

QCX
Avro
CF105
P-WT-
98
C.2

21

CF-105

P/Wind Tunnel/98

N.A.F. LOW SPEED WIND TUNNEL TESTS

January 1956

FINAL CORRECTED PLOTS.

April 1956

FILE IN VAULT

NRC - CISTI
J. H. PARKIN
BRANCH

MAY 11 1995

ANNEXE
J. H. PARKIN
CNRC - ICIST



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

UNCLASSIFIED

AIRCRAFT CF-105

REPORT NO. P/WIND TUNNEL/98

FILE NO.

NO. OF SHEETS

TITLE:

N.A.E. LOW SPEED WIND TUNNEL TESTS

JANUARY 1956

FINAL CORRECTED PLOTS

PREPARED BY Stability and
Control Group

DATE April '56

CHECKED BY J. Clark

DATE April '56

SUPERVISED BY

H. Matkowsky

DATE June '56

APPROVED BY

J. Chamberlain

DATE June '56

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

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AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT

CF-105

N.A.E. LOW SPEED

REPORT NO. P/WIND TUNNEL/98

SHEET NO. i

PREPARED BY

DATE

CHECKED BY

DATE

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TEST PERIOD IPURPOSE

The tests in test period I were performed to determine the effect of ground on the low speed longitudinal characteristics, and the elevator effectiveness. A large proportion of the test period was used to determine strut tare and interference corrections for the three point support system.

CONFIGURATION

The model configuration used for these tests was as follows:

- B₂ - area rule body.
- V₁ - fin with separate rudder.
- W₁ - 3 $\frac{1}{2}$ % cambered wing.
- E₁₀ - 10% extended leading edge outboard of wing transport joint.
- N₅ - 5% deep notch at wing transport joint.
- D_{B-4} - 8° leading edge droop inboard of notch, 4° droop outboard of notch.

The ground board was located .3 b/2, .4 b/2 and .7 b/2 from a point .097 below the MAC measured at .277

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MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. P/WIND TUNNEL/98

SHEET NO. ii

AIRCRAFT

CF-105

.07 SCALE MODEL

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CONTROL DEFLECTION

Elevator: 10, 5, 2.5, 0, -2.5, -5, -10, -15, -20, -25, -30
Aileron : none
Rudder : none

SPEED RANGE

Mach number = .21
Reynolds number = 3.1×10^6

FINAL CORRECTED PLOTS

The curves presented in this report were based on data obtained in Runs 1 to 54. The plots included are listed in the index by section number and sheet number.

Corrections have been applied to account for strut tare and interference effects, wall and blockage effects. The data were reduced to .287 on the MAC, and .287, .317 and .357 at 8 inches above the fuselage datum which corresponds to the mean vertical C.G. position on the full scale aircraft.

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N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

FORM 1544

56)

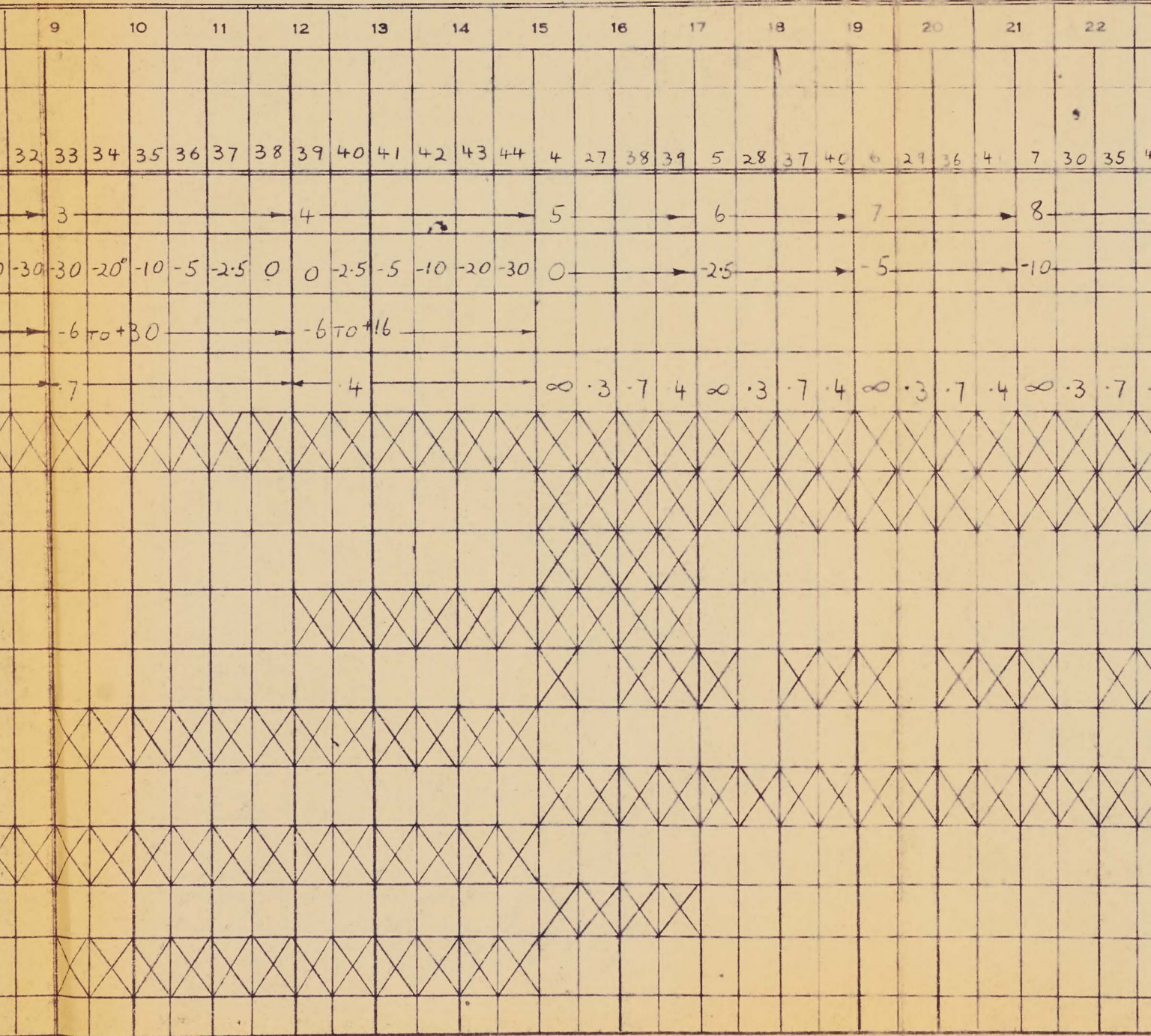
C. G. POSITION
CASE HORIZONTAL VERTICAL

- 1 .282 M.A.C.
- 2 .282 8" ABOVE F.D.
- 3 .312 8" ABOVE F.D.
- 4 .332 8" ABOVE F.D.
- 5 .352 8" ABOVE F.D.

AVRO AIRCRAFT

MALTON, ONT.
ENGINEERING D

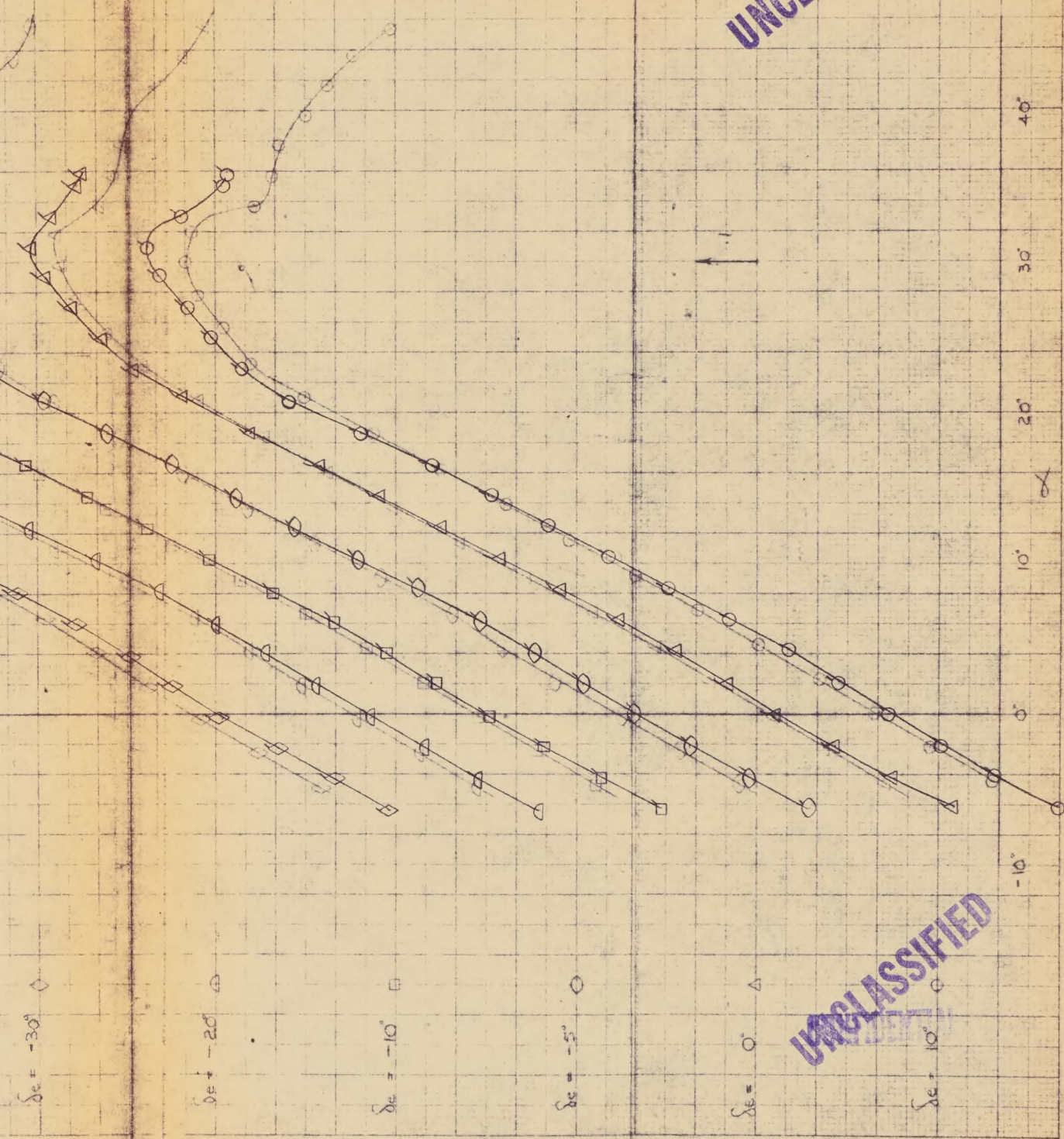
AIRCRAFT
WEIGHT
C. G. POSITION



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P/MT 82
98

1-1A



C-105

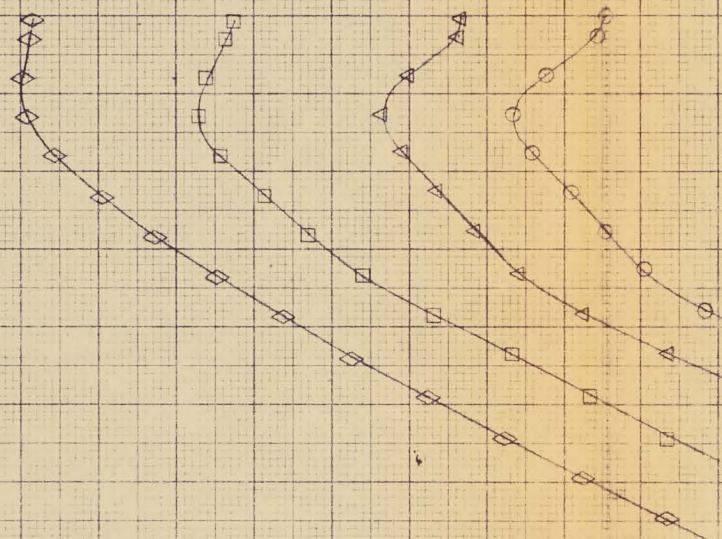
N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

C_L vs α

C_L

α

ORIGINS



C_L

C-105

C_L vs α + Jc

10

NRC W T TESTS

NO GROUND BOARD

8

6

4

2

0

-2

-4

-6

ANGLE OF ATTACK (α)

-2°
-4°
-6°

2°
4°
6°
8°
10°
12°
14°
16°
18°
20°

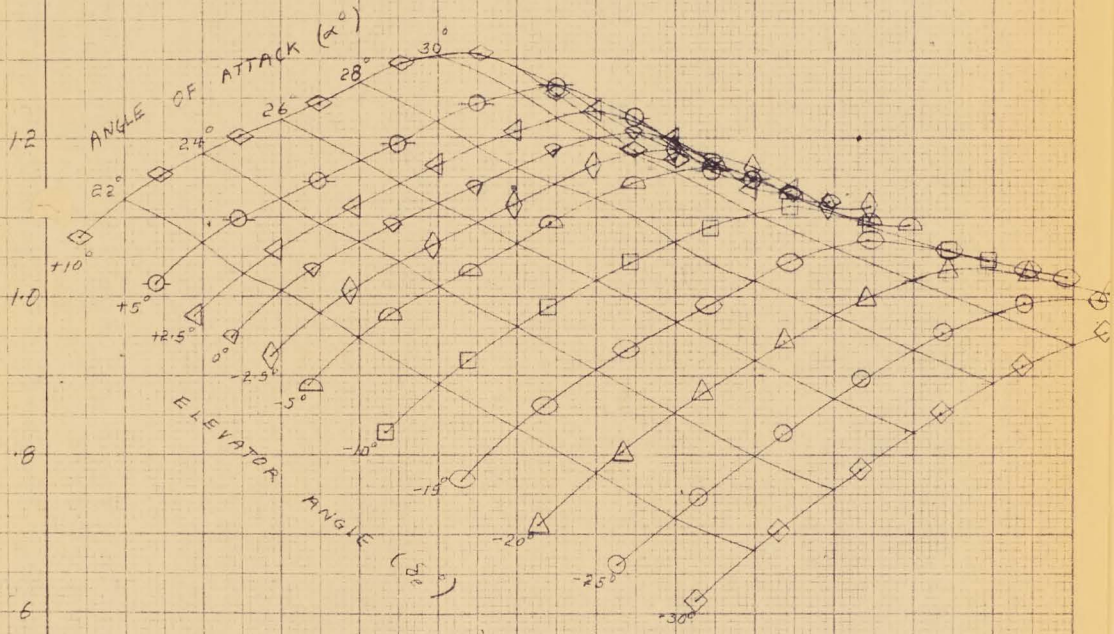
C-105

C_L vs $\alpha + \delta_e$

N.R.C. W.T. TESTS

NO GROUND BOARD

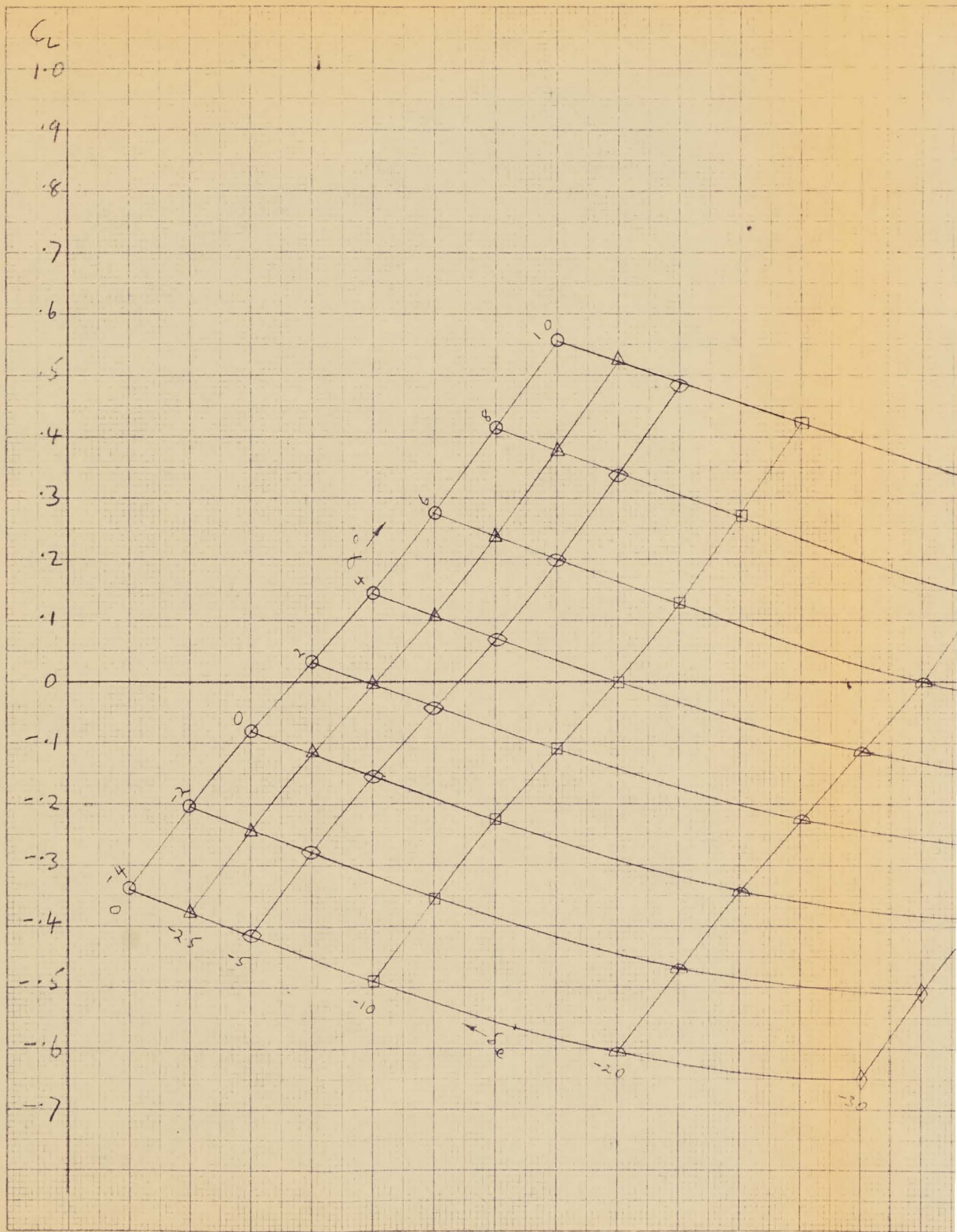
C_L 1.4



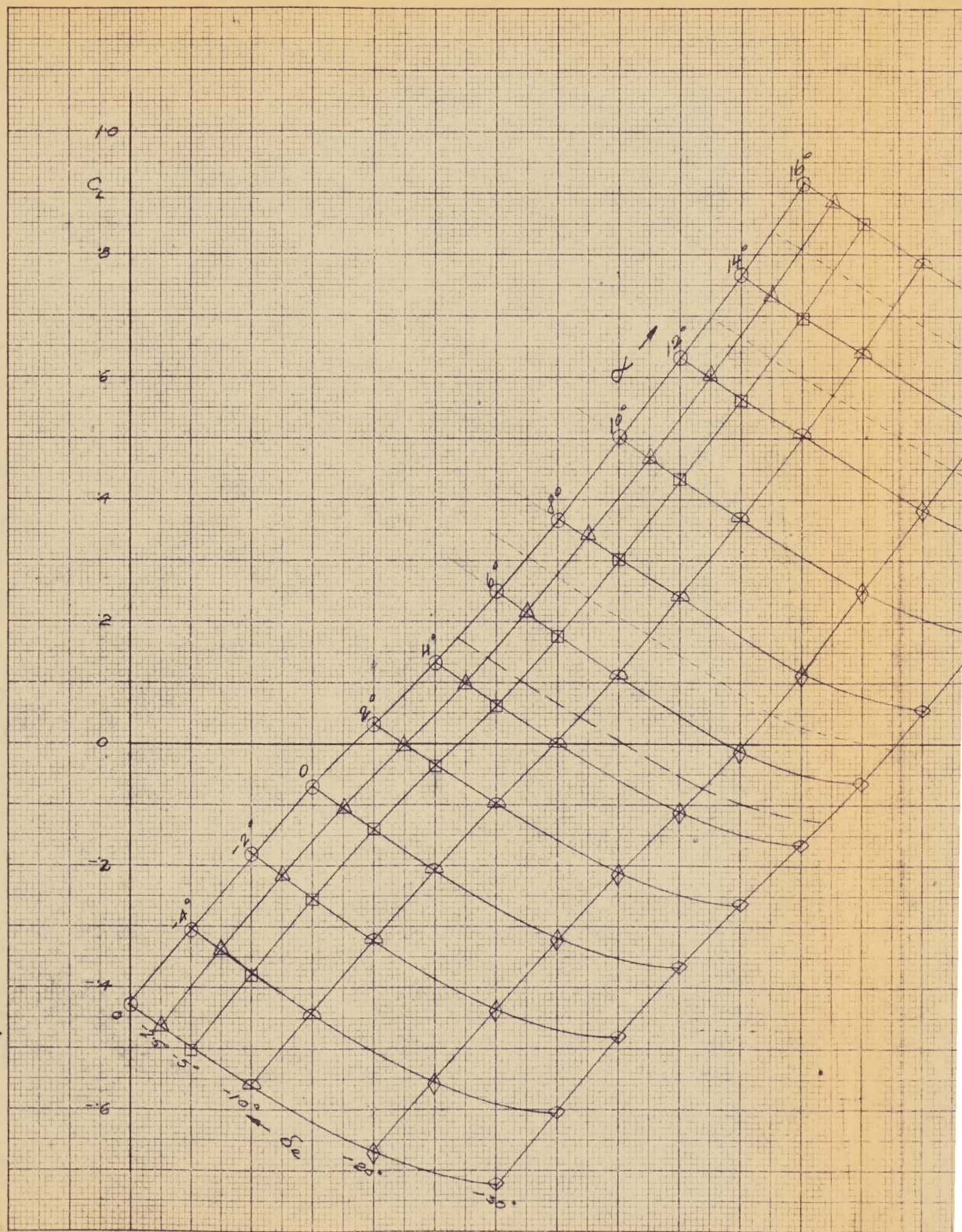
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UNCLASSIFIED
CONFIDENTIAL

