

QCX
Avro
CF105
P-Stab-146

FILE IN VAULT
UNCLASSIFIED

ANALYZED

C-105

P/STABILITY/146

OPEN CANOPY EFFECTS

Copy 8



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

ANALYZED

AIRCRAFT C-105

REPORT NO. P/Stability/146

FILE NO.

NO. OF SHEETS

TITLE

Classification cancelled / changed to Unclassified
By authority of AVRO Arrow Declassif. Board
Date 28 Jul 87
Signature [Signature] Co-Chairperson
Unit / Rank / Appointment DSIS 3

OPEN CANOPY EFFECTS



PREPARED BY J. Clark

DATE June 1957

CHECKED BY

DATE June 1957

SUPERVISED BY [Signature]

DATE June 1957

APPROVED BY [Signature]

DATE

~~CONFIDENTIAL~~

ISSUE NO.	REVISION NO.	REVISED BY	APPROVED BY	DATE	REMARKS

48009

8795248



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

REPORT NO. P/Stability/146

SHEET NO.

PREPARED BY

DATE

J. P. Clark

June 1957

CHECKED BY

DATE

OPEN CANOPY EFFECTS

1. Longitudinal Stability

1. a.c. and C_{M_0}
2. C_{L_α}
3. Drag

2. Directional Stability

1. C_{n_β}
2. C_{l_β}
3. C_{Y_β}
4. a_1 vertical tail

3. Canopy Hinge Moments

1. Hinge moments in pitch
2. Hinge moments in yaw

Classification cancelled / changed to Unclassified
By authority of AVRO Arrow Declassif. Board
Date 28 Jul 87
Signature *Blair*, Co-Chairperson
Unit / Rank / Appointment DSIS 3



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. P/Stability/146

SHEET NO.

AIRCRAFT:

C-105

OPEN CANOPY EFFECTS

PREPARED BY

DATE

J. Clark

June 1957

CHECKED BY

DATE

1. LONGITUDINAL STABILITY

1.1 a.c. and C_{M_0}

The effects of open canopy on pitching moment are minor. No appreciable change is apparent in the slope of C_M vs. C_L and therefore no change occurs in the position of the aerodynamic center. Comparisons are shown on sheets 1.1.1 to 1.1.3. A small positive change in C_{M_0} occurs with canopy open and this is plotted on sheet 1.1.4.

1.2 $C_{L\alpha}$

No effect. Comparisons are shown on sheets 1.2.1 to 1.2.3.

1.3 Drag

Drag is increased by opening the canopy as would be expected, but the increase with the rear canopy only open is slightly greater than the increase with both open. Comparisons are given in sheets 1.3.1 to 1.3.3 and the drag increments on sheet 1.3.4.

~~CONFIDENTIAL~~

AIR ROYAL CANADIEN LIMITEE
MONTREAL, QUEBEC

TECHNICAL DEPARTMENT

AIRCRAFT

C-105

OPEN CANOPY EFFECTS

REPORT NO. P/Stability/146

SHEET NO.

PREPARED BY

DATE

J. Clark

June 1957

CHECKED BY

DATE

2. LATERAL STABILITY2.1 $C_{n\beta}$

Opening the canopies reduces $C_{n\beta}$. See sheet 2.1.5.

Comparisons are shown on sheets 2.1.1 to 2.1.4.

2.2 $C_{l\beta}$

The effects of open canopy on $C_{l\beta}$ are negligible.

Comparisons are shown on sheets 2.2.1 to 2.2.4.

2.3 $C_{y\beta}$

The effects of open canopy on $C_{y\beta}$ are small,

since the increase in $C_{y\beta}$ due to canopy tends

to cancel the loss in tail lift effectiveness.

See sheet 2.3.5. Comparisons are shown on sheets 2.3.1 to 2.3.4.

2.4 $a_{1(V)}$

The loss in $a_{1(V)}$ due to open canopy is plotted

on sheet 2.4.5. Comparisons are shown on sheets

2.4.1 to 2.4.4.

~~CONFIDENTIAL~~



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

OPEN CANOPY EFFECTS

REPORT NO. P/Stability/146

SHEET NO.

PREPARED BY

DATE

J. Clark

June 1957

CHECKED BY

DATE

3. HINGE MOMENTS

Full scale canopy hinge moment is given by

$$HM = C_h \times q \times 15625 \text{ inch - pounds.}$$

The following plots are included in this section:

<u>Canopy Position</u>	<u>Canopy Leaf</u>	<u>Sheet</u>
------------------------	--------------------	--------------

3.1 Hinge Moment in Pitch

Both closed	Left forward	3.1.1
"	Right forward	3.1.2
"	Left rear	3.1.3
"	Right rear	3.1.4
F'w'd closed, rear open	Left forward	3.1.5
"	Right forward	3.1.6
"	Left rear	3.1.7
"	Right rear	3.1.8
Both open	Left forward	3.1.9
"	Right forward	3.1.10
"	Left rear	3.1.11
"	Right rear	3.1.12

3.2 Hinge Moment in Yaw

Both closed,	$\alpha = 2$	Left forward	3.2.1
"	"	Right forward	3.2.2
"	"	Left rear	3.2.3
"	"	Right rear	3.2.4
"	$\alpha = 10$	Left forward	3.2.5
"	"	Right forward	3.2.6
"	"	Left rear	3.2.7
"	"	Right rear	3.2.8
F'w'd closed, rear open, $\alpha = 2$	"	Left forward	3.2.9
"	"	Right forward	3.2.10
"	"	Left rear	3.2.11
"	"	Right rear	3.2.12
"	$\alpha = 10$	Left forward	3.2.13
"	"	Right forward	3.2.14
"	"	Left rear	3.2.15
"	"	Right rear	3.2.16

~~CONFIDENTIAL~~



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. P/Stability/146

SHEET NO. 1

AIRCRAFT

C-105

OPEN CANOPY EFFECTS

PREPARED BY

DATE

J. Clark

June 1957

CHECKED BY

DATE

Canopy Position

Canopy Leaf

Sheet

Both open,

$\alpha = 2$	Left forward	3.2.17
"	Right forward	3.2.18
"	Left rear	3.2.19
"	Right rear	3.2.20
$\alpha = 10$	Left forward	3.2.21
"	Right forward	3.2.22
"	Left rear	3.2.23
"	Right rear	3.2.24

~~CONFIDENTIAL~~

C - 10.5

CAL W/T TESTS (MARCH '57)

Cm wa Sl

($\sigma_{\theta} = 10^{\circ}$)



CONF'G - B4-1C1-XM

CANOPY

FWD	AFT	RUNS
%	%	%
□	□	□
△	△	△
3/3	3/3	3/3

JUNE '57

Run No
SYMBOL
MACH

D/STAR 1146 3.2.9

HN

PISTAR 1146

1.1.2

HN
MAY '57

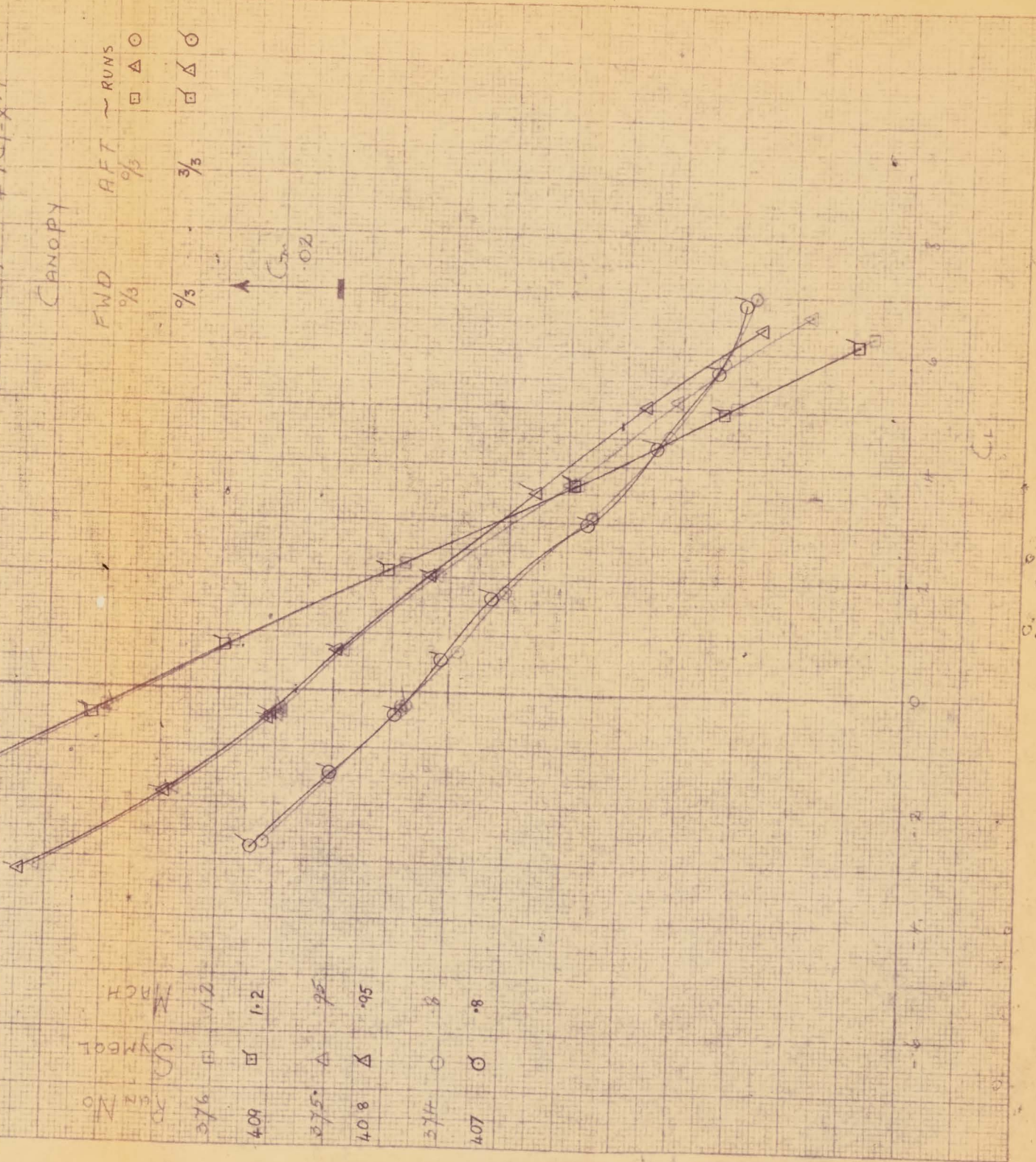
PISTAR 1146

1.1.1

JUNE '57

CANOPY

FWD
%
%
AFT
%
%
RUNS
□ Δ ○
□ Δ ○



Run No
Symbol
Mach

376	□	1.2
409	□	1.05
375	Δ	.95
408	Δ	.95
374	○	.8
407	○	.8

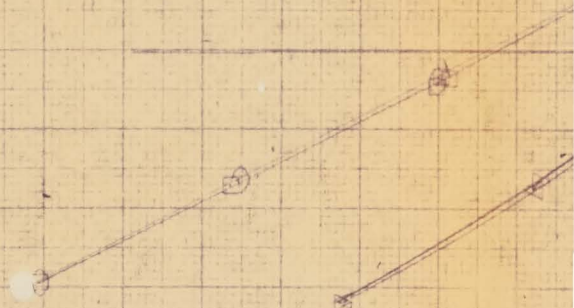
~~CONFIDENTIAL~~

C-105

CAL W/T TESTS (MARCH '87)

C_m vs C_l

($\delta_{\alpha} = 10^\circ$)



CONF'G - $B_4 - C_1 - X M$

CANOPY

	FWD	AFT
$\square \Delta \bigcirc$	$\frac{0}{3}$	$\frac{0}{3}$
$\bigcirc \nabla \bigcirc$	$\frac{3}{3}$	$\frac{3}{3}$

