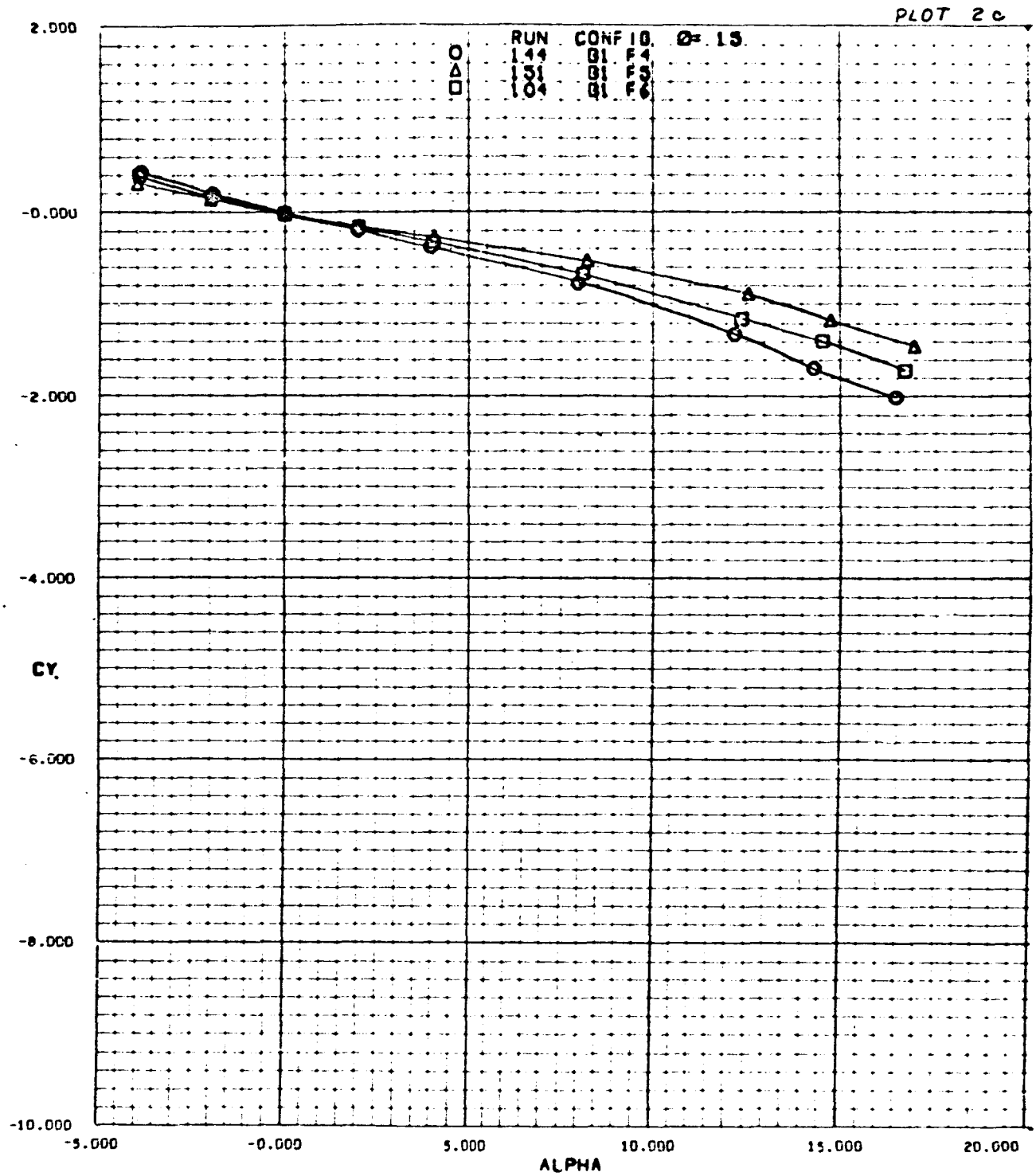
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104 01 F6
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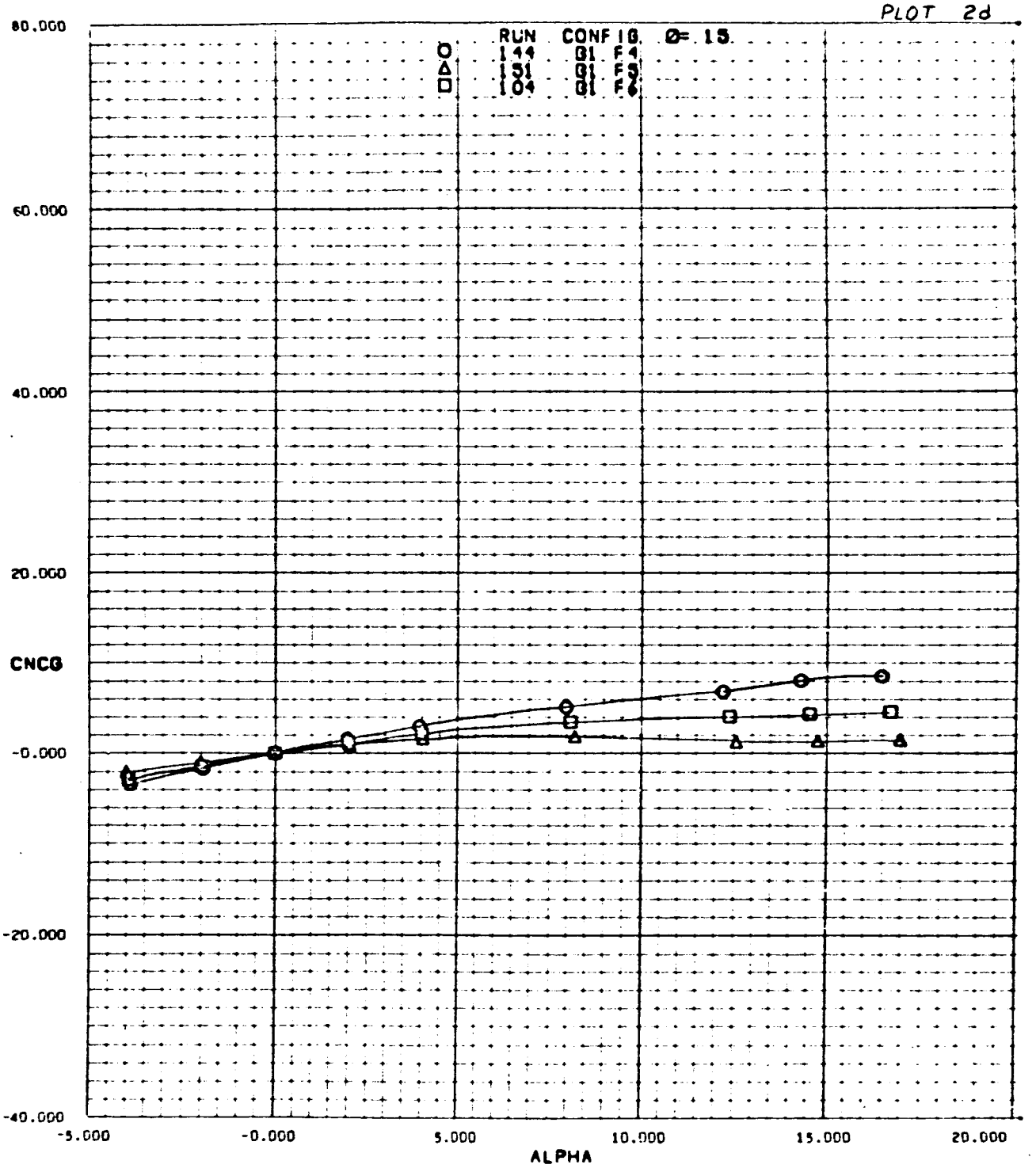
PLOT 2d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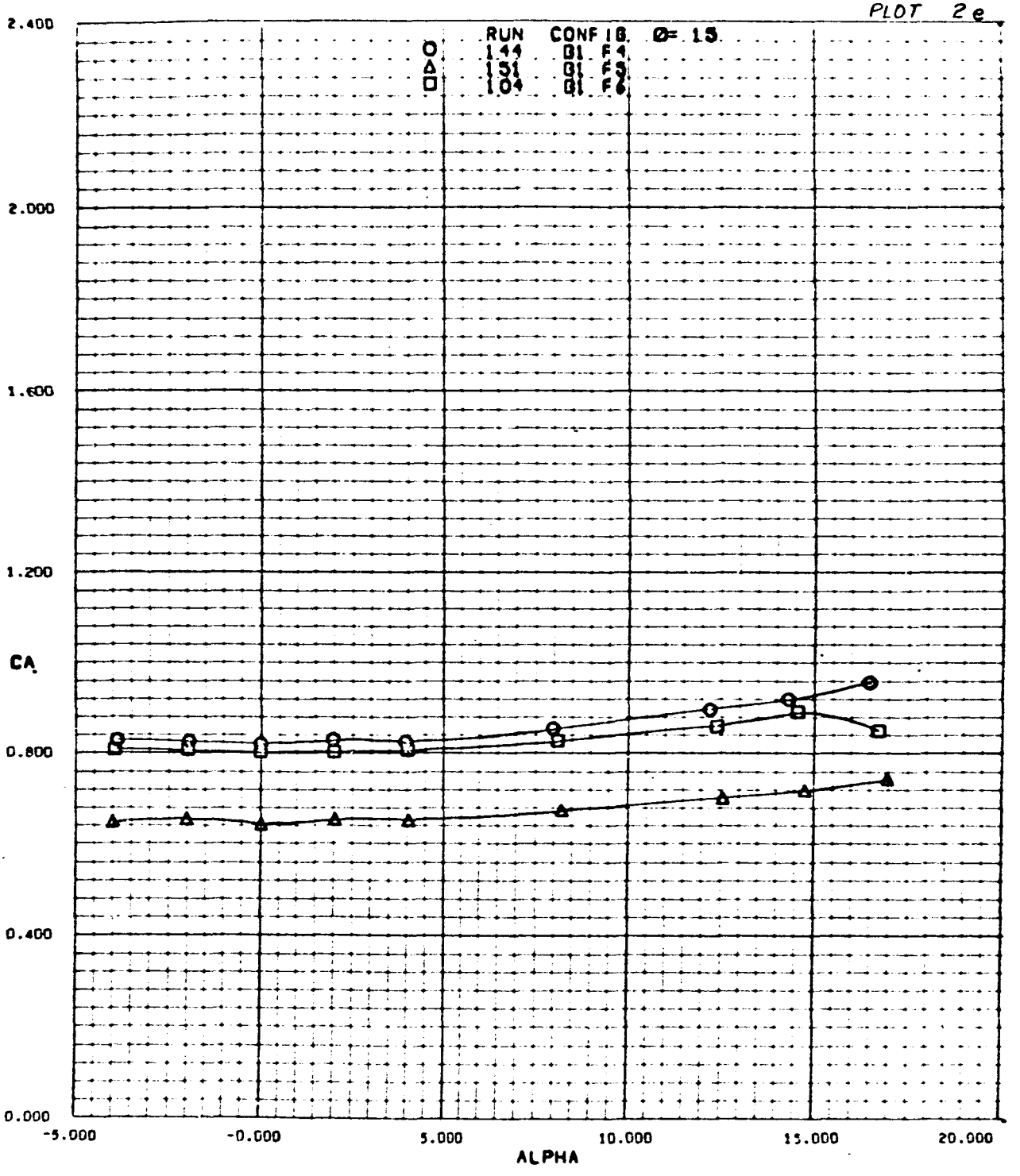
10

PLOT 2e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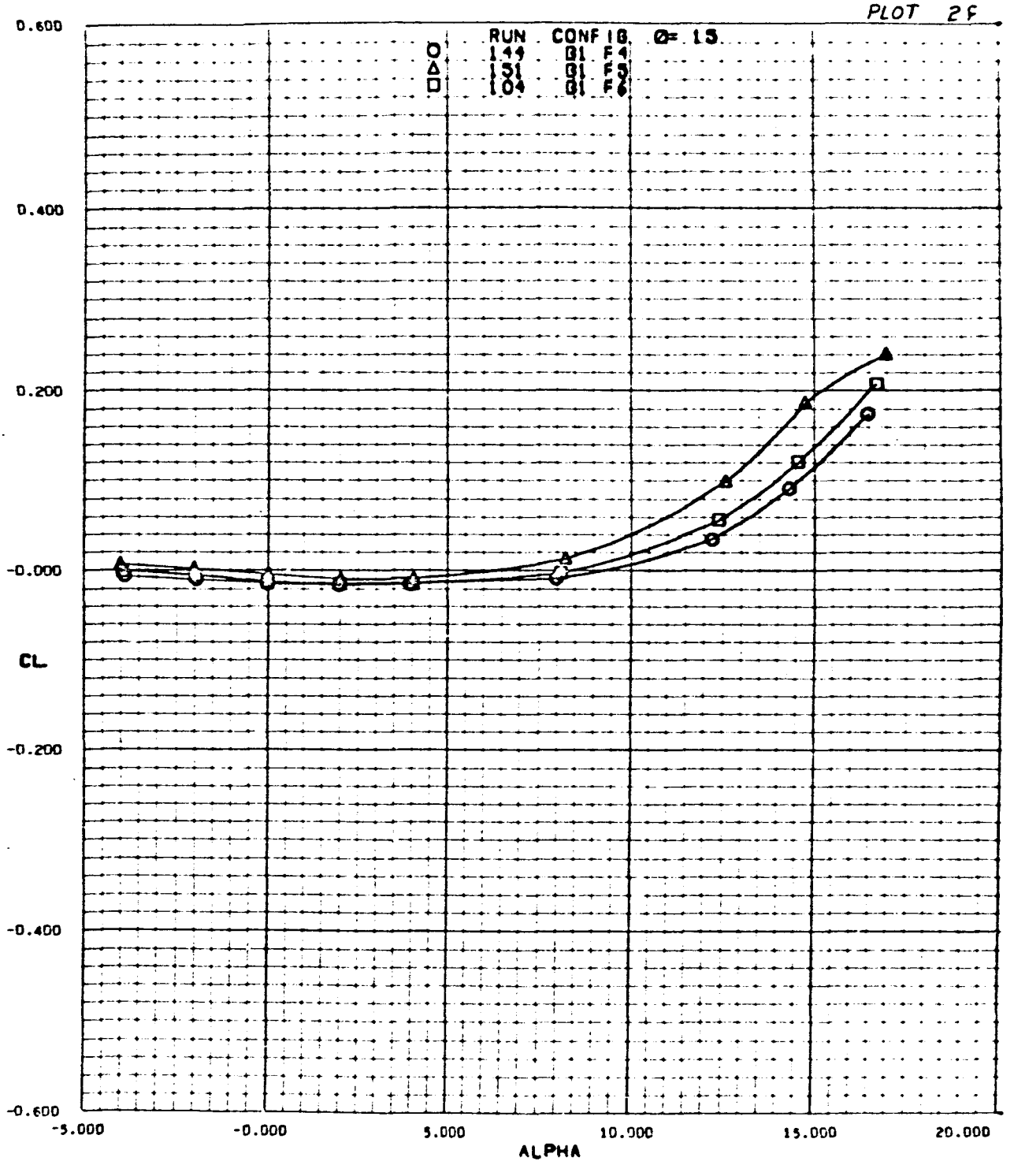
ALPHA