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



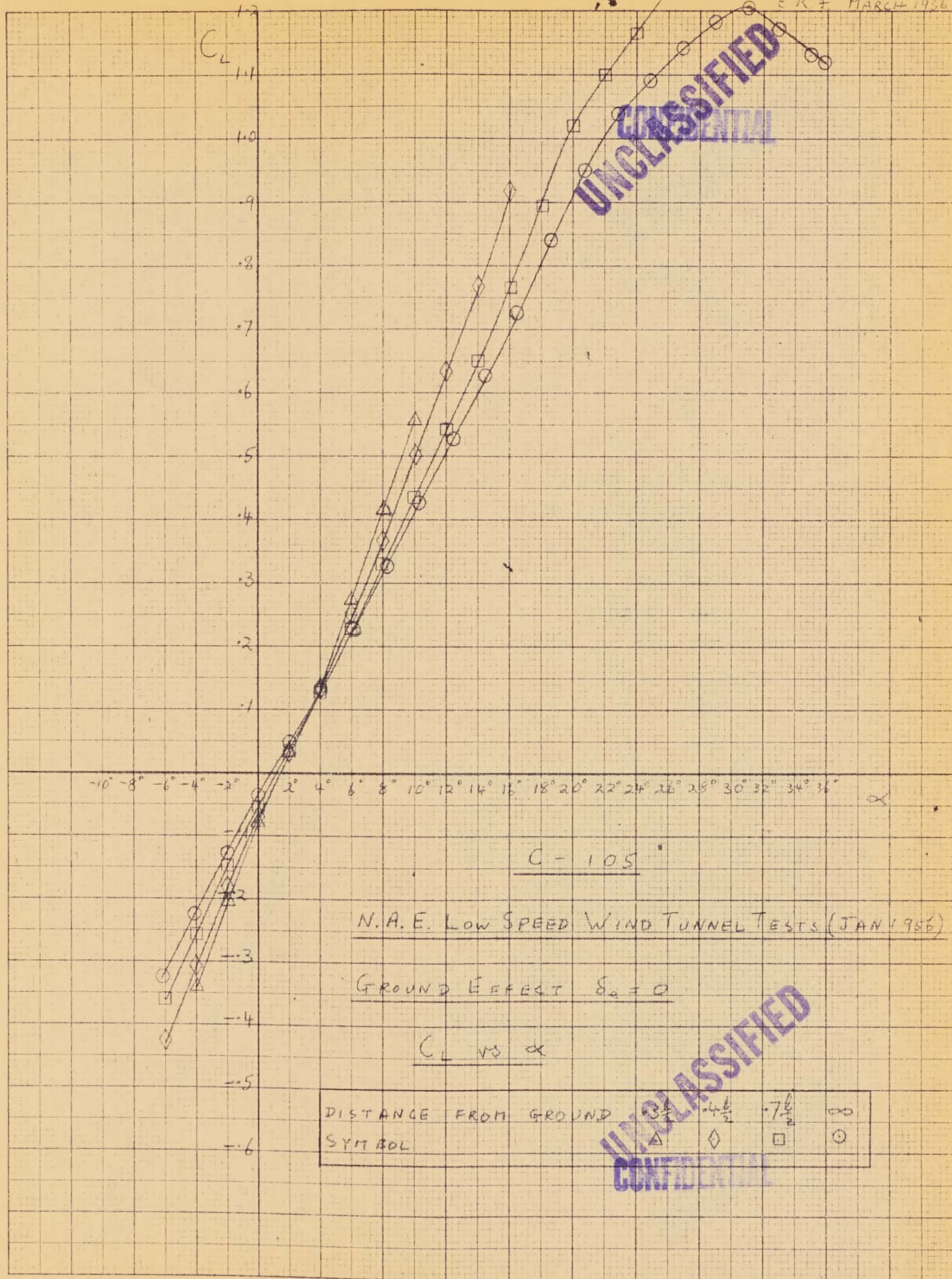
KE 10 X 10 TO THE 1/2 INCH 350-11L
KEUTELA ESSER CO. MADE IN U.S.A.