Run No
MACH
SYMBOL

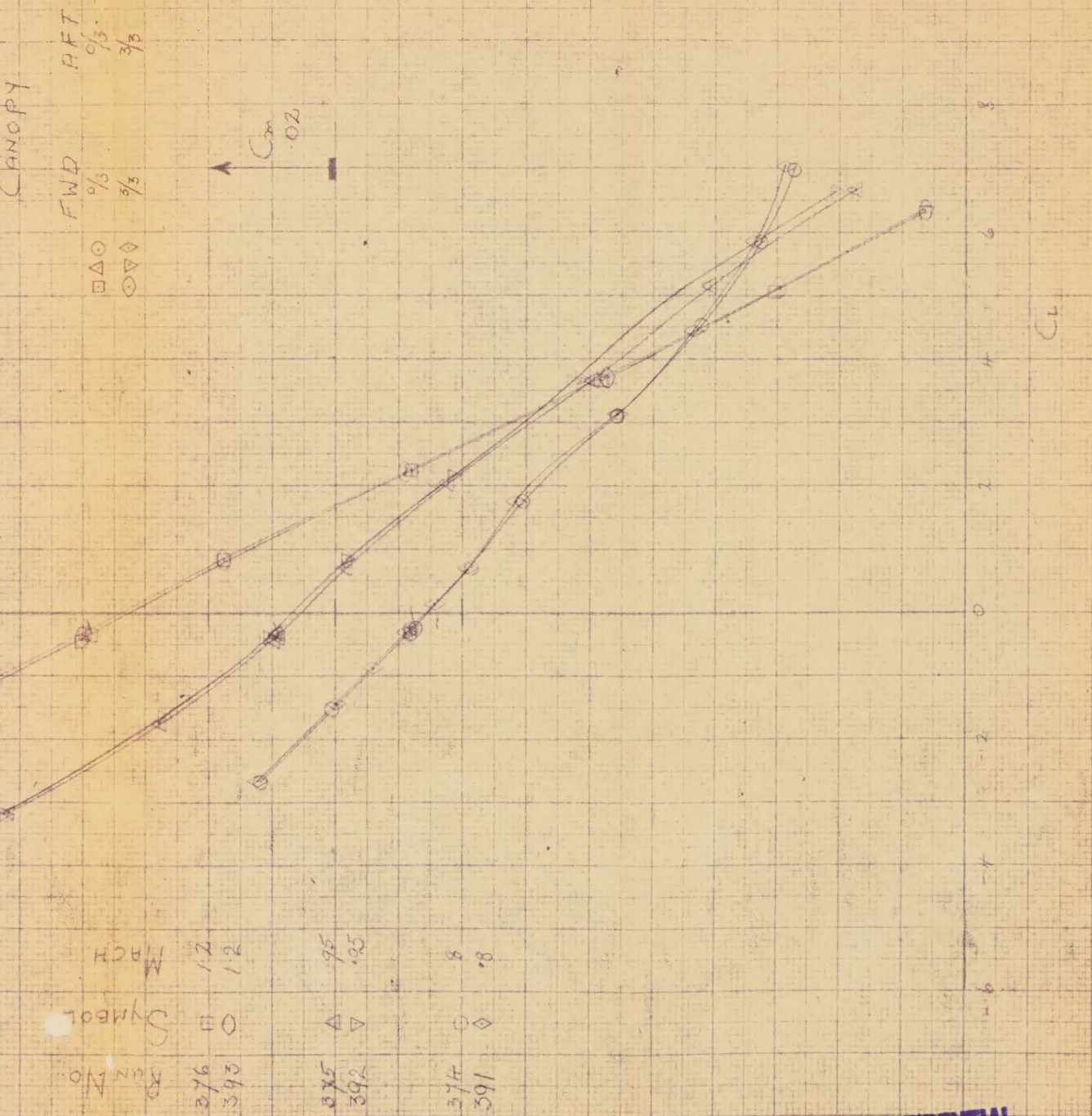
D/STAR 146 3.2.7

H.N.
May '57

PISTAR 146

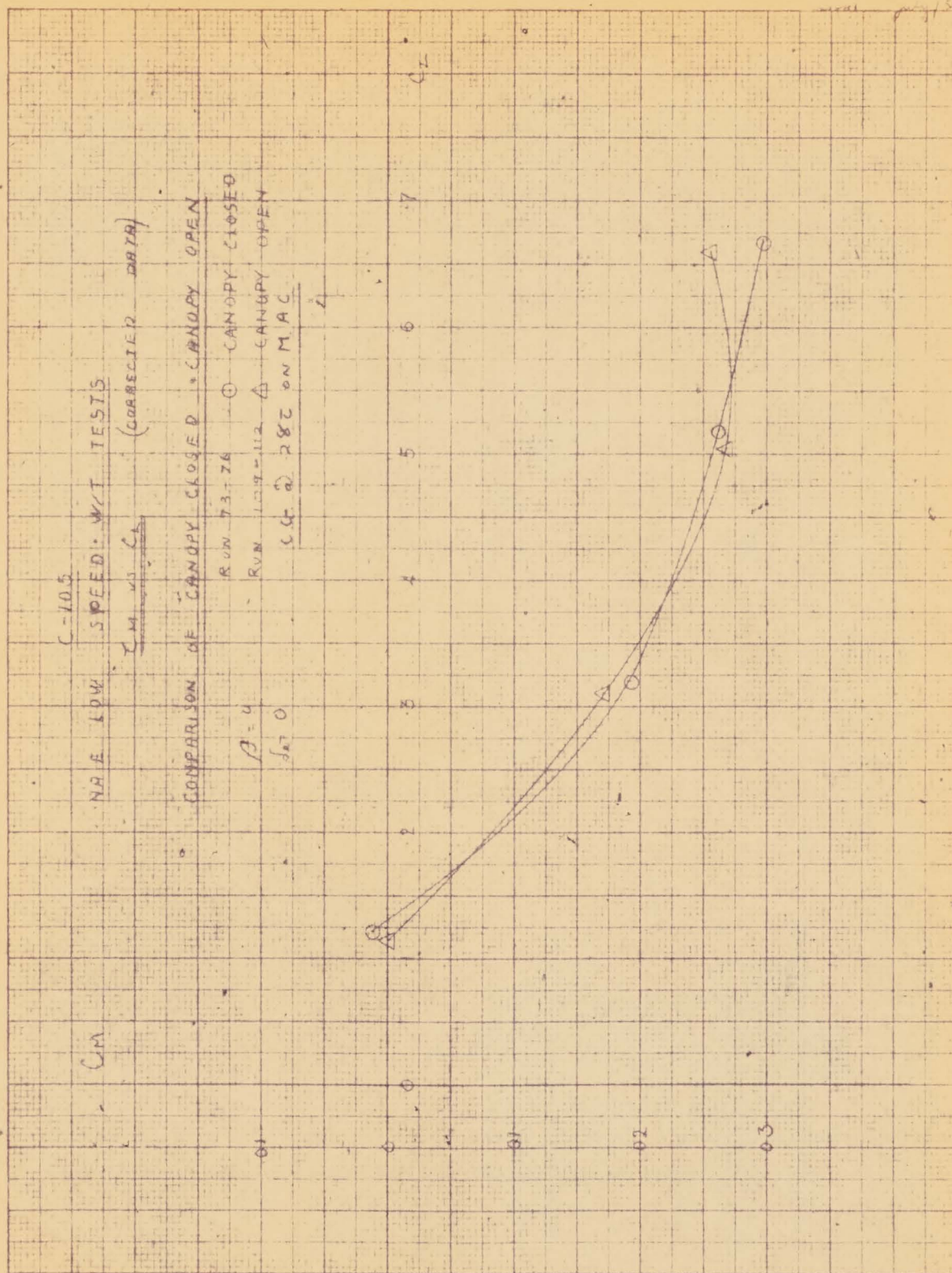
1.1.2

June 1957



~~CONFIDENTIAL~~

CONFIDENTIAL



P/WT/119

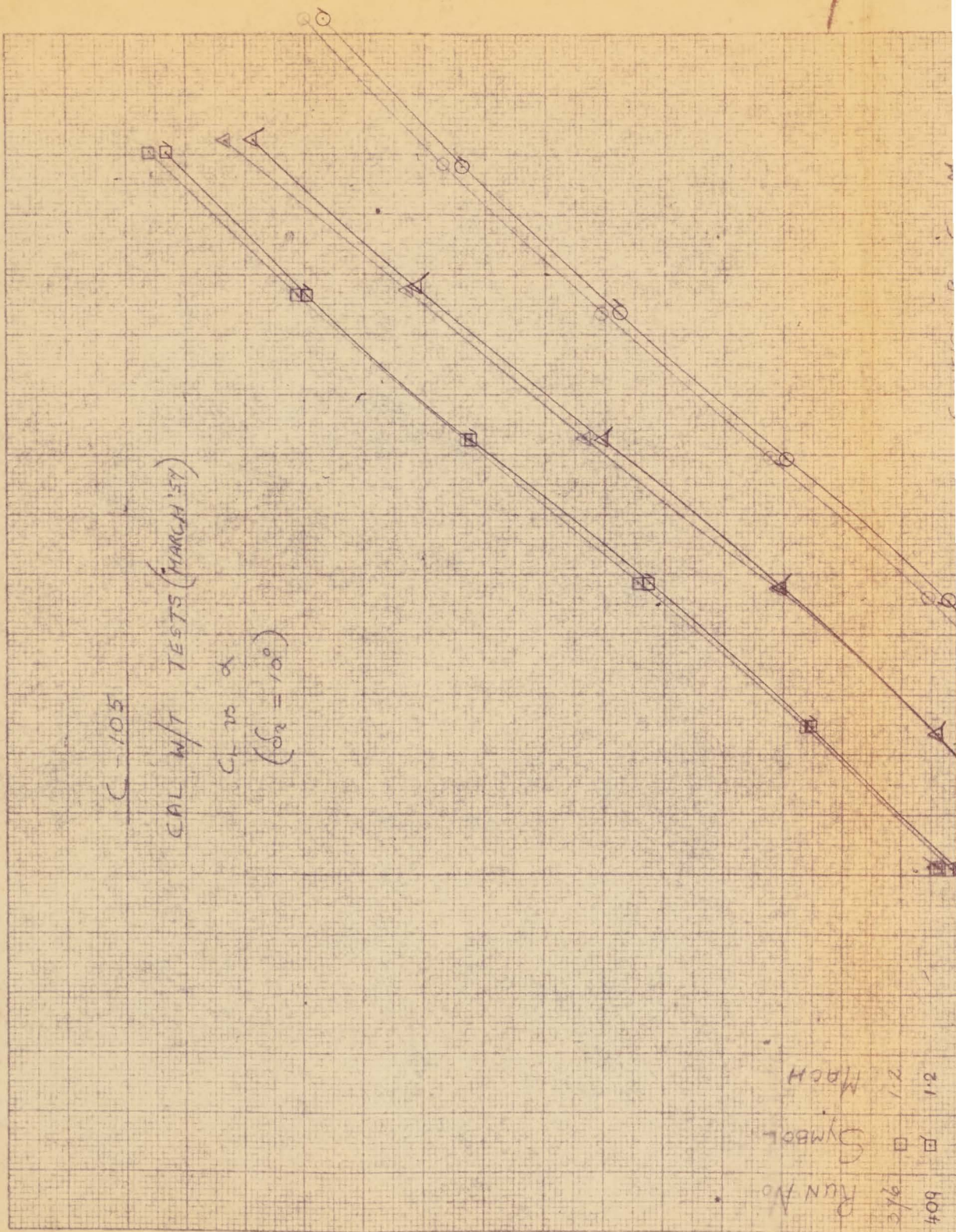
~~CONFIDENTIAL~~

MOE 10 X 10 TO THE 1/2 INCH 359-111L
KELUFFEL & ESSER CO. MADE IN U.S.A.

C-105

CAL W/T TESTS (MARCH 15)

$C_L = 10 \alpha$
($\alpha = 10^\circ$)



Run No. 0 100 200 300 400
Symbol $\square$ $\triangle$ $\circ$
Mach 0 0.4 0.8 1.2 1.6 2.0 2.1

C-105

CAL W/T TESTS (MARCH '59)

CL vs α

$$(g_2 = 10^0)$$

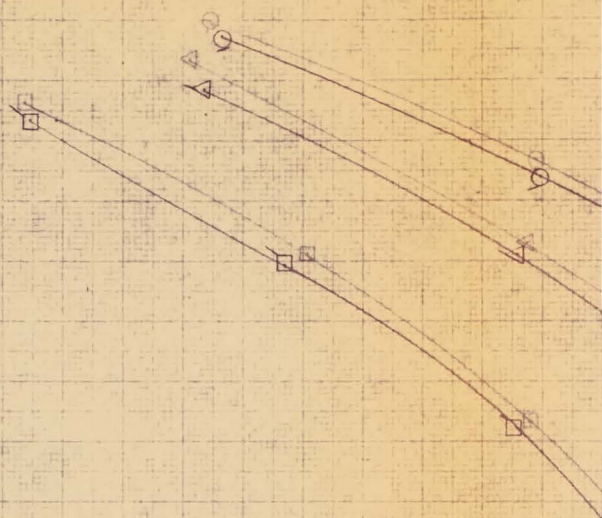
June '57

C-105
CAL. W/T TESTS (MARCH '57)
 $C_D \approx C_L$
($\delta_2 = 10^\circ$)

CONFIG: B4-C1-XM

CANOPY

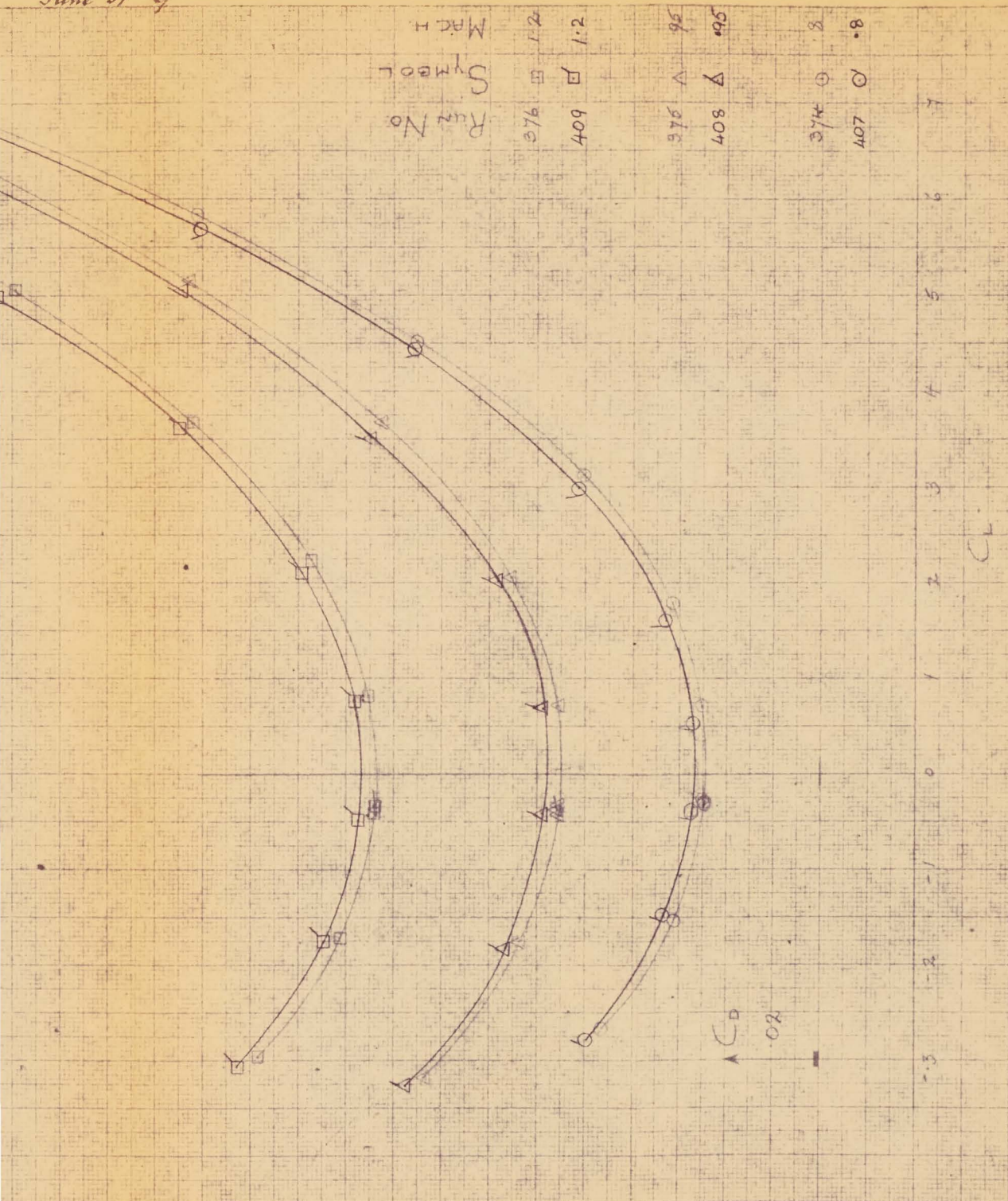
	FWD 1/3	AFT 2/3
1/3	○	○
2/3	△	△
3/3	□	□



W.H. INNES

HN.
May 57

June '57 C



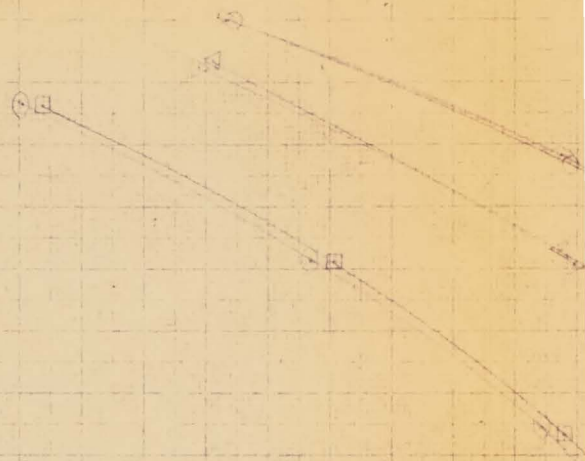
~~CONFIDENTIAL~~

C-105
 CAL W/T TESTS (MARCH '54)
 C_D vs C_L
 ($\delta_2 = 10^\circ$)

CONFIG: - B4-C1-XM

CANOPY

FWD	AFT	
$\frac{1}{3}$	$\frac{0}{3}$	$\square \triangle \diamond$
$\frac{2}{3}$	$\frac{1}{3}$	$\circ \nabla \diamond$



C-105
EFFECTS OF CANOPY
 $\Delta C_{D_{MIN}}$ VS MACH NO.

CANOPY
EWD AFI
O OPEN OPEN
 Δ CLOSED OPEN

$\Delta C_{D_{MIN}}$

.006

.004

.002

0

2

4

6

8

10

12

14

16

18

20

MACH NO

Time

R.S.R.

P/Slide/116

1-3-4

~~CONFIDENTIAL~~

PLOT 259

C-105
C.A.L. W/T TESTS
(MARCH/57)

CONFIG: B₄-M C₁-x

C_n vs β

$\alpha \approx 12^\circ$

SEALS IN

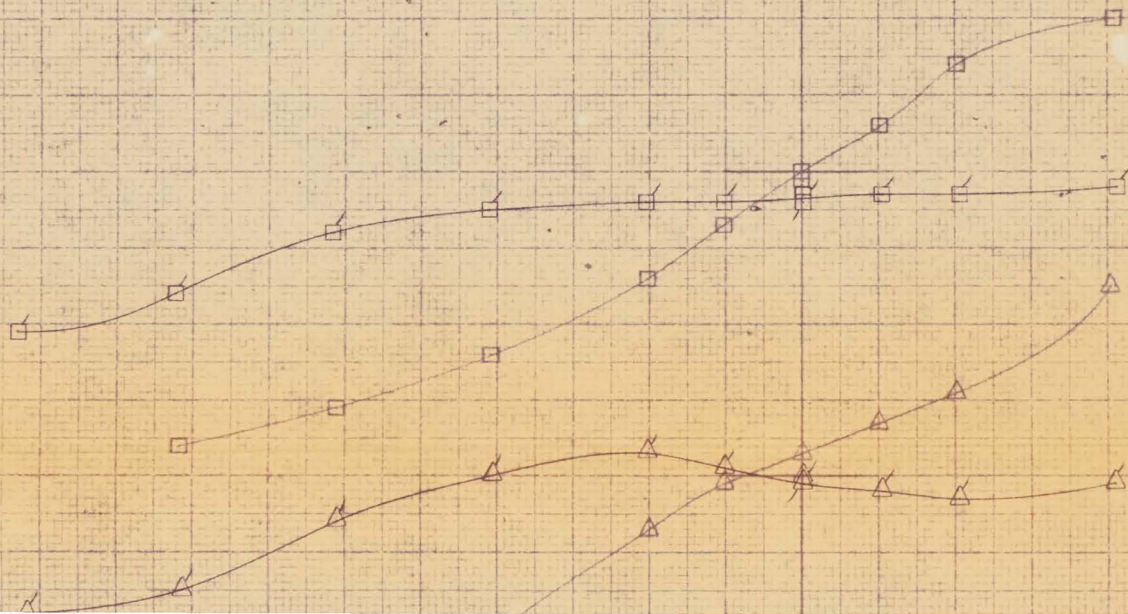
CG = 0.282 ON MAC

□ Δ □ CANOPIES CLOSED

○ Δ □ CANOPIES OPEN

C_n

SYMBOL	MACH N°	RUN N°
□	1.20	385
□		390
Δ	95	384
Δ		388



PLOT 258

C-105
C.A.L. W/T TESTS
(MARCH/57)

CONFIG: B4-1MC1-x

C_n vs β

$\alpha \approx 2.5^\circ$

SEALS IN

$CG = 0.28\bar{c}$ ON M.A.C.