PLOT 2F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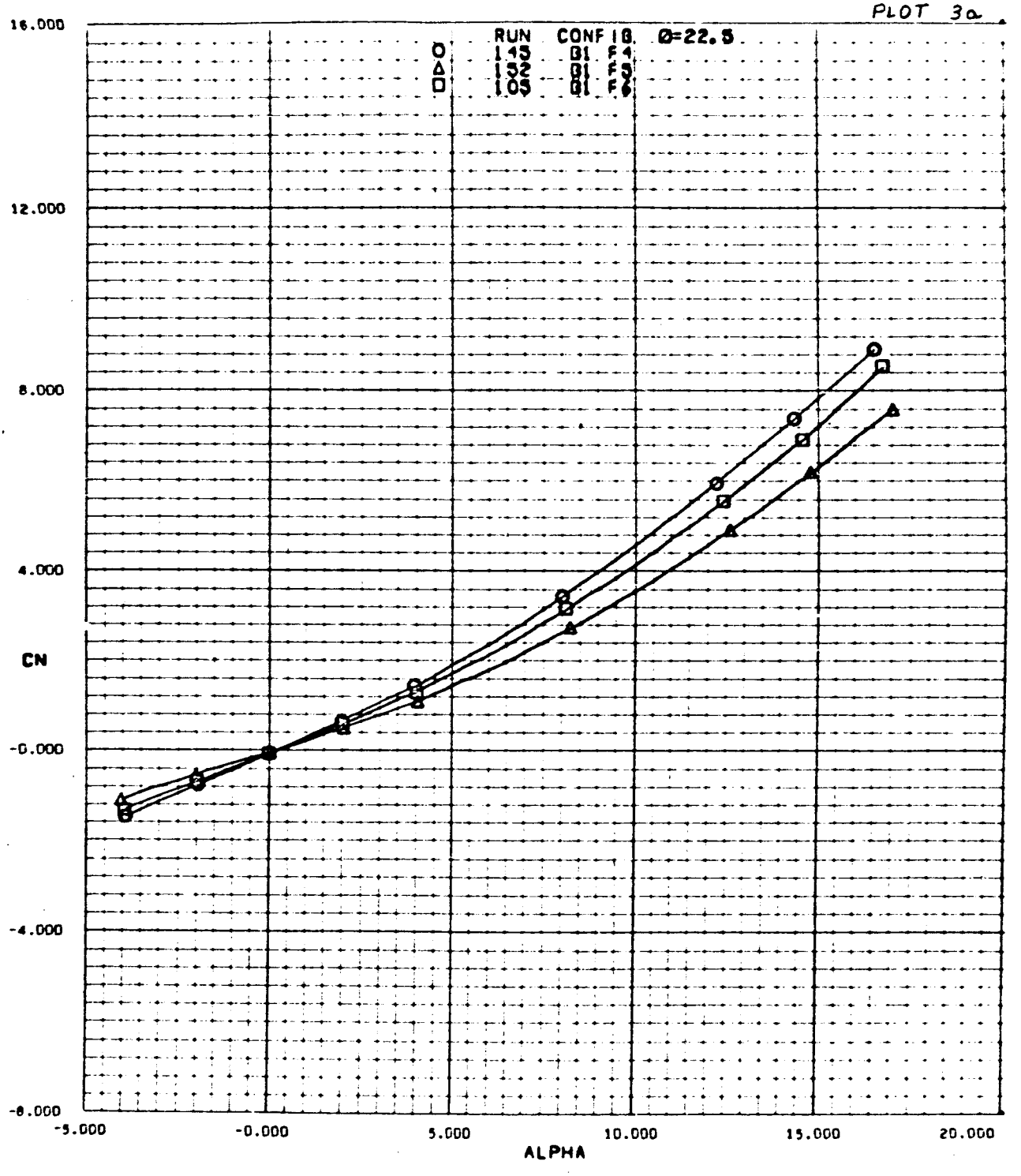
PLOT 3a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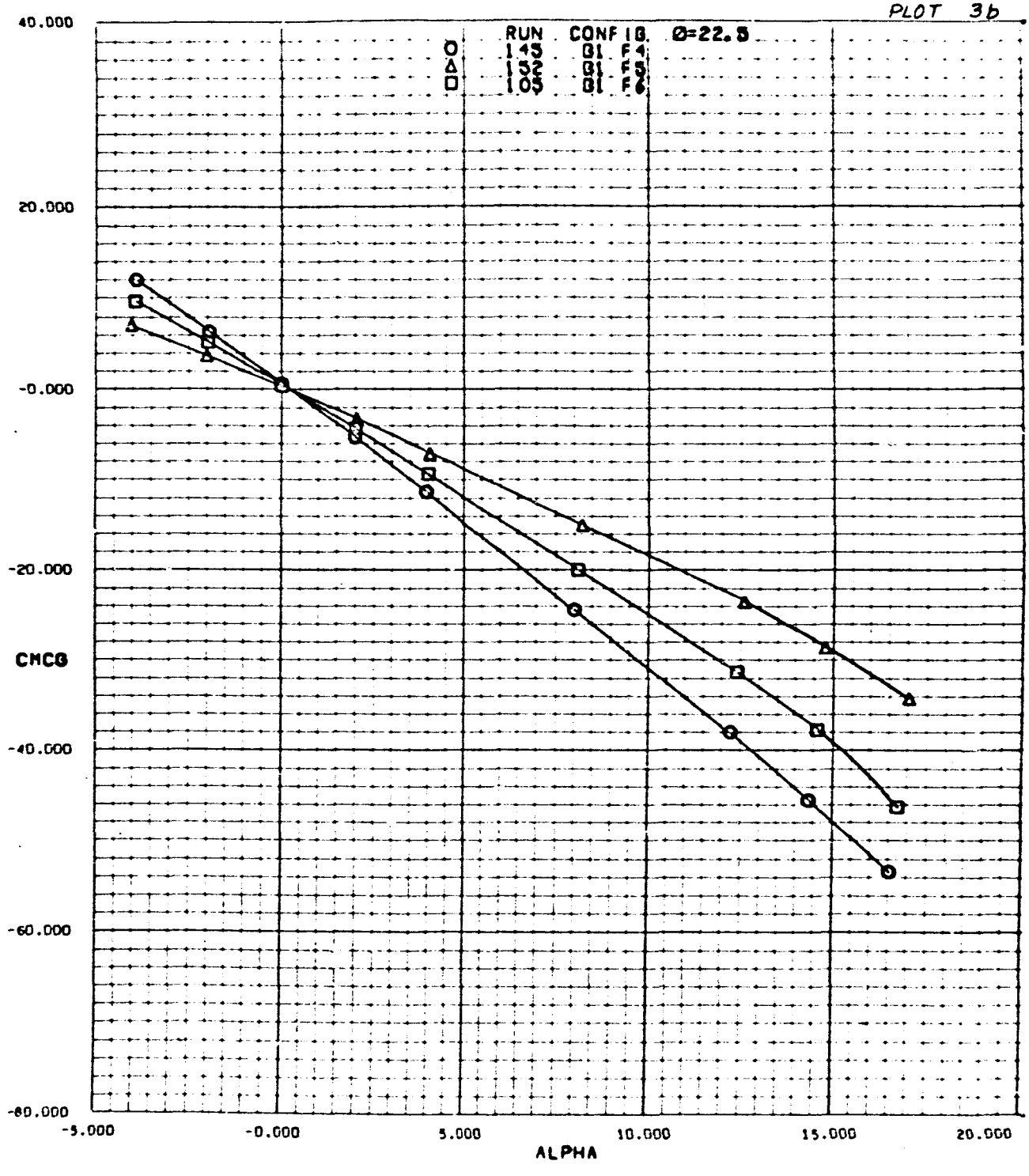
PLOT 3b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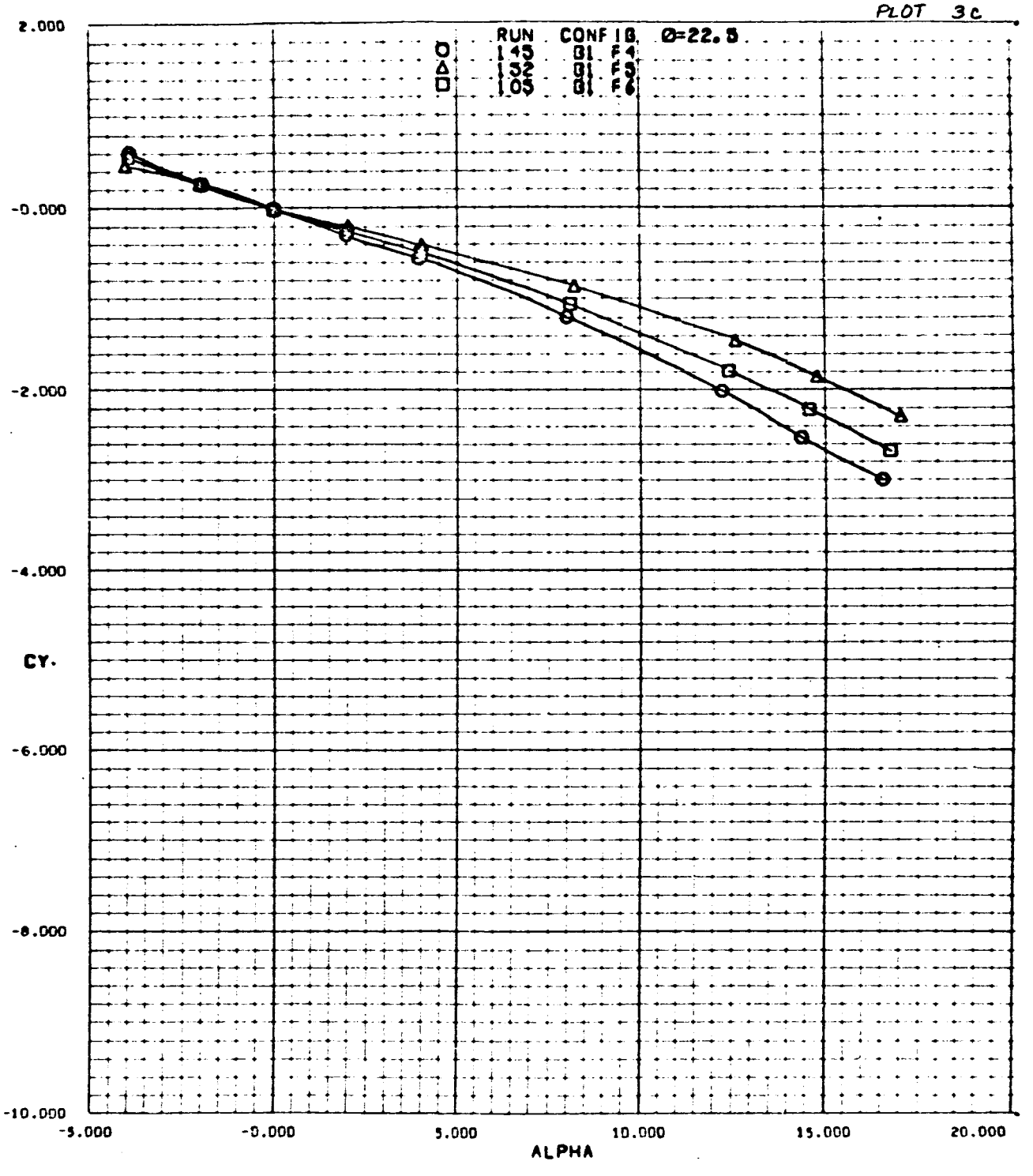
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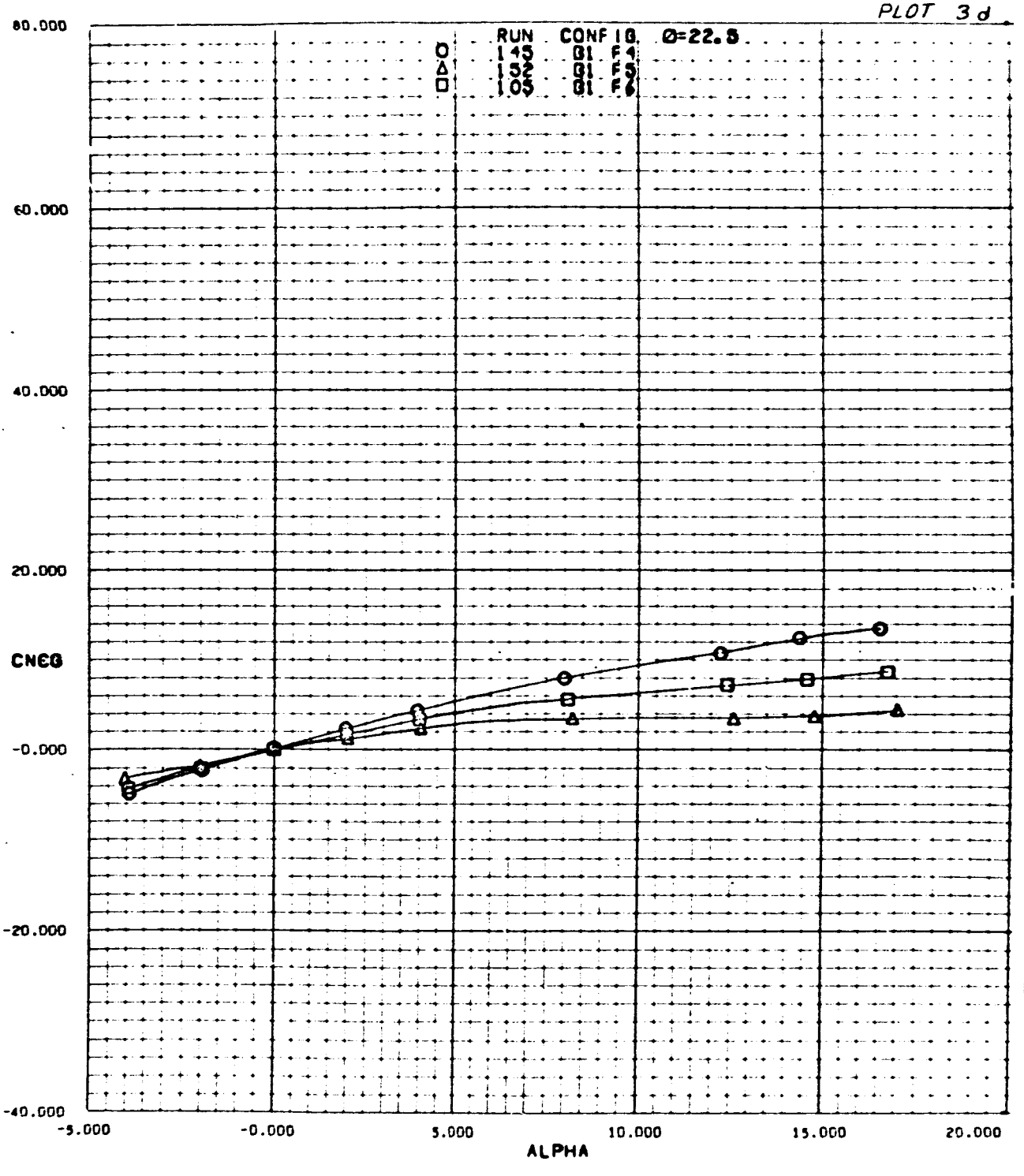
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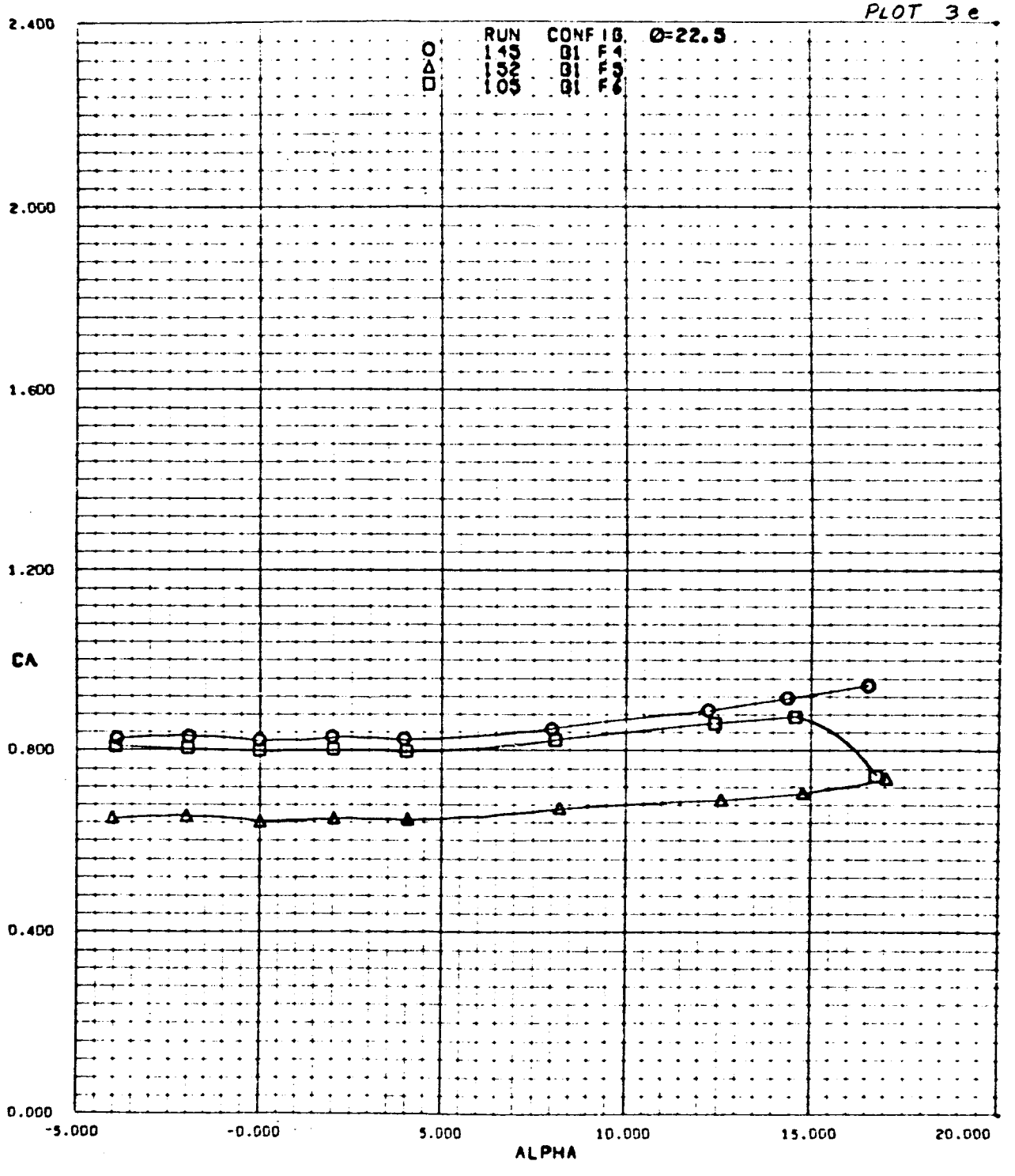
16