P/WT/98

1-5

ERT MARCH 1956



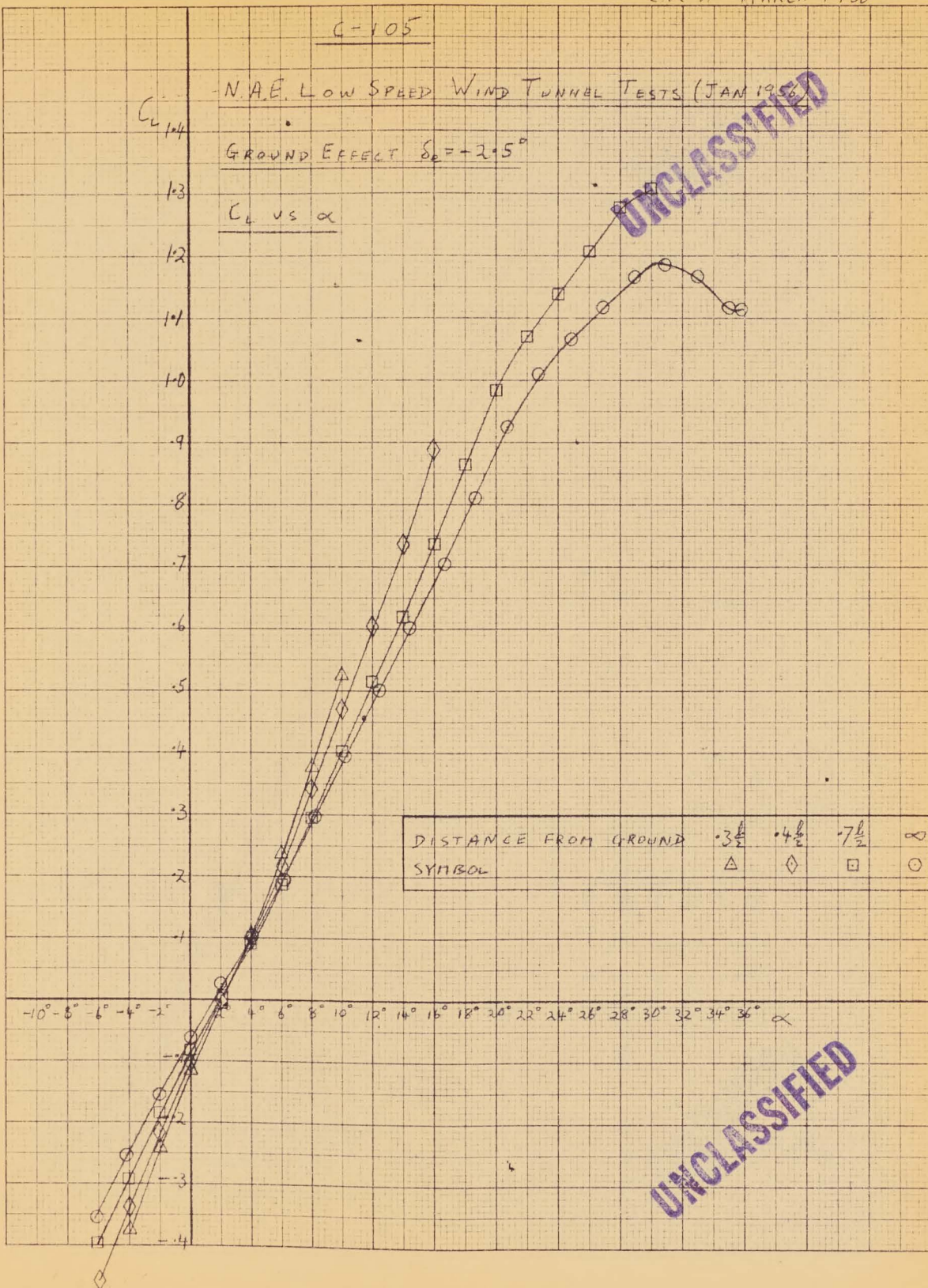
P/WT/98

1.6

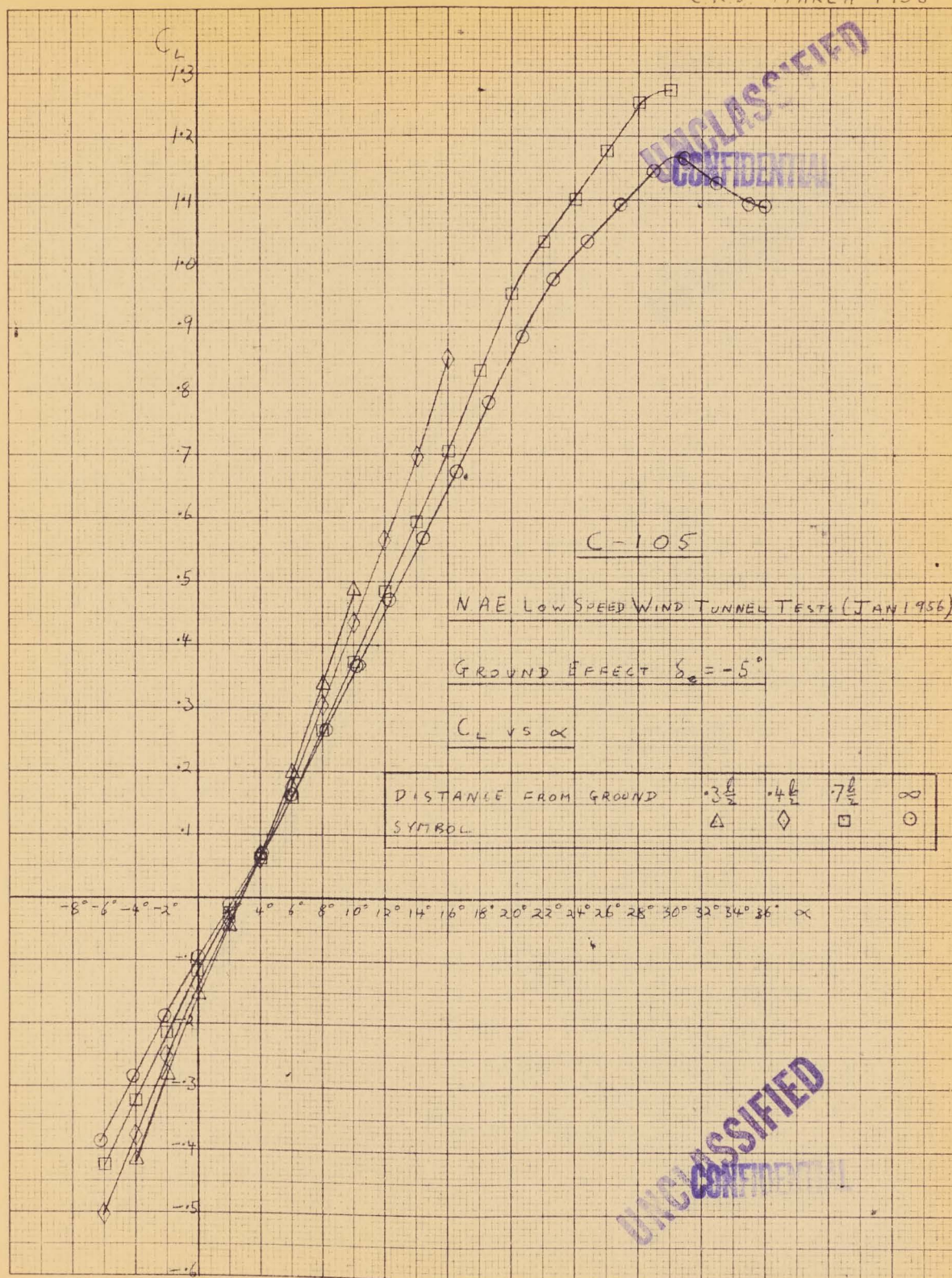
E.R.F. MARCH 1956

C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

GROUND EFFECT $\delta_e = -2.5^\circ$ C_L vs α 

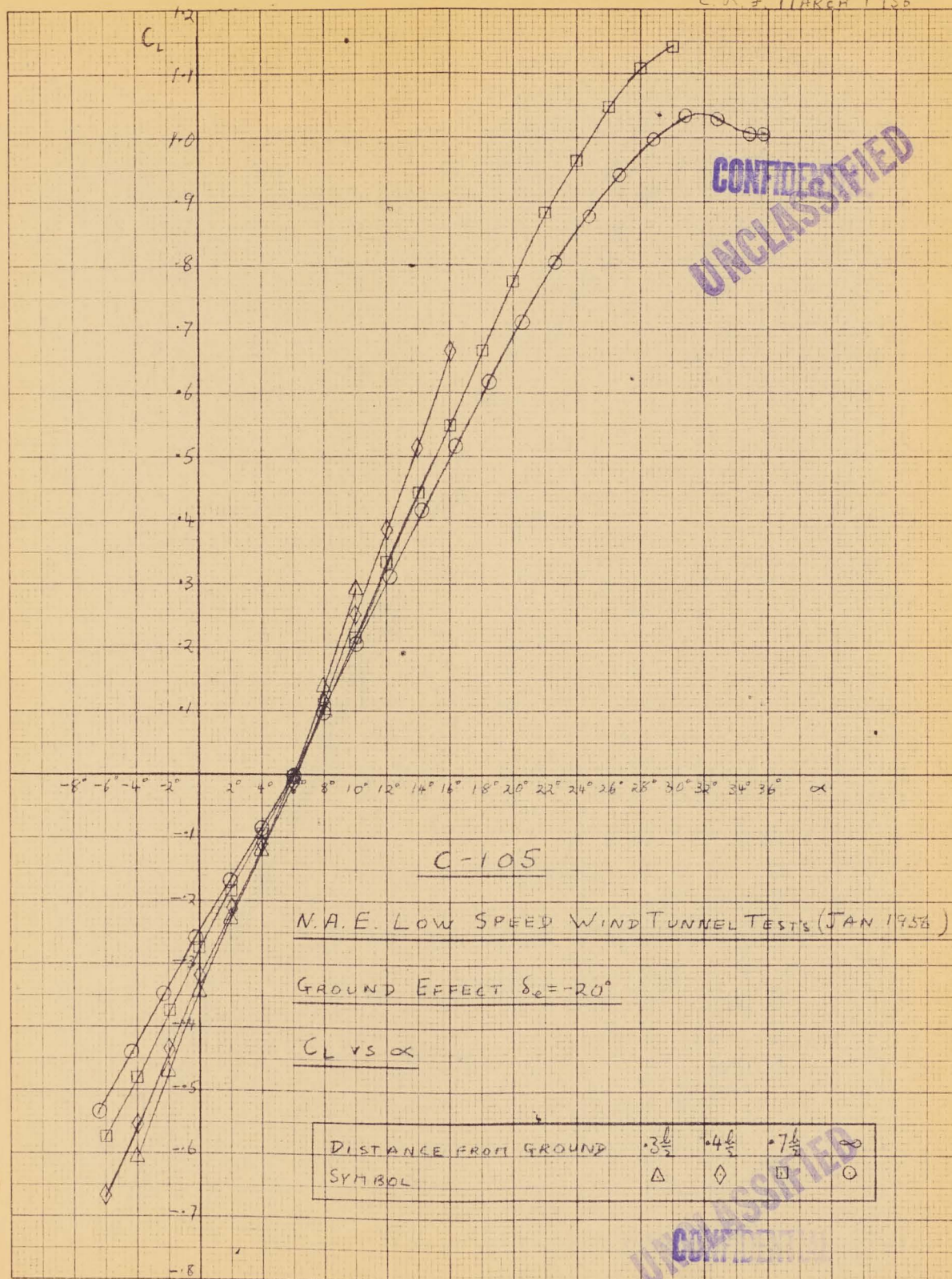
P/WT/98 1-7
 E.R.F. MARCH 1956



P/WT/98

1.9

E. R. 7. MARCH 1956



359-12

10 X 10 TO THE 1/2 INCH
NEUFEL & ESSER CO.
MILWAUKEE, WIS.

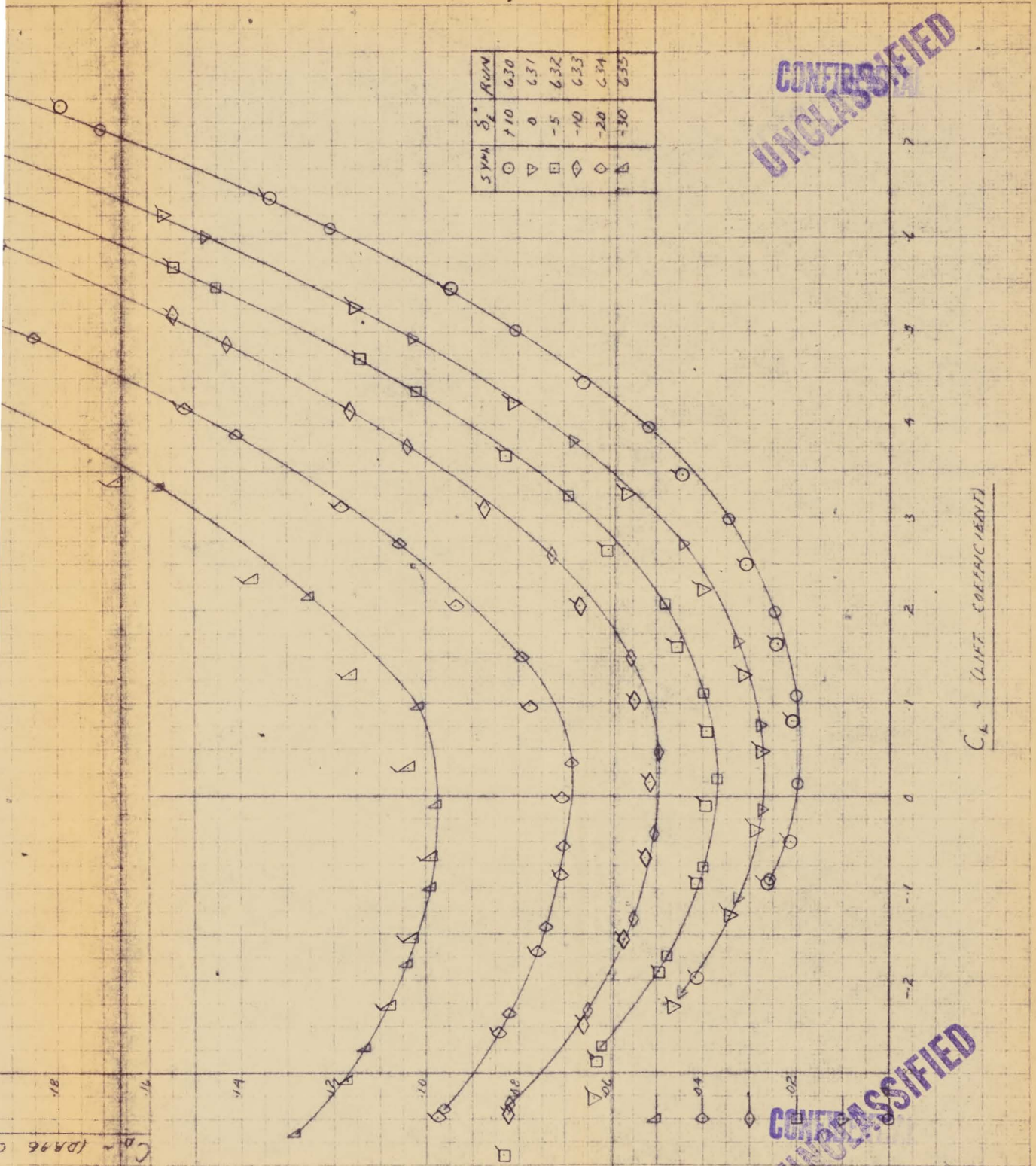
K&E

SHT. ~ 21

P/WIND TUNNEL/82 21
R. SKULSKY 98

SYN	δ_2	RUN
○	+10	630
▽	0	631
□	-5	632
◇	-10	633
◇	-20	634
△	-30	635

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C_L (LIFT COEFFICIENT)

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C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

C_D

C_D vs C_L AND δE

(RUN #1 to #11)

($M=0.21$)

32

30

28

26

24

22

20

18

$C_L = 0.70$

0.65

0.60

$\delta E = -30^\circ$

$C = 105$

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

C_D

C_D VS C_L AND α

(Run #1 to #11)

32

30

28

26

24

22

20

18

16

$C_L = 0.70$

0.65

0.60

0.55

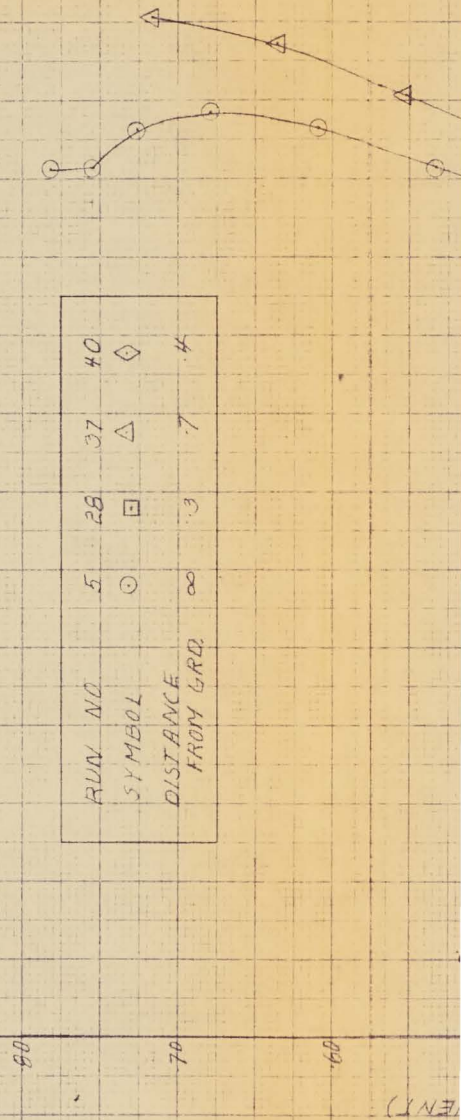
$\alpha = -30^\circ$

C = 105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN. 1956)

GROUND EFFECT $\delta_g = -2.5$

C_D VS C_L



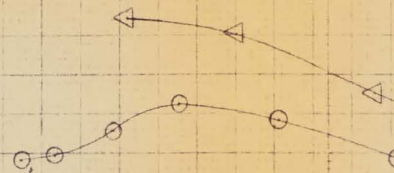
C - 105

NAE. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

GROUND EFFECT $\delta_g = -5$

C_p vs C_L

RUN NO.	6	29	36	41
SYMBOL	○	□	△	◇
DISTANCE FROM GRD.	∞	.3	.7	.4



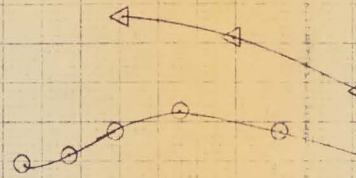
C - 10.5

NAE. LOW SPEED WIND TUNNEL TESTS (JAN. 1956)

GROUND EFFECT $S_g = -10^\circ$

C_D VS C_L

RUN NO.	7	30	35	42
SYMBOL	○	□	△	◇
DISTANCE FROM GRD.	∞	.3	.7	.4



C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN. 1956)

GROUND EFFECT $\delta_c = -20^\circ$

C_D VS C_L

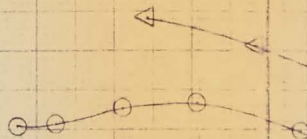
RUN NO	9	31	34	43
SYMBOL	○	□	△	◇
DISTANCE FROM GRD.	∞	.3	.7	.4

80

76

60

(E.M.T.)



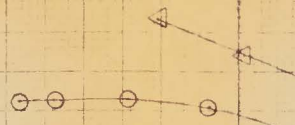
C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN. 1956)

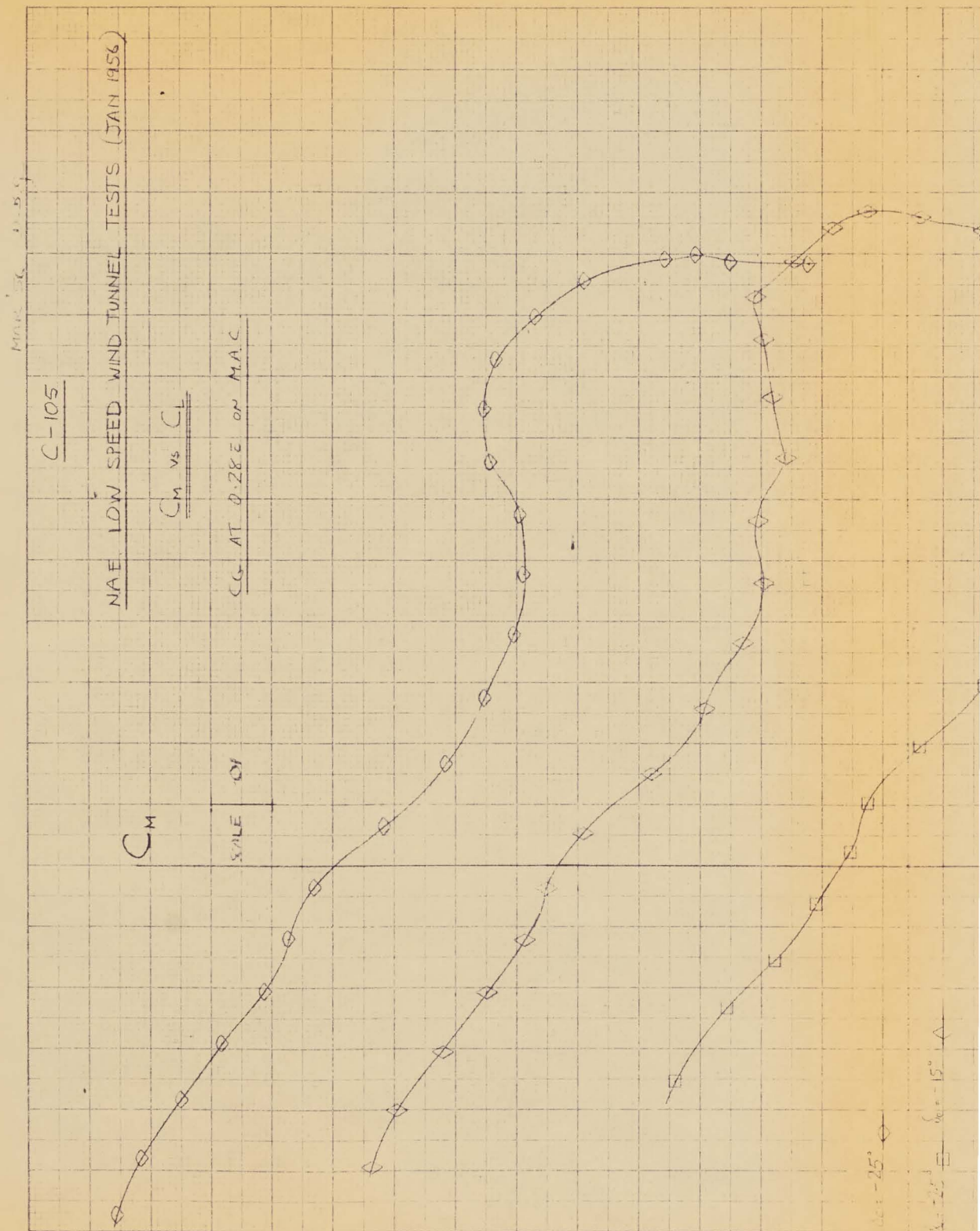
GROUND EFFECT $\delta_g = -30$

C_D VS C_L

RUN NO.	11	32	33	44
SYMBOL	○	□	△	◇
DISTANCE FROM GRD.	∞	.3	.7	.4



(INVERT)



359-11L

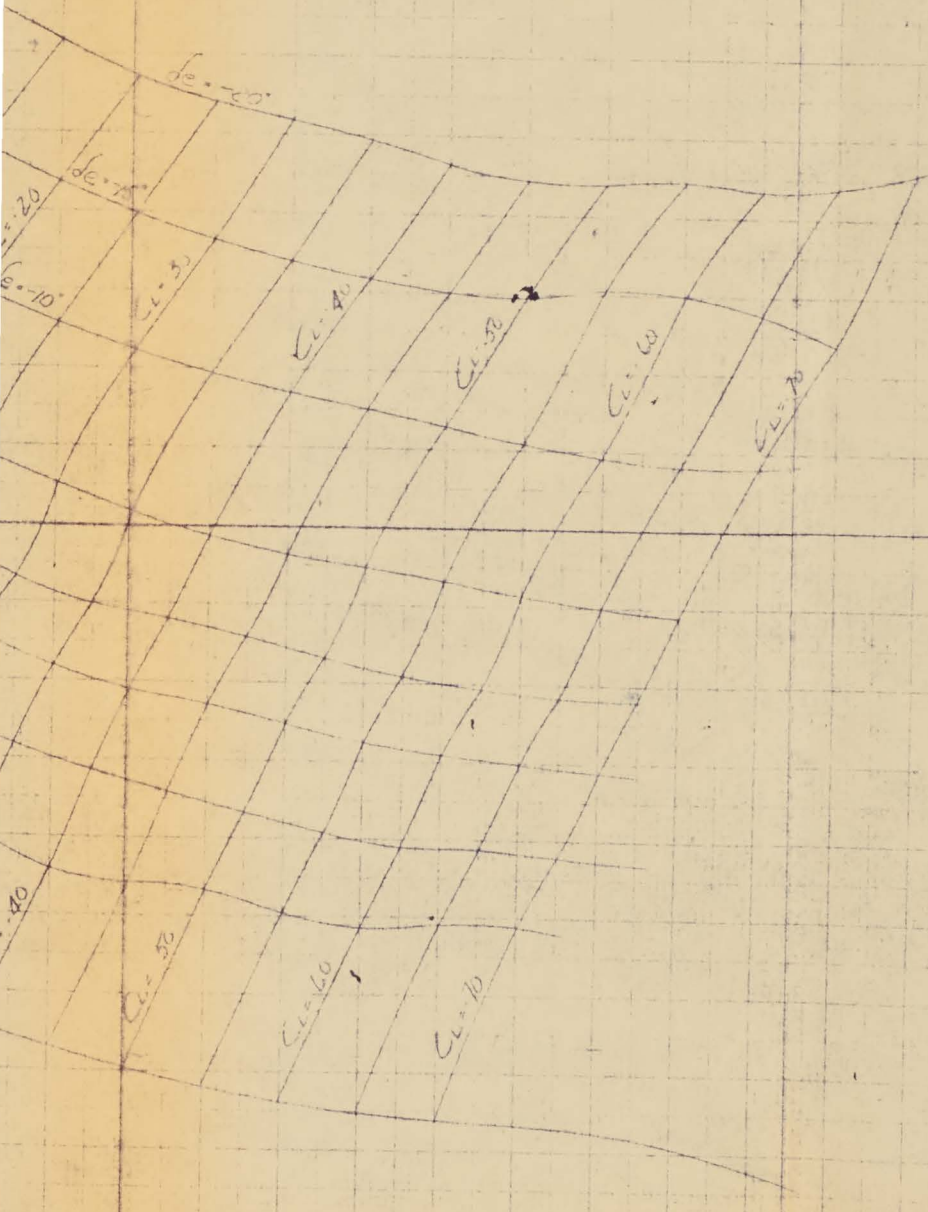
Crowley JUL 157 P161/109
1/15/56

C-105

N.A.E. LOW SPEED WIT TESTS
(JAN. 1956)

C_M VS C_L & C_D

C_D AT 28° in MRC



C-105

N.A.E. LOW SPEED W.T. TESTS (DEC 1955)

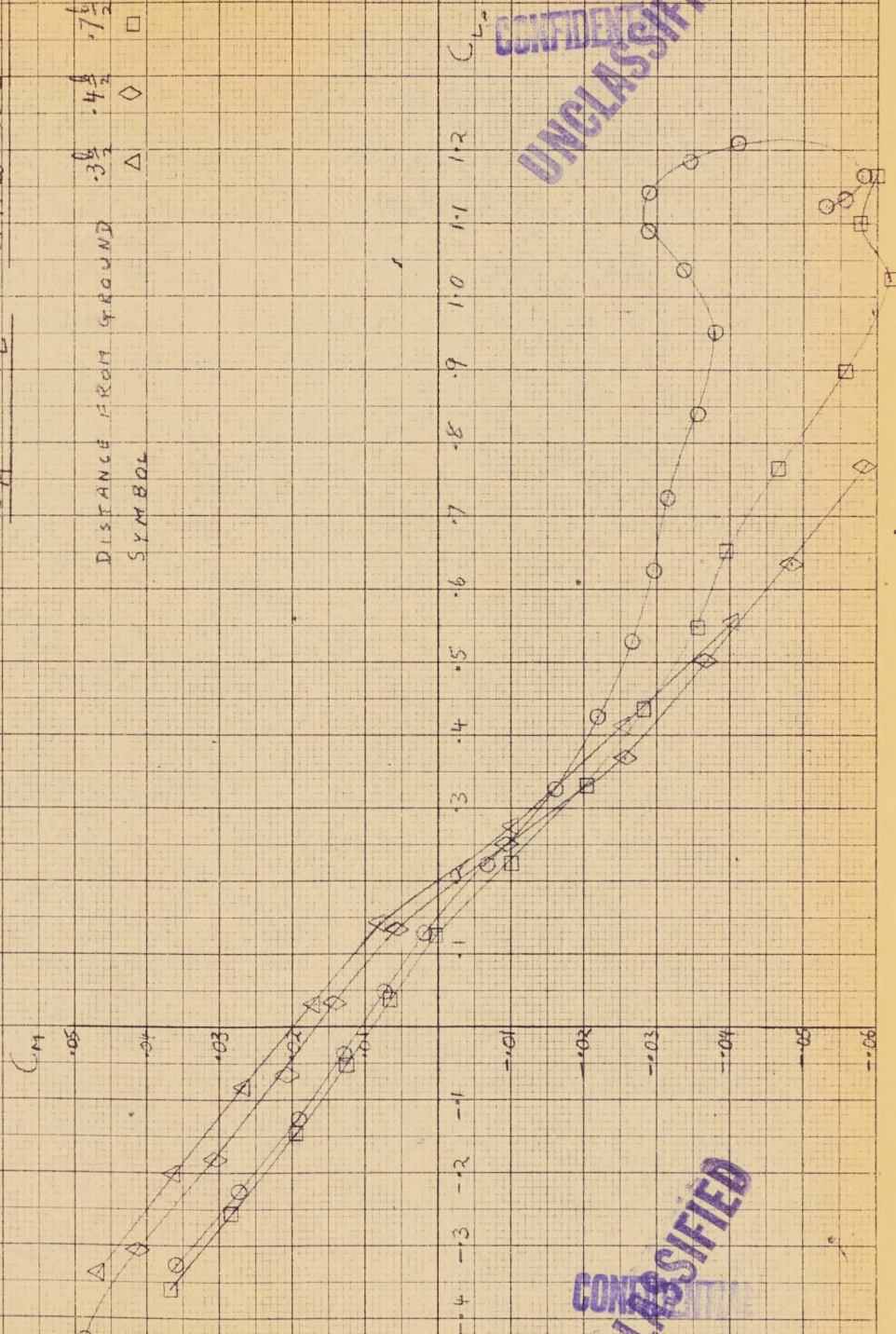
GROUND EFFECT $\delta_g = 0$

C_M vs C_L

C.G. @ .28 Z ON M.A.C.