○ △ □ CANOPIES CLOSED

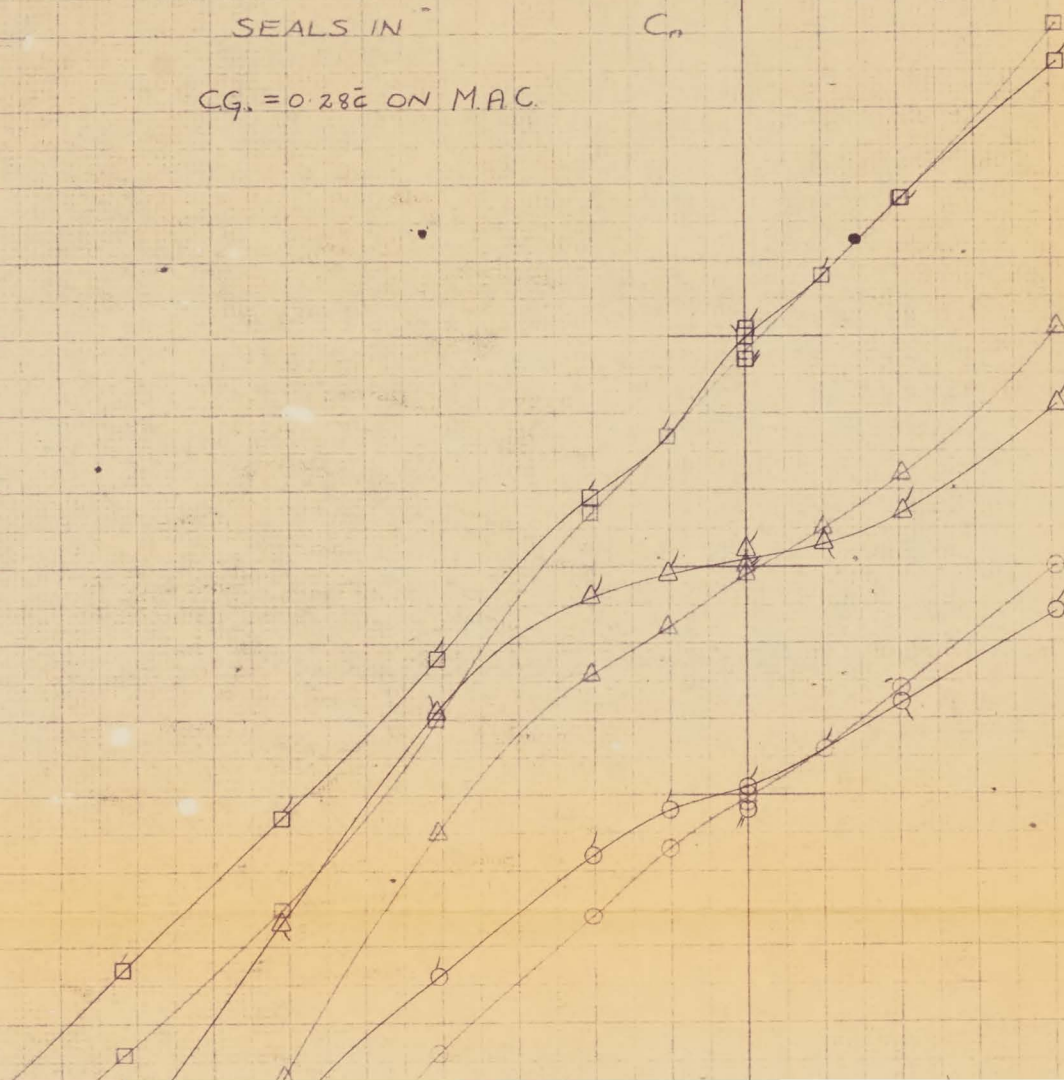
○-△ □ FWD CLOSED
AFT OPEN

SYMBOL
MACH N°
RUN N°

□ 1-20 382
□ 402

△ 95 378
△ 400

○ 80 377
○ 399



PLOT 259

C-105
C.A.L. W/T TESTS
(MARCH/57)

CONFIG: B₄-M C₁-X

C_n vs β

$\alpha \doteq 12^\circ$

SEALS IN

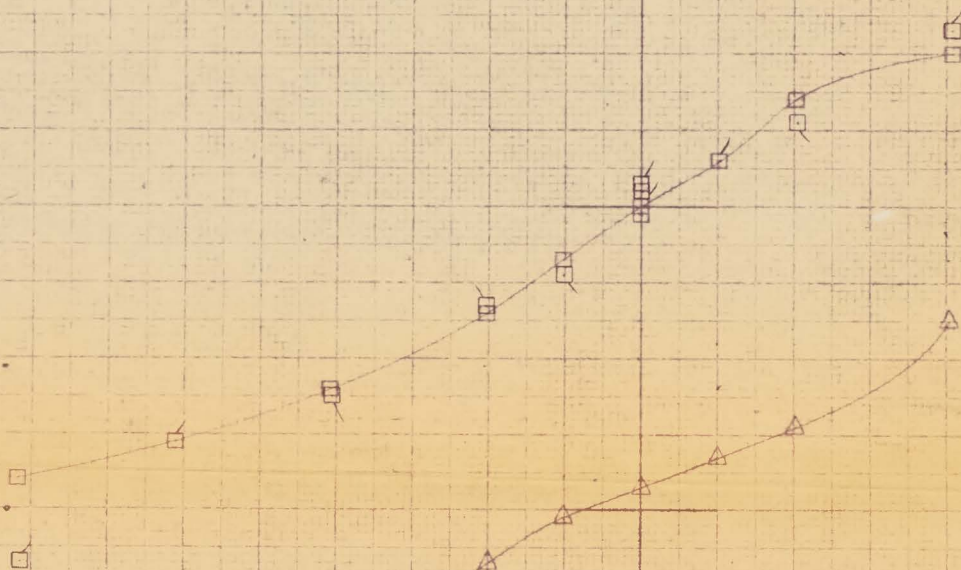
CG = 0.282 ON M.A.C.

○ Δ □ CANOPIES CLOSED

○ Δ □ FWD CLOSED
AFT OPEN

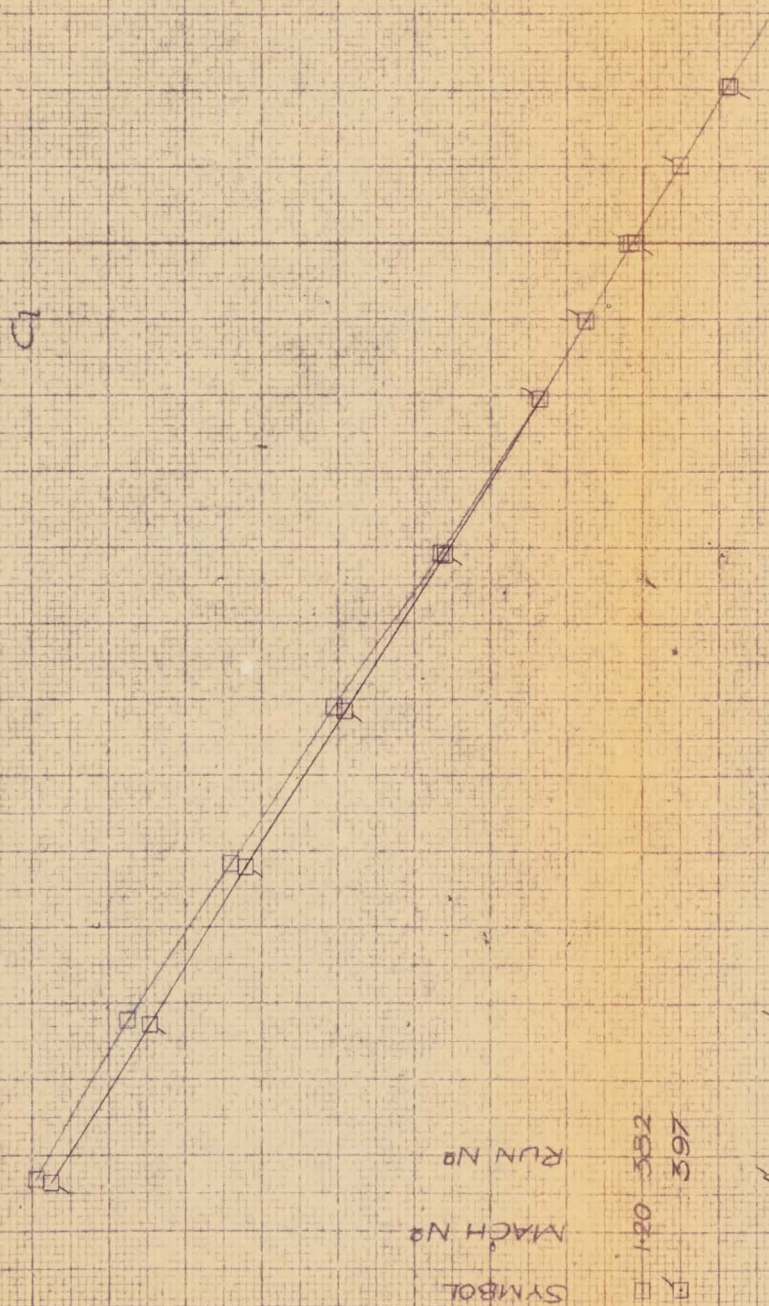
C_n

SYMBOL	MACH N°	RUN N°
□	1.20	385
□		406
Δ	0.95	384
Δ		404



PLOT 262

C-105
CAL W/T TESTS
(MARCH/57)
 C_L vs β
 $\alpha \doteq 2.5^\circ$
SEALS IN
CG = 0.28E ON MAC
CONFIG: B4-1, MC1-x
CANOPIES CLOSED
CANOPIES OPEN