PLOT 3e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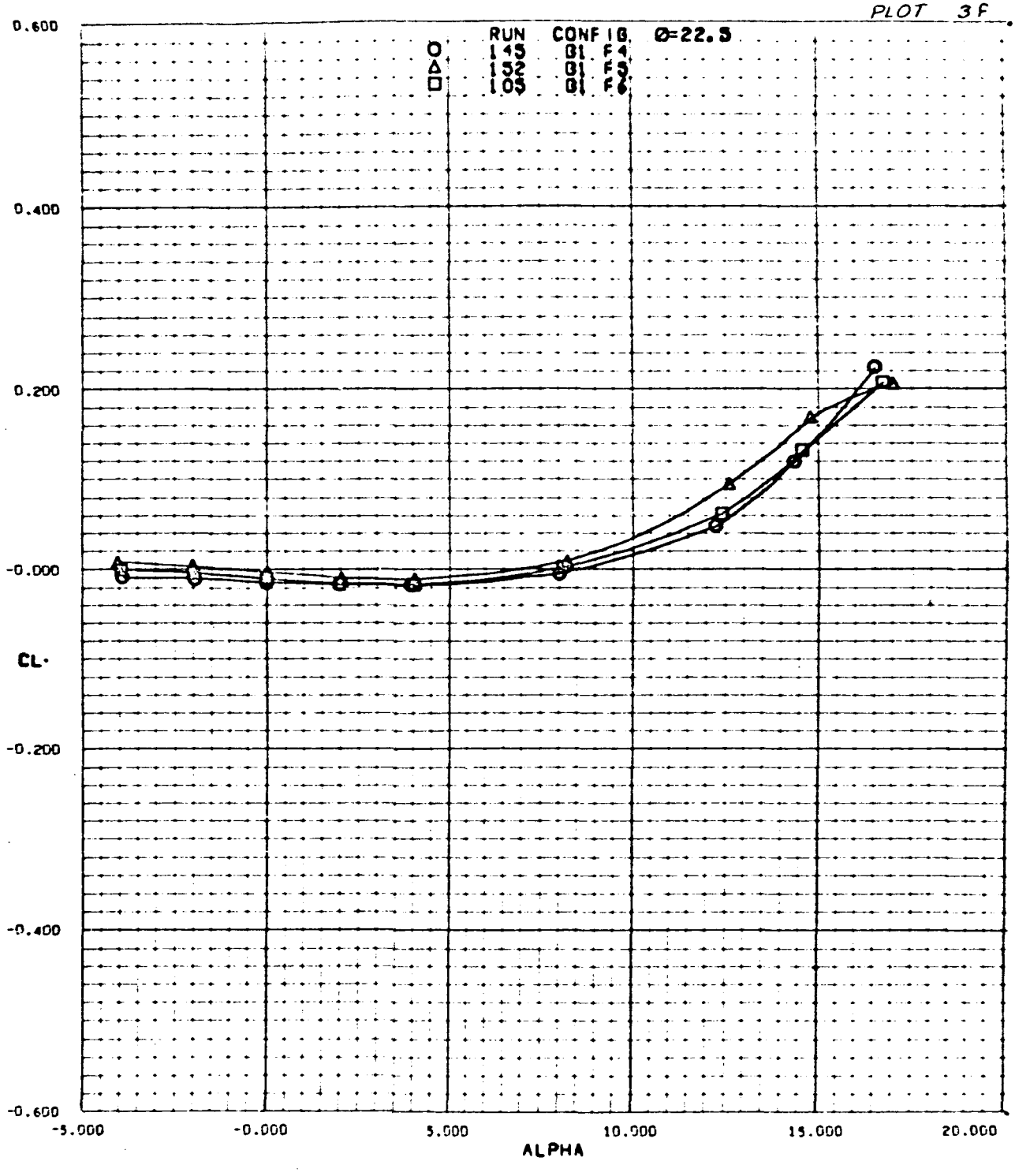
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0.400
0.200
-0.000
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CL·
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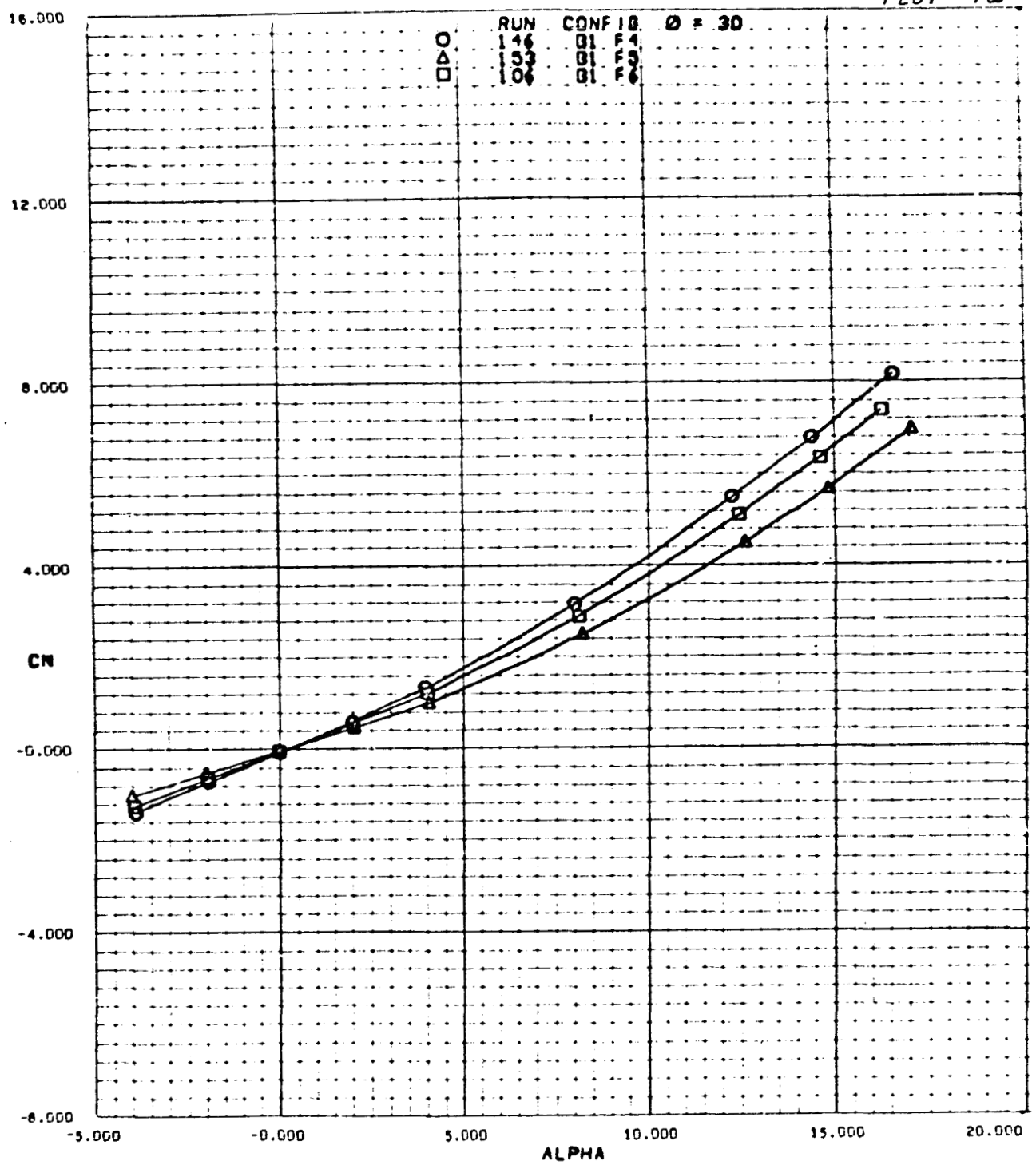
20.000
ALPHA

PLOT 4a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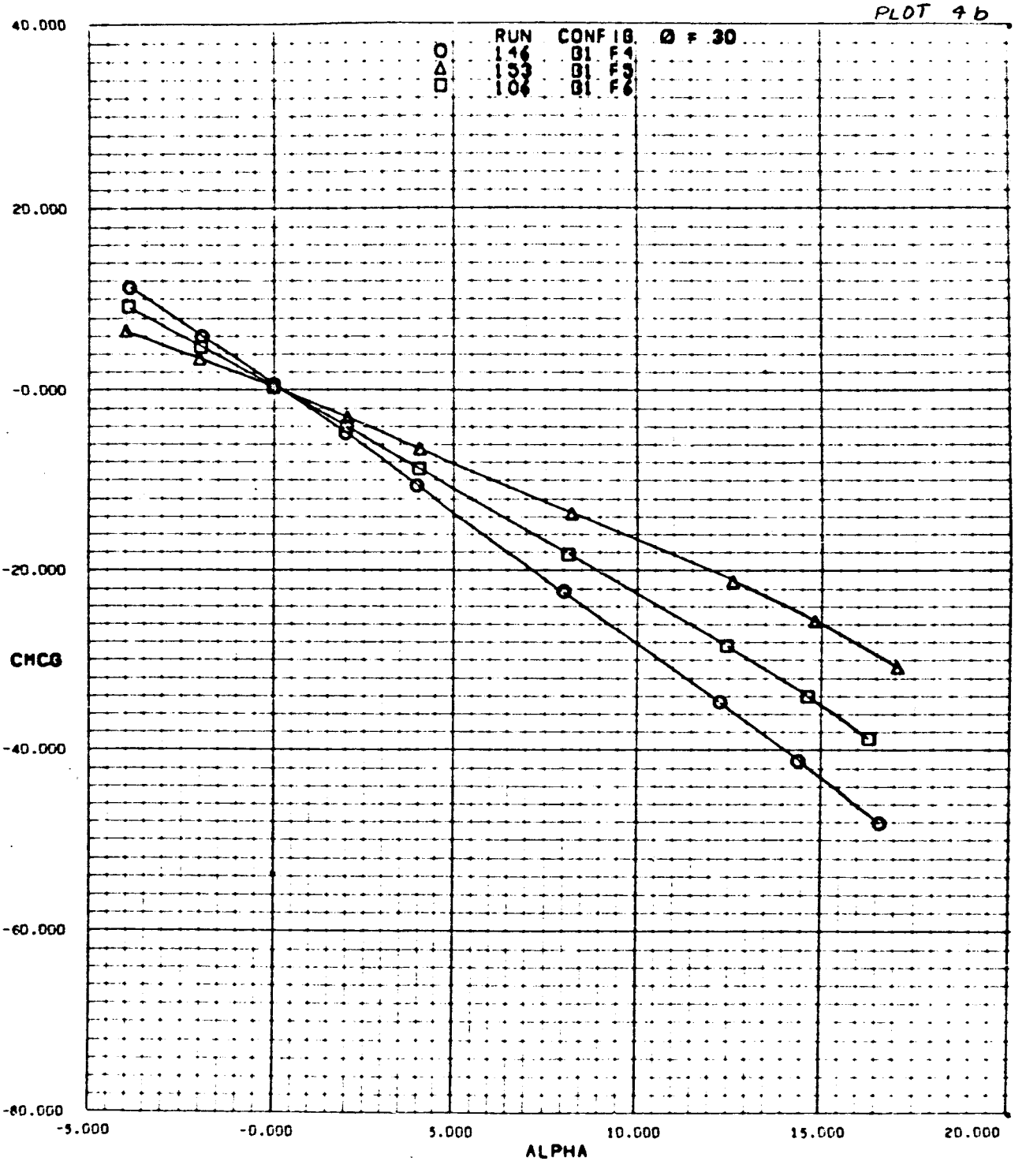
PLOT 4b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CMCG
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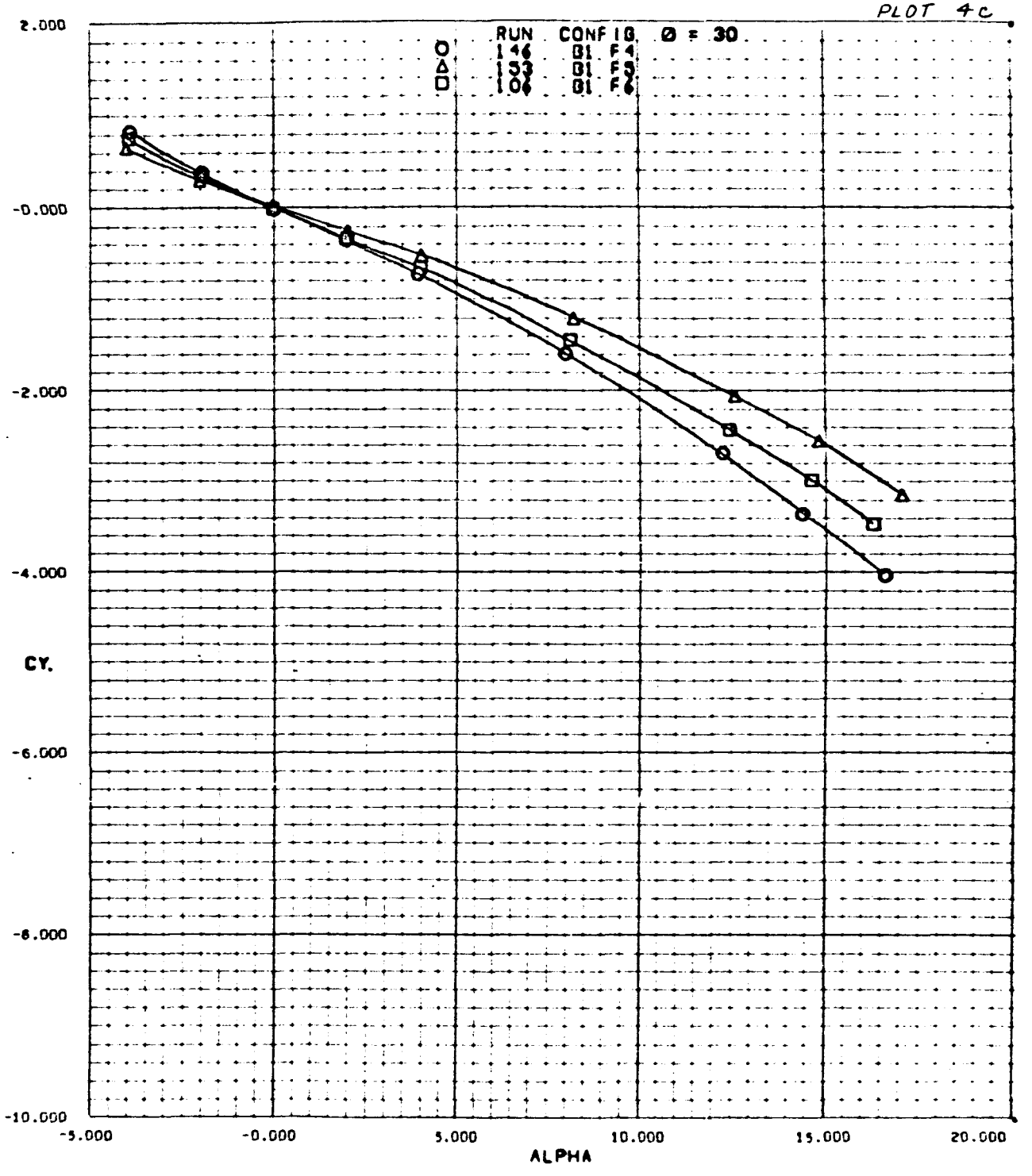
ALPHA