DISTANCE FROM GROUND
SYMBOL

Δ .38
 $\diamond$.48
 $\square$.76
 $\circ$ ∞

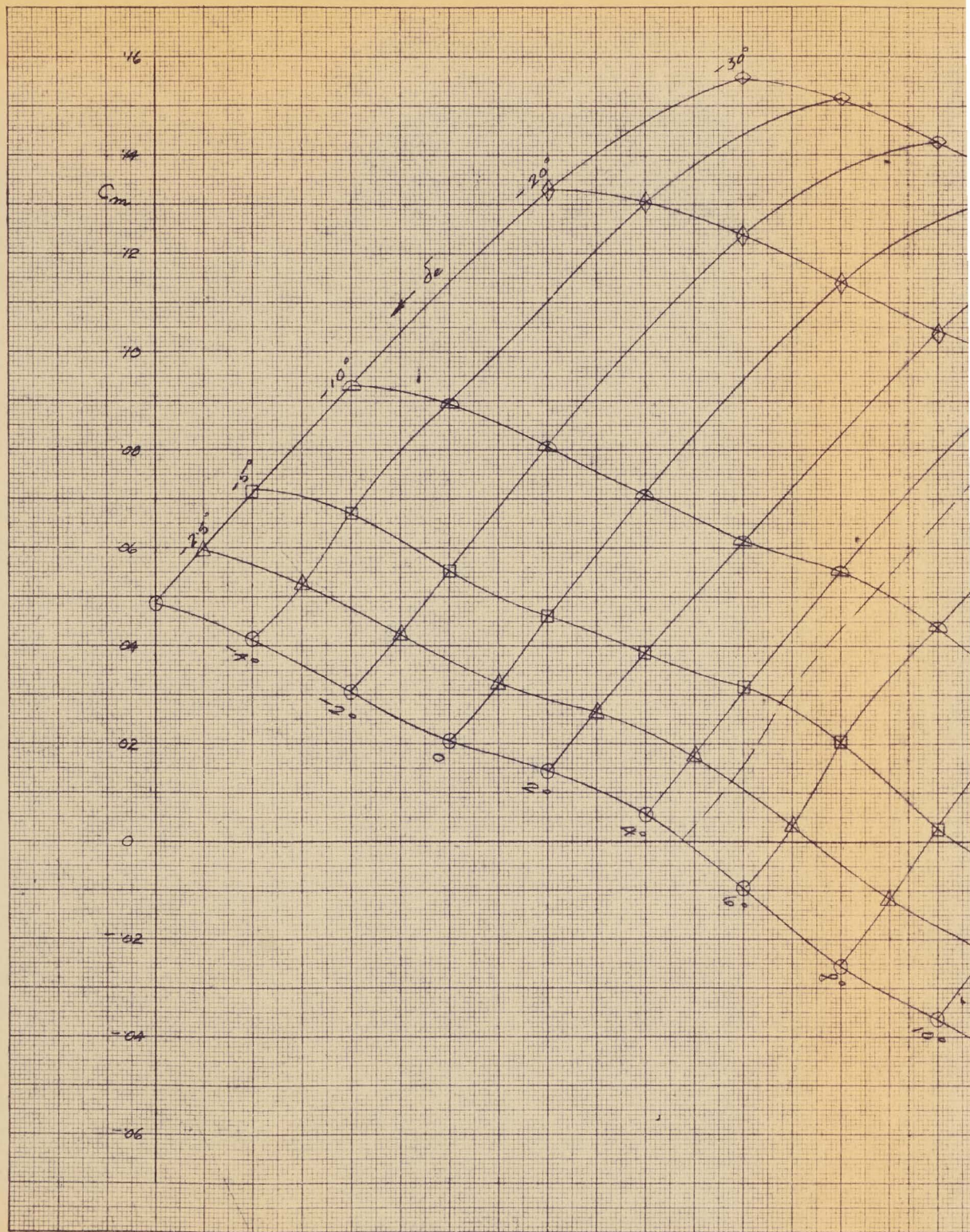


P/WT/98 3.5
ER 3 MARCH 1956

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259-14L KUFFEL & ESSER CO.
 Millimeters, 5 mm. lines reversed cm. lines heavy.
 #40718 U.S.A.



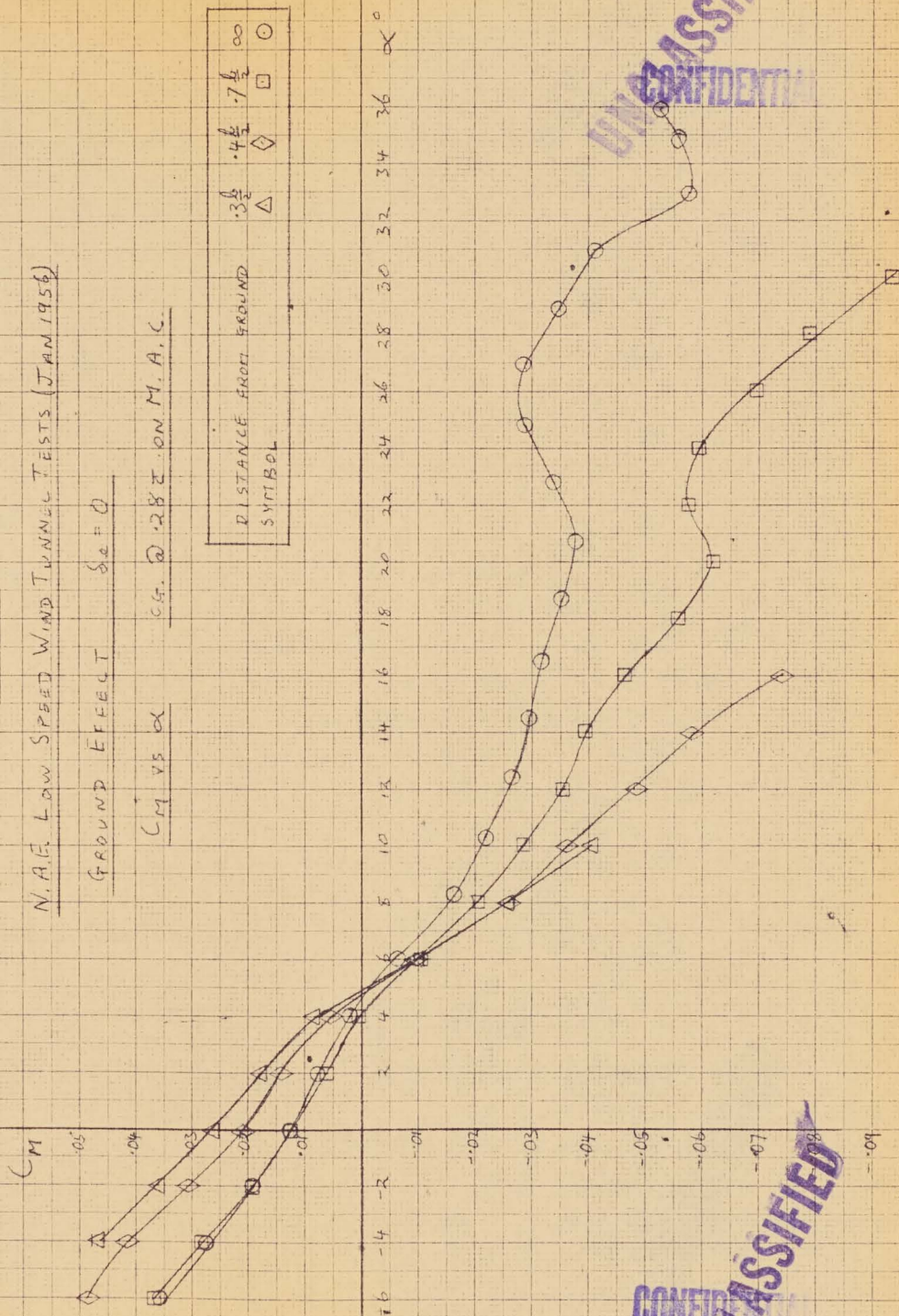
C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

GROUND EFFECT $\delta_2 = 0$

CM VS α CG. @ 28% ON M.A.C.

DISTANCE FROM GROUND	3 $\frac{1}{2}$	4 $\frac{1}{2}$	7 $\frac{1}{2}$	∞
SYMBOL	Δ	$\diamond$	$\square$	$\circ$



P/WT/98 4.5
APRIL 1956 E R 7

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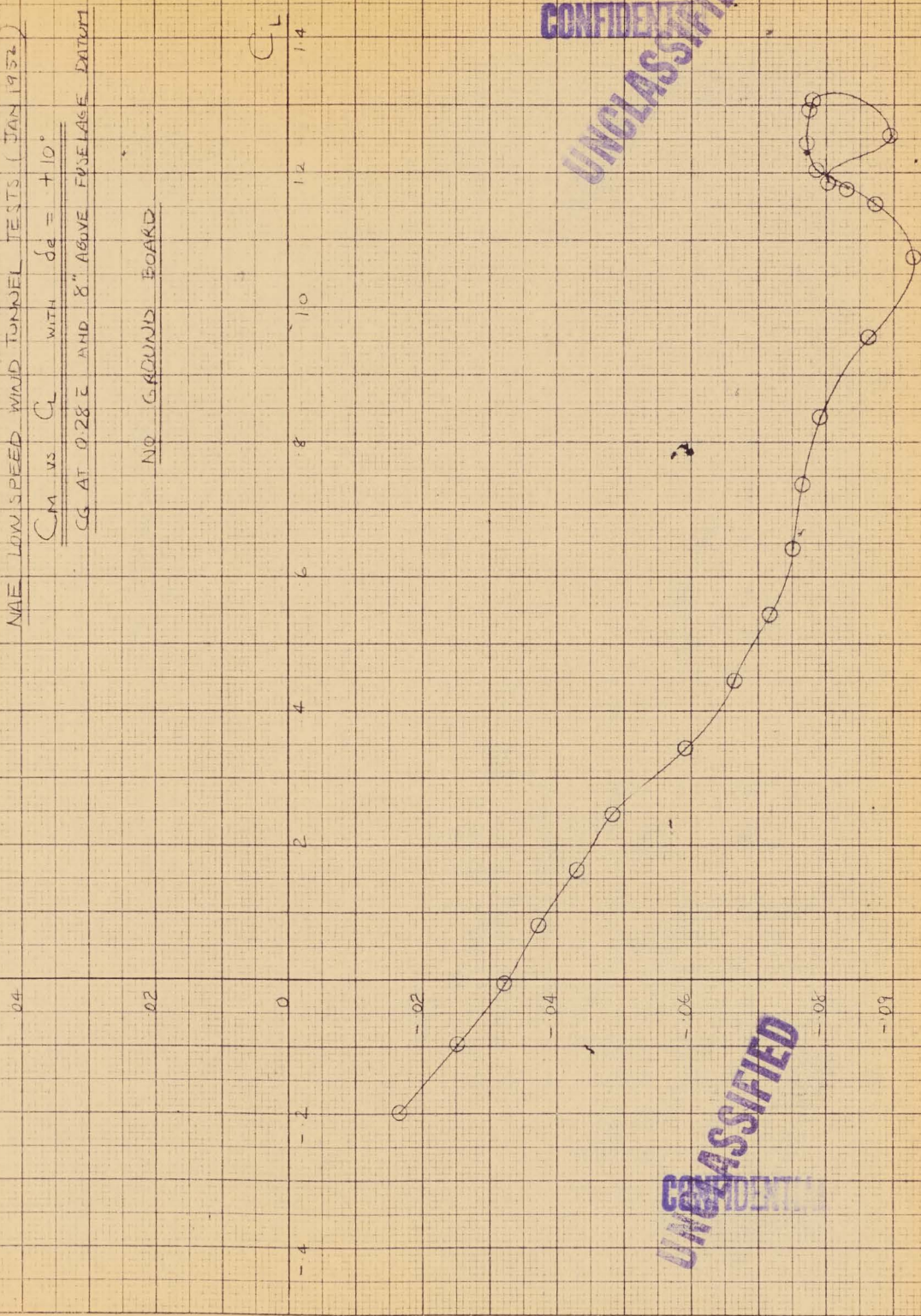
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C-105
NAE LOW SPEED WIND TUNNEL TESTS (JAN 1932)
 C_M vs C_L WITH $\delta\alpha = +10^\circ$
CG AT 0.282 AND 8" ABOVE FUSELAGE EXIT

NO GROUND BOARD

C_L

C_M



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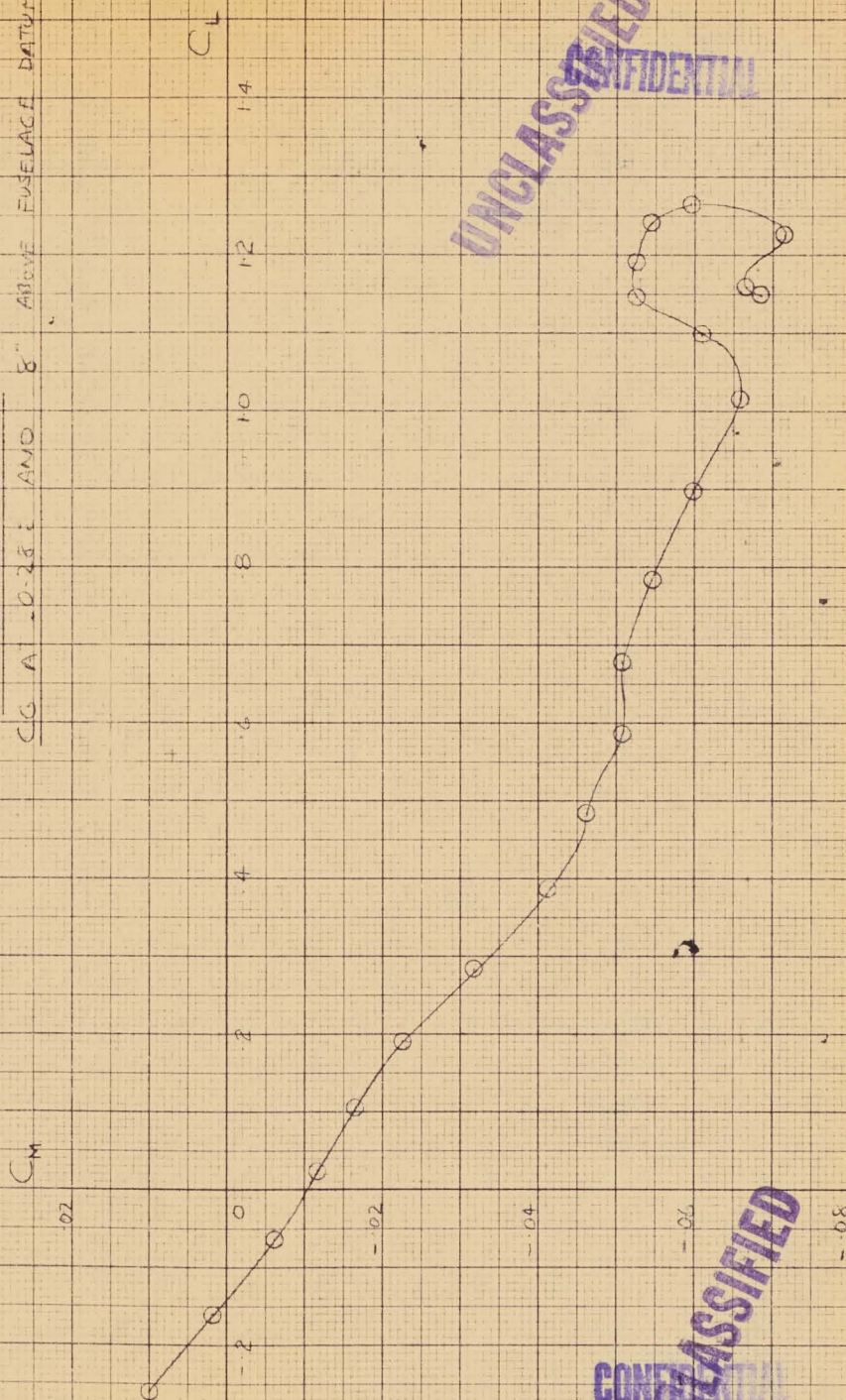
UNCLASSIFIED

C-105
NAE LOW SPEED WIND TUNNEL TESTS (JAN 1932)

C_M vs C_L WITH $\delta E = +5^\circ$

NO GROUND BOARD

CG AT .0-282 AND 8" ABOVE FUSELAGE DATUM



MAY 56 DBC

PJW 198

5-18

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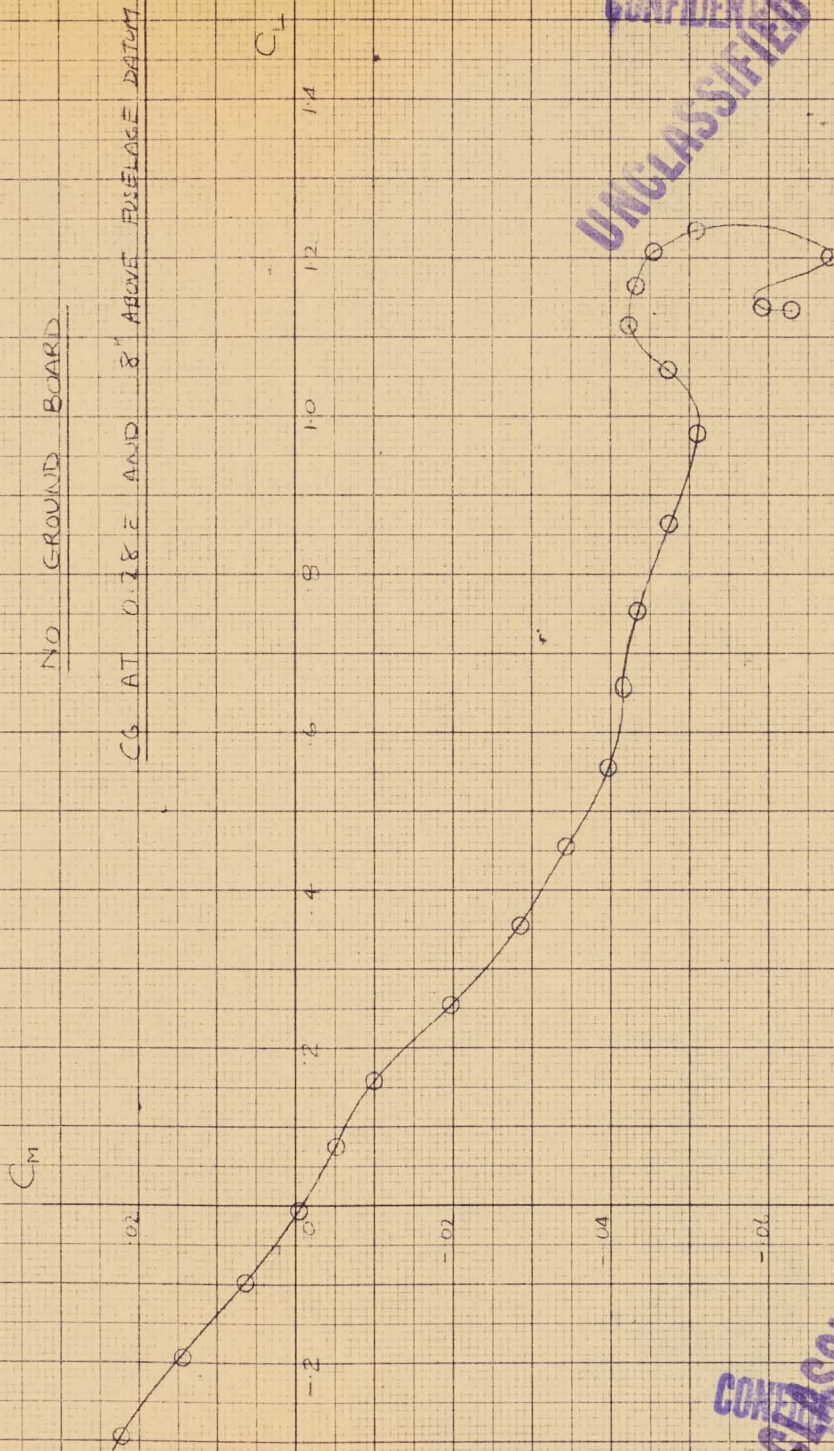
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C-105
N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