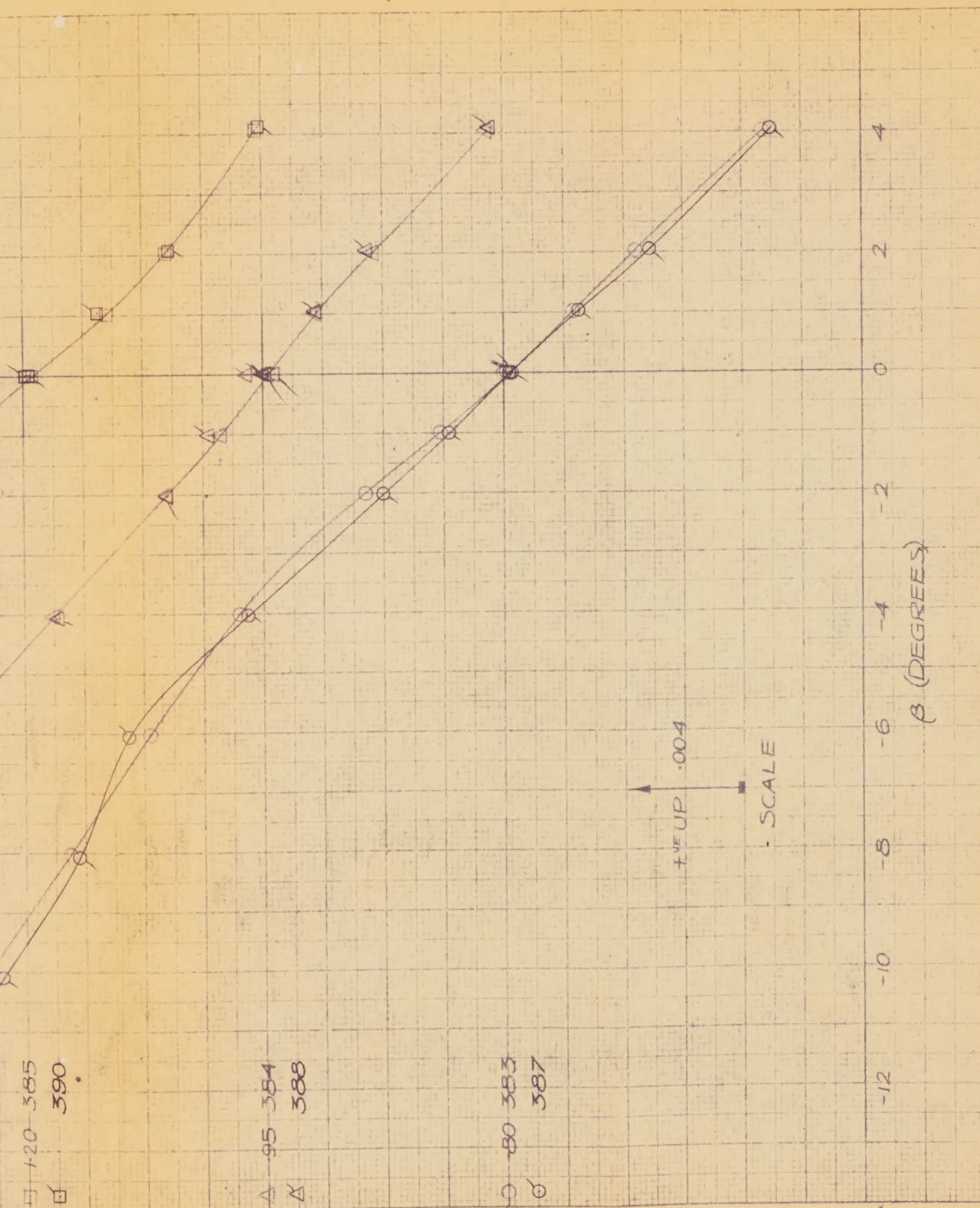


D/STAN 1116 3.2.9

W. H. INNES
APR 157

$p/S_{kl}/1+6$

2.2.2



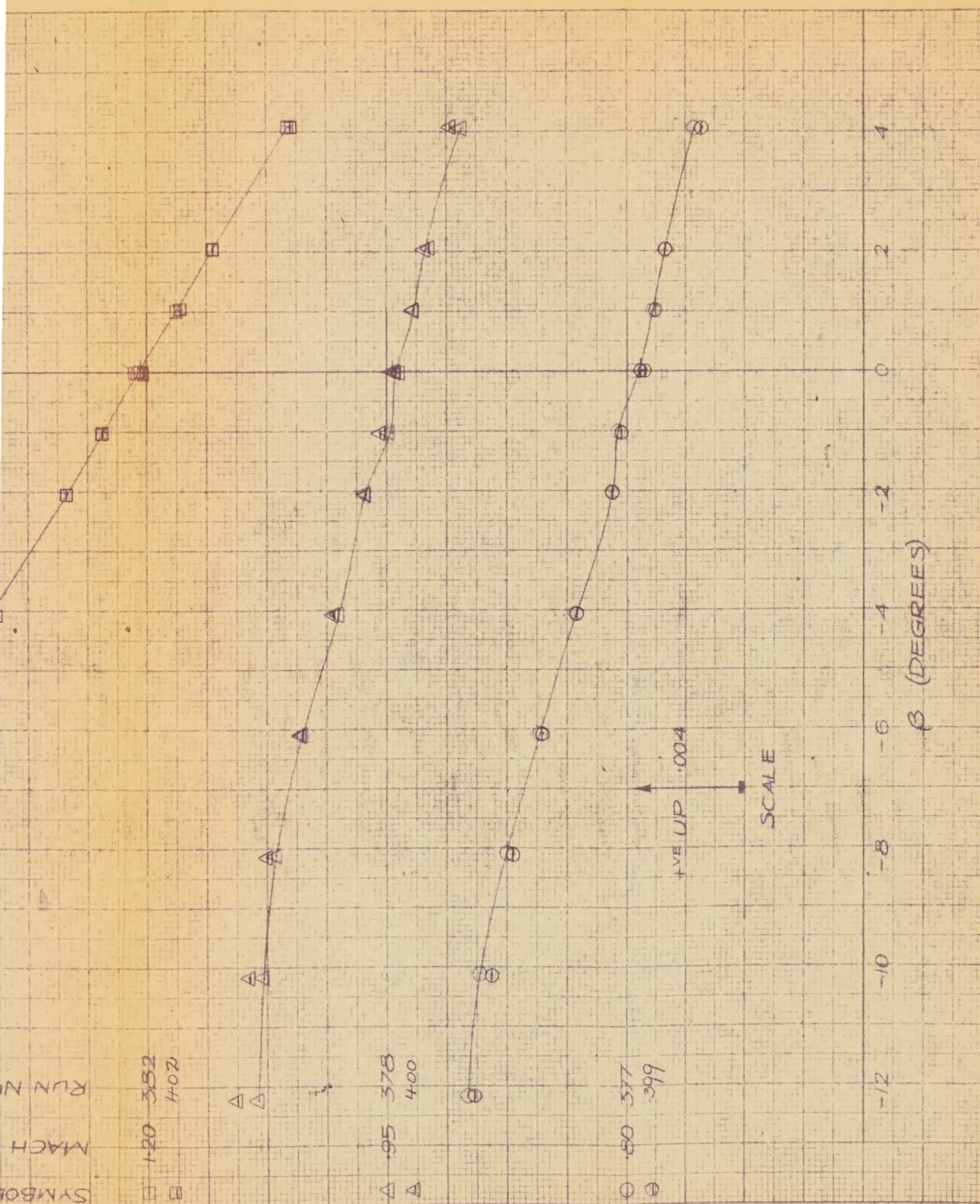
~~CONFIDENTIAL~~

12/STAN 146 3.2.9

W. H. INNES
APR/57

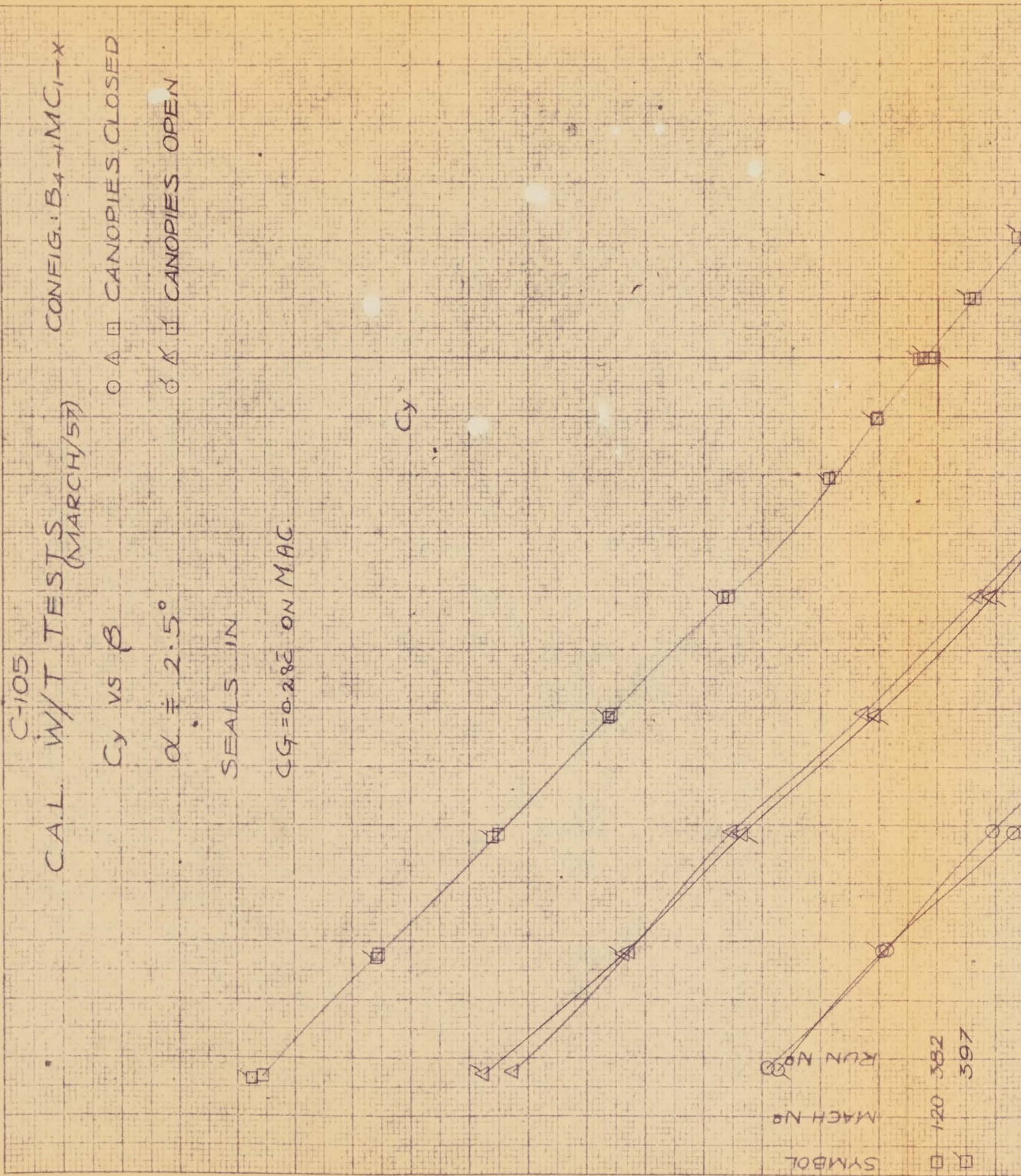
P/Stal/14-6

2.2.4

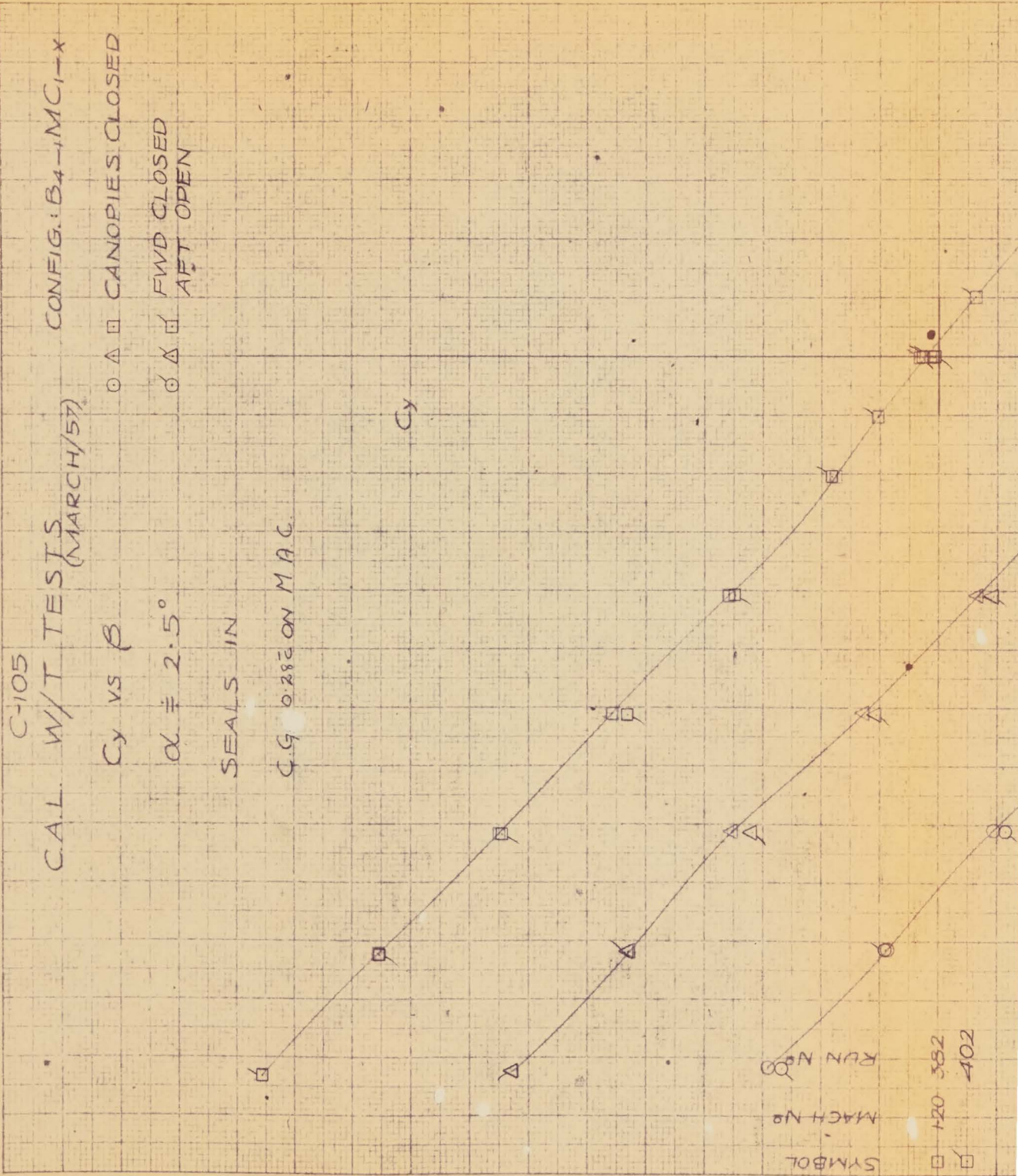


~~CONFIDENTIAL~~

PLOT 260

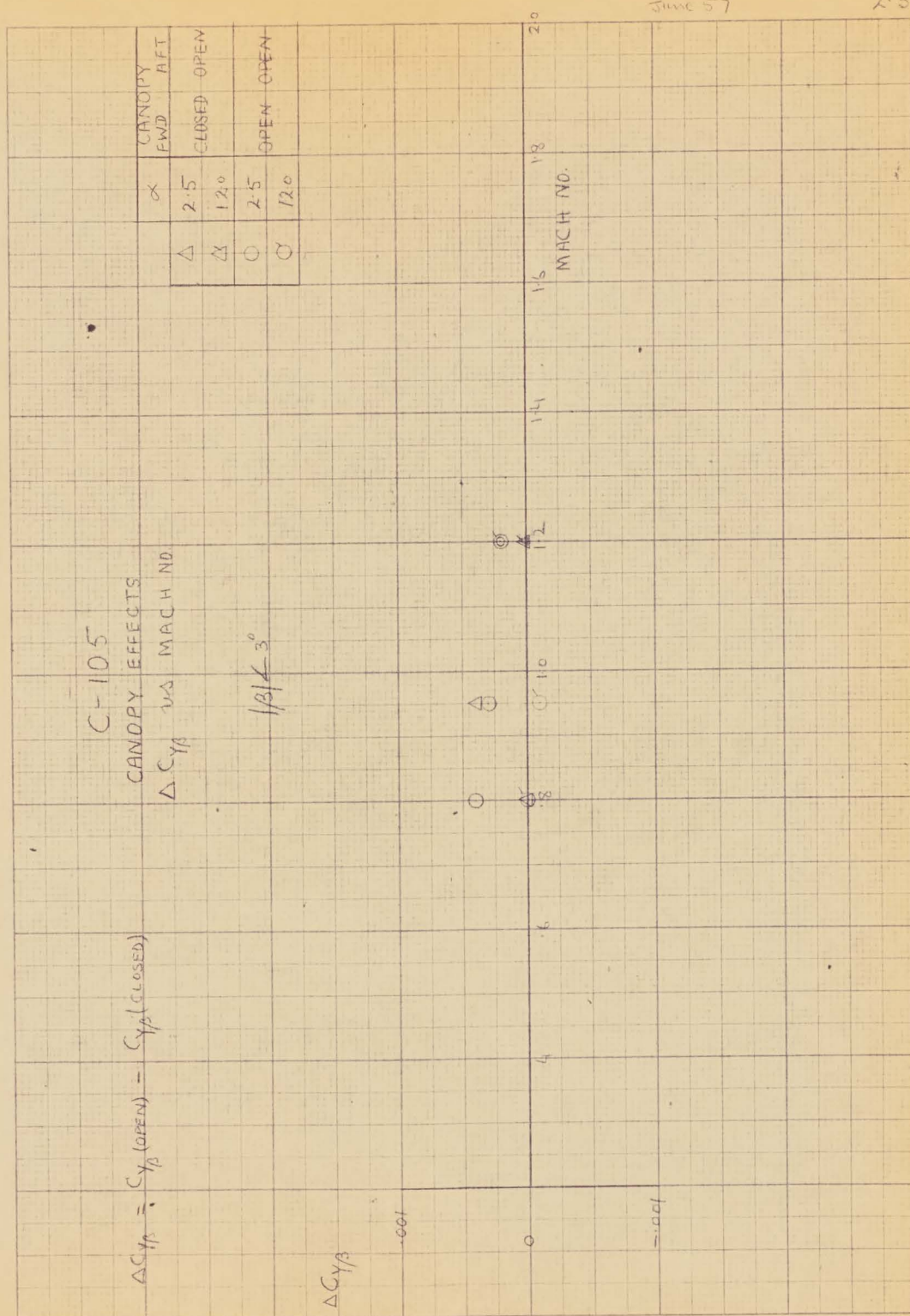


PLOT 260



RSR
JUNE 57

P/STAB/146
2.3.5



PLOT 253

C-105
CAL W/T TESTS
(MARCH/57)

CONFIG: B₄-1MC₁-X

$C_Y(V)$ vs. β

⊕ △ □ CANOPIES CLOSED

$\alpha \doteq 12^\circ$

⊕ △ □ CANOPIES OPEN

SEALS IN

$C.G. = 0.28\bar{E}$ ON M.A.C.

$C_Y(V)$

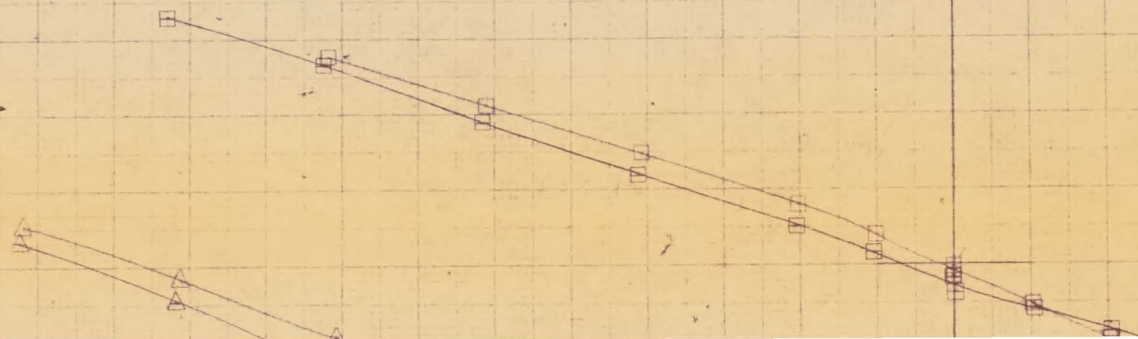
SYMBOL

MACH N^o

RUN N^o

□ 1.20 385

390



PLOT 252

C-105
CAL. W/T TESTS
(MARCH/57)

CONFIG: B₄-1 MC₁-x

C_{y(w)} VS β

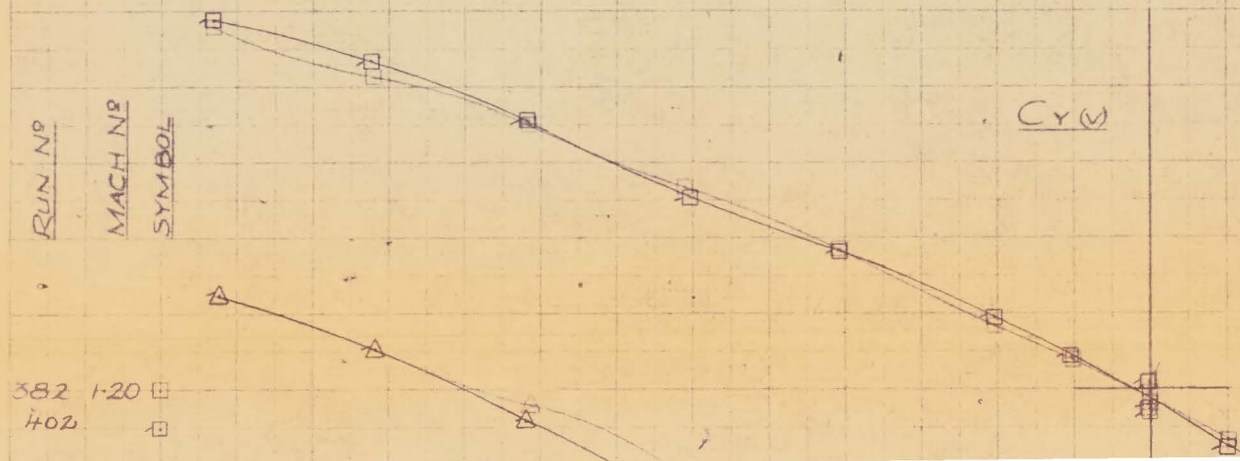
○ △ □ CANOPIES CLOSED

$\alpha \doteq 2.5^\circ$

⊕ △ ⊞ CANOPIES F_{9/3} A_{3/3}

SEALS IN

C.G. = 0.282 ON M.A.C.



PLOT 253

C-105
C.A.L. W/T TESTS
(MARCH/57)

CONFIG: B₄-1MC1-X

C_y(V) vs β

$\alpha \div 12^\circ$

SEALS IN

C.G. = 0.28E ON M.A.C.

○ △ □ CANOPIES CLOSED

○ △ □ CANOPIES F_{9/3} A_{5/3}

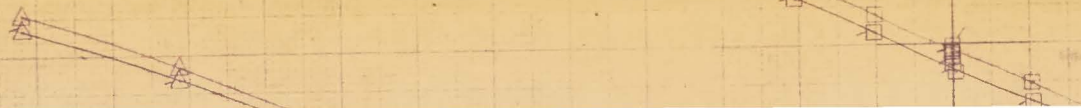
C_y(V)