PLOT 4c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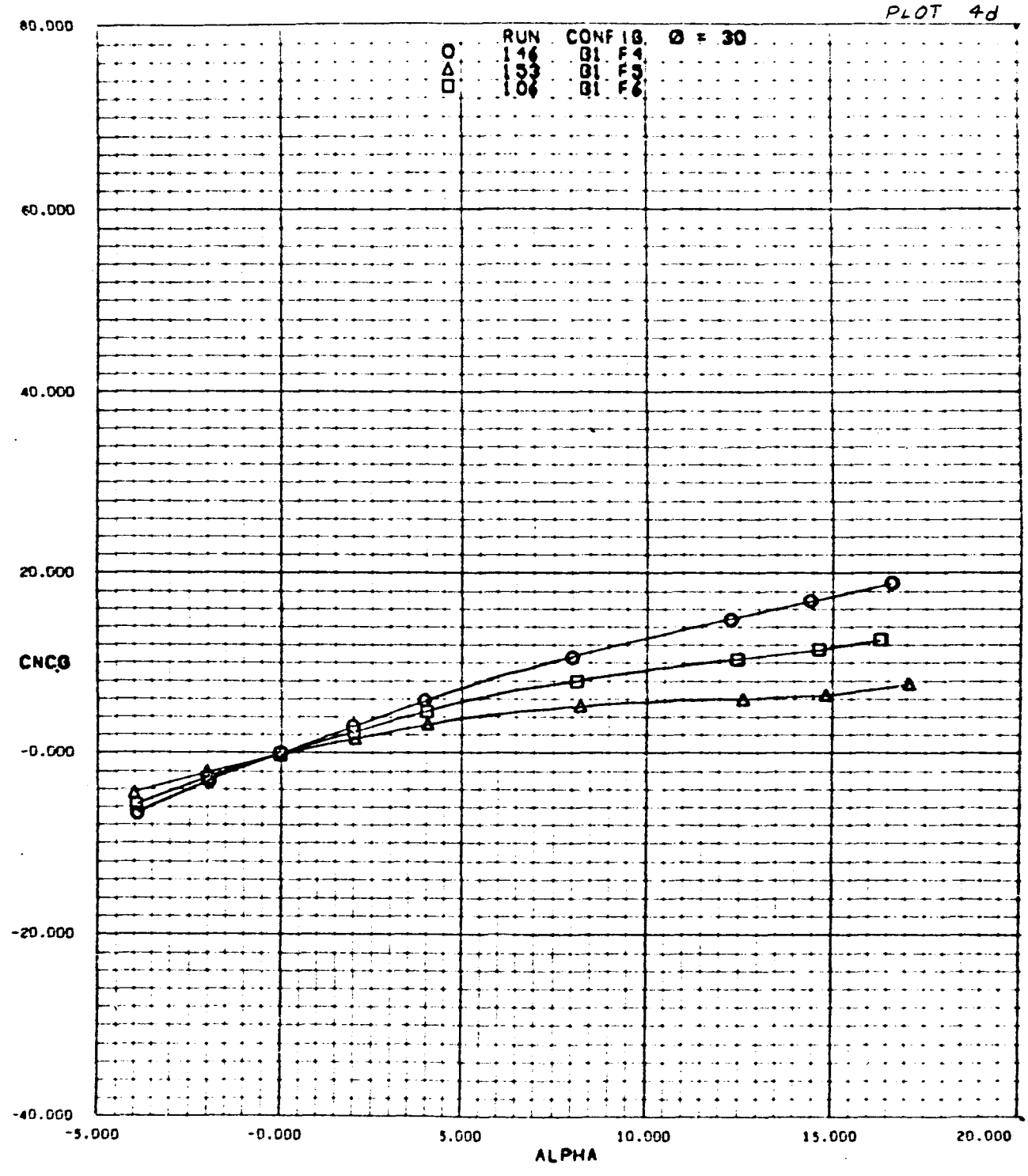
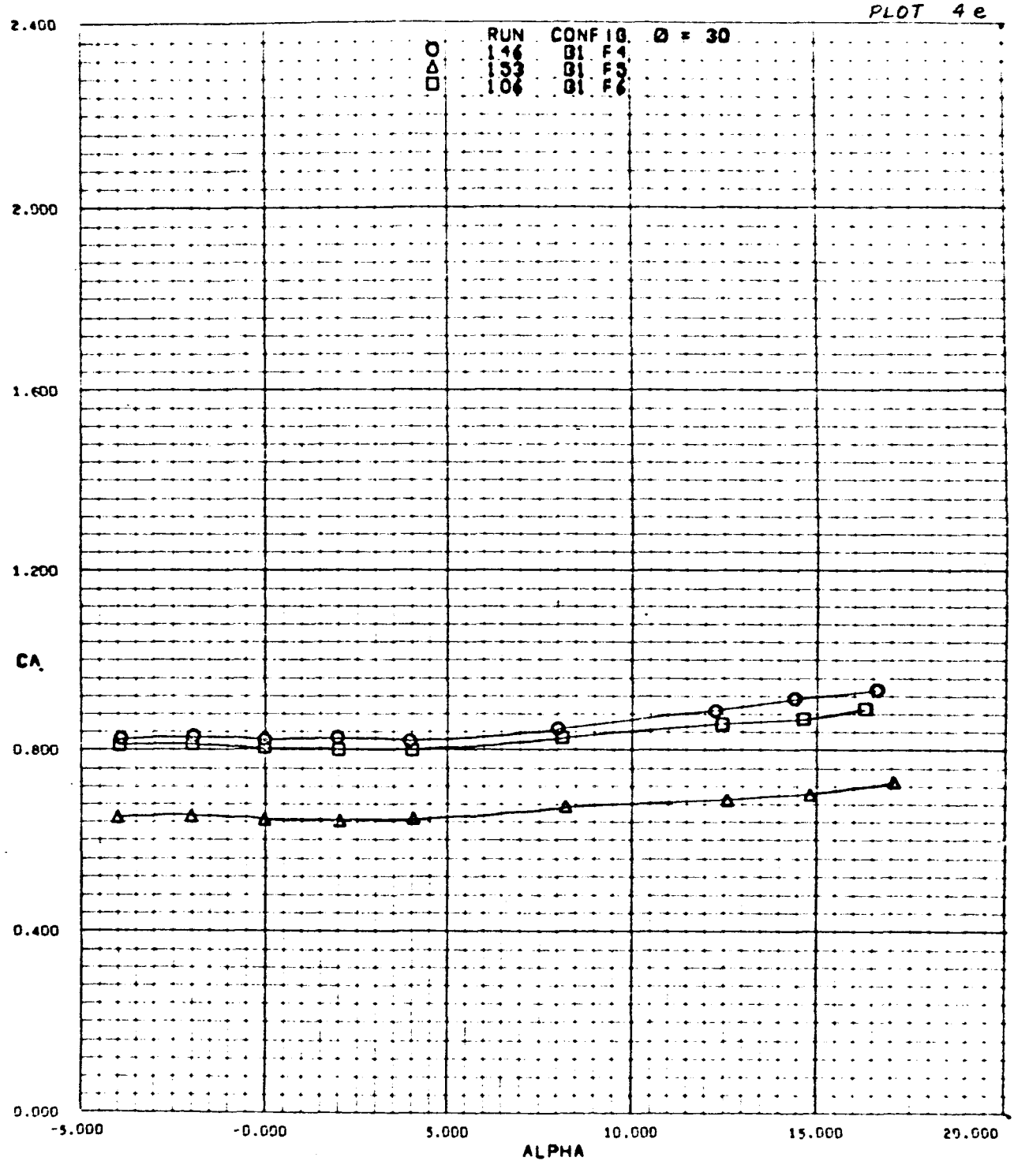
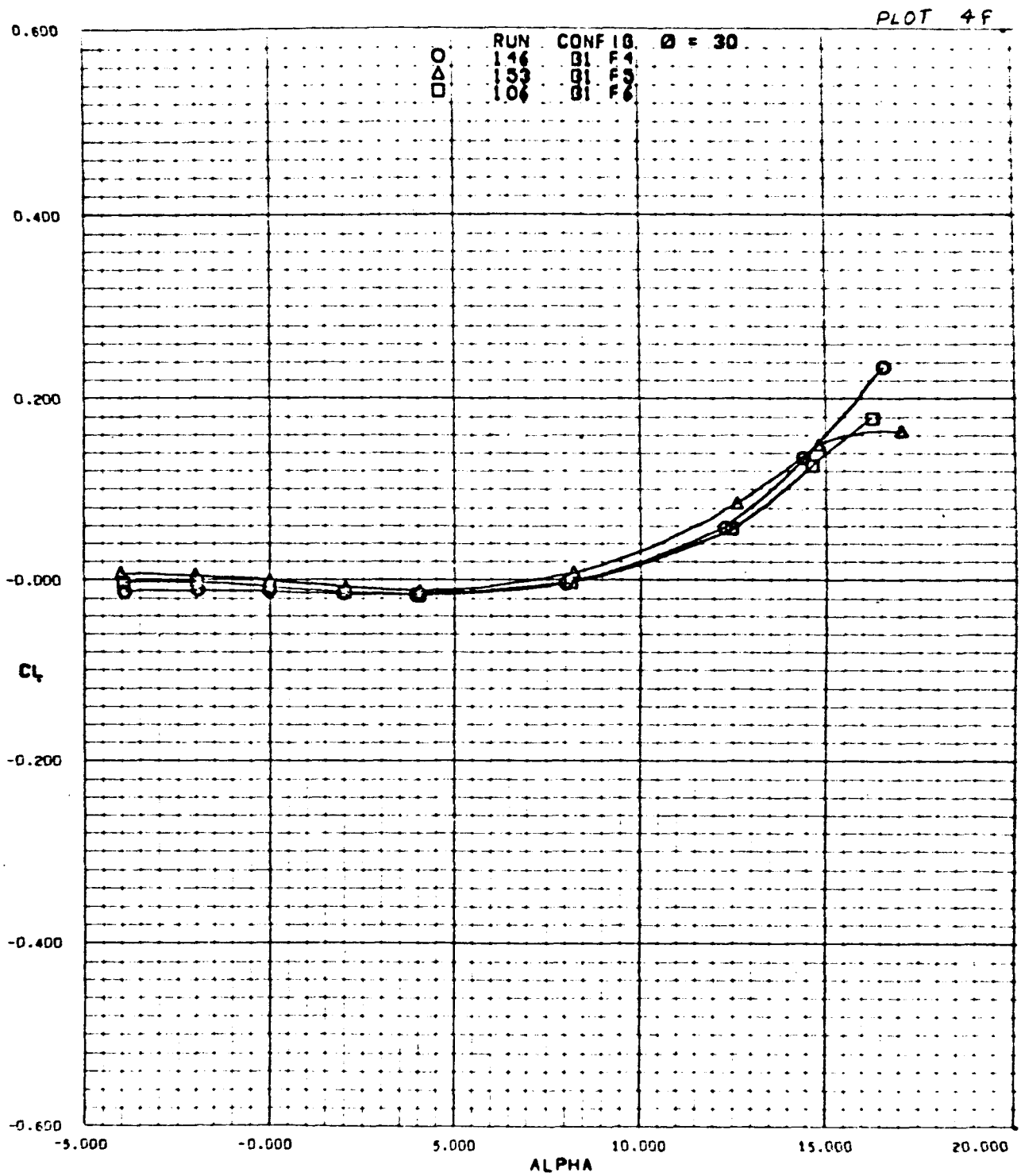
CY.
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

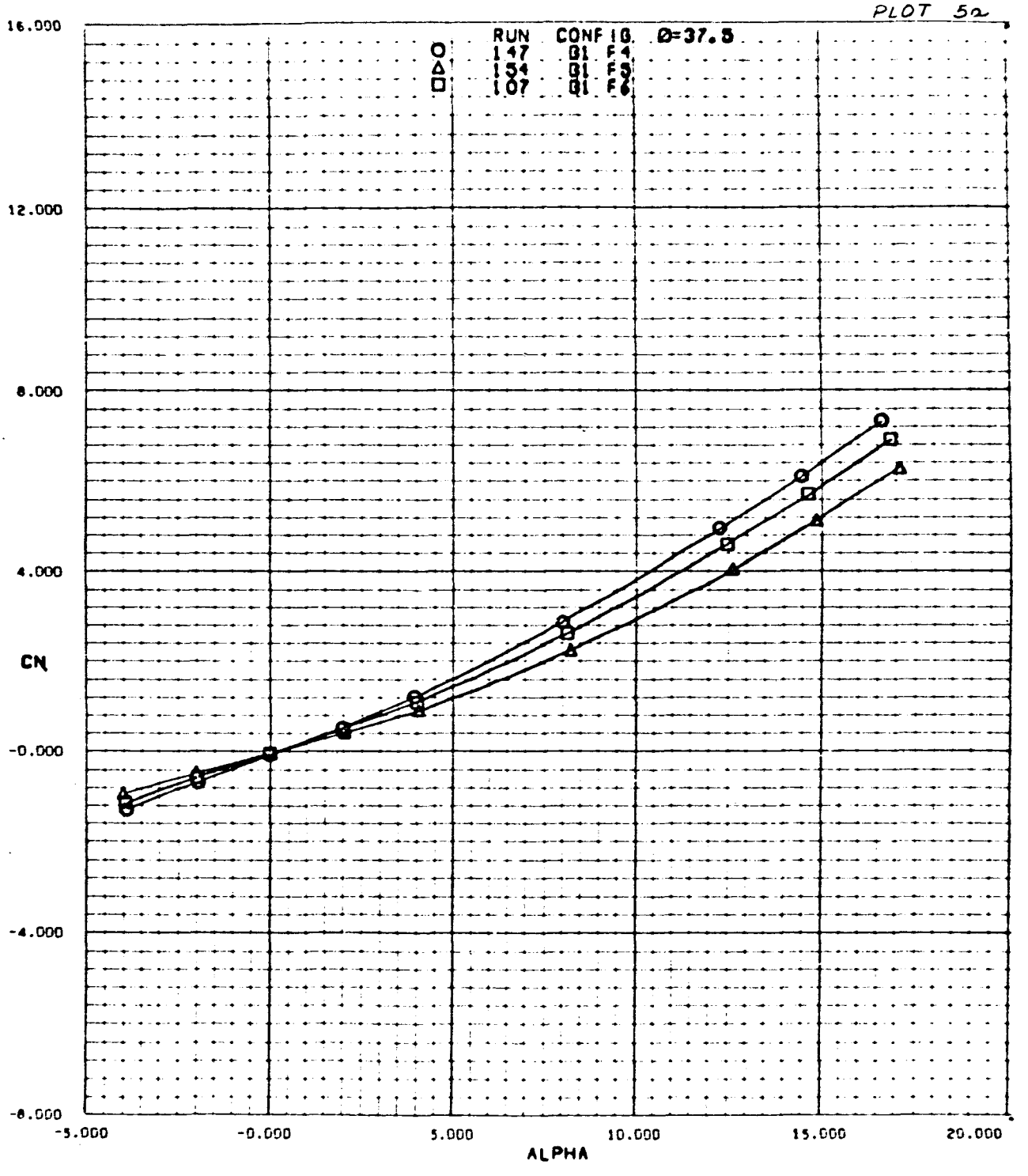

PLOT 4d
RUN CONFIG. Ø = 30
O 146 B1 F4
Δ 153 B1 F5
□ 106 B1 F6
60.000
40.000
20.000
-0.000
-20.000
-40.000
CNCG
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 4e