C_M vs C_L WITH $\alpha = +2.5^\circ$

NO GROUND BOARD

C_G AT 0.182 AND 8" ABOVE FUSELAGE DATUM

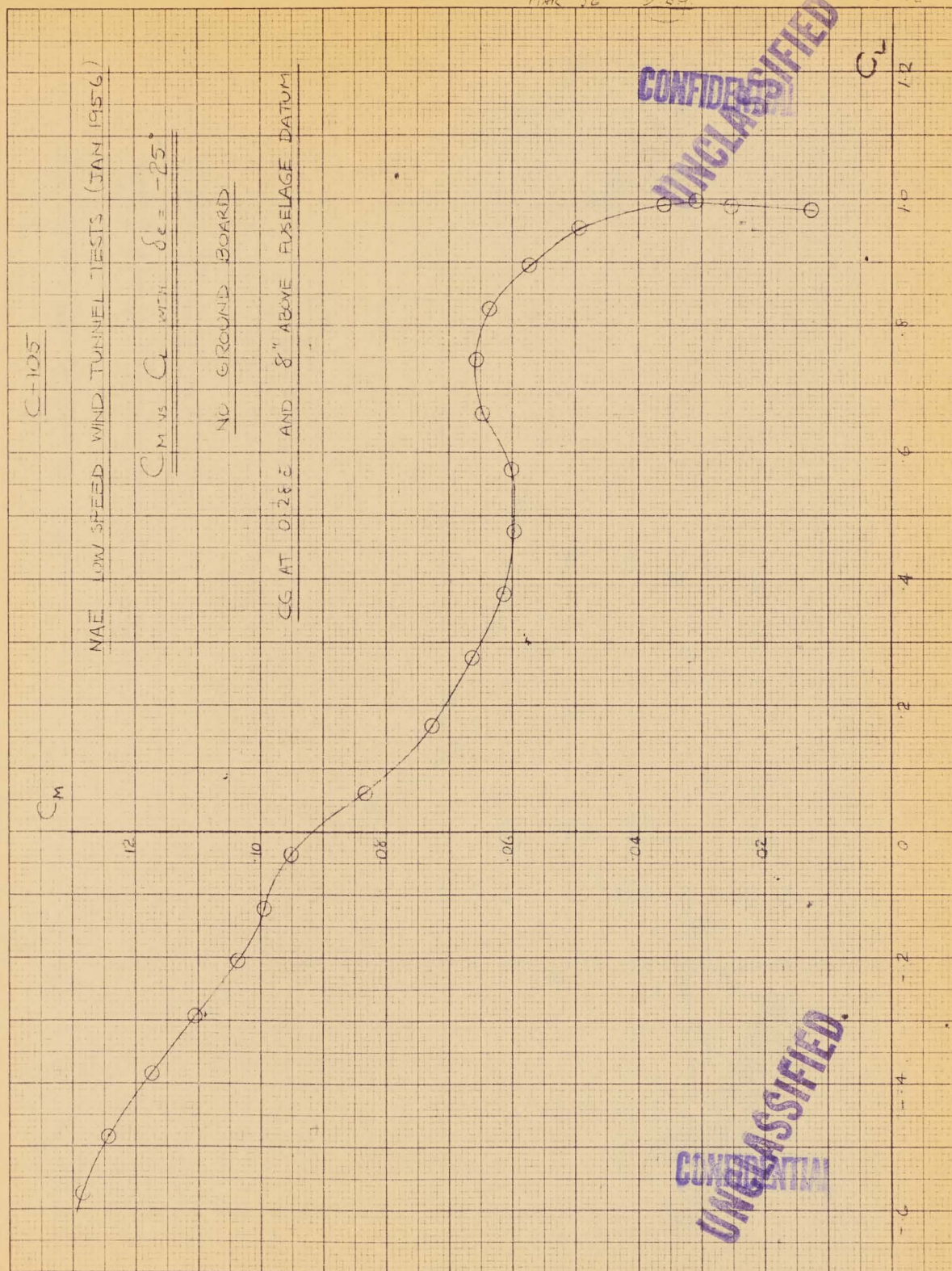


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P/WT/98
 MAR '56 D.B.G.

5-1c



C-105
NAE LOW SPEED WIND TUNNEL TESTS (JAN 56)

EFFECT OF GROUND ON C_M VS C_L WITH $\delta_c = 0^\circ$

CG AT 0.28 $\bar{z}$ AND 8" ABOVE FUSELAGE MIDCHORD

DISTANCE FROM GROUND

SYMBOL

Δ

$\diamond$

$\square$

$\circ$

C_L

1.4

1.2

1.0

.8

.6

.4

.2

0

-.2

-.4

C_M

.04

.02

0

-.02

-.04

-.06

-.08

-.10

-.12

-.14

-.16

-.18

-.20

-.22

-.24

-.26

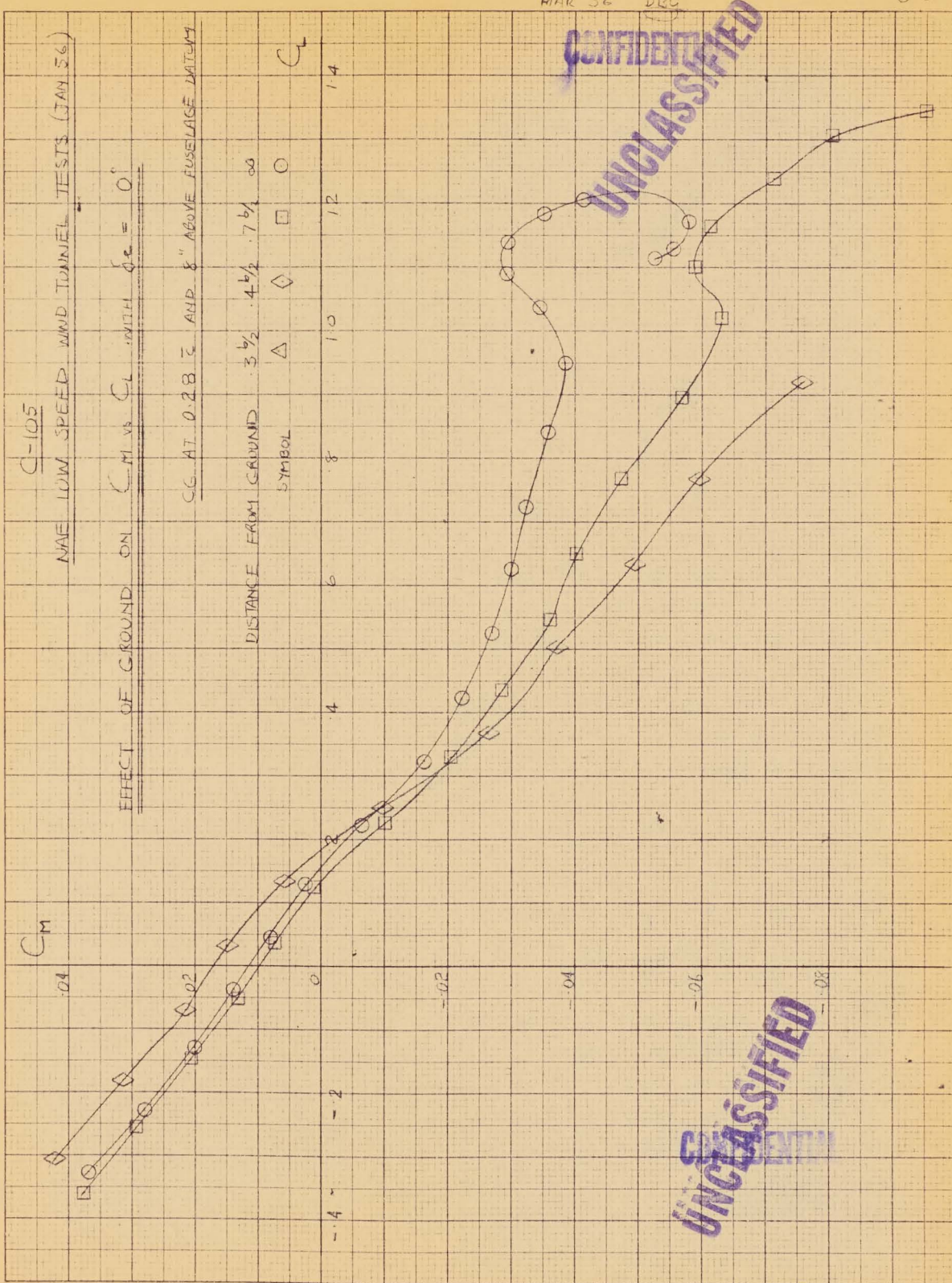
MAR 56 DRG

P/WT/ 98

5.5

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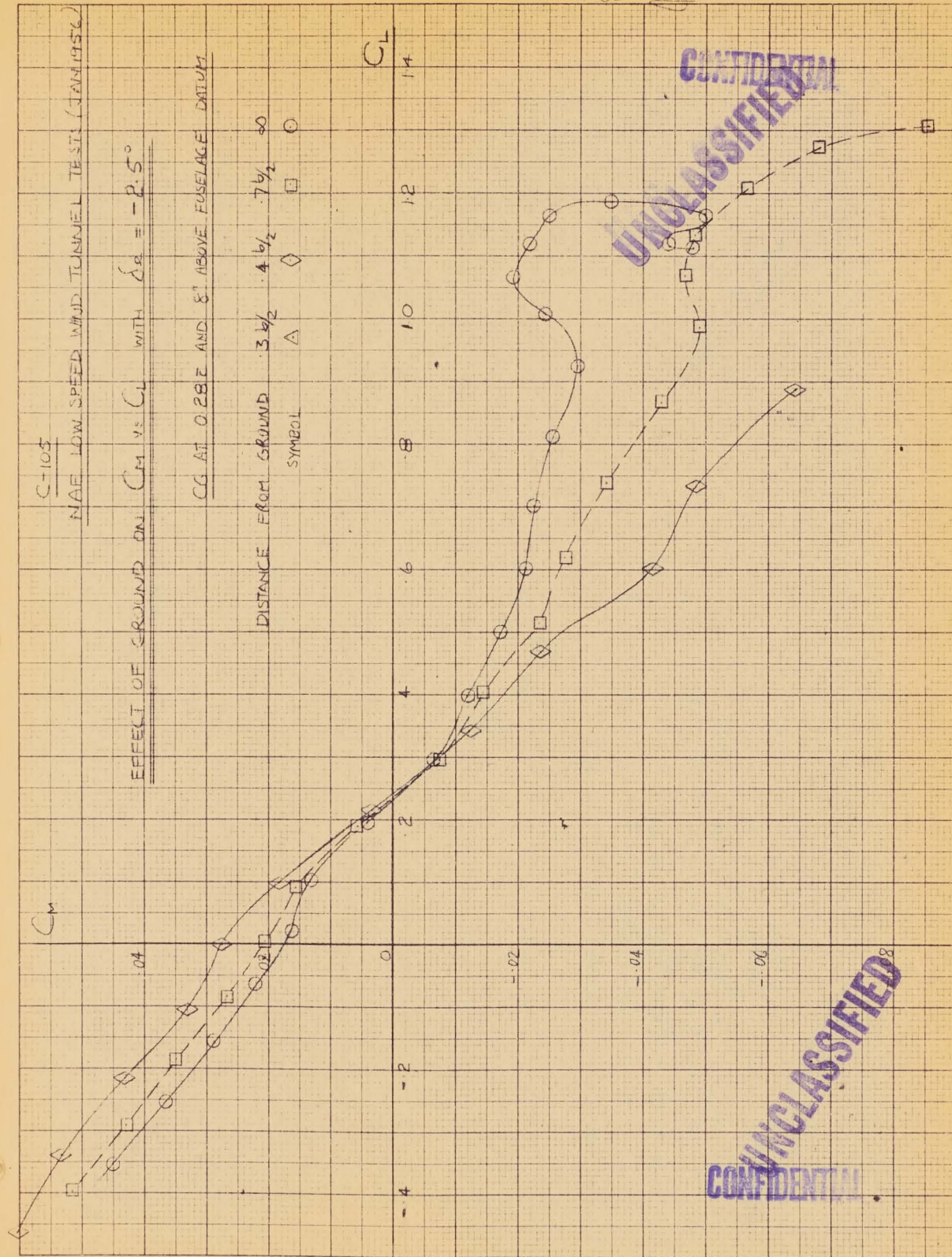
C-105

NAE LOW SPEED WIND TUNNEL TEST (JAN 1956)

EFFECT OF GROUND ON C_M vs C_L WITH $\delta_a = -2.5^\circ$

CG AT 0.28Z AND 8" ABOVE FUSELAGE DATUM

DISTANCE FROM GROUND
3 1/2 4 1/2 7 1/2 ∞
SYMBOL Δ $\diamond$ $\square$ $\circ$



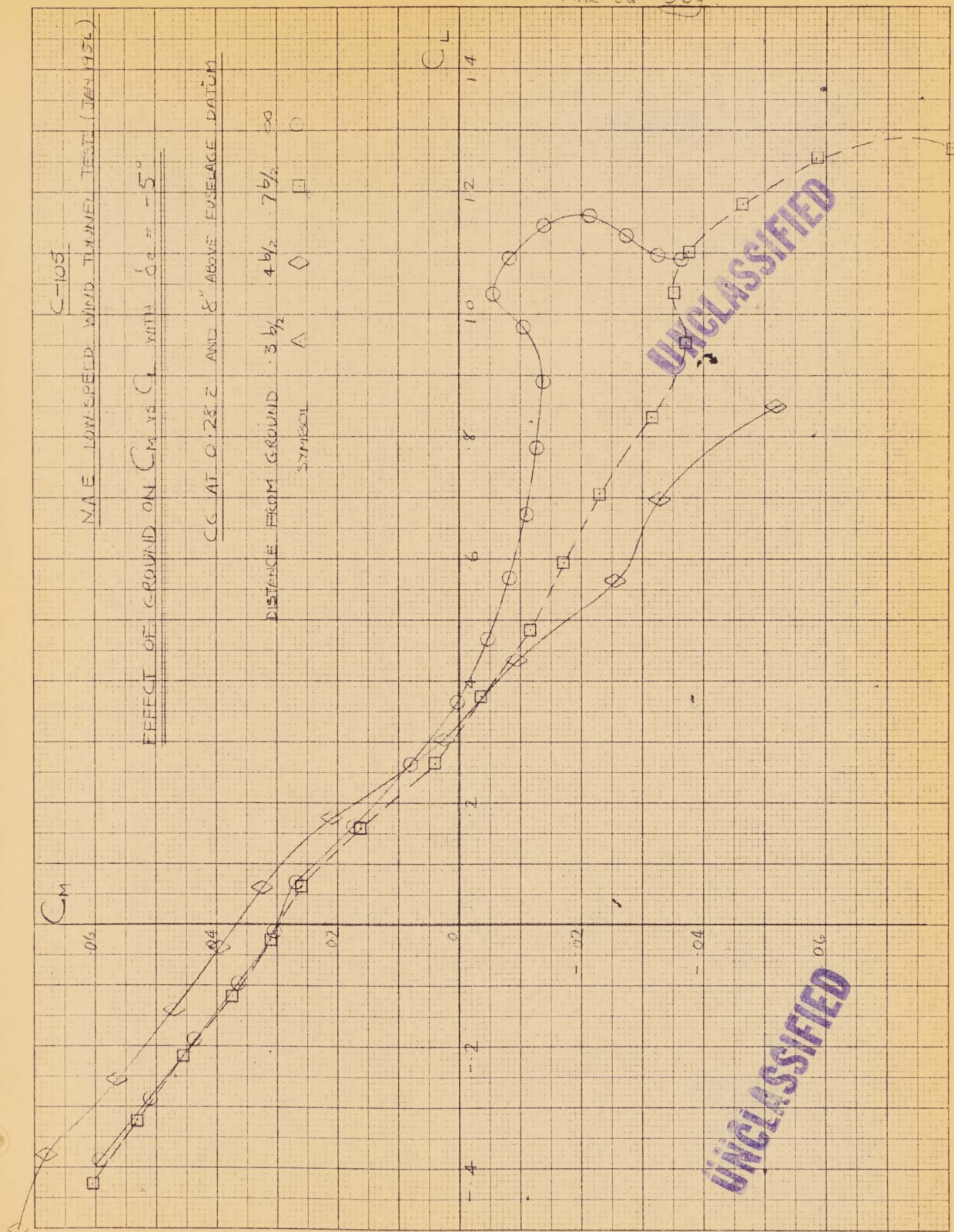
MAR '56 DBS

P/WT/98

5-6

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C-105 NAE LOW-SPEED W/T TESTS (JAN 58)

EFFECT OF GROUND ON C_m vs C_l WITH $\delta_e = -10^\circ$

C_g AT 0.28 $\bar{z}$ AND 8" ABOVE FUSELAGE DATUM

DISTANCE FROM GROUND $3\frac{1}{2}$ $4\frac{1}{2}$ $7\frac{1}{2}$ ∞

SYMBOL

Δ

$\diamond$

$\square$

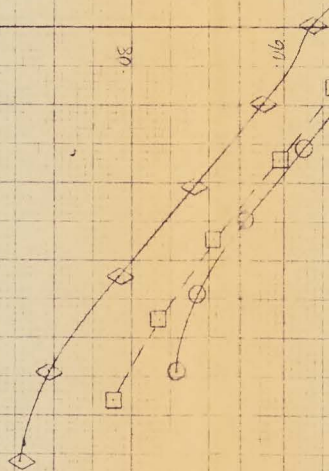
$\circ$

C_m

0

30

60



C-105

NAE LOW-SPEED WIND TUNNEL TESTS (JAN 56)

EFFECT OF GROUND ON C_M VS C_L WITH $\delta_e = -20^\circ$

CG AT 0.28Z AND 8" ABOVE FUSELAGE DATUM

DISTANCE FROM GROUND $3\frac{1}{2}$ $4\frac{1}{2}$ $7\frac{1}{2}$ ∞
 SYMBOL Δ $\diamond$ $\square$ $\circ$

C_M

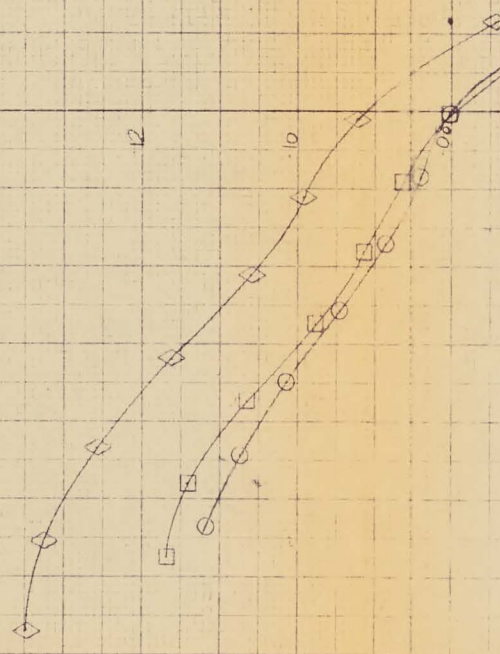
16

14

12

10

8



C-105

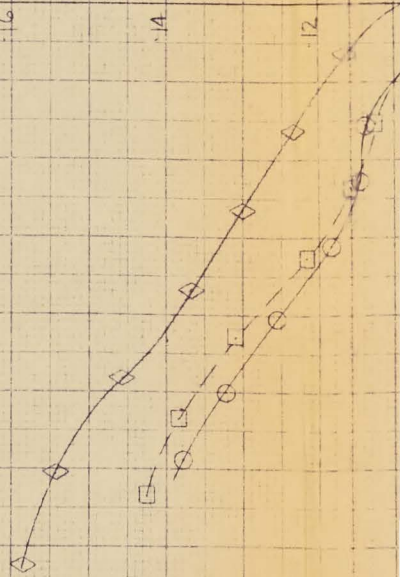
NAE LOW SPEED WIND TUNNEL TESTS (JAN 1936)