SYMBOL

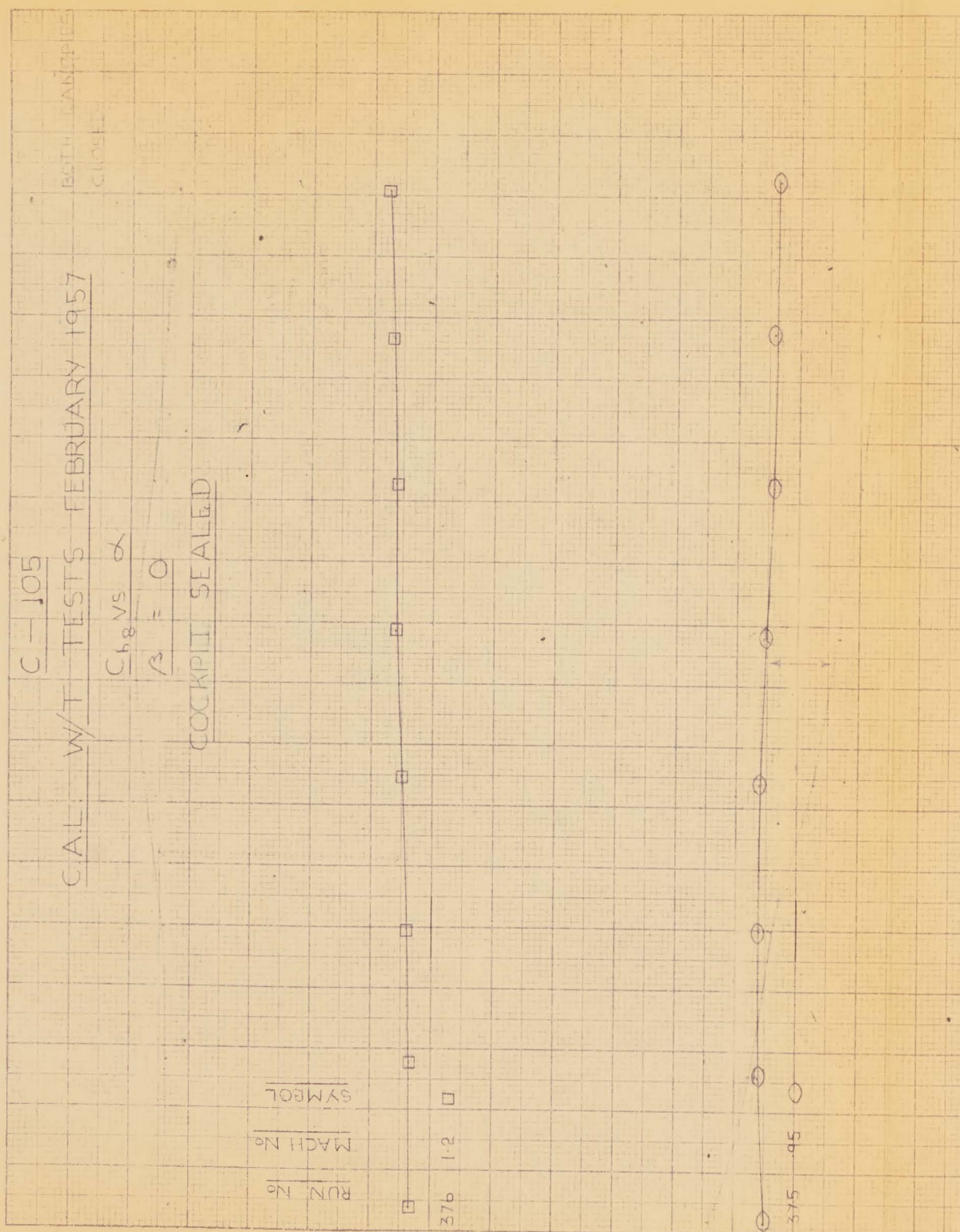
MACH No

RUN No

120 385



PHOT 234



K&E 10X10 TO THE 1/2 INCH
 REUPPEL & JESSER CO.
 359-411L
 4477 A 112

PLOT 237

1507-1 CANONIQUE
 CLOSED

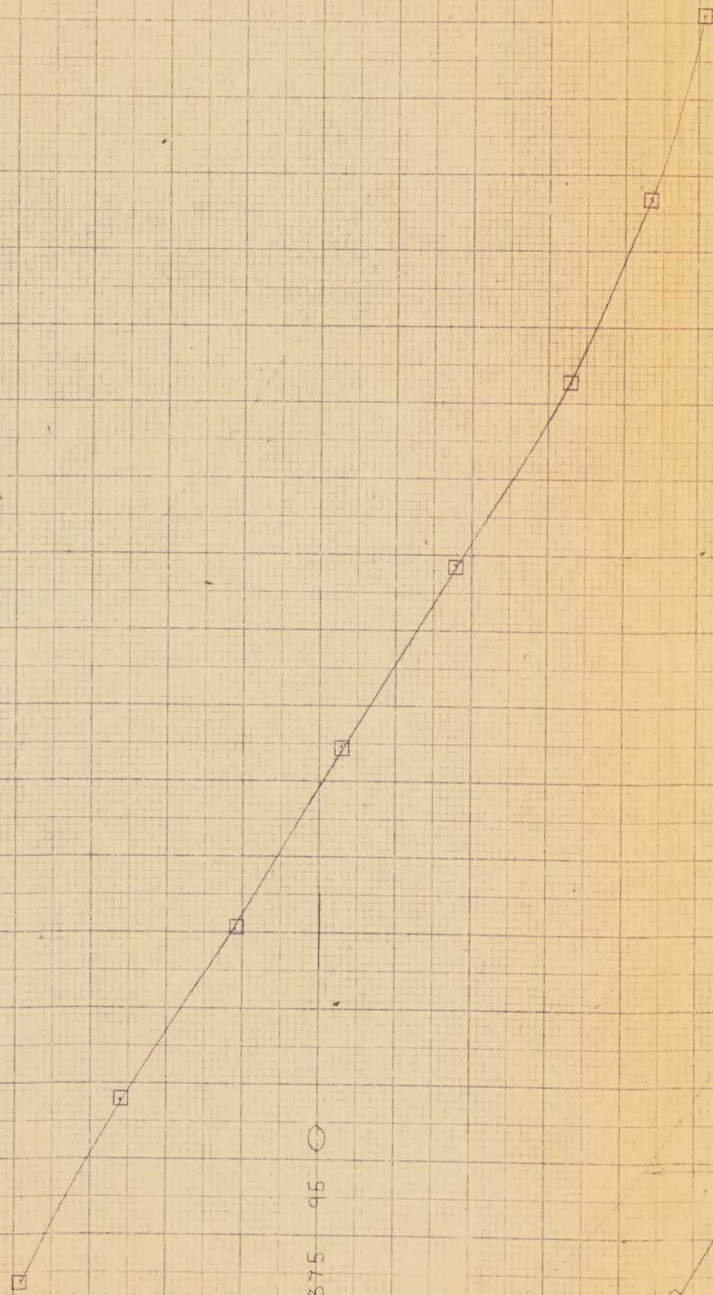
C-105
 CAL W/T TESTS FEBRUARY 1957

C_h vs α
 $\beta = 0$

COCKPIT SEALED

RUN No
 MACH No
 SYMBOL

376 12 □



K&E
10 X 10 TO THE 1/2 INCH
KEUPPEL & ESSER CO.
358-11L
MADE IN U.S.A.

PLOT 240

C-105

CAIL W/T TESTS FEBRUARY 1957

Ch_g vs α
 $\beta = 0$

COCKPIT SEALED

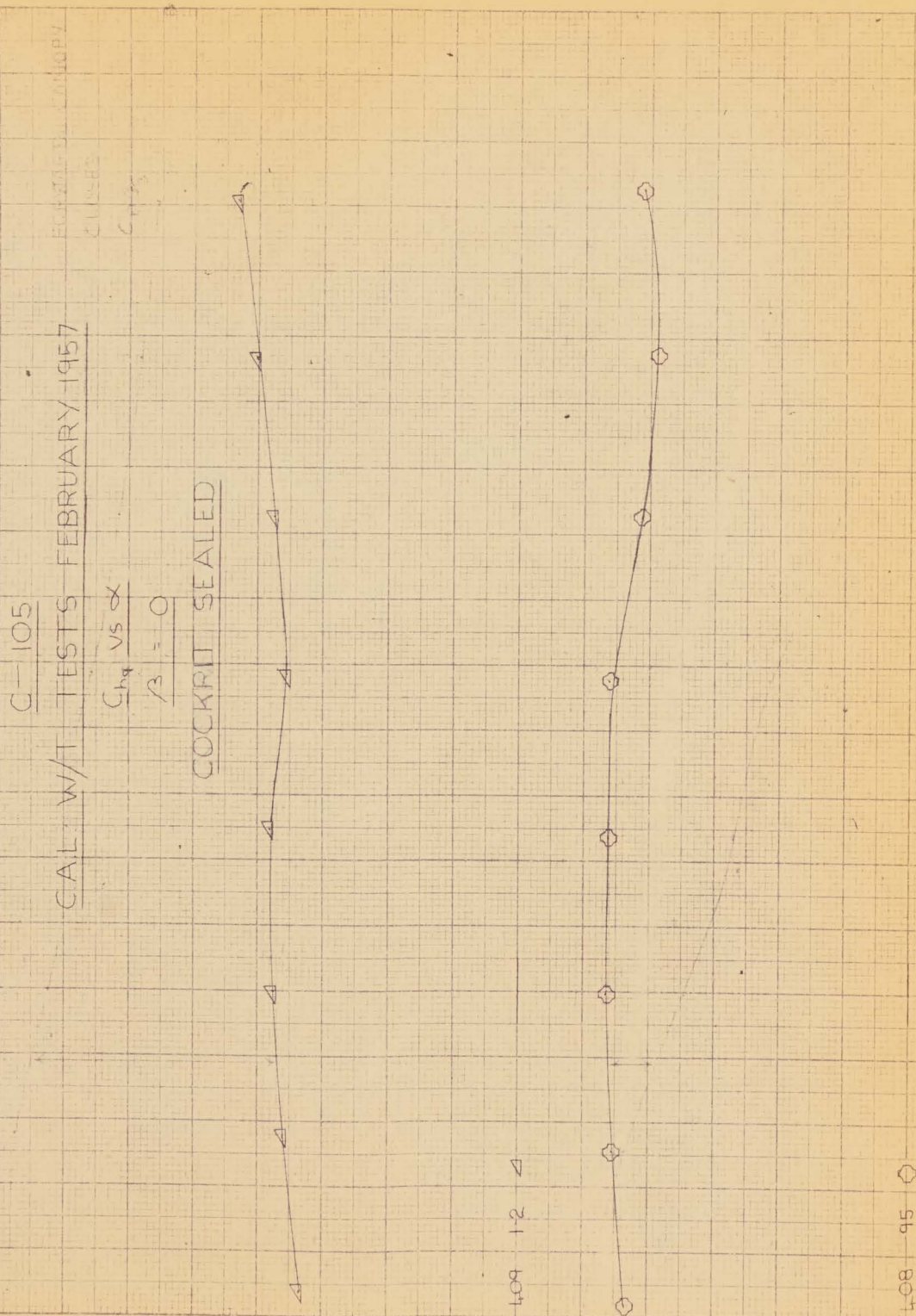
FORWARD CANOPY
CLOSED
Cm 25



LOG 1-2



PLOT 241



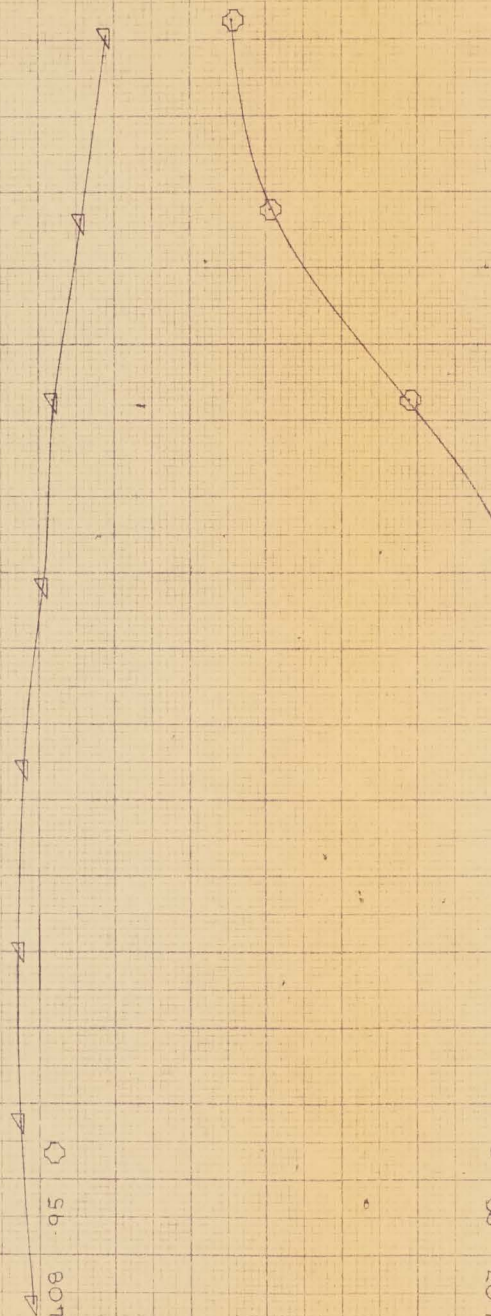
PLOT 242

C-105
 CAL. W/T TESTS FEBRUARY 1957

C_{h10} vs α
 $\beta = 0$

COCKPIT SEALED

RUN No
 MACH No
 SYMBOL



PLOT 247

C-105

CAL W/T TESTS FEBRUARY 1957

C_{D_9} vs. α

$\beta = 0$

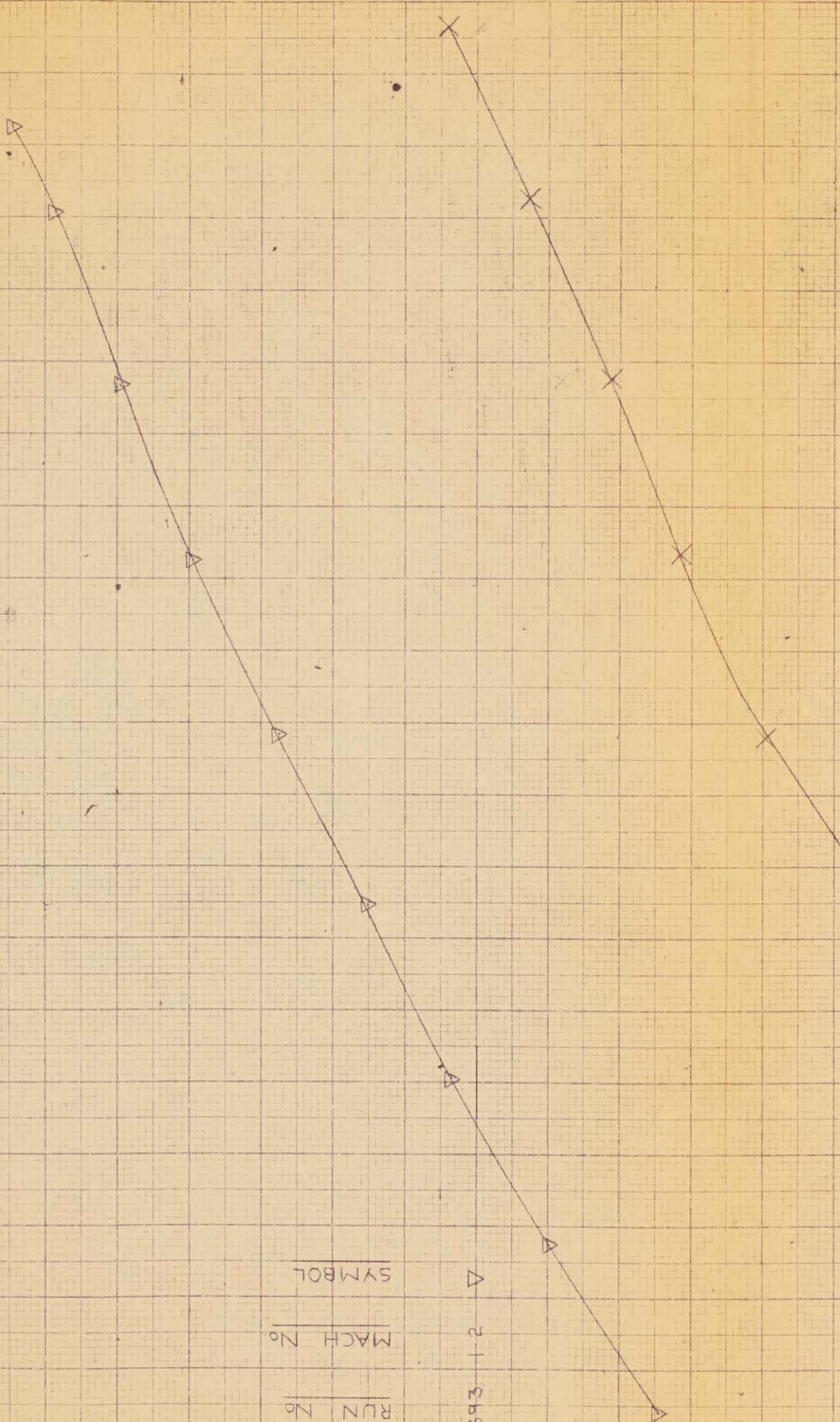
COCKPIT SEALED

BATH CANNIBLES
F. CHILL

RUN
No
MACH
No
SYMBOL

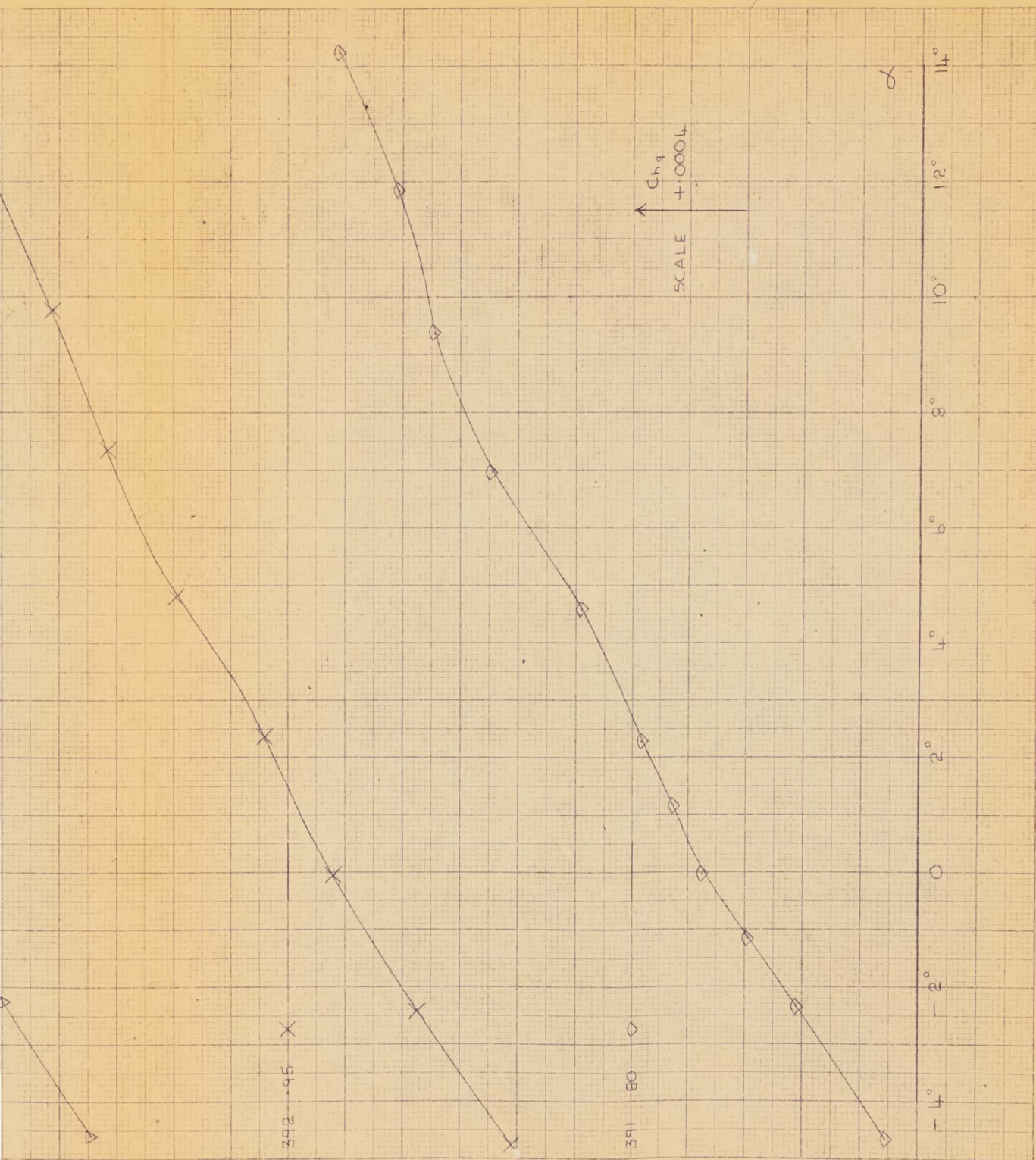
393 1-2

Δ



P/STAB/1146

3.1.10



~~CONFIDENTIAL~~

PLOT 248

C-105

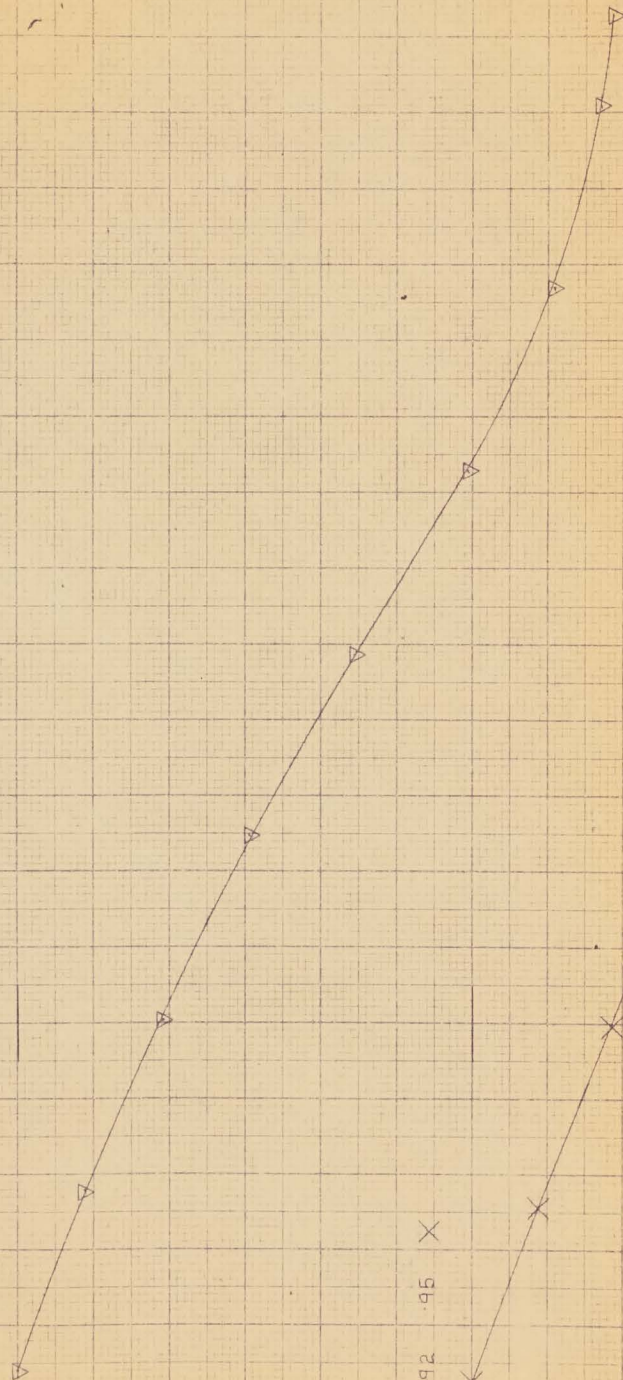
C.A.L. W/T TESTS FEBRUARY 1957

C_{H_0} vs α

$\beta = 0$

COCKPIT SEALED

193 1-2 ∇



192 1-5 x

K&E 10 X 10 TO THE 1/2 INCH 359-11L
KEUFFEL & ESSER CO. MADE IN U.S.A.