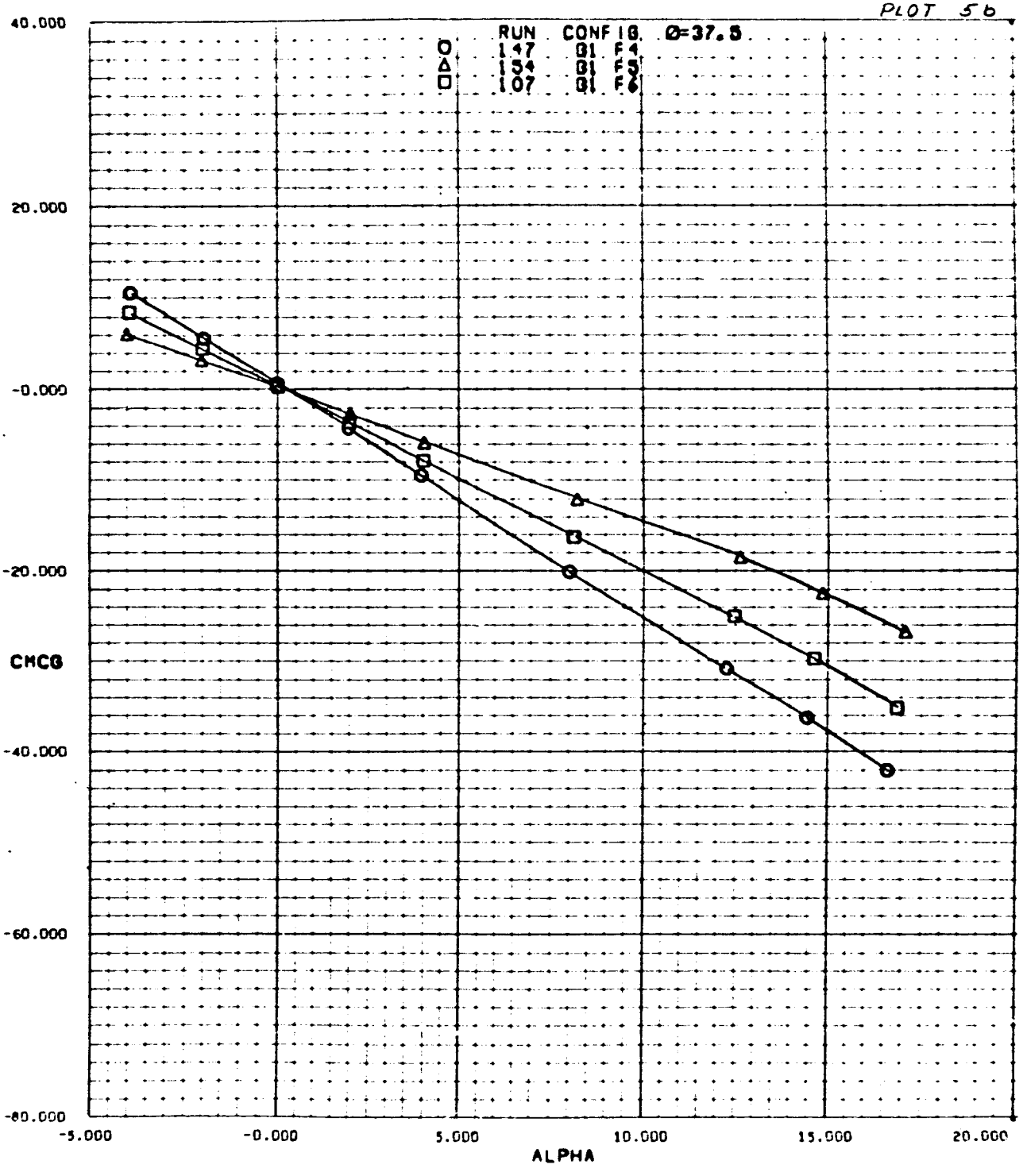

RUN CONFIG. Ø = 30
146 B1 F4
153 B1 F5
104 B1 F6
2.400
2.000
1.600
1.200
CA
0.800
0.400
0.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

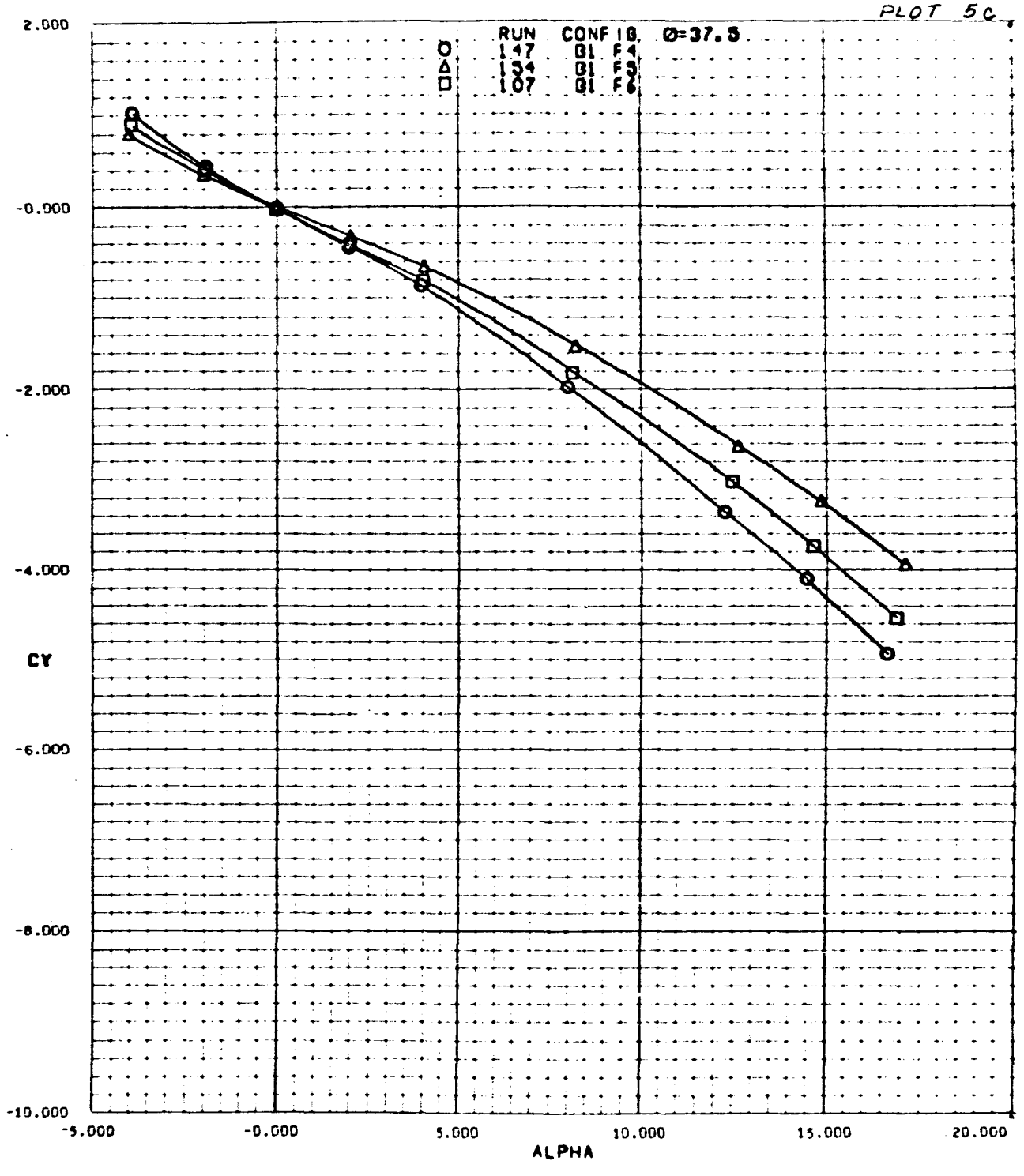

PLOT 4F
RUN CONFIG. Ø = 30
O 146 B1 F4
Δ 153 B1 F5
□ 106 B1 F6
0.600
0.400
0.200
-0.000
-0.200
-0.400
-0.600
C_L
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 5a

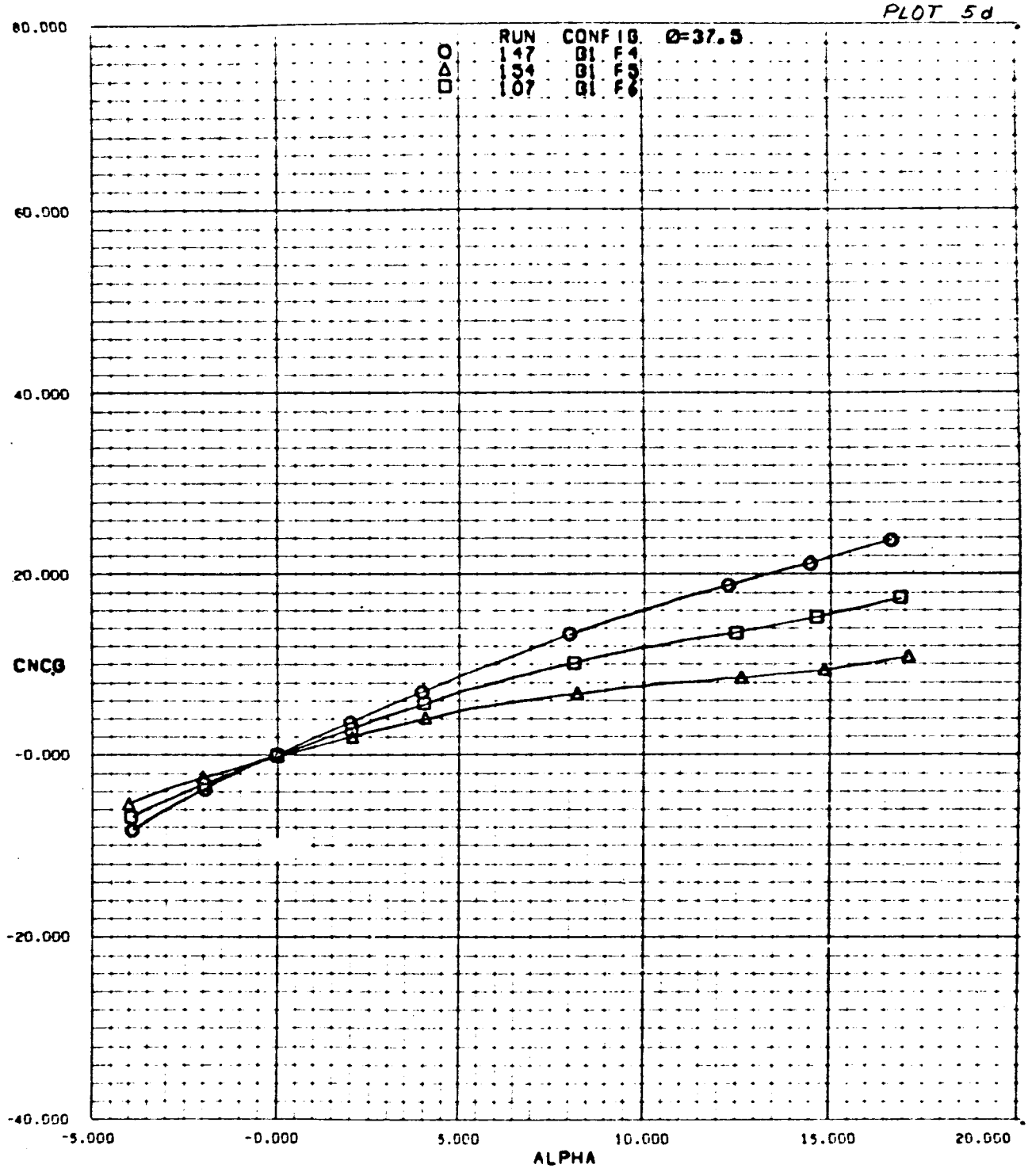

RUN CONFIG. Ø=37.5
147 B1 F4
154 B1 F5
107 B1 F6
16.000
12.000
8.000
4.000
-0.000
-4.000
-8.000
CN
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 56

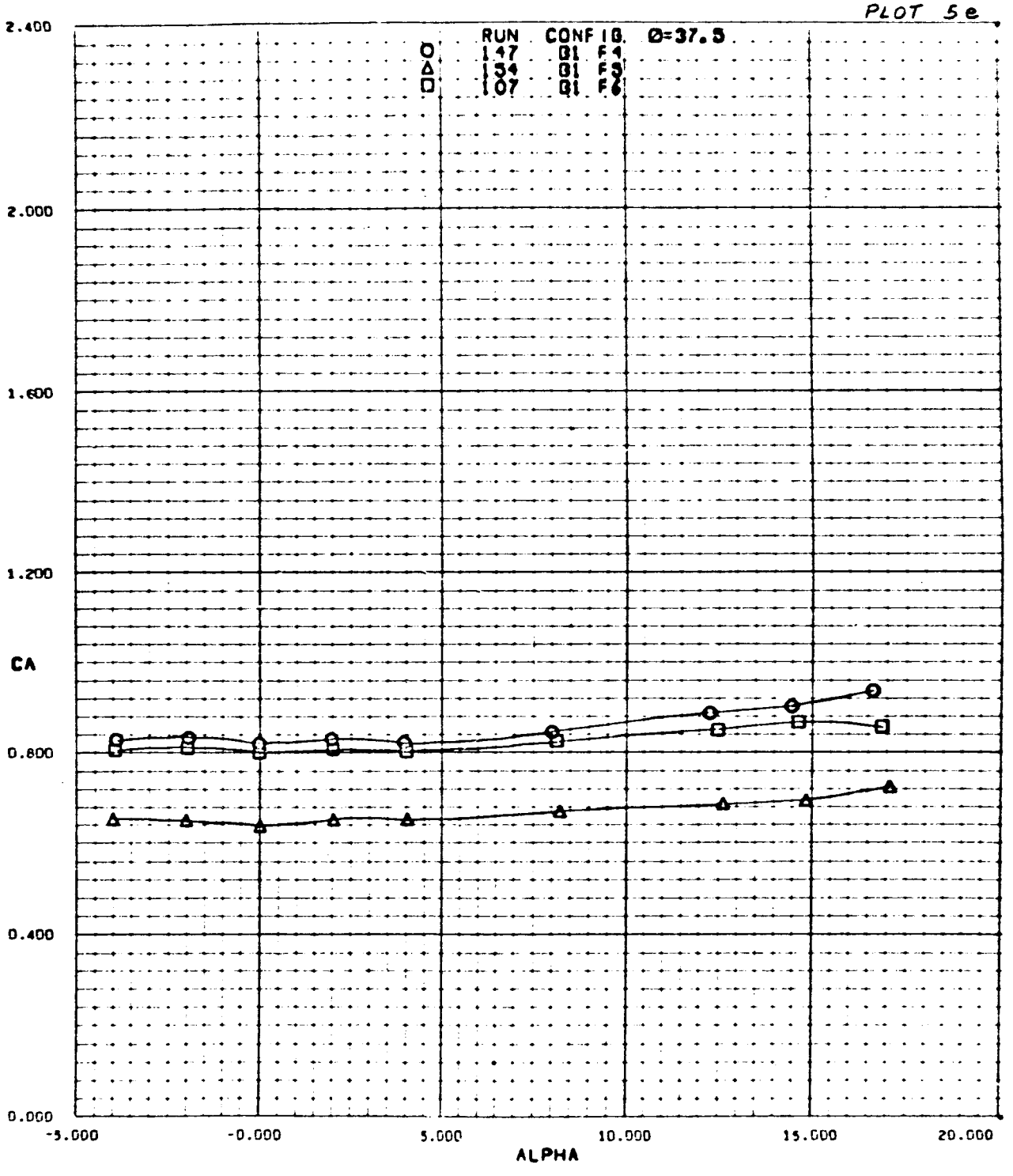

RUN CONFIG. Ø=37.5
147 B1 F4
154 B1 F5
107 B1 F6
40.000
20.000
-0.000
-20.000
-40.000
-60.000
-80.000
CMCG
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

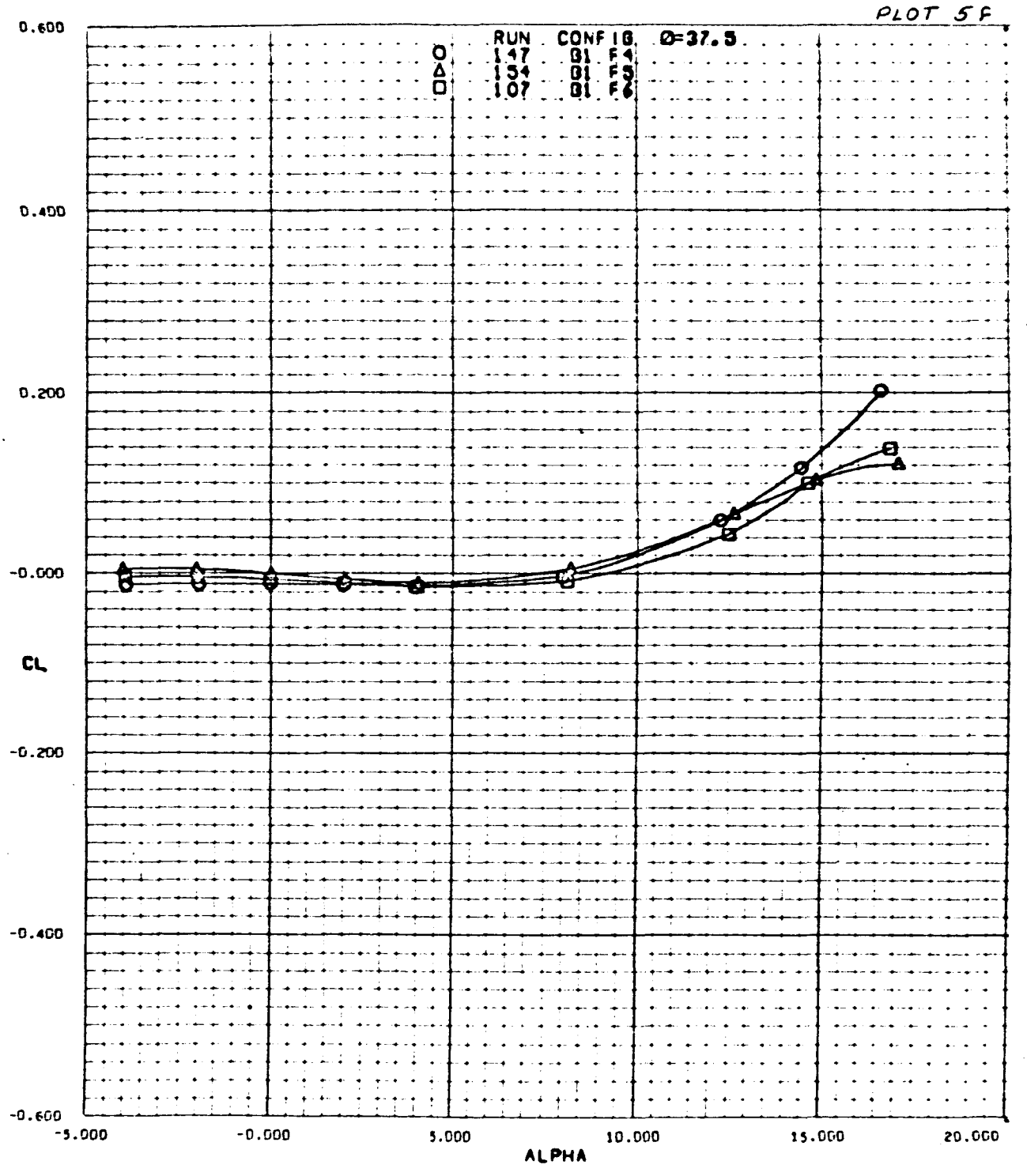

PLOT 5c
RUN CONFIG. Ø=37.5
147 B1 F4
134 B1 F5
107 B1 F6
2.000
-0.000
-2.000
-4.000
CY
-6.000
-8.000
-10.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 5d