EFFECT OF GROUND ON C_M WITH $\alpha = -30^\circ$

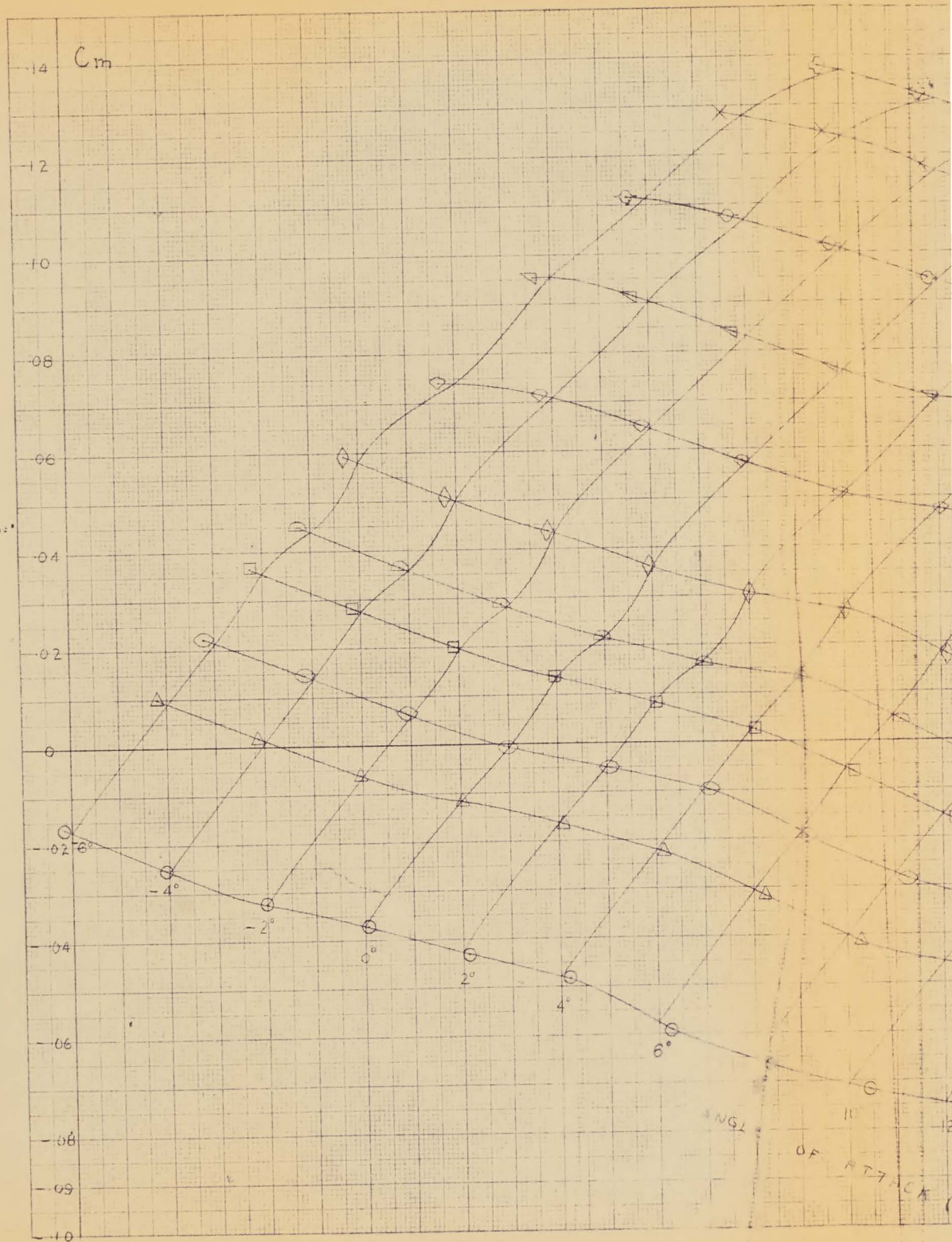
C_M AT 0.28 Z AND 8" ABOVE FUSELAGE DATUM

DISTANCE ABOVE GROUND
SYMBOL Δ $\diamond$ $\square$ $\circ$ ∞

C_M



10 X 10 TO THE CM. 359-14L
 K&E ROUFFE & ESSER CO. CARLISLE, PA.



YB 88 Mar/50

R/WT/98

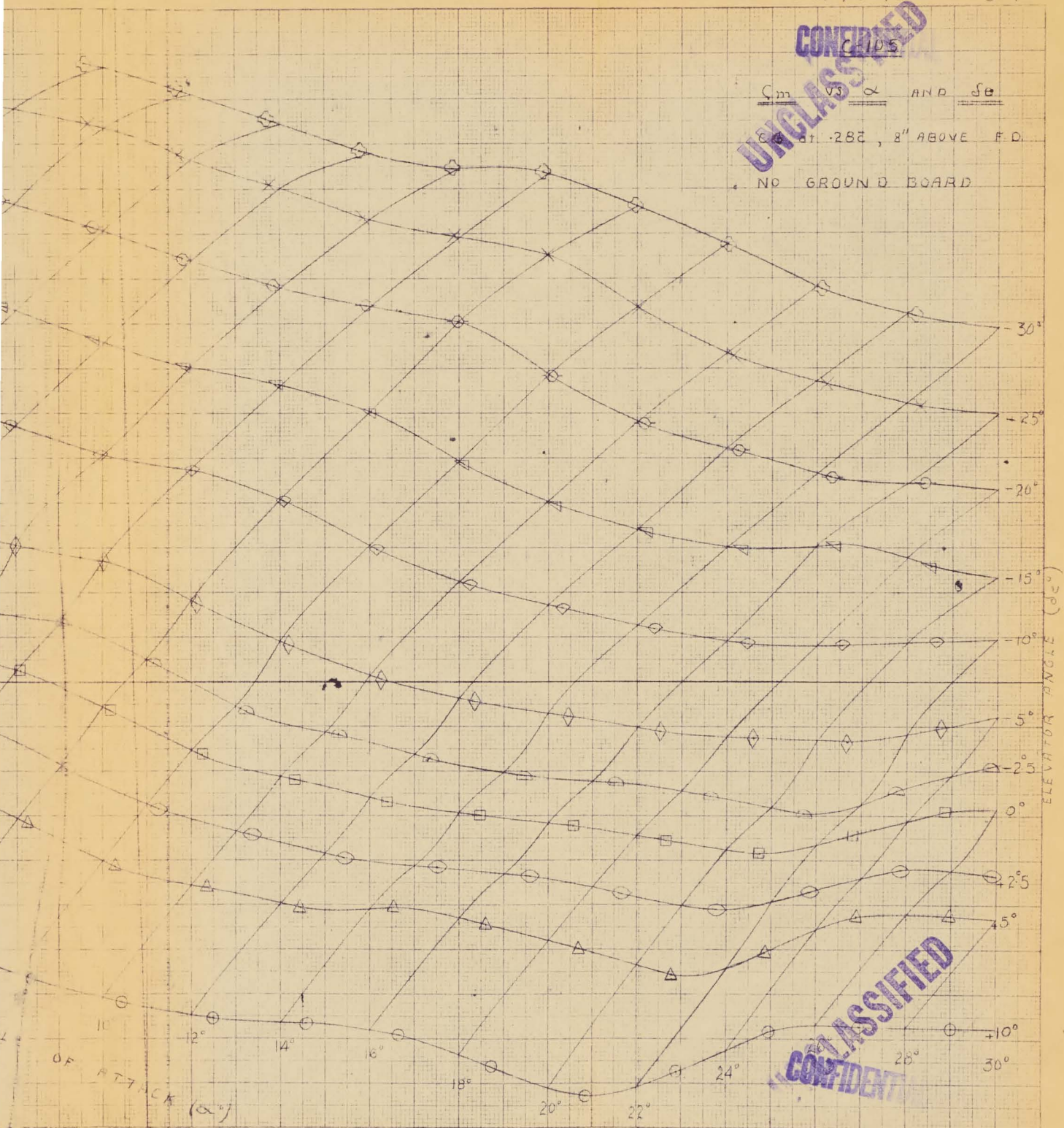
6.1

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Cm vs α AND δ

6.6 at .282, 8" ABOVE F.D.

NO GROUND BOARD



P/NT 798

6.4

MAR 16 1952

1.35.

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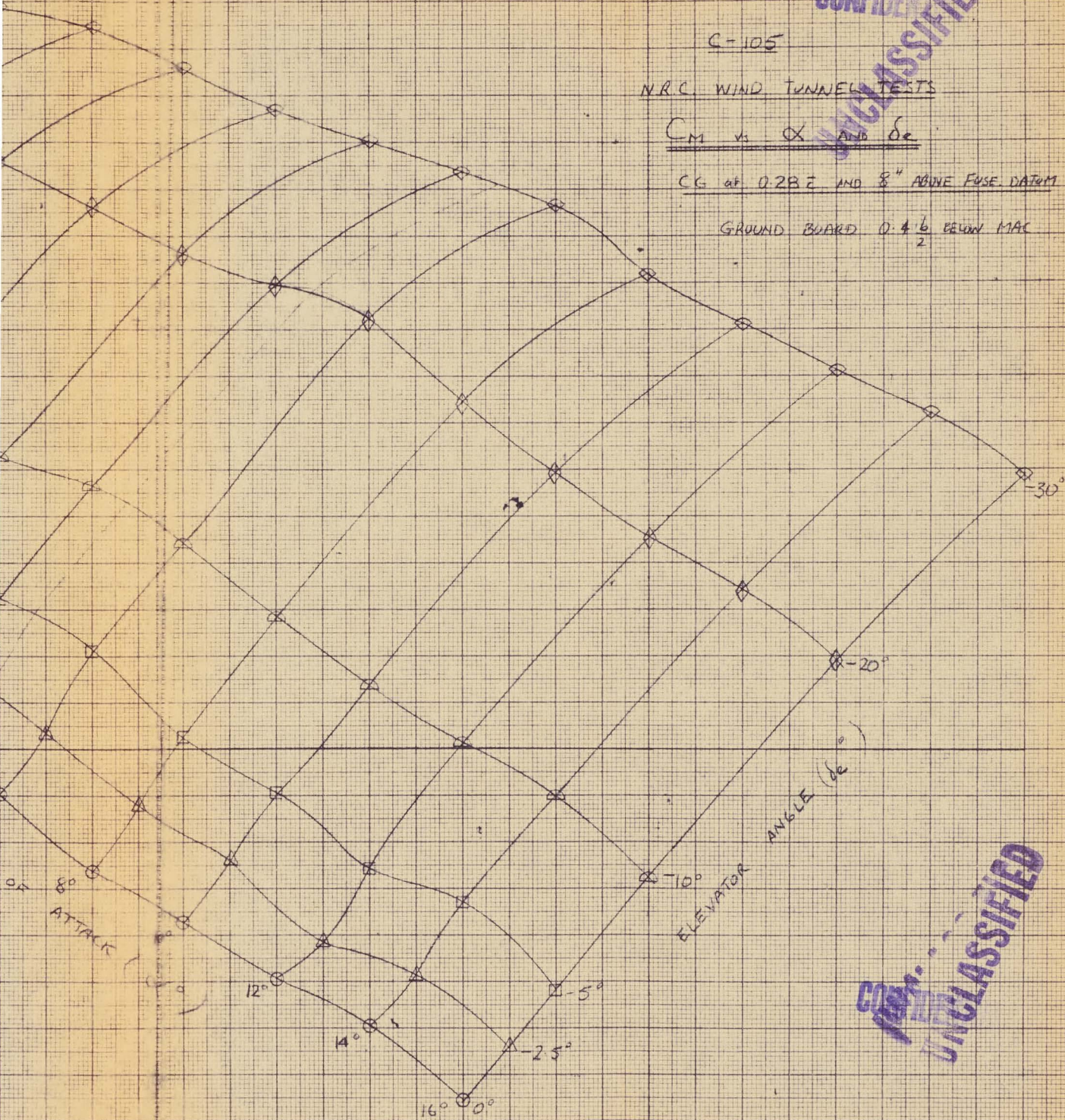
C-105

N.R.C. WIND TUNNEL TESTS

C_M vs α AND δ_e

CG at 0.282 AND $\frac{8}{2}$ " ABOVE FUSE DATUM

GROUND BOARD $0.4 \frac{1}{2}$ BELOW MAC



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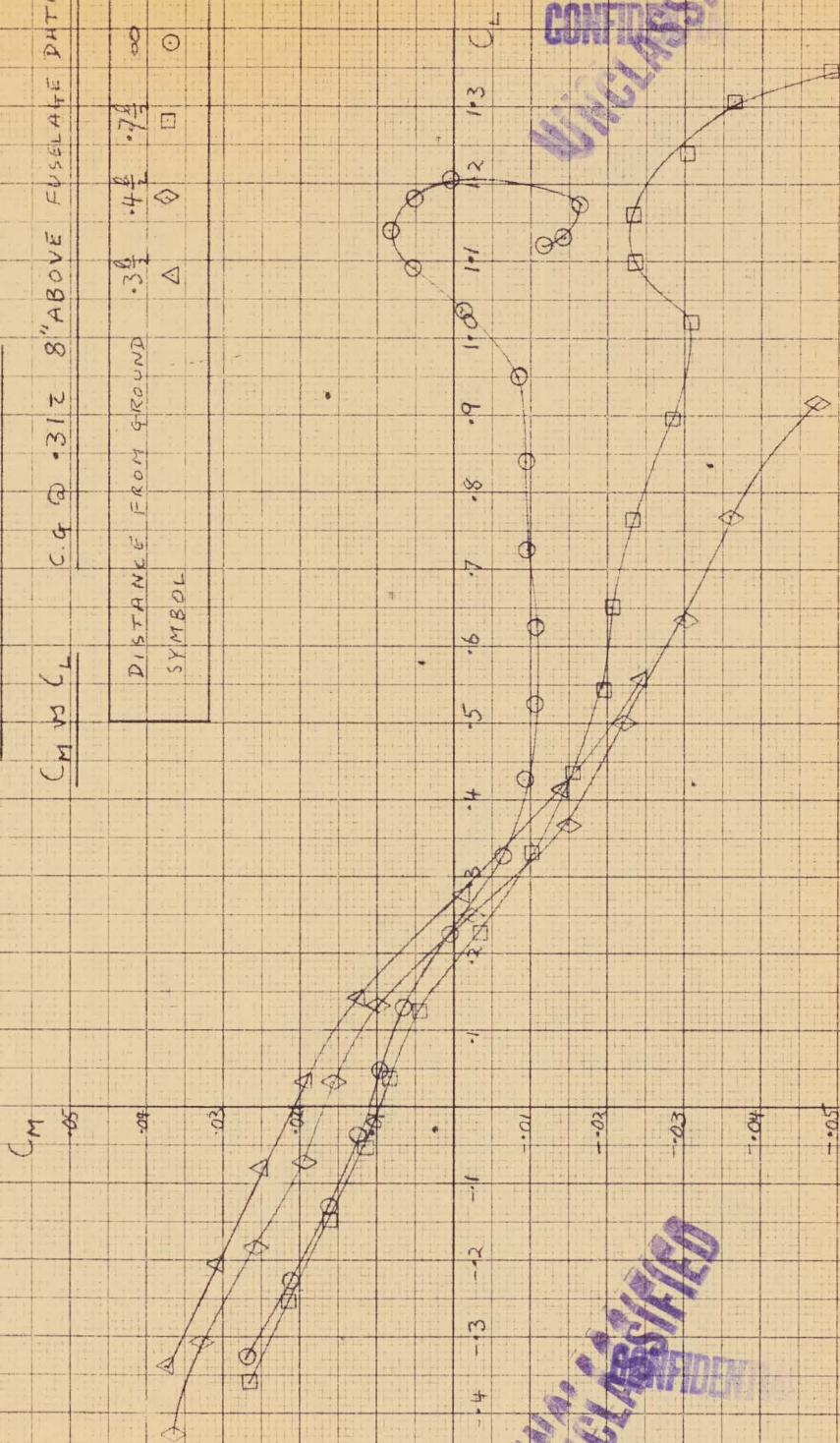
C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

GROUND EFFECT $\delta_E = 0$

C_M vs C_L C.G. @ .312 8" ABOVE FUSELAGE DATUM

DISTANCE FROM GROUND	SYMBOL
.30	Δ
.40	$\diamond$
.70	$\square$
∞	$\circ$



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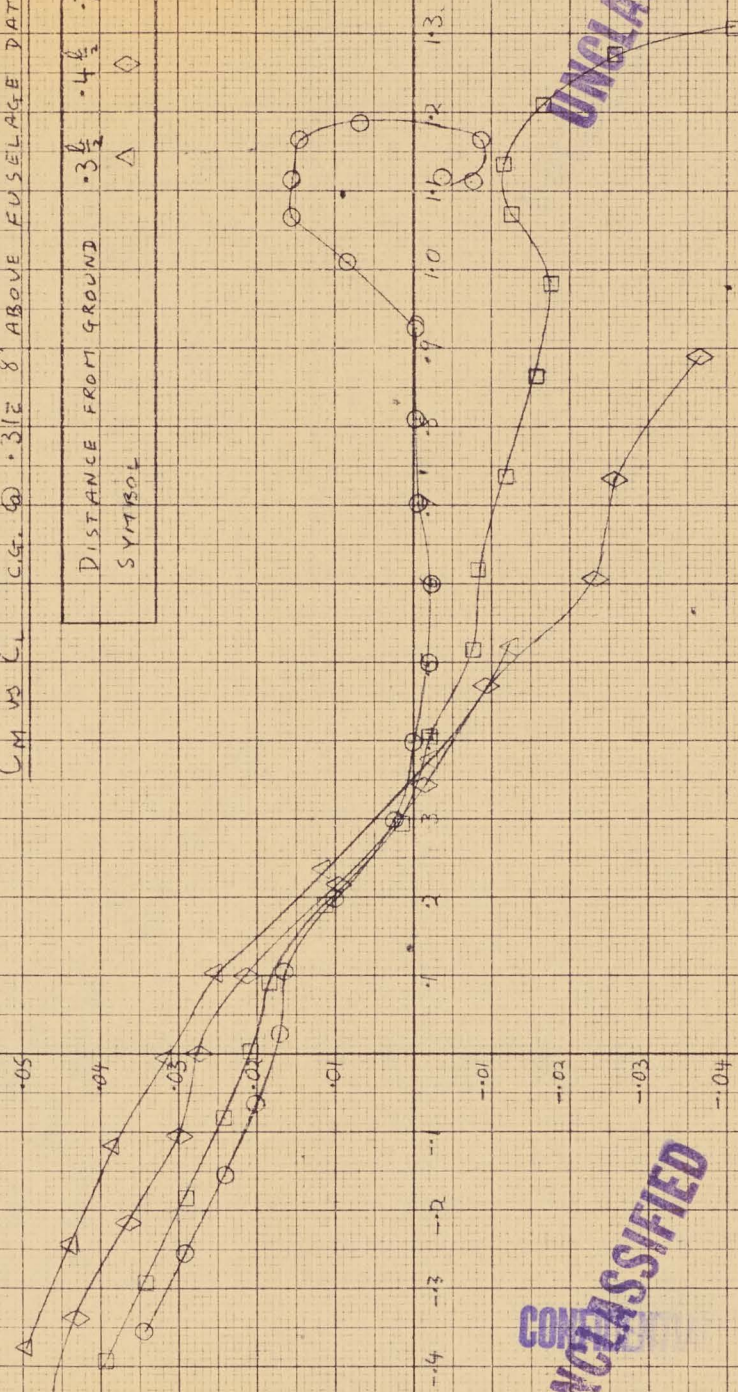
C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1956)