PLOT 249

C-105
CAL. W/T TESTS - FEBRUARY 1957

C_h vs. α

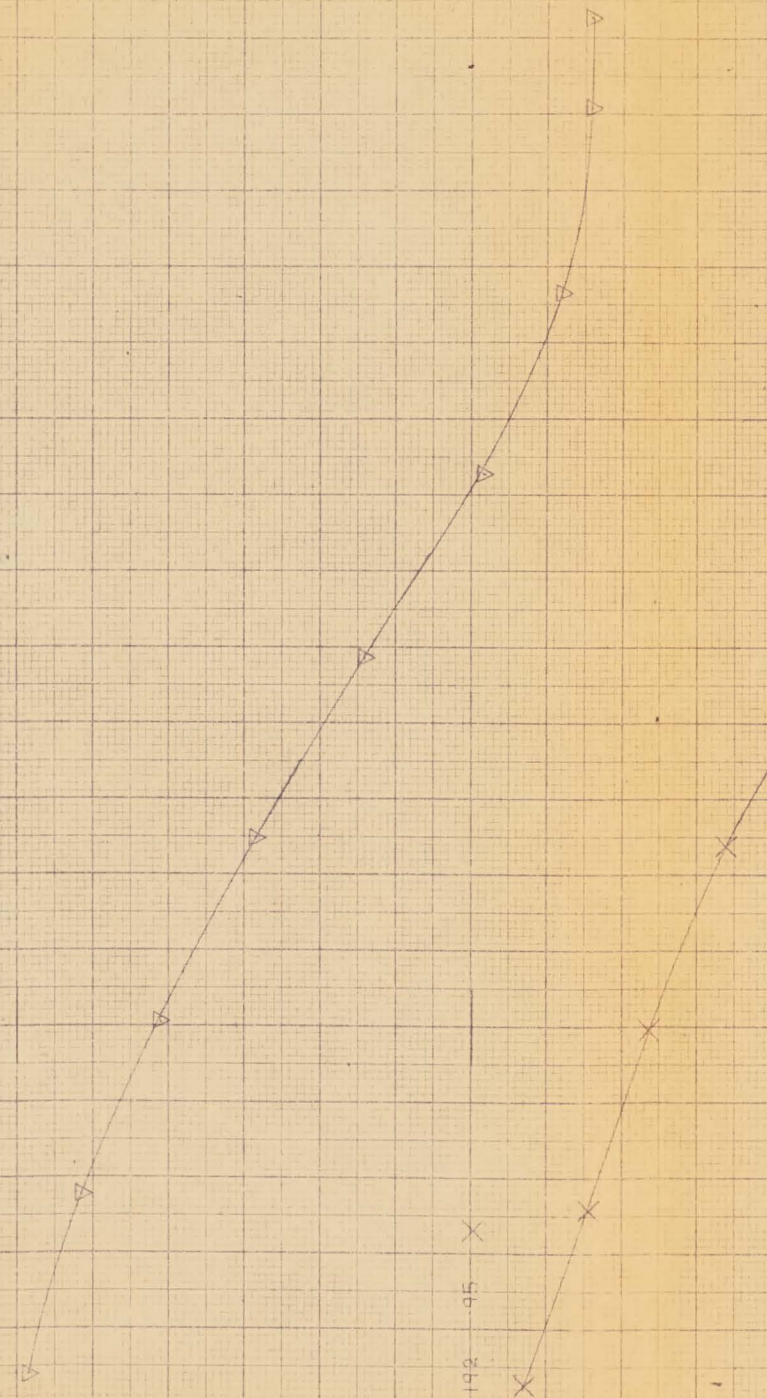
$\beta = 0$

COCKPIT SEALED

RUN No
MACH No
SYMBOL

193 1.2 Δ

192 .95 X



Plot 13
174

C-105

CAL. W/T. TESTS FEBRUARY 1957

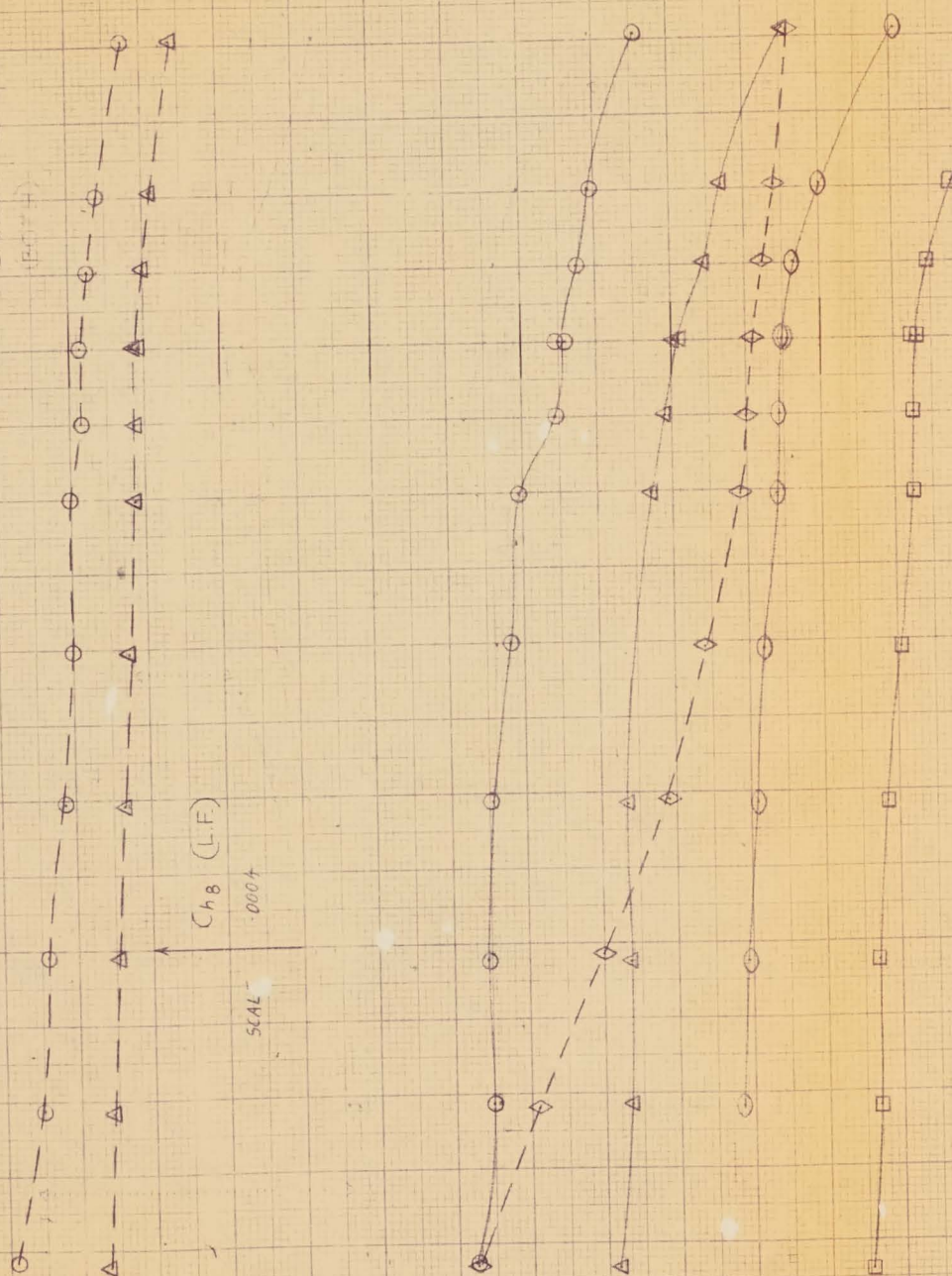
C_h vs. β

$\alpha = 2$

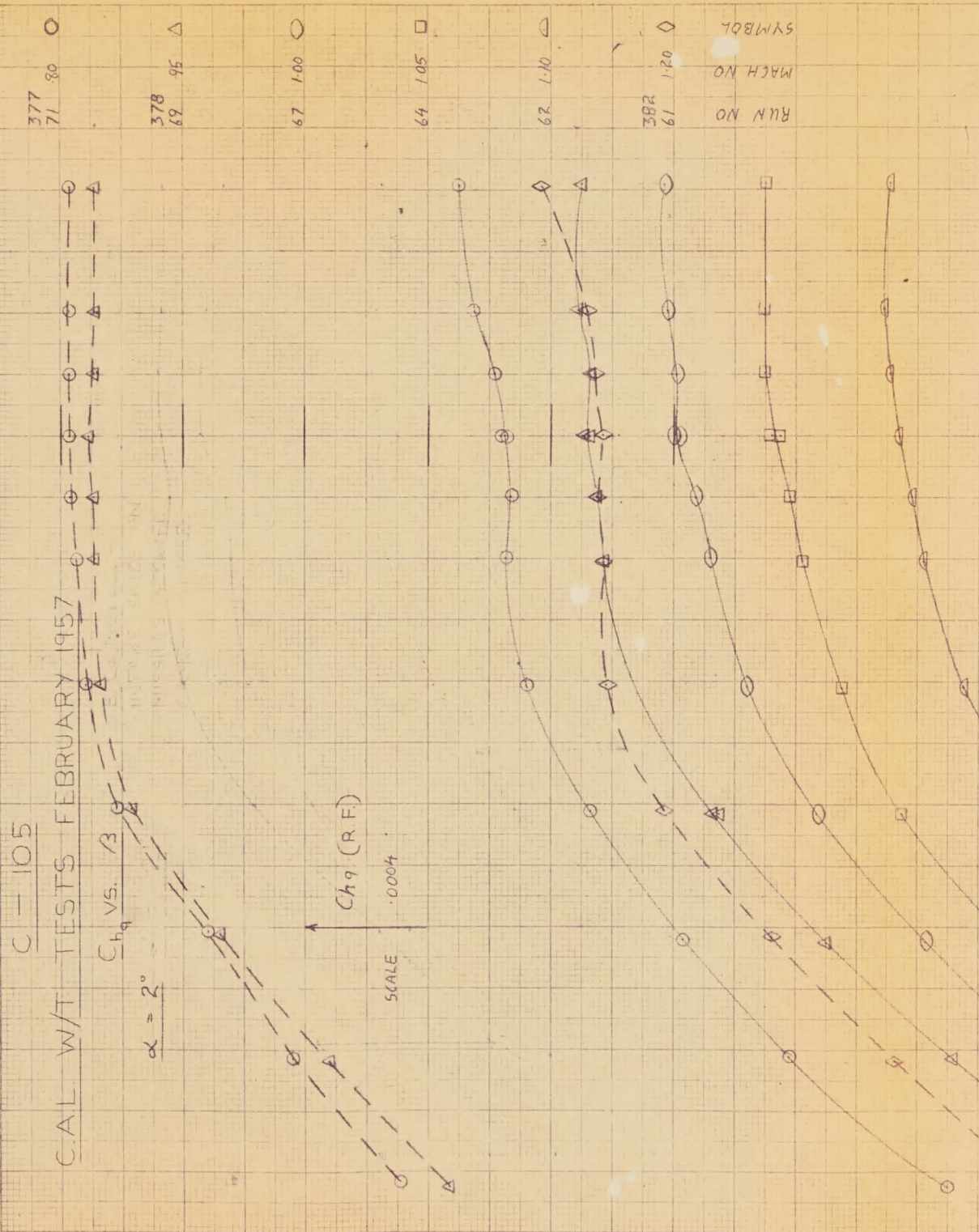
B₁C₉MSI2345
INTAKE SKIDS ON.
MISSILES STOWED.
CANOPY CLOSED.

RUN NO
MACH NO
SYMBOL

377	71	80
378	69	95
67	100	
64	105	
62	110	
382	61	120

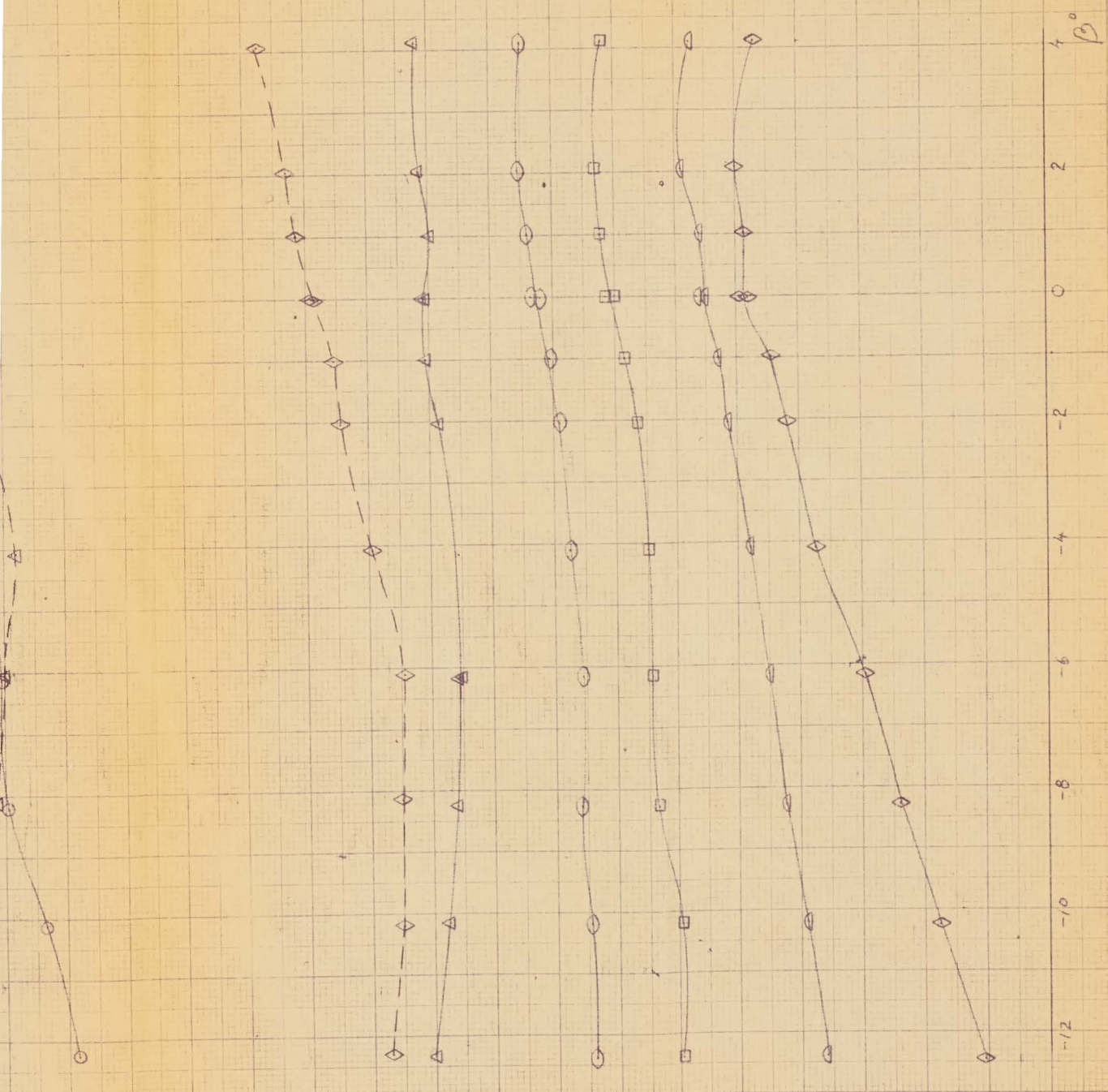


Plot 15
175



P/STAB/146 3.2.3

RUN
MACH
SYMB



~~CONFIDENTIAL~~

Plot 14
180

C - 105

CAL. W/T TESTS FEBRUARY 1957

C_{hg} vs β

$\alpha = 210^\circ$

B/C MS123LS
INTAKE SKIDS ON.
MISSILES STOWED
CANOPY CLOSED.