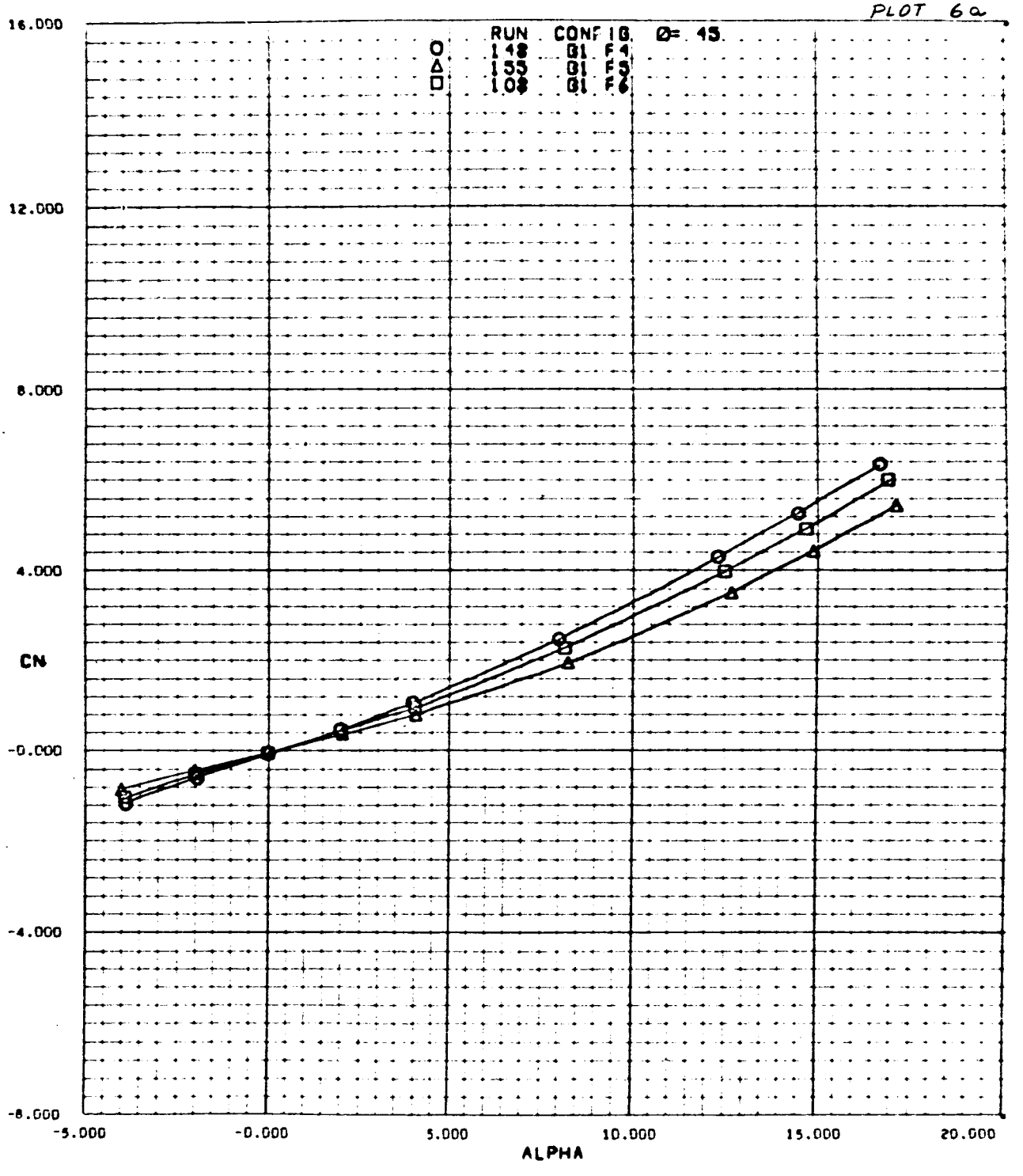

RUN CONFIG. Ø=37.5
○ 147 B1 F4
△ 154 B1 F5
□ 107 B1 F6
60.000
40.000
20.000
CNCG
-0.000
-20.000
-40.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 5e

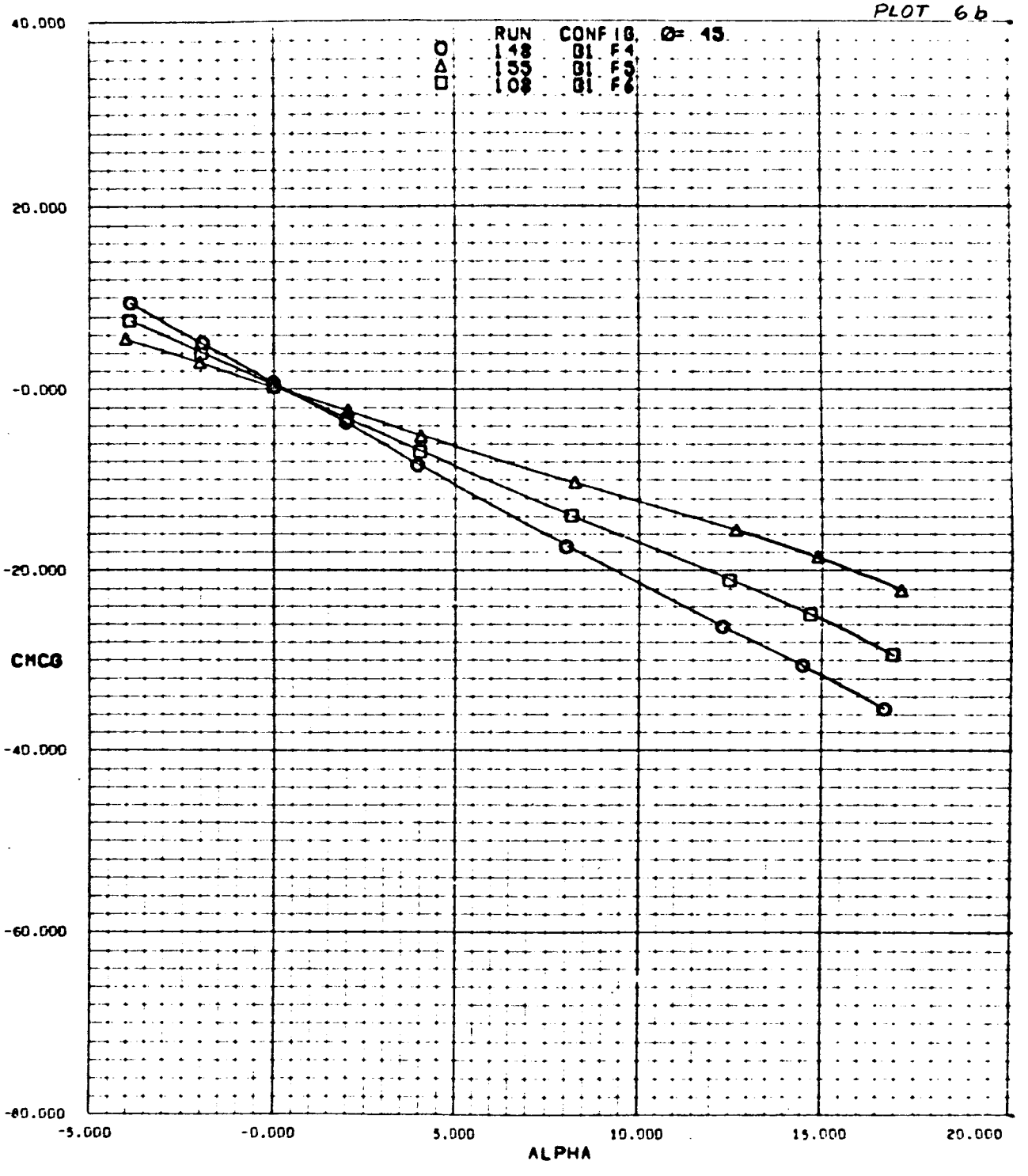

RUN CONFIG. Ø=37.5
○ 147 B1 F4
△ 134 B1 F5
□ 107 B1 F6
2.400
2.000
1.600
1.200
CA
0.800
0.400
0.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA


PLOT 5F
RUN CONFIG Ø=37.5
147 B1 F4
154 B1 F5
107 B1 F6
0.600
0.400
0.200
-0.000
-0.200
-0.400
-0.600
CL
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

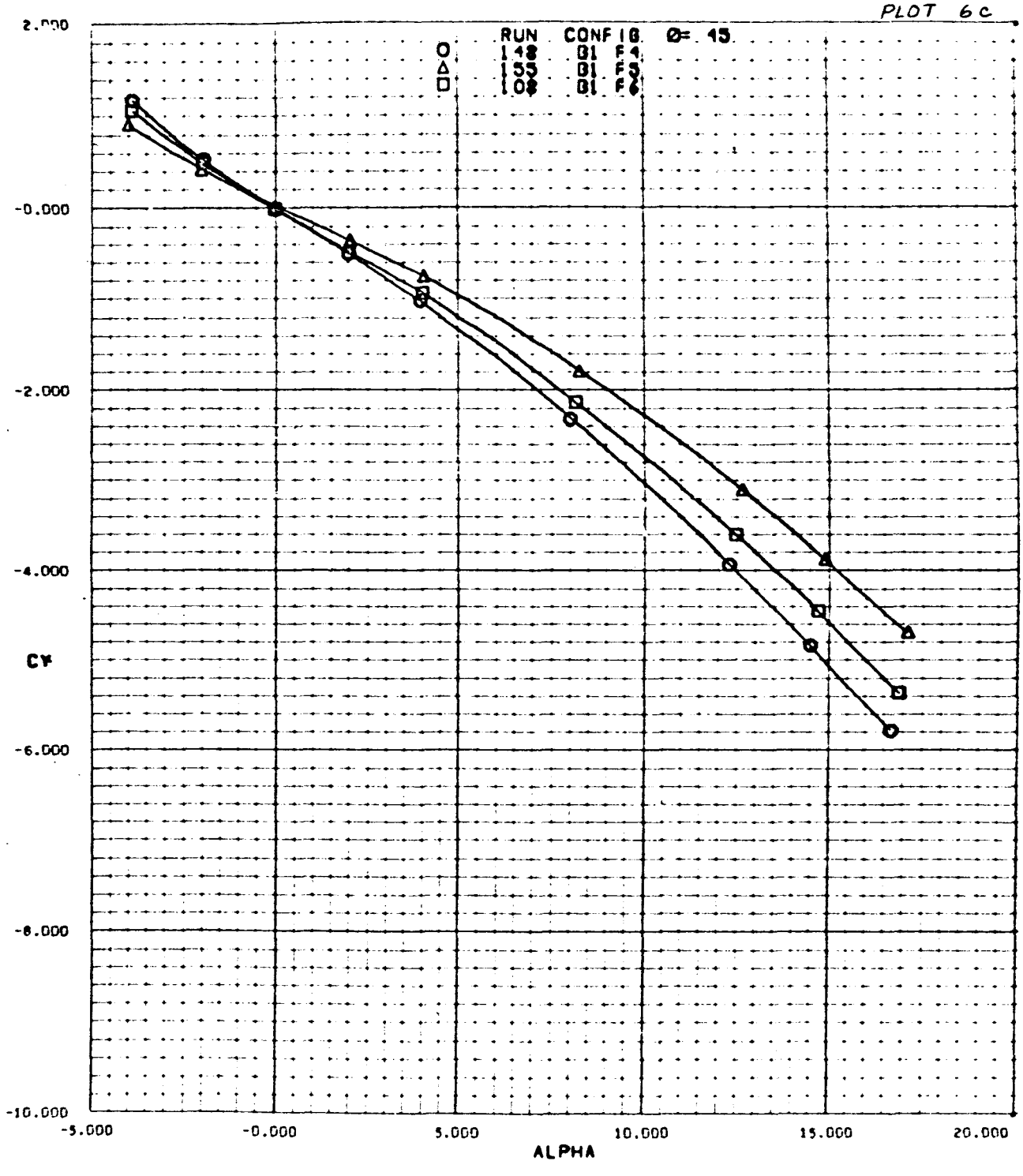
PLOT 6a


RUN CONFIG. Ø= 45.
○ 148 G1 F4
△ 155 G1 F5
□ 108 G1 F6
16.000
12.000
8.000
4.000
-0.000
-4.000
-8.000
CN
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

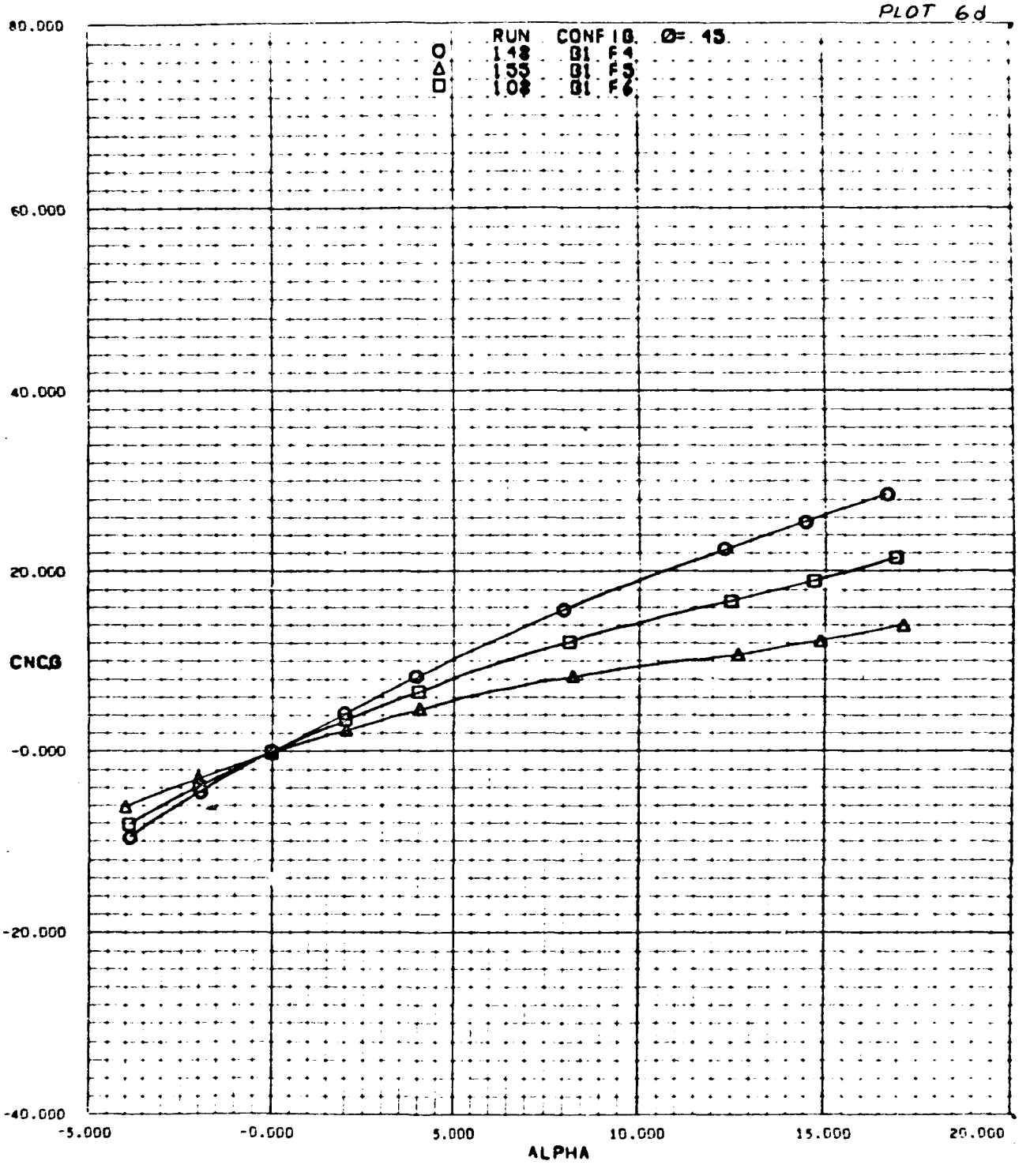
PLOT 6b


RUN CONFIG. Ø= 45.
148 B1 F4
135 B1 F5
108 B1 F6
40.000
20.000
-0.000
-20.000
-40.000
-60.000
-80.000
CMCG
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