GROUND EFFECT $\delta_2 = -2.5^\circ$

C.M. VS C_L C.G. 60 3 1/2 8" ABOVE FUSELAGE DATUM

DISTANCE FROM GROUND	3 1/2	4 1/2	7 1/2	∞
SYMBOL	Δ	$\diamond$	$\square$	$\circ$



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P/WT/98

7.6

ER 5 JAN 1956

P/WT/98

7.7

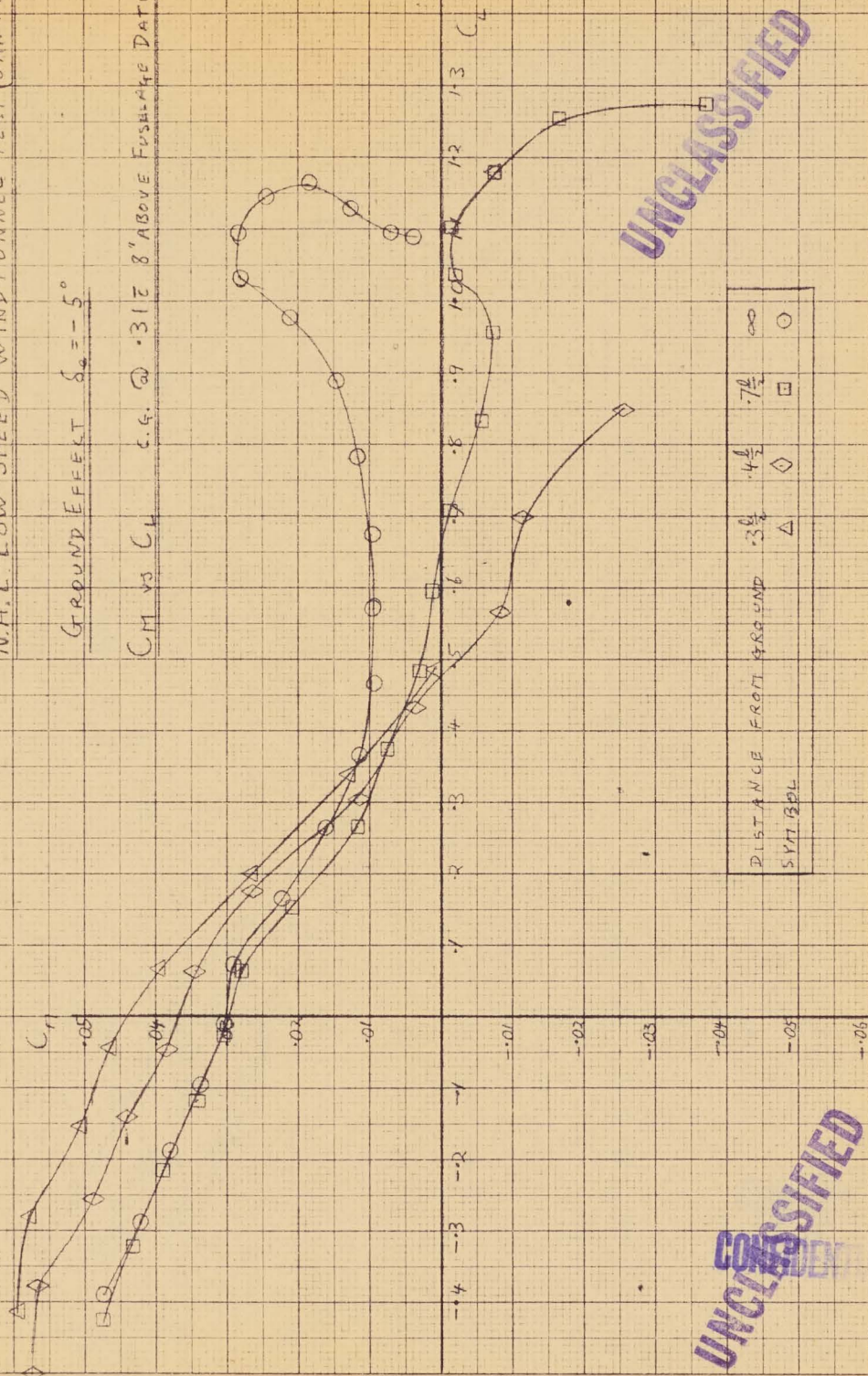
ER3. MARCH 1956

C-105

N.A.E. LOW SPEED WIND TUNNEL TEST (JAN 1956)

GROUND EFFECT $\delta_0 = -5^\circ$

C_M vs C_L c.g. @ .312 8' ABOVE FUSelage DATUM



DISTANCE FROM GROUND
SYMBOL

∞

$7\frac{1}{2}$

$4\frac{1}{2}$

$3\frac{1}{2}$

Δ

$\diamond$

$\square$

$\circ$

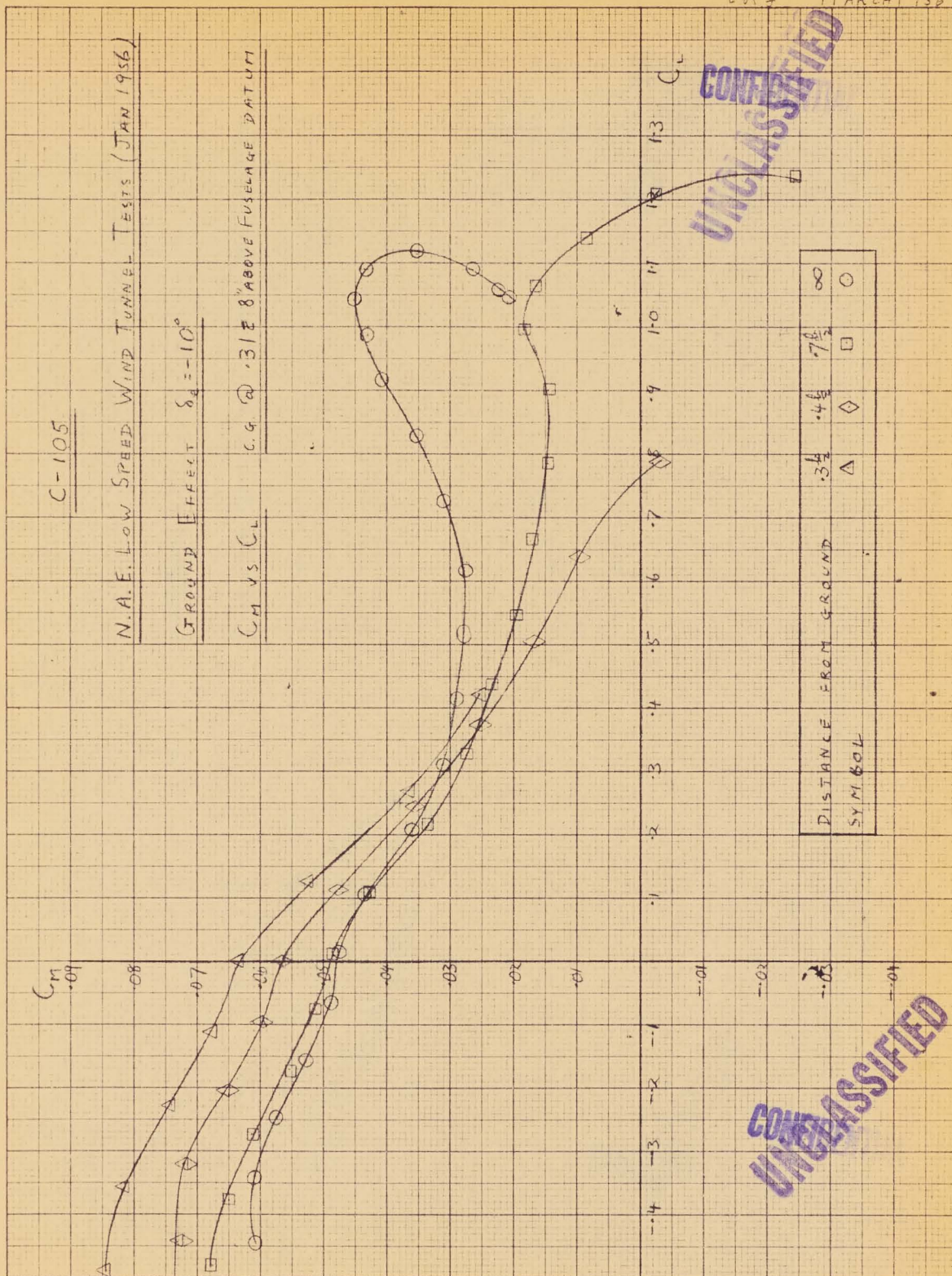
UNCLASSIFIED

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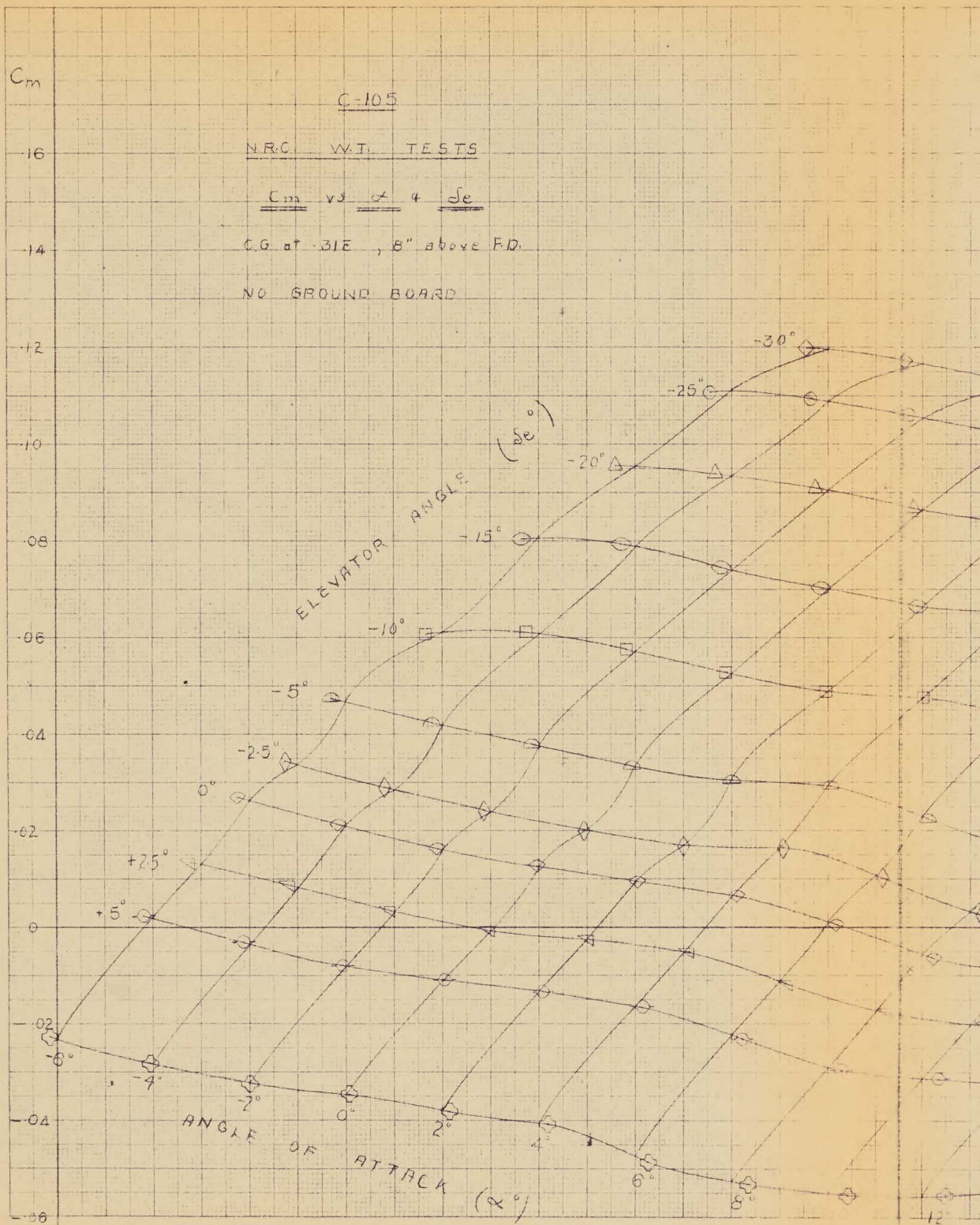
P/WT/98