RUN NO
383
73.80
MACH NO
SYMBOL

384
70.95
Δ

68 100 ○

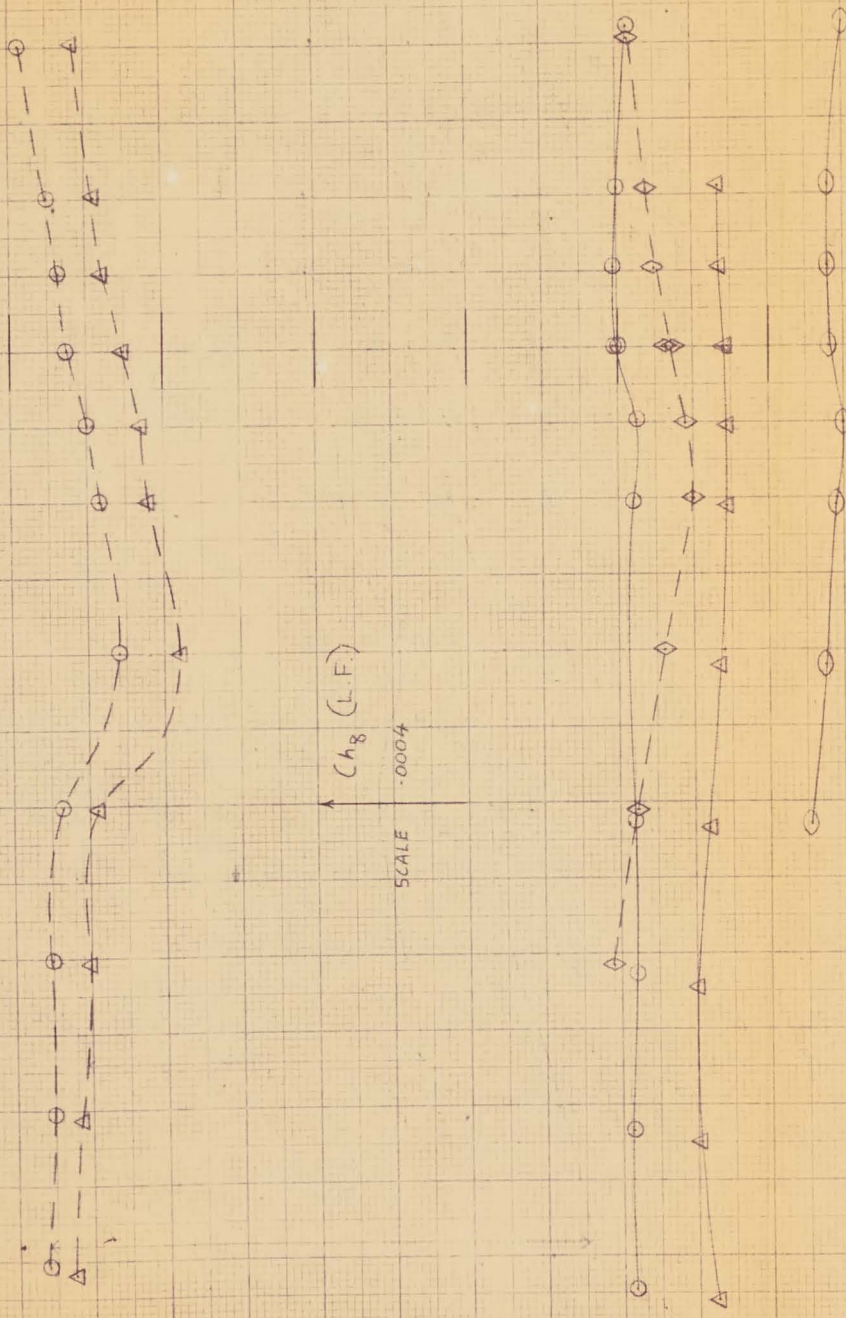
65 105 □

63 110 ○

385
60 120 ○

C_{hg} (L.F.)

SCALE .0004



Plot 18

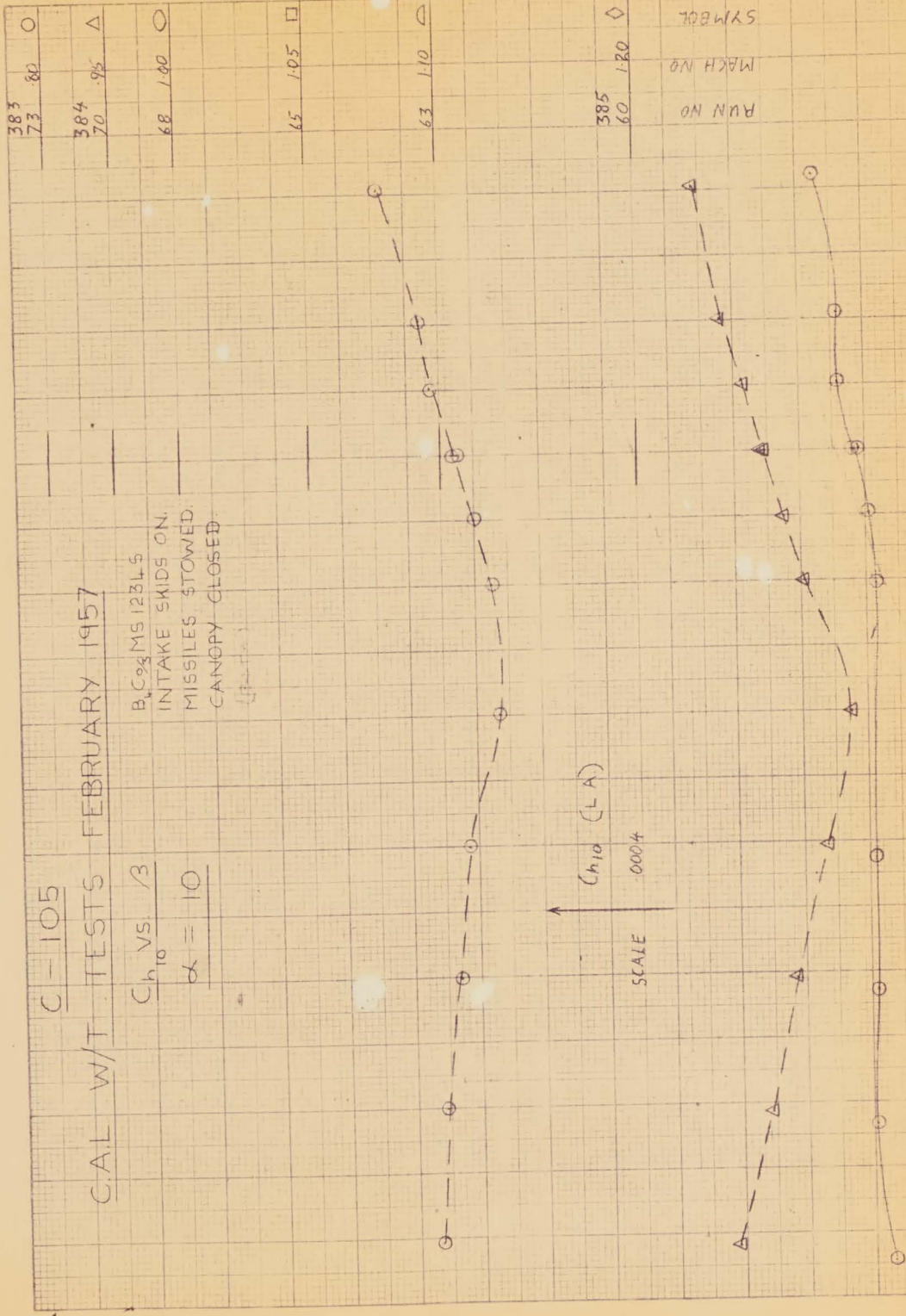
C-105

CAL W/T TESTS FEBRUARY 1957

C_{h10} VS. β

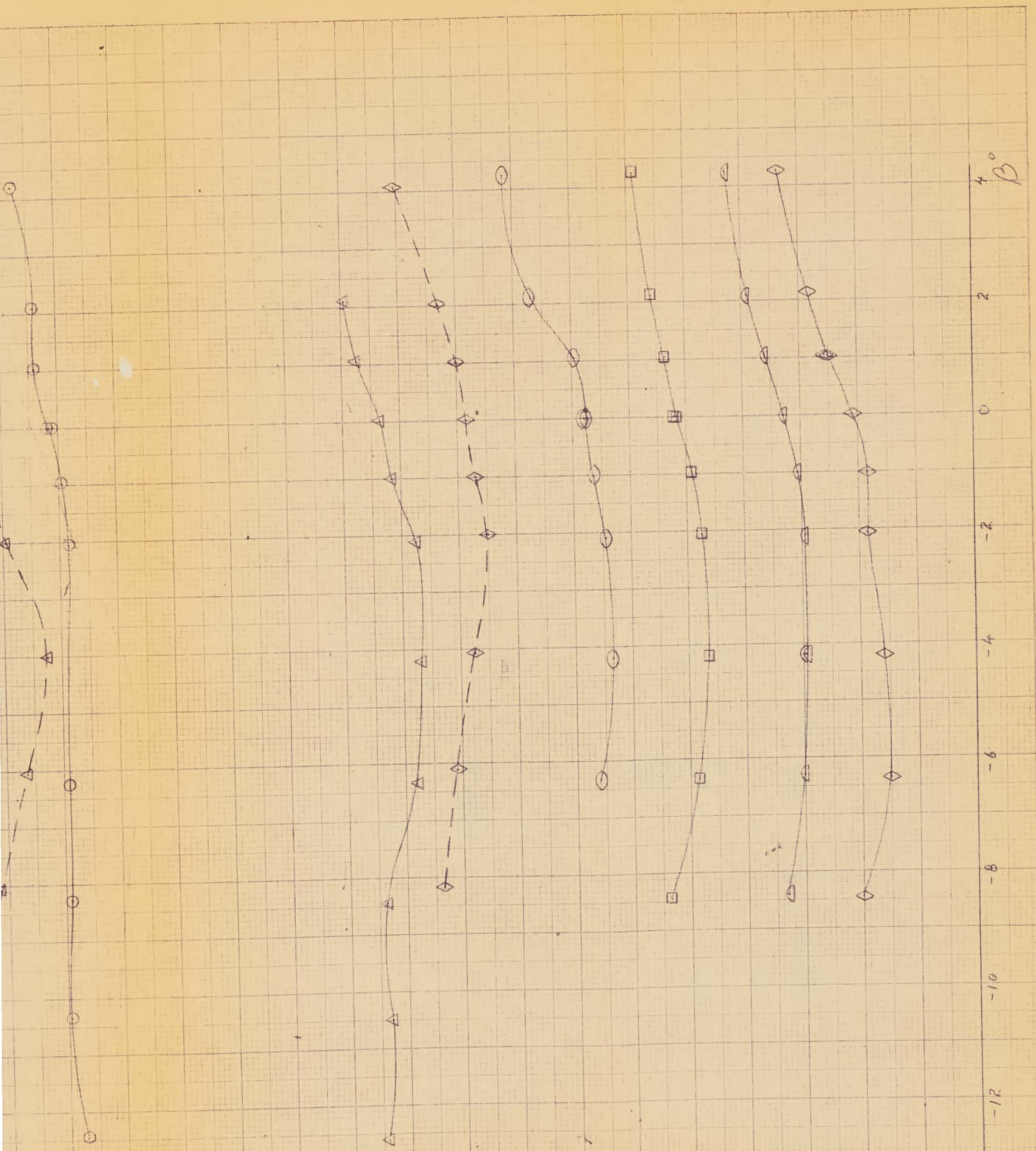
$\alpha = 10$

BC93 MS 123LS
INTAKE SKIDS ON.
MISSILES STOWED.
CANOPY CLOSED.



P/STAB/146 3.2.9

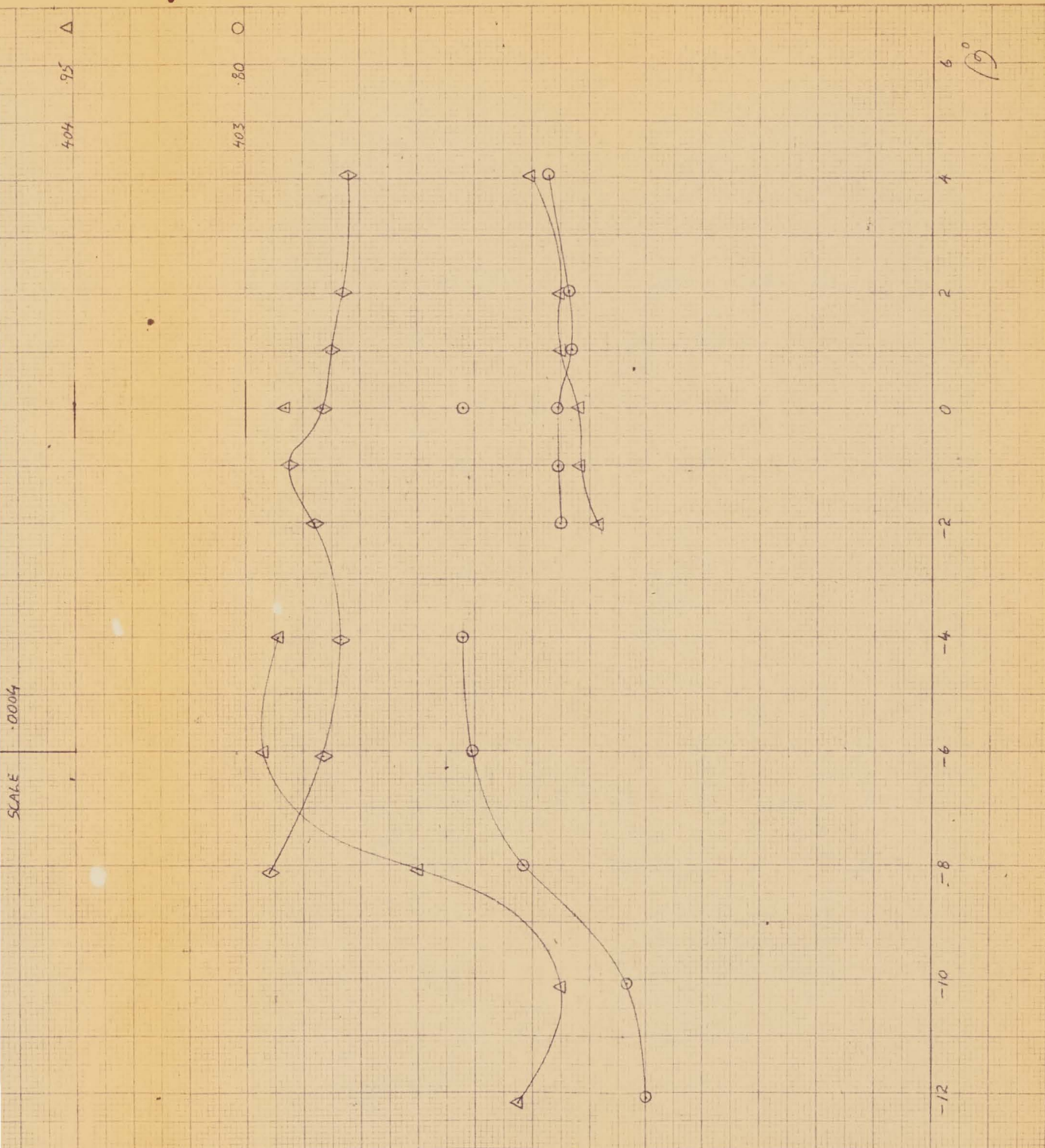
P/STAB/146 3.2.7



~~CONFIDENTIAL~~

P/STAB/1146

3.2.16



~~CONFIDENTIAL~~

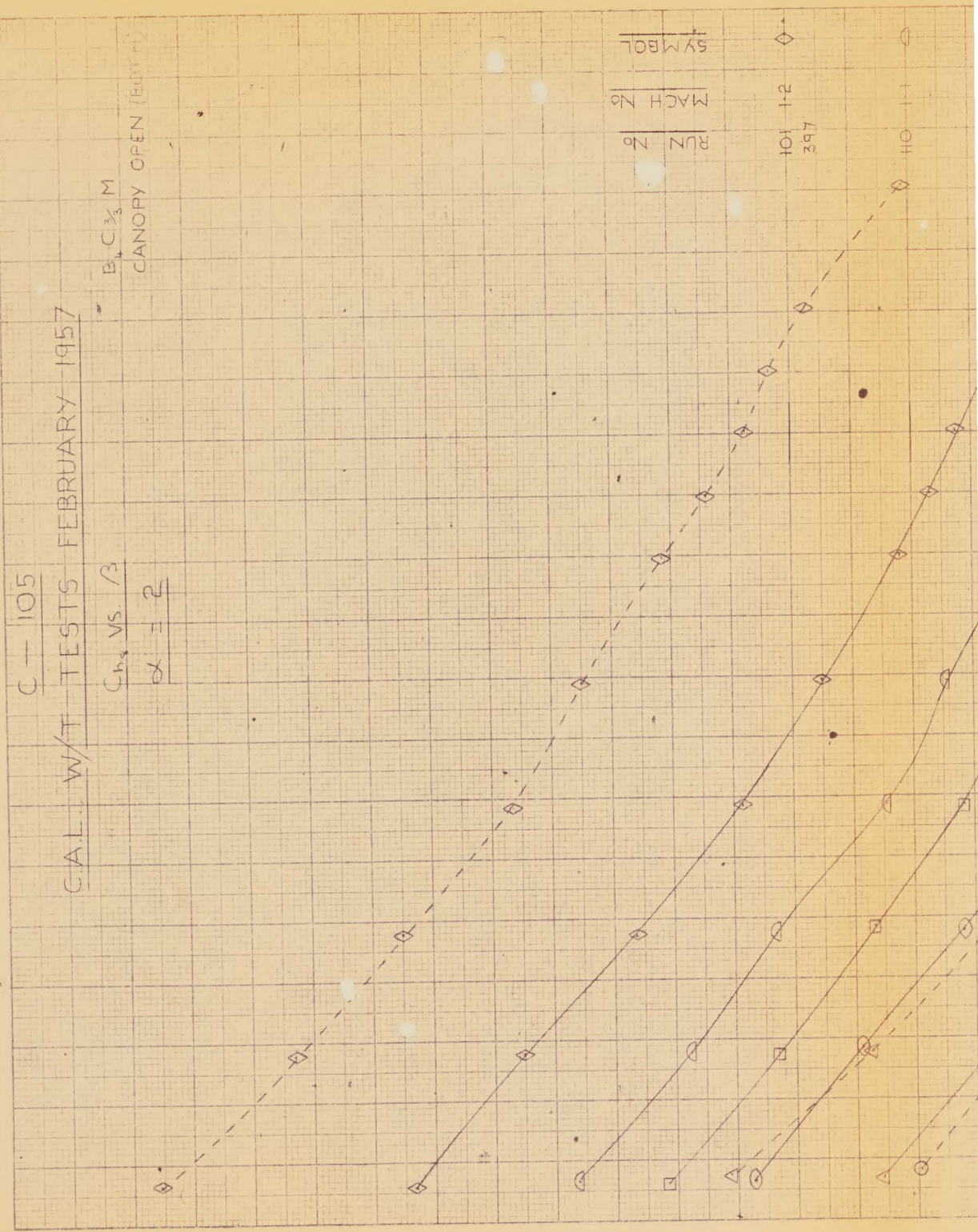
K-2 10 X 10 TO THE 1/2 INCH 359-111L
 KUTTER & LINDER CO. MADE IN U.S.A.