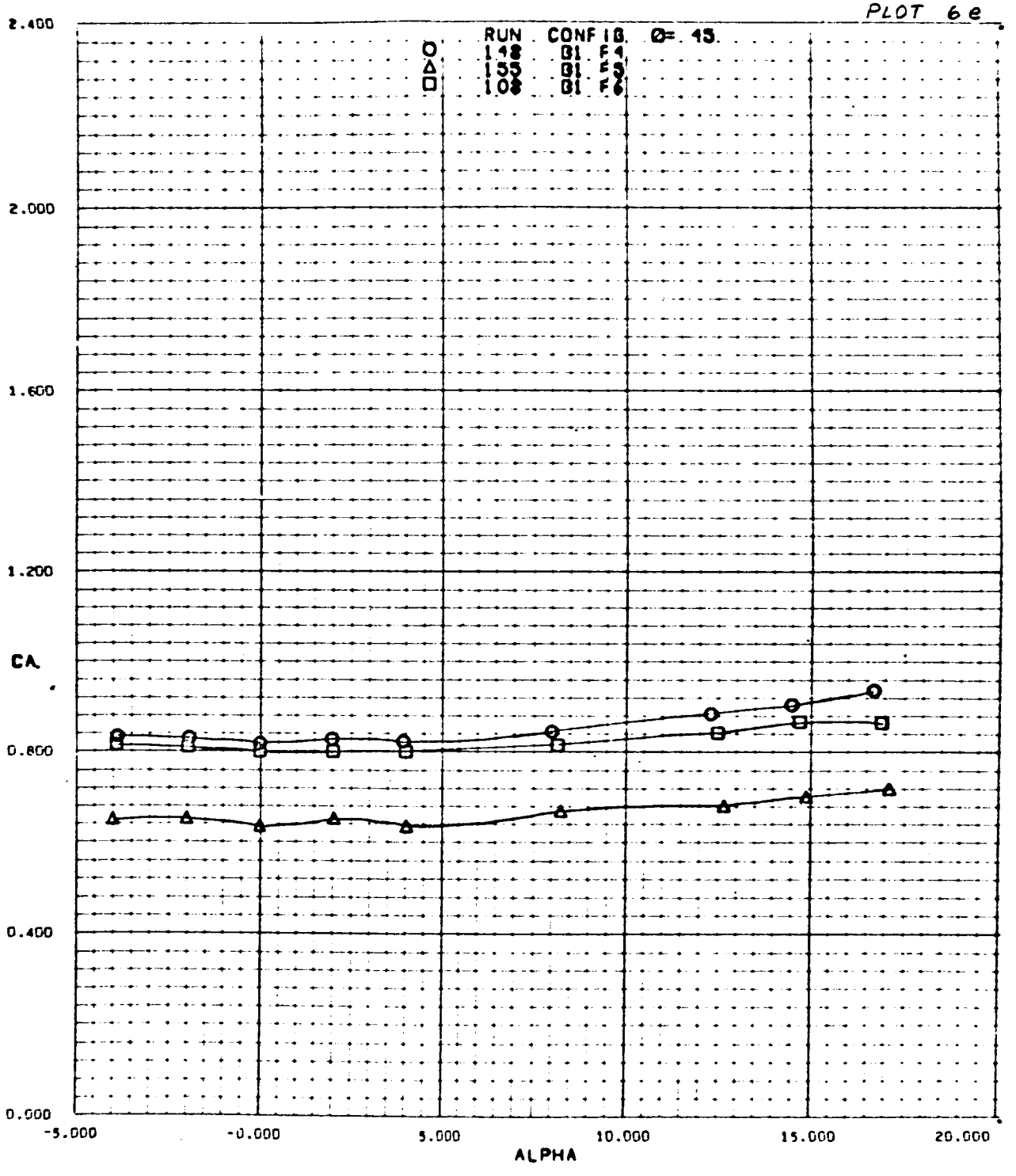
PLOT 6c


RUN CONFIG Ø= 15
148 B1 F4
155 B1 F5
108 B1 F6
2.000
-0.000
-2.000
-4.000
-6.000
-8.000
-10.000
CY
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

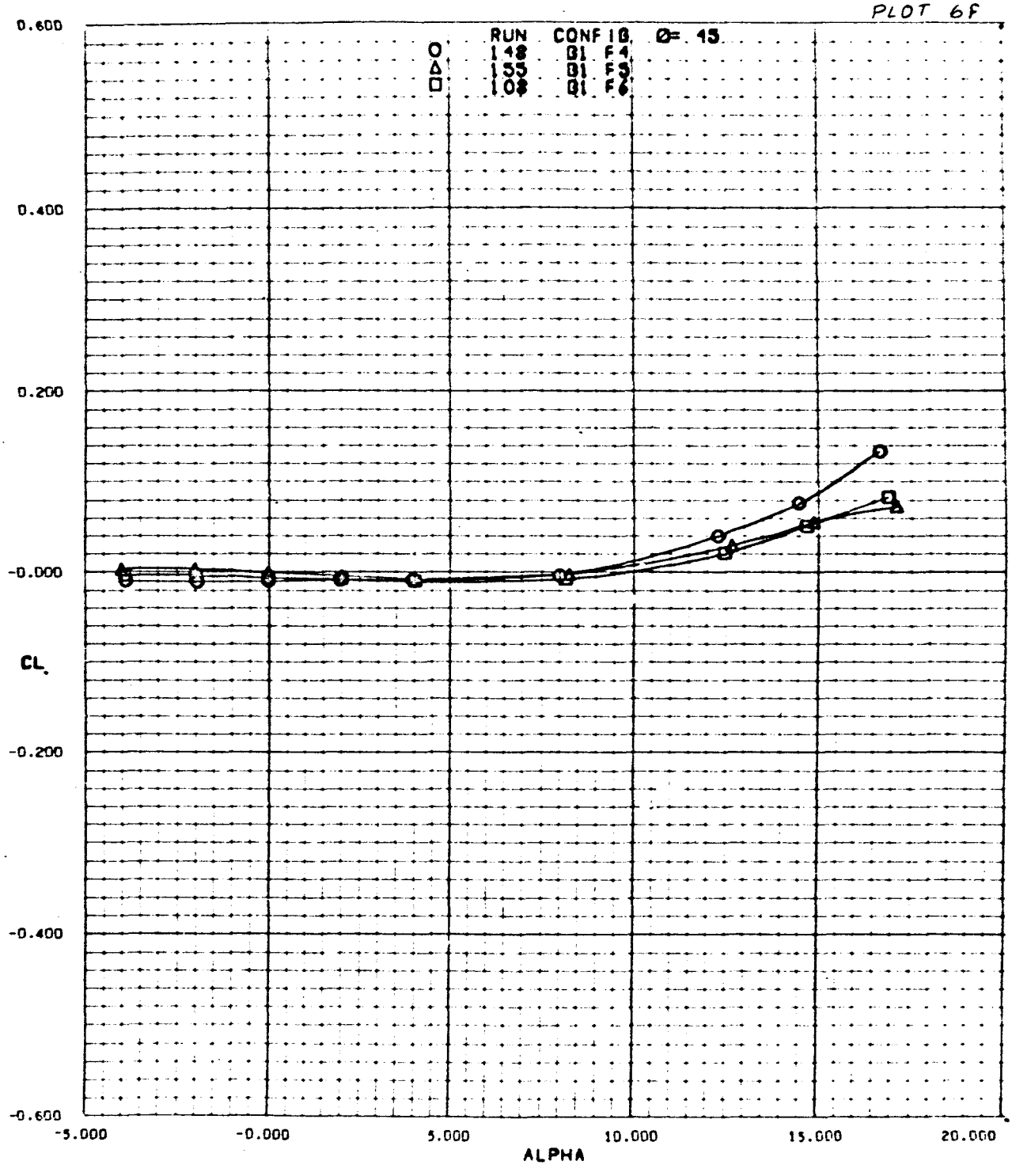
PLOT 6d


RUN CONFIG. Ø= 45.
○ 148 B1 F4
△ 155 B1 F5
□ 108 B1 F6
80.000
60.000
40.000
20.000
CNCB
-0.000
-20.000
-40.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

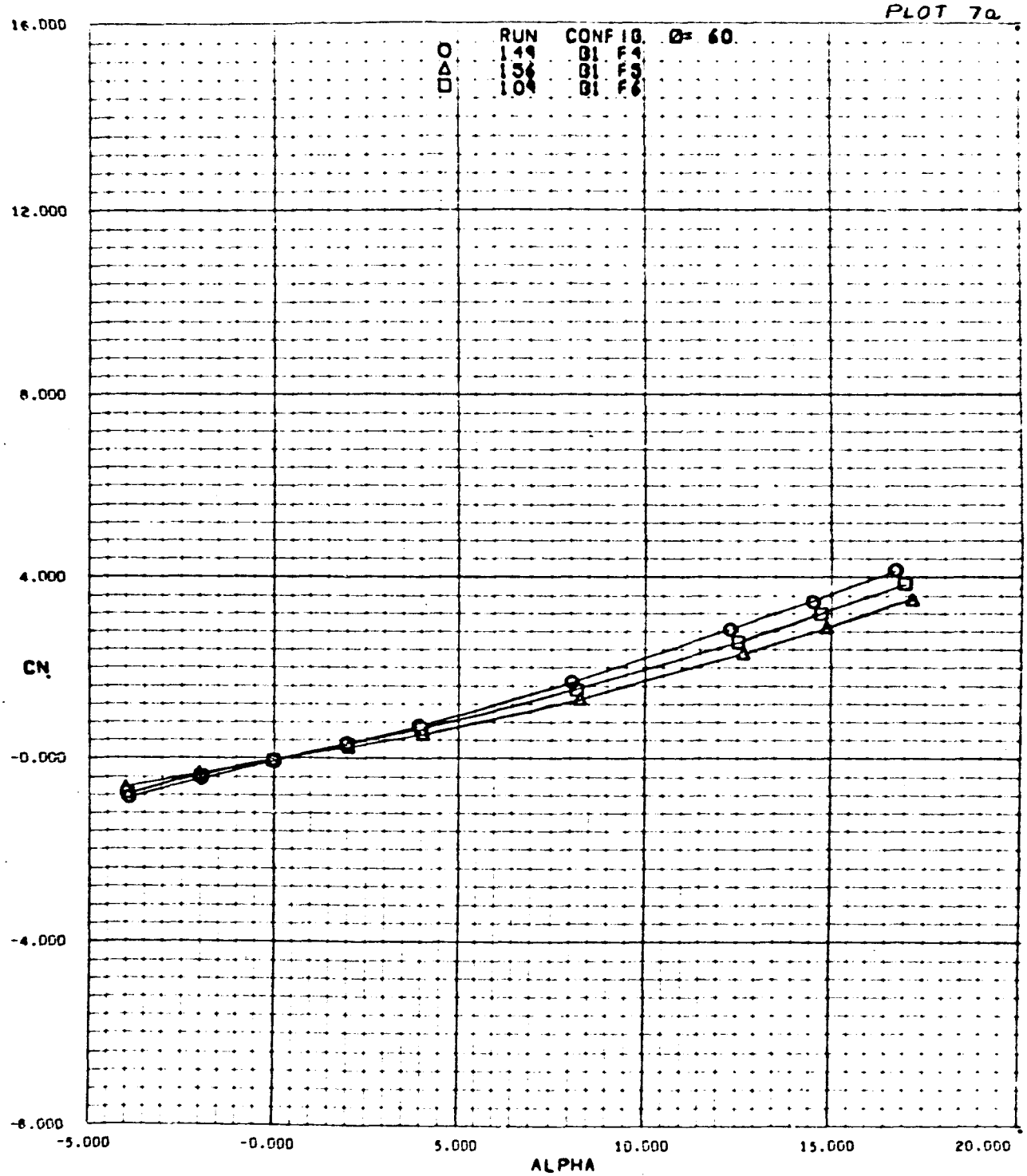
PLOT 6e


RUN CONFIG. Ø= 45.
148 B1 F4
155 B1 F5
108 B1 F6
2.400
2.000
1.600
1.200
CA
0.800
0.400
0.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

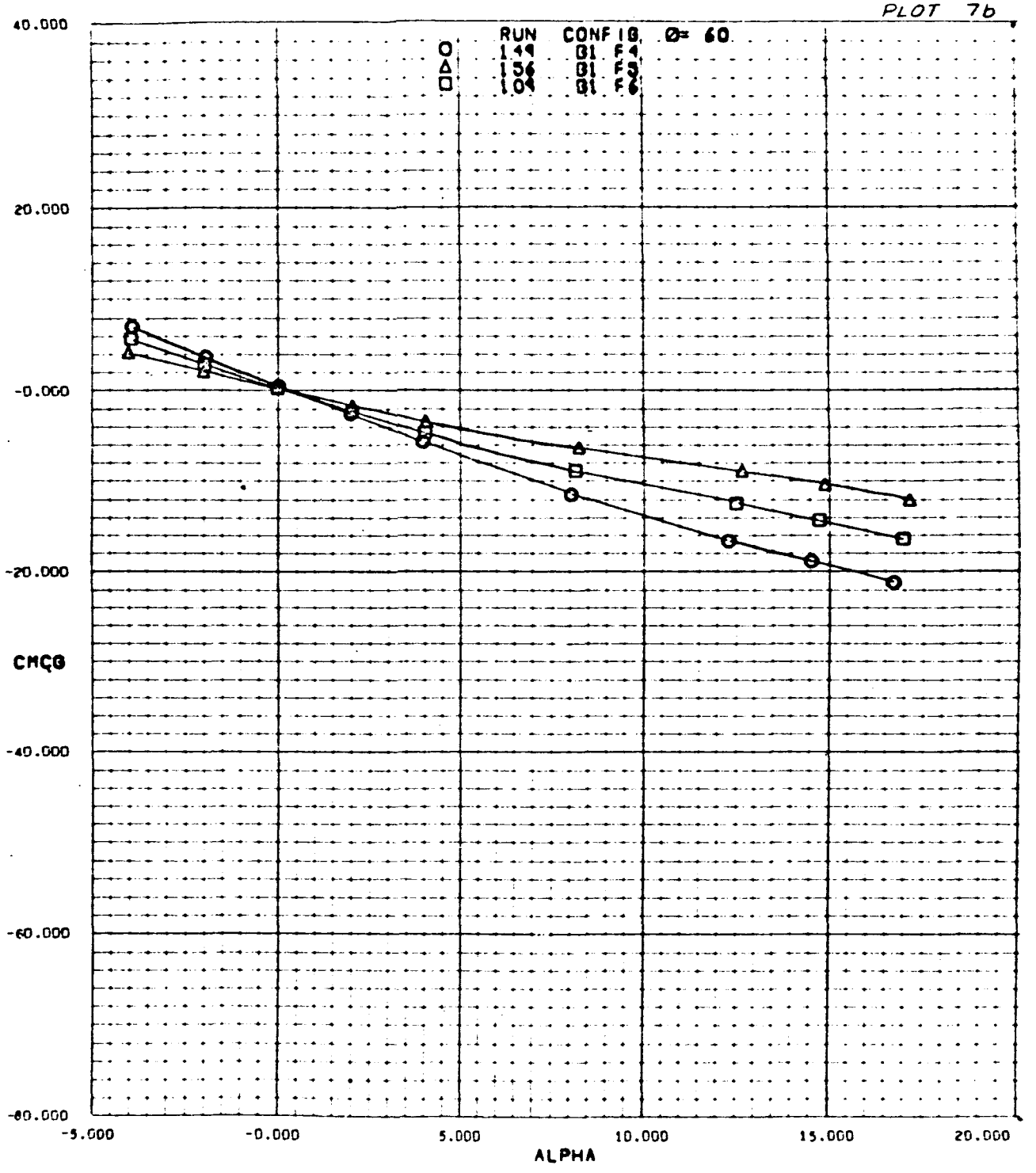
PLOT 6F


RUN CONFIG Ø= 45
148 B1 F4
155 B1 F5
108 B1 F6
0.600
0.400
0.200
-0.000
-0.200
-0.400
-0.600
CL
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