7.8

ER# MARCH 1956



10 X 10 TO THE CM. 359-141L
KEUPEL & ESSER CO. LINCOLN

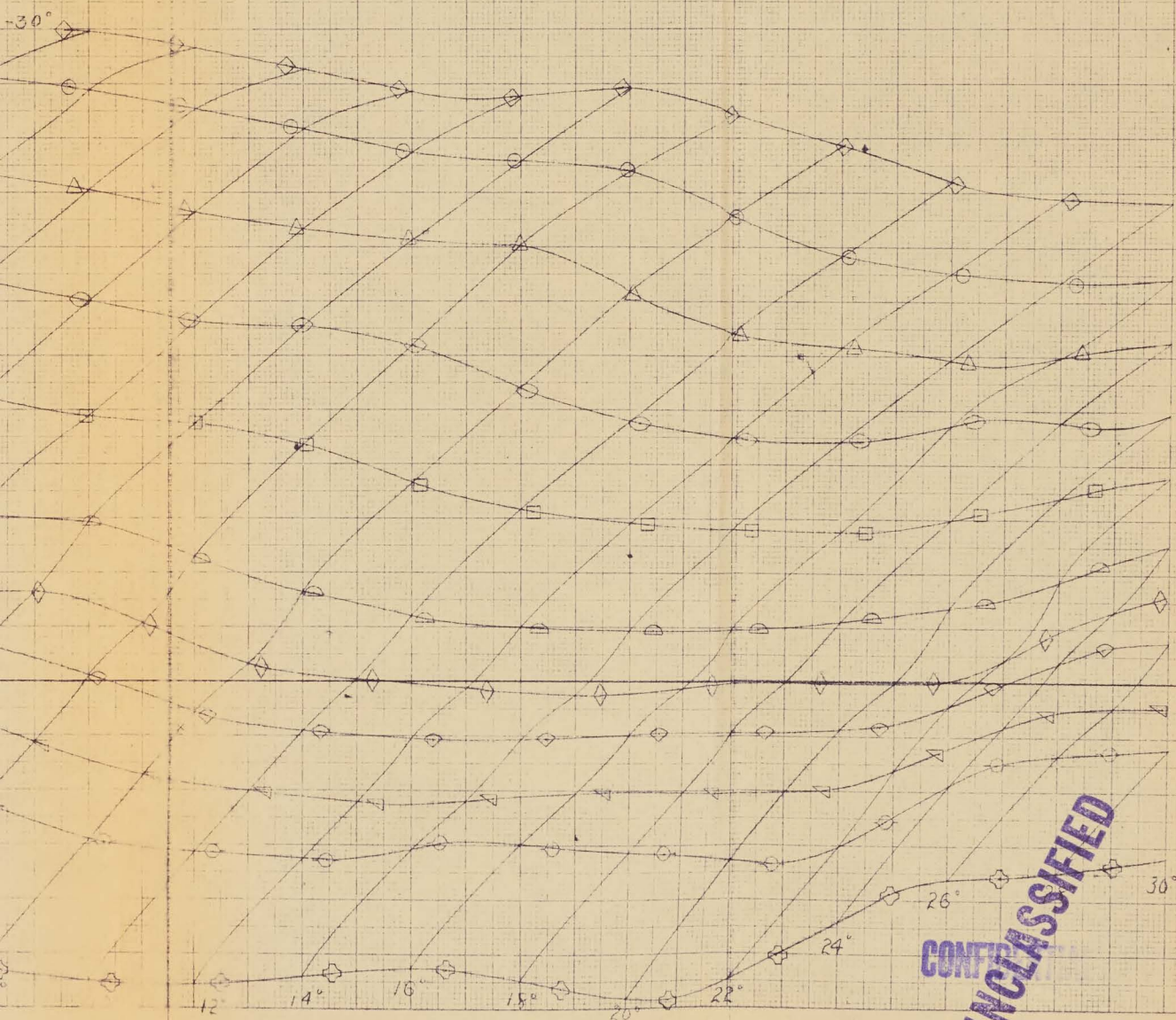


P/WT/98

YB/H mar 156

8

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P/WT/98

max 154 438

8.3

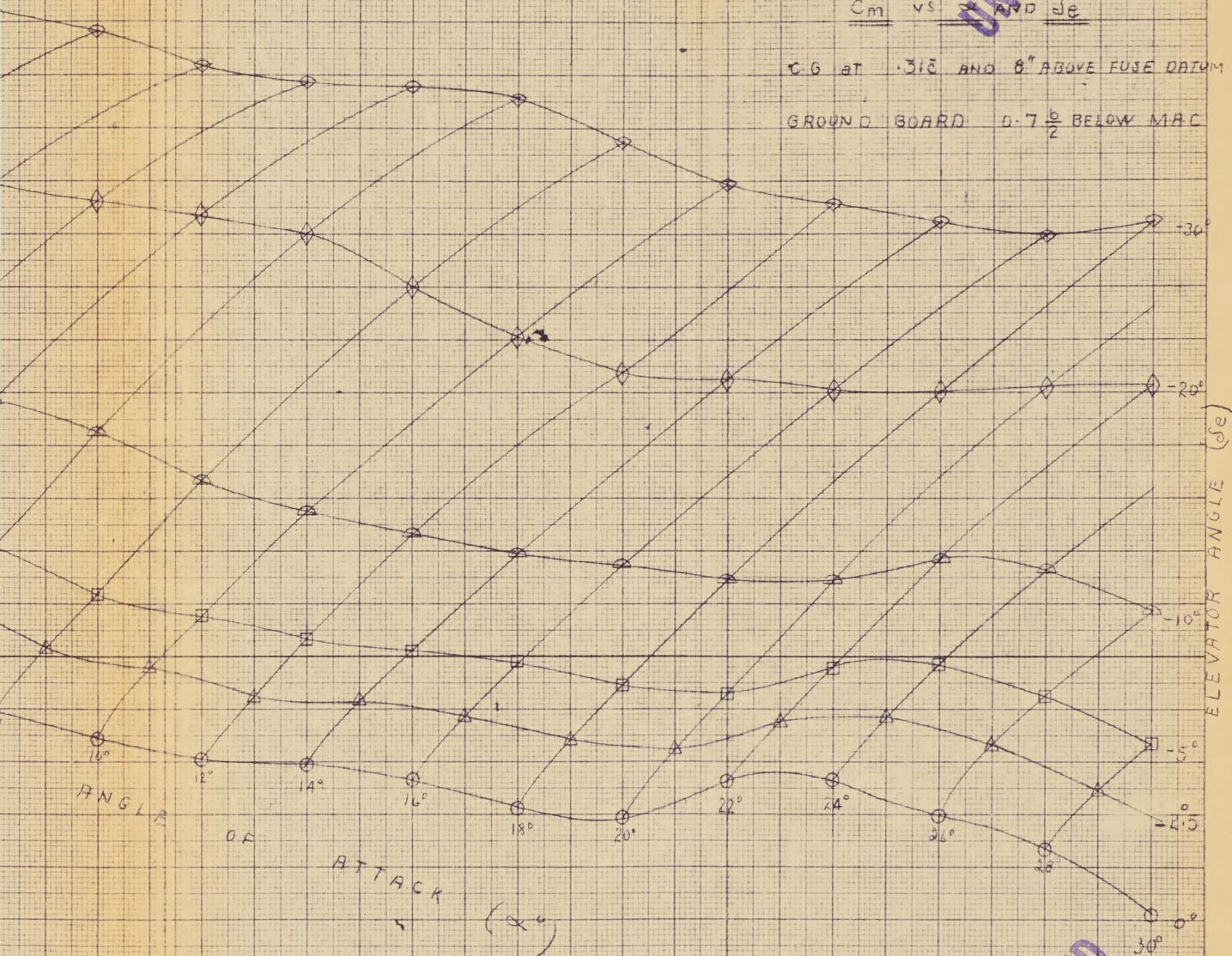
G-105

N.R.C W.T TESTS

Cm vs AND Se

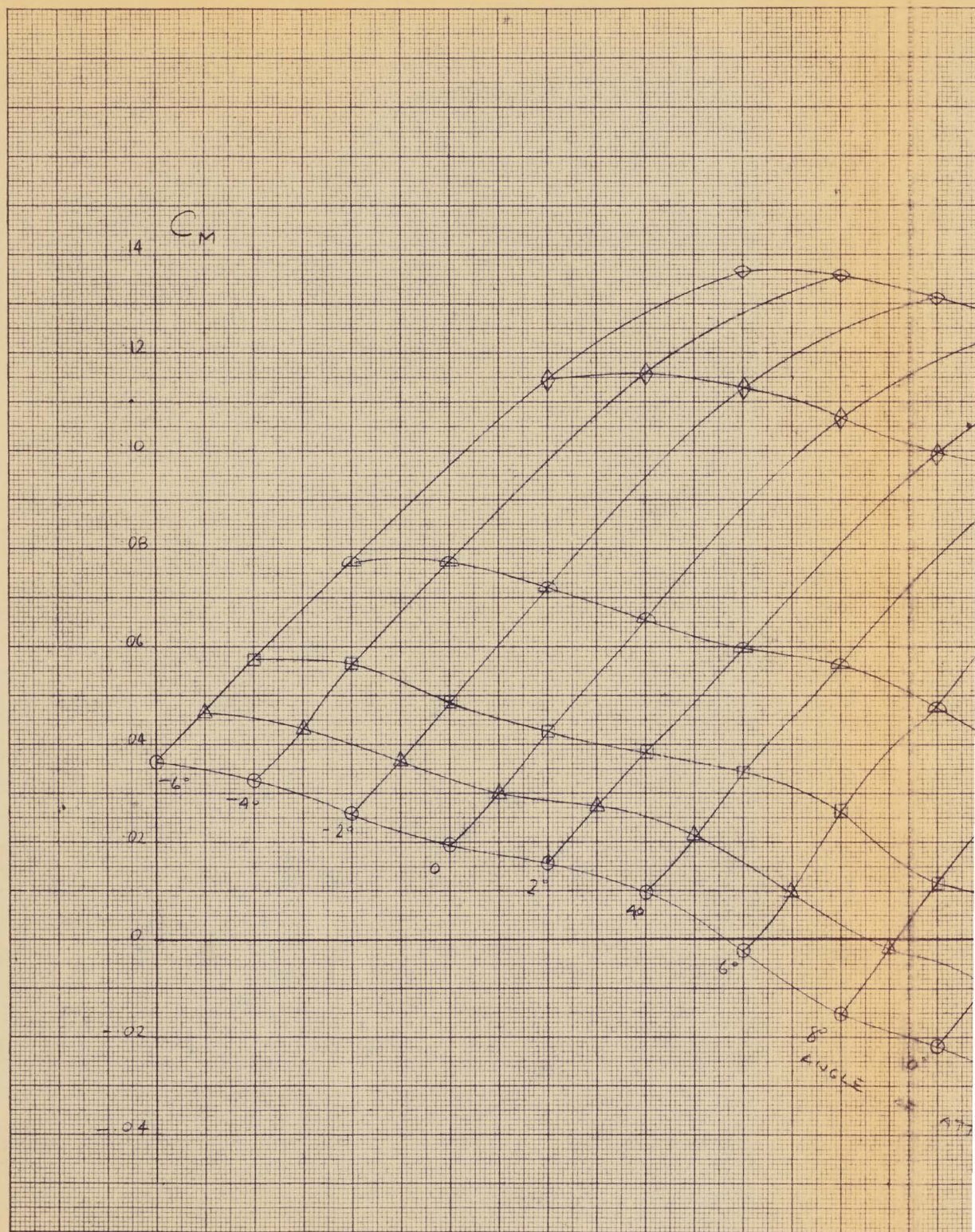
C.G. at .318 AND 8" ABOVE FUSE DATUM

GROUND BOARD 0.7 $\frac{6}{2}$ BELOW MAC



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359-141 KEUFFEL & ESSER CO.
 Millimeters, 5 mm. Lines accented, cm. lines heavy.
 MADE IN U.S.A.



MAR 16 1956 D.B.C.

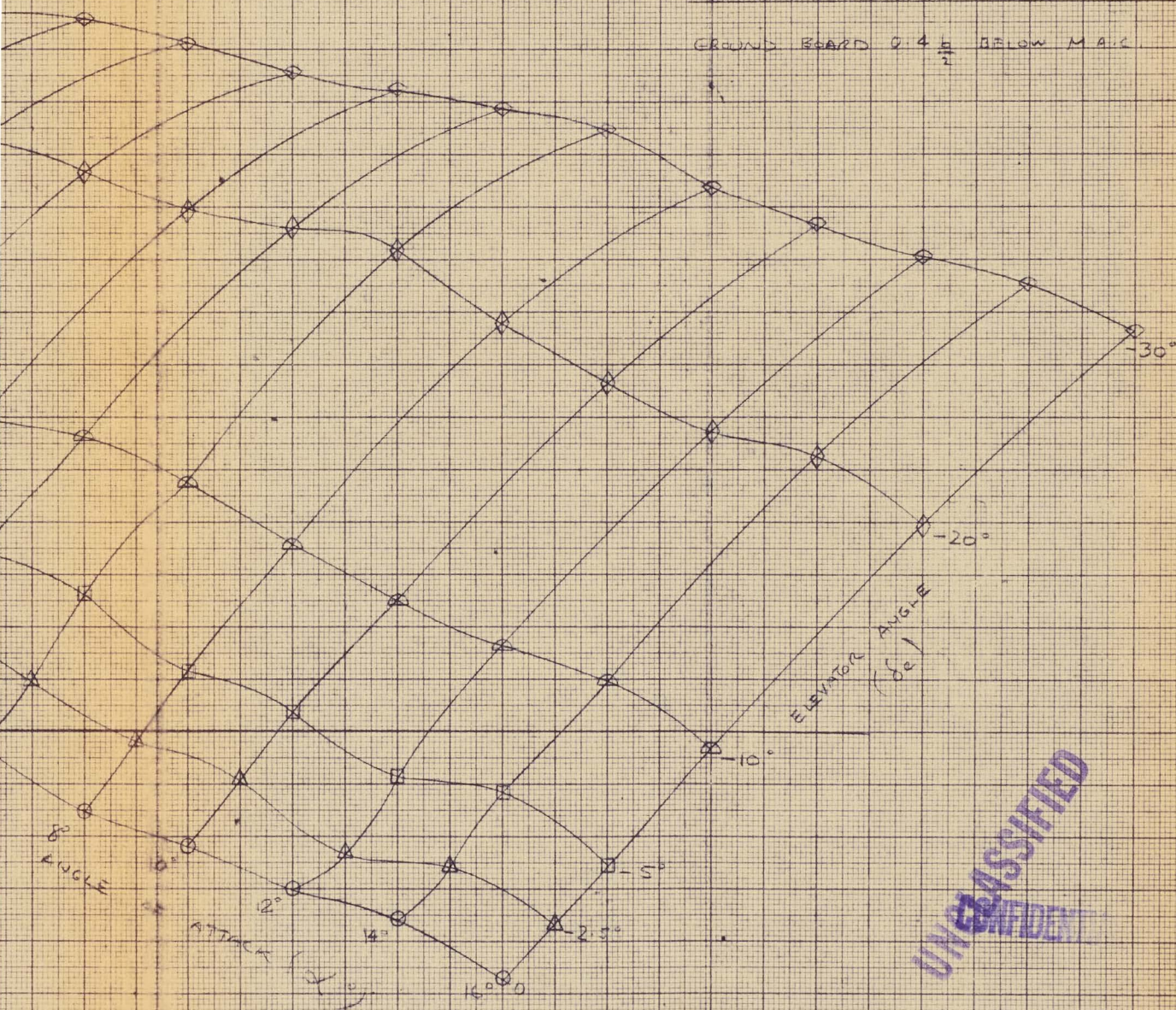
C-105

N.R.S. WIND TUNNEL TESTS

SMALL ANGLE

CG AT 0.312 AND 8" ABOVE FUEL DATUM

GROUND BOARD 0.4 $\frac{1}{2}$ BELOW M.A.C.



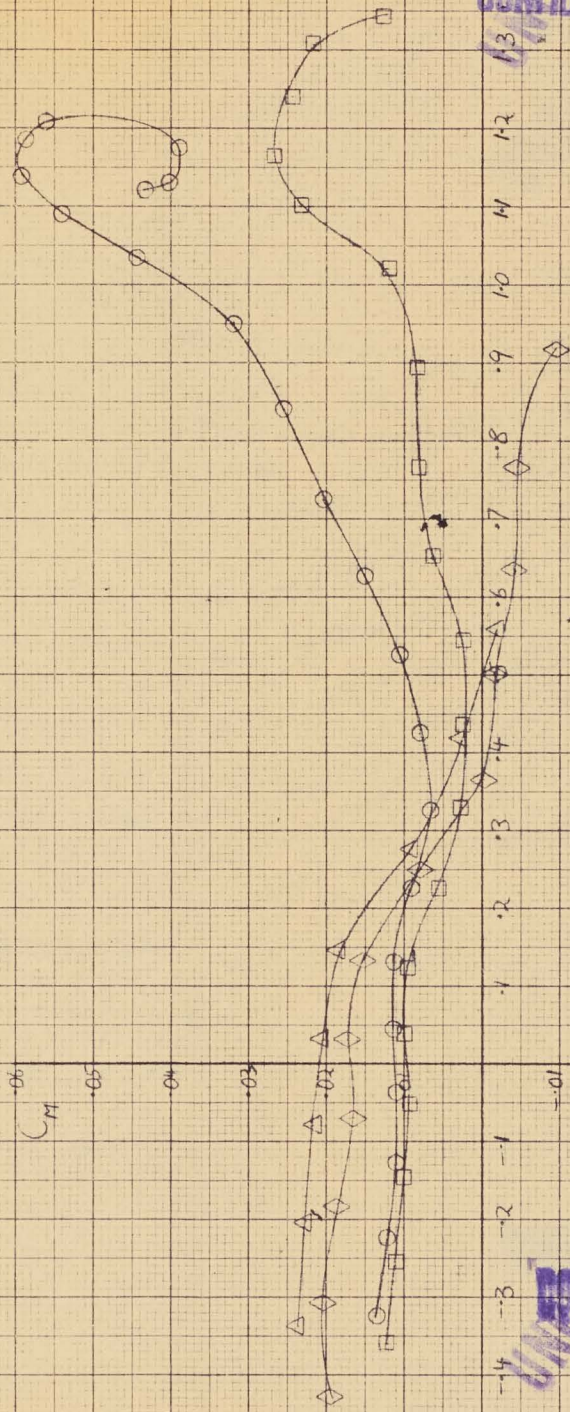
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C-105

N.A.E. LOW SPEED WIND TUNNEL TESTS (JAN 1954)

GROUND EFFECT $\delta_c = 0$

C_M vs C_L $C_L \approx .352$ 8" ABOVE FUSELAGE DATUM



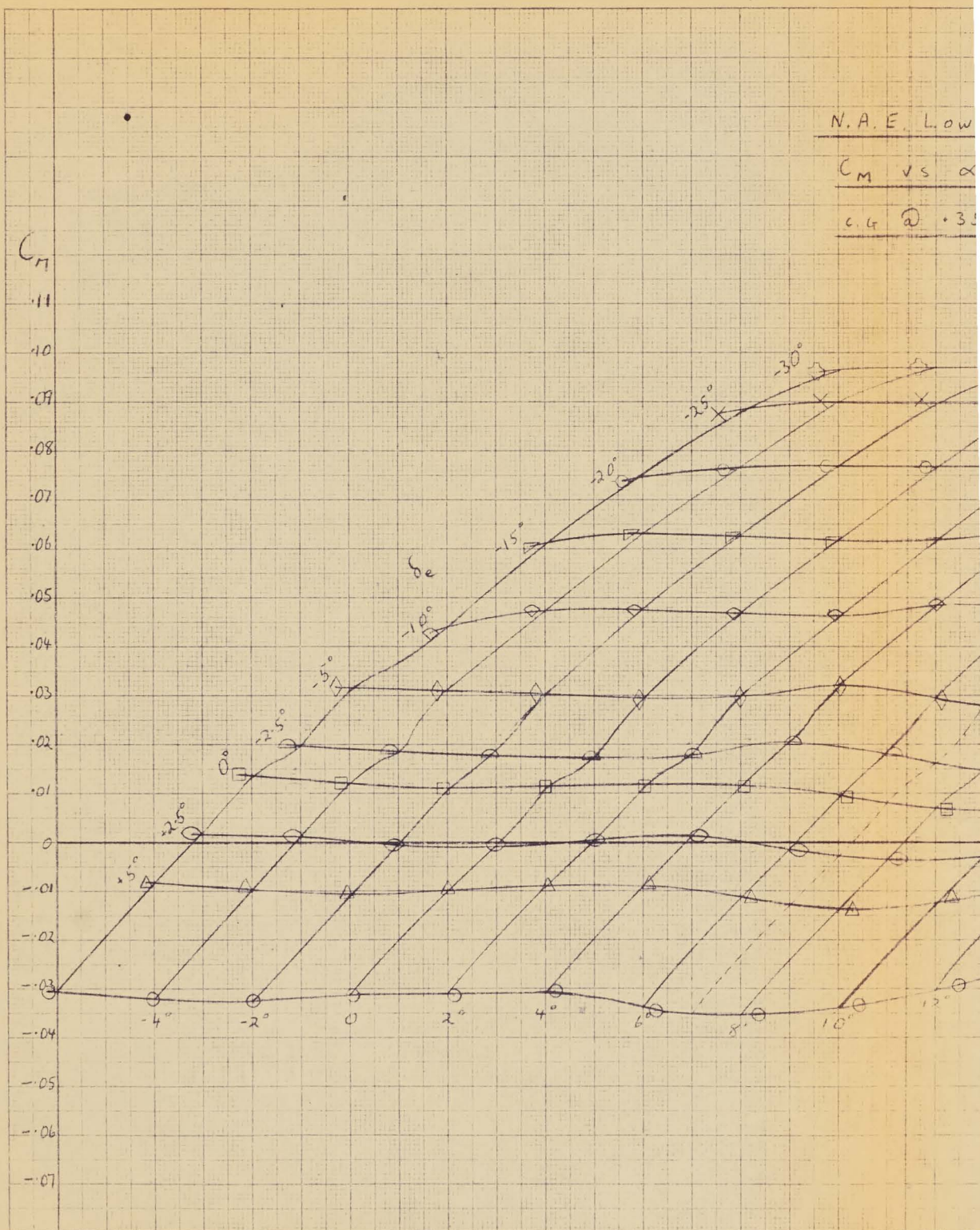
DISTANCE FROM GROUND	SYMBOL
0	○
1/2	□
1	◇
2	△
∞	○

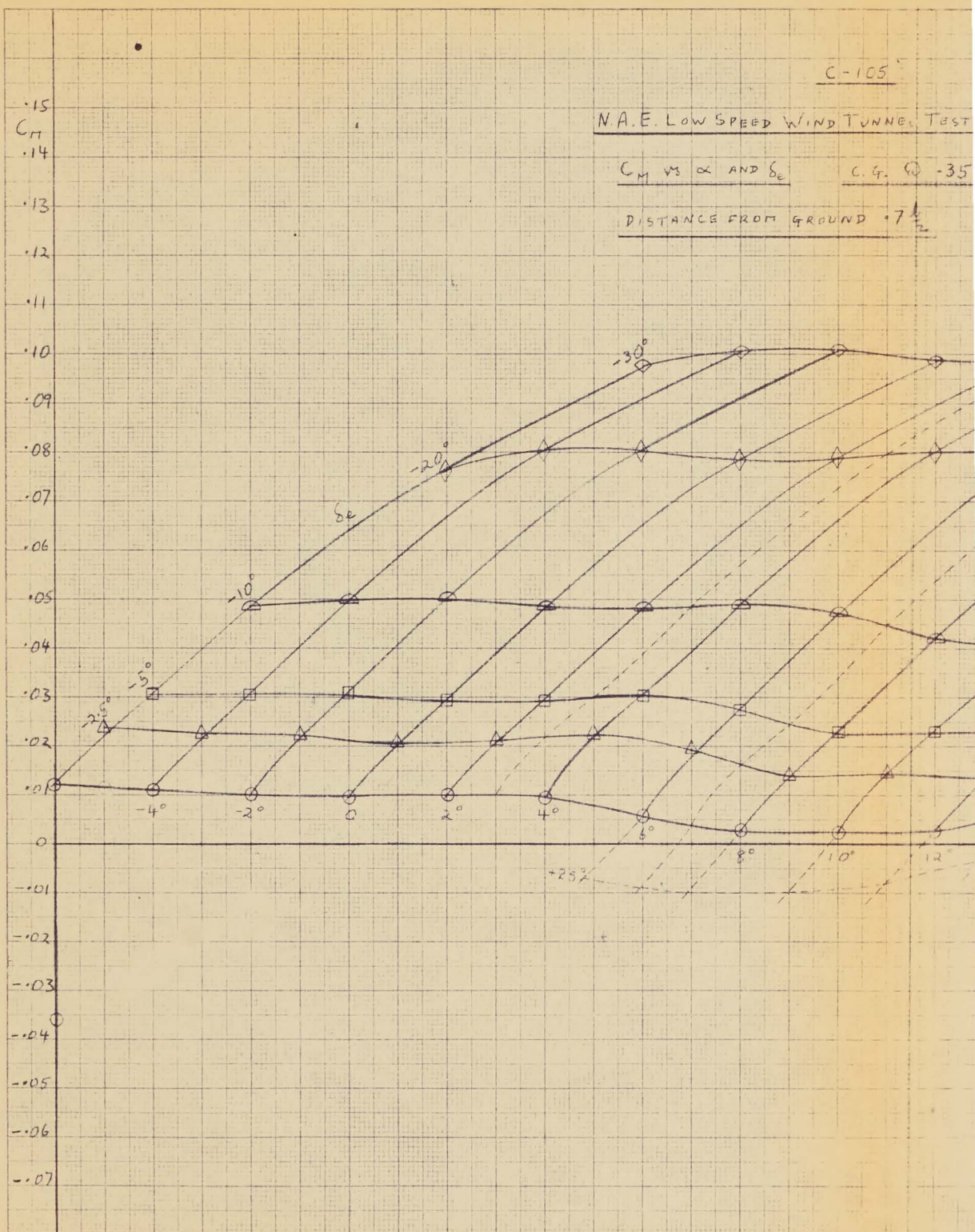
P/WT/98 9.5
ERJ MARCH 1956

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10 X 10 TO THE CM. 359.14L
KEITHLEY - FISHER CO.





HUGHES
1955
MADE IN U.S.A.