PLOT 67
 PLOT 198

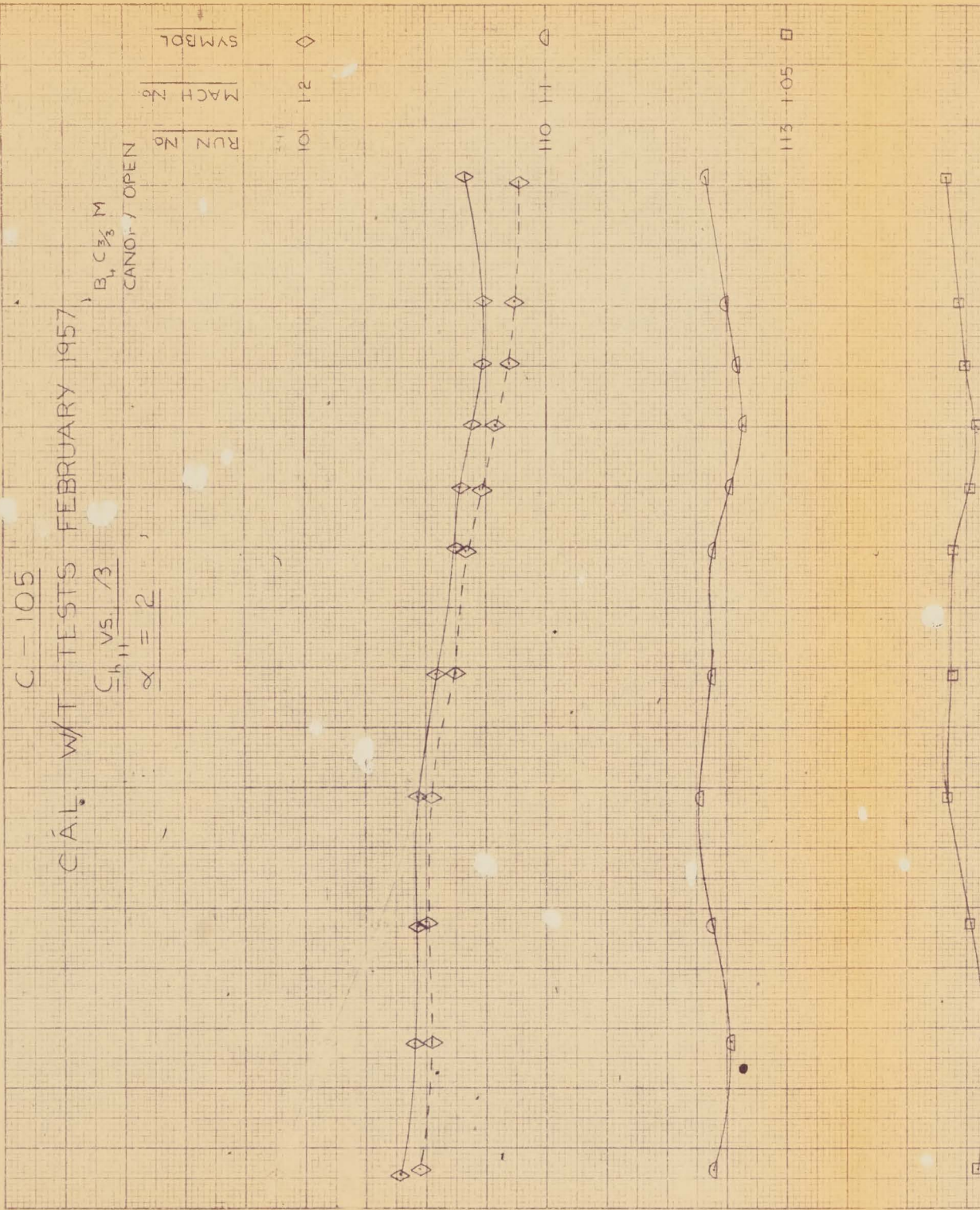
C-105
 CAL. W/T TESTS FEBRUARY 1957

C_{hs} vs. β
 $\alpha = 2$

$B_{1/2} C_{3/2} M$
 CANOPY OPEN (EDDY +)



PLOT 73



PLOT 206
 PLOT 72

C-105

CAL. W/T TESTS FEBRUARY 1957

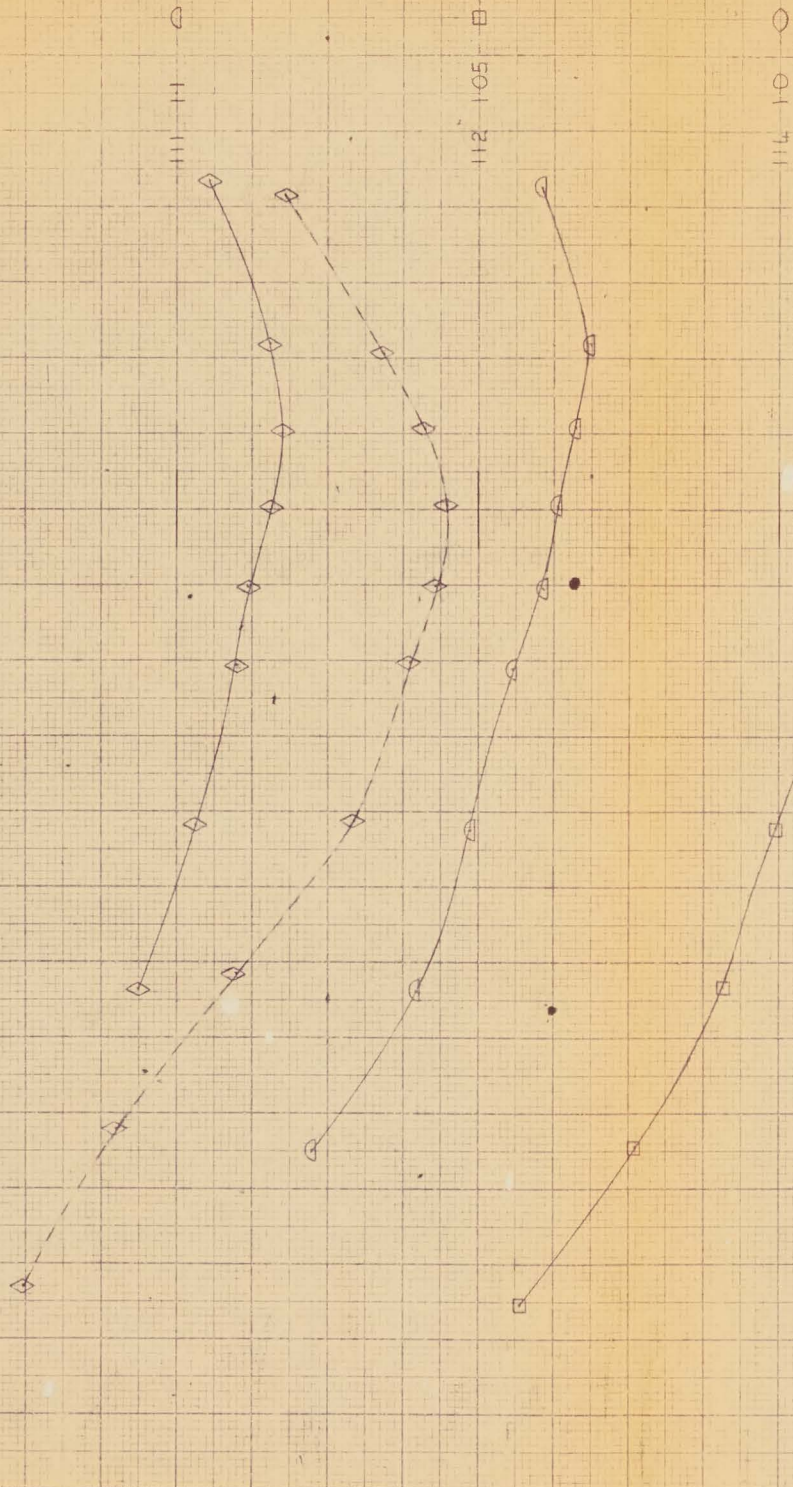
$$C_{h_{10}} \text{ vs. } \beta$$

$$\alpha = 10$$

B.C. $\frac{3}{4}$ M-
 CANOPY OPEN
 (C₁₀)

SYMBOL
 MACH N
 R N

390
 101 1-2 $\diamond$



KE 10 X 10 TO THE 1/2 INCH 350-11L
KEUFFEL & ESSER CO. MADE IN U.S.A.

PLOT 71

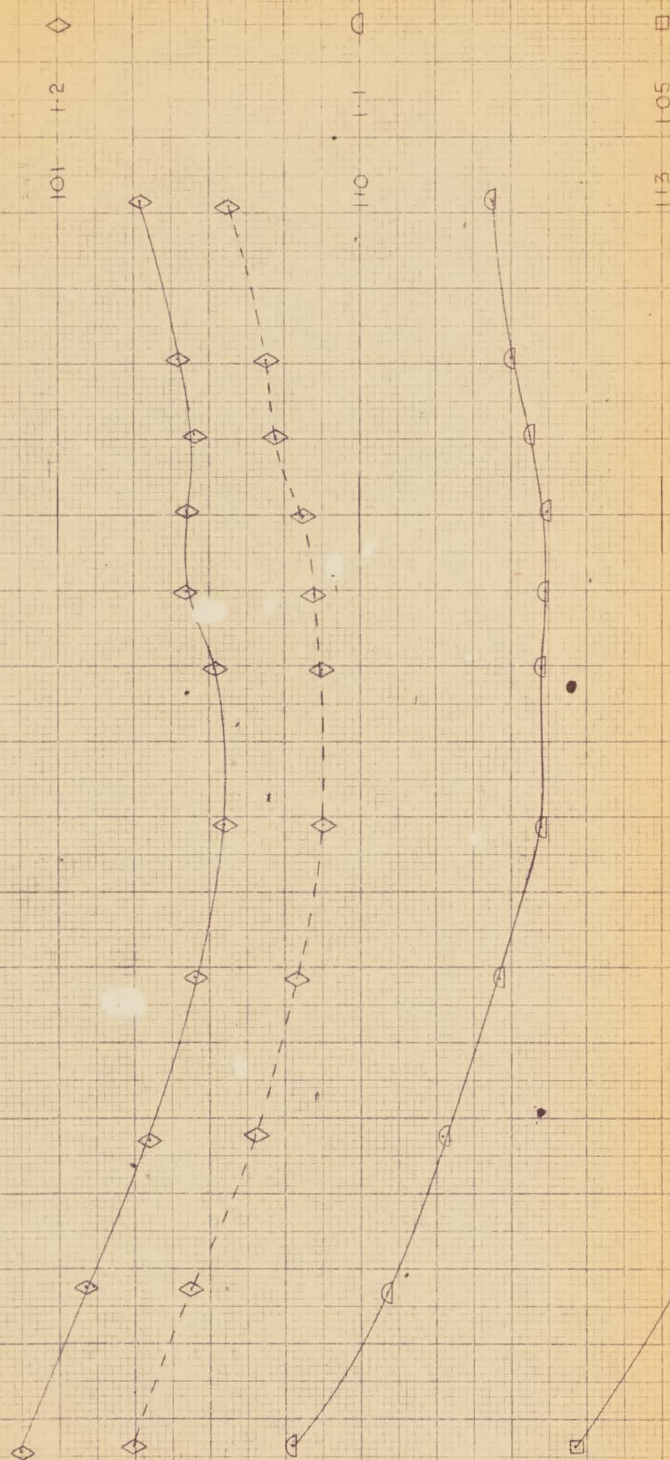
$C = 105$

CAL. W/T TESTS FEBRUARY 1957

$C_{h_{10}} \text{ vs. } \beta$

$\alpha = 2$

$B_+ C_{3/2} M$
CANOPY OPEN



PLOT 70
PLOT 205

C-105

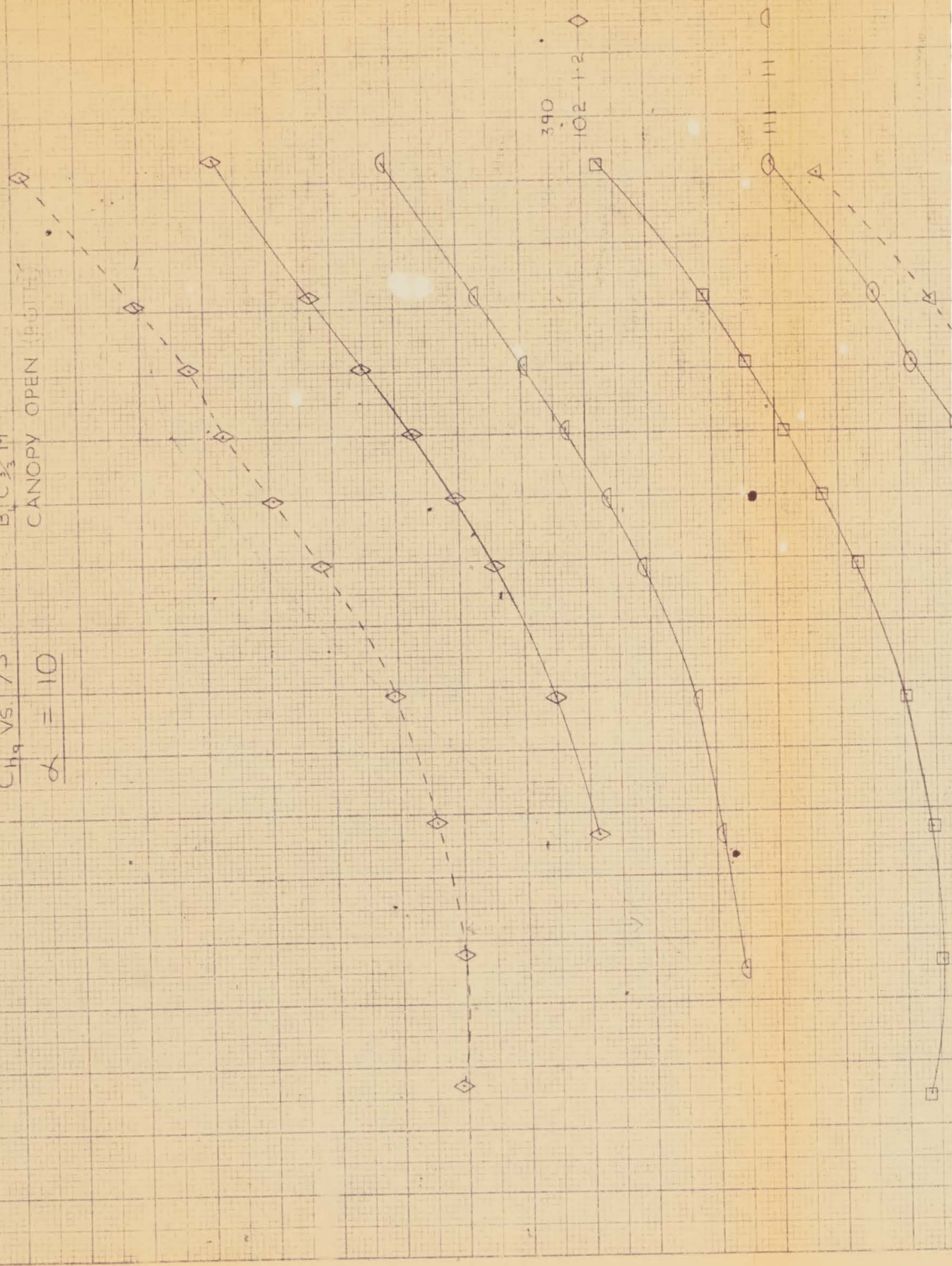
CAL. W/T TESTS FEBRUARY 1957

Ch_9 vs. β

$\alpha = 10$

$B_1 C \frac{3}{2} M$

CANOPY OPEN (PLOT 70)



Classification cancelled / changed to Unclassified
By authority of AVRO Arrow Declassif. Board
Date 28 Jul 87
Signature *Blumenthal*, Co-Chairperson
Unit / Rank / Appointment DSIS 3