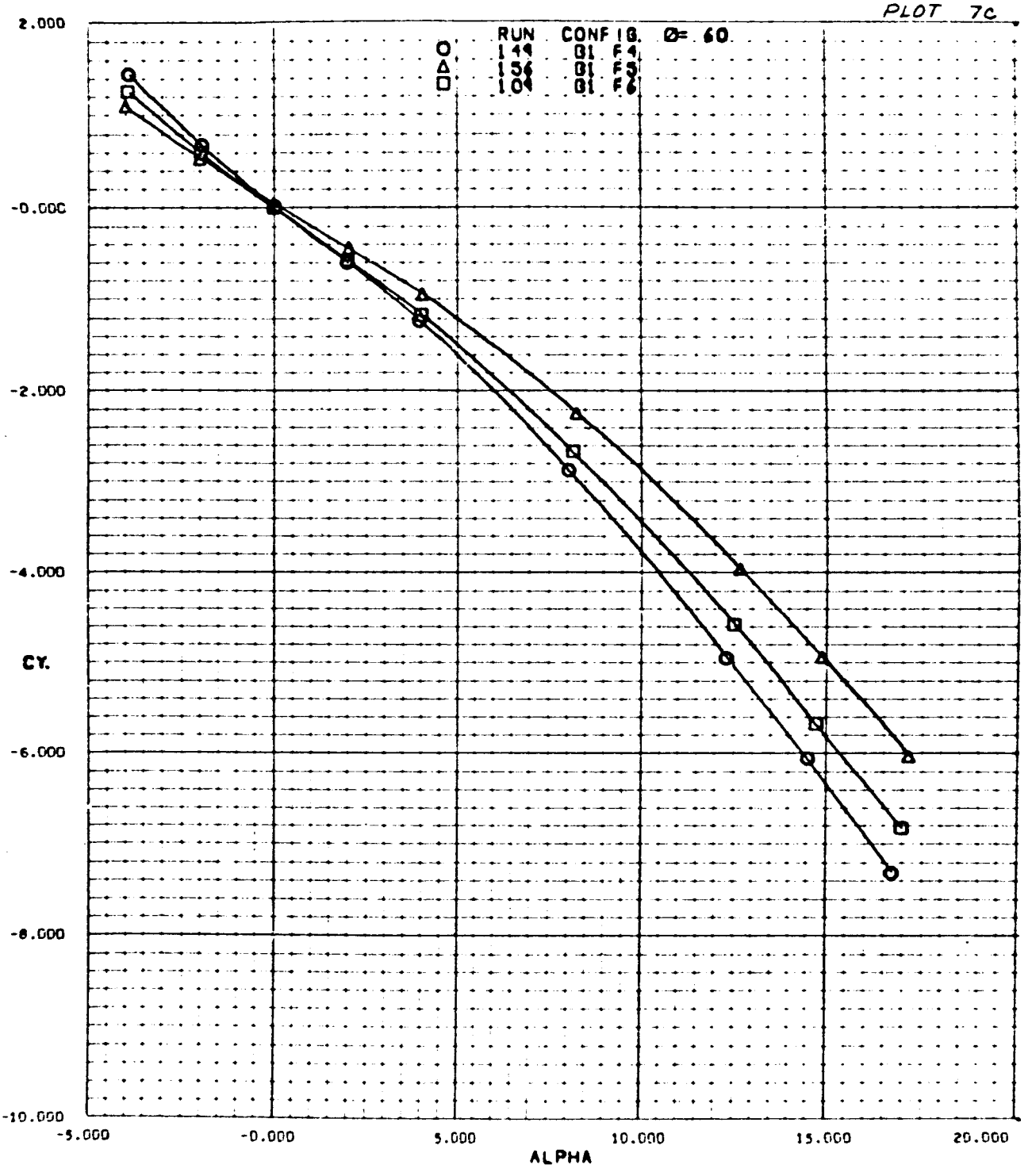
PLOT 7a


RUN CONFIG. Ø= 60.
○ 149 B1 F4
△ 156 B1 F5
□ 109 B1 F6
16.000
12.000
8.000
4.000
-0.000
-4.000
-8.000
CN
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

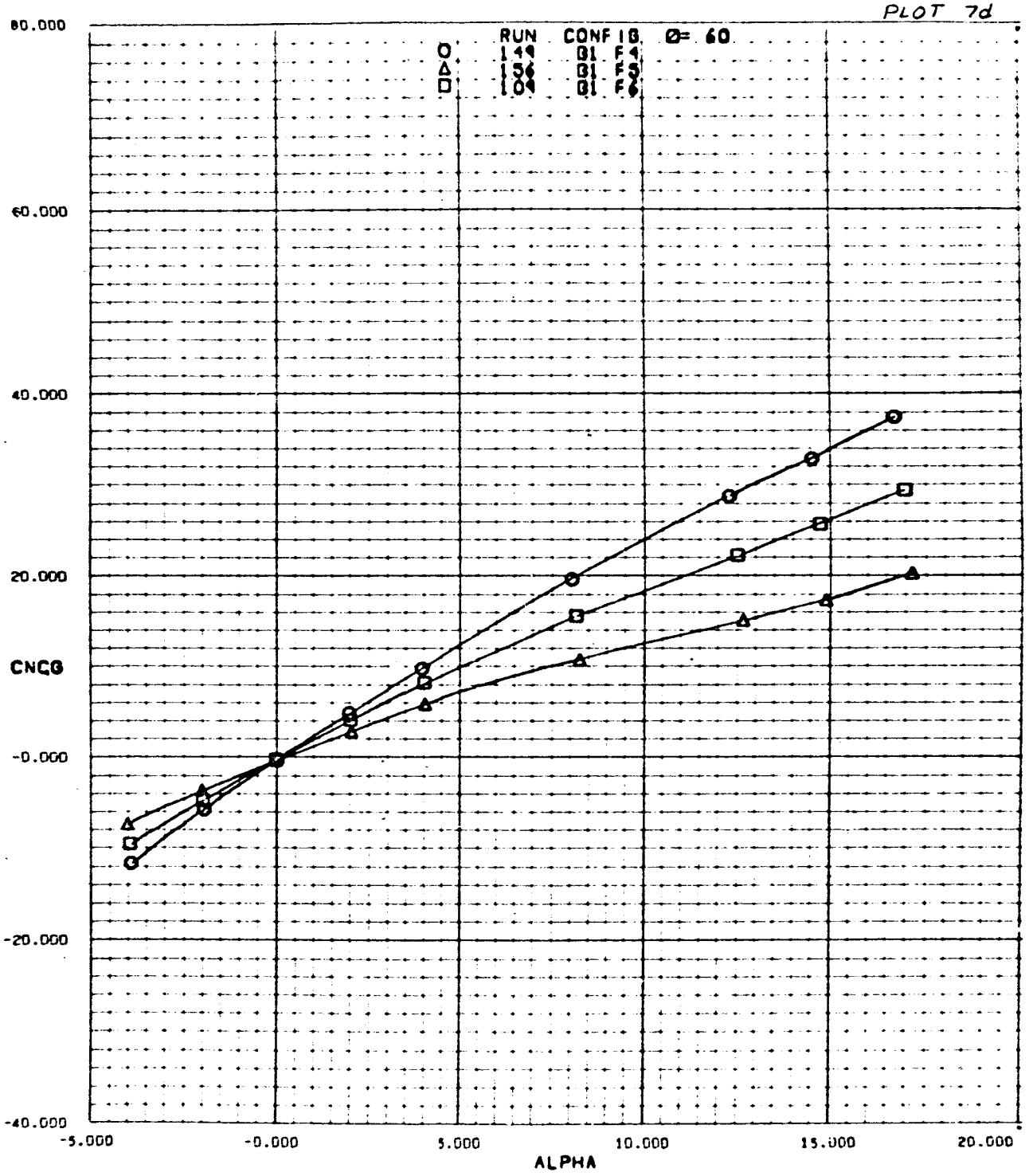
PLOT 7b


RUN CONFIG Ø= 60
○ 149 B1 F4
△ 156 B1 F5
□ 104 B1 F6
40.000
20.000
-0.000
-20.000
-40.000
-60.000
-80.000
CMCG
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 7c

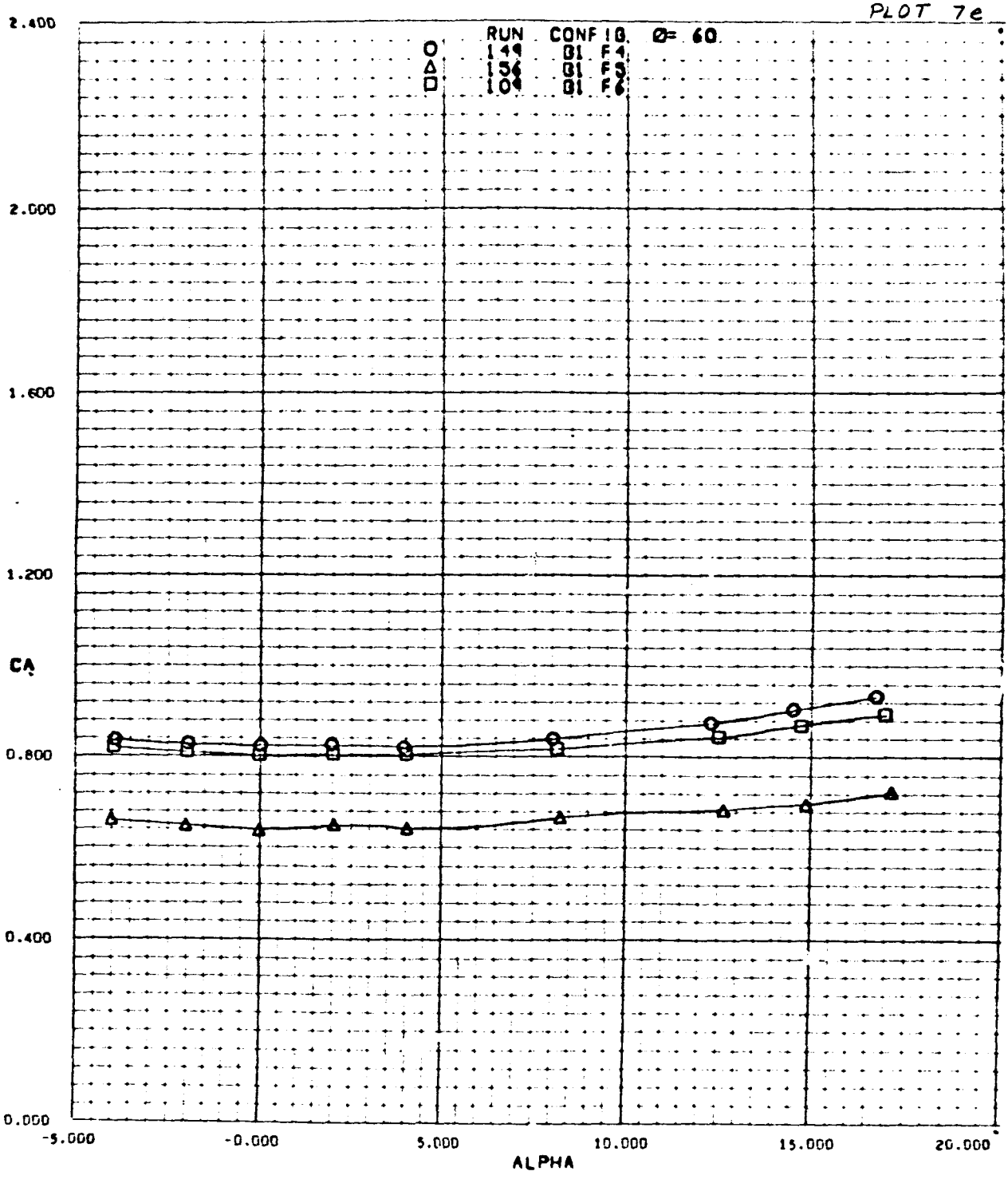

RUN CONFIG. Ø= 60
149 B1 F4
156 B1 F5
104 B1 F6
2.000
-0.000
-2.000
-4.000
CY.
-6.000
-8.000
-10.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 7d

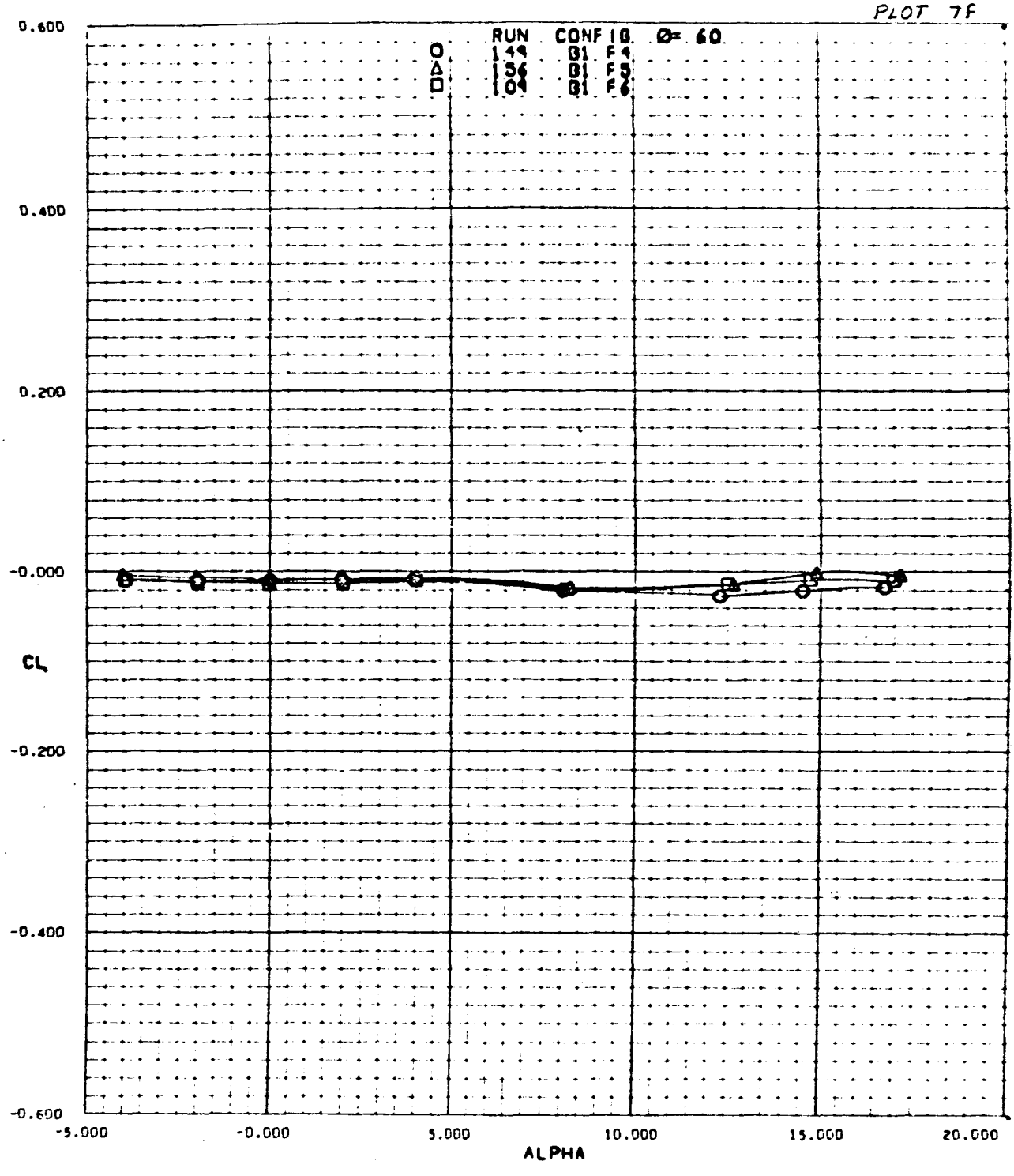

RUN CONFIG. Ø= 60
149 B1 F4
156 B1 F5
104 B1 F6
60.000
40.000
20.000
CNCG
-0.000
-20.000
-40.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

40

PLOT 7e


RUN CONFIG. Ø= 60.
144 B1 F4
156 B1 F5
104 B1 F6
2.400
2.000
1.600
1.200
CA
0.800
0.400
0.000
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA

PLOT 7F


RUN CONFIG. Ø= 60
○ 149 B1 F4
△ 156 B1 F5
□ 104 B1 F6
0.600
0.400
0.200
-0.000
-0.200
-0.400
-0.600
CL
-5.000
-0.000
5.000
10.000
15.000
20.000
ALPHA