

QC
Avro
C-105
P/WT/21

QC
Avro
CF105
P-WT-21

(27)

FILE IN VAULT

G-105

P/Wind Tunnel/21

UNCLASSIFIED
STABILITY DERIVATIVES

C.A.L. WIND TUNNEL

ANALYZED

APRIL 1954

COMPARISON WITH ESTIMATES

21



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Canada
C.I.S.T.I.
Aeronautical and
Mechanical
Engineering Library

Conseil national de recherches
Canada
I.C.I.S.T.
Bibliothèque
d'aéronautique
et de génie mécanique

ANALYZED

TP
A

DATE

Report no.: QCX - AVRO - CF105 - P-WT-21

has been downgraded to : _____
 de-classified

by (Name): Michel W. Drapeau

(Dept.): A/DND Coordinator, Access to Information

Date: Dec. 7, 1992

R. Auger
Signature



45112

12416839



UNCLASSIFIED

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C-105

REPORT NO. P/WIND TUNNEL/21

FILE NO:

NO. OF SHEETS: _____

TITLE:

confirmed as
Classification ~~cancelled~~ / changed to: UNCLASSIFIED
By authority of: DRDA 7/DARFT 5-8/DAS Eng 6-4-5
Date: 5 Nov 1992
Signature: B. Aubrey
Unit / Rank / Appointment: DSIS/3, Secretary CRAD HQ DRP

LONGITUDINAL AND LATERAL STABILITY DERIVATIVES

Extrapolated to $M = 2.0$

Comparison of Theoretical Estimates with C.A.L. Wind Tunnel Tests

April 1954.

PREPARED BY S. Kwiatkowski DATE May 1954.

CHECKED BY _____ DATE _____

SUPERVISED BY _____ DATE _____

APPROVED BY _____ DATE _____

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

FORM 1316A

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO P/WIND TUNNEL/21

SHEET NO 1

AIRCRAFT:

C-105

PREPARED BY

DATE

S. Kwiatkowski

May 1954.

CHECKED BY

DATE

INDEX

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I. Longitudinal Stability and Control

1.1 Lift

$C_{L\alpha}$ $-2^\circ < \alpha < +2^\circ$ 1.1.1

$C_{L\alpha}$ $+2^\circ < \alpha < 12^\circ$ 1.1.2

α_0 1.1.3

1.2 Pitching Moment

Aerodynamic Centre 1.2.1

C_{M_0} 1.2.2

1.3 Elevators

$C_{L\delta}$ 1.3.1

$C_{M\delta}$ at const. α 1.3.2

$C_{M\delta}$ at const. C_L 1.3.3

Elevator c.p. 1.3.4

C_{h_0} 1.3.5

$C_{h\alpha}$ 1.3.6.

$C_{h\delta}$ 1.3.7

II. Lateral Stability and Control

2.1 Aileron Derivatives

$C_{n\delta_a}$ 2.1.1

$C_{l\delta_a}$ 2.1.2

$C_{y\delta_a}$ 2.1.3

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO P/Wind Tunnel/21

SHEET NO 11

AIRCRAFT:

C-105

PREPARED BY

DATE

S. Kwiatkowski

May 1954.

CHECKED BY

DATE

2.2 Aileron Hinge Moments

$C_{h\alpha}$	$-5^\circ < \alpha < +6^\circ$	2.2.1
$C_{h\alpha}$	$+6^\circ < \alpha < +12^\circ$	2.2.2
$C_{h\dot{\alpha}}$	$-5 < \dot{\alpha} < +6^\circ$	2.2.3
$C_{h\dot{\alpha}}$	$+6^\circ < \dot{\alpha} < +12^\circ$	2.2.4
$C_{h\delta}$		2.2.5

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III. Directional Stability and Control

3.1 Sideslip Derivatives

$C_{y\beta}$	fin on	3.1.1
$C_{y\beta}$	fin off	3.1.2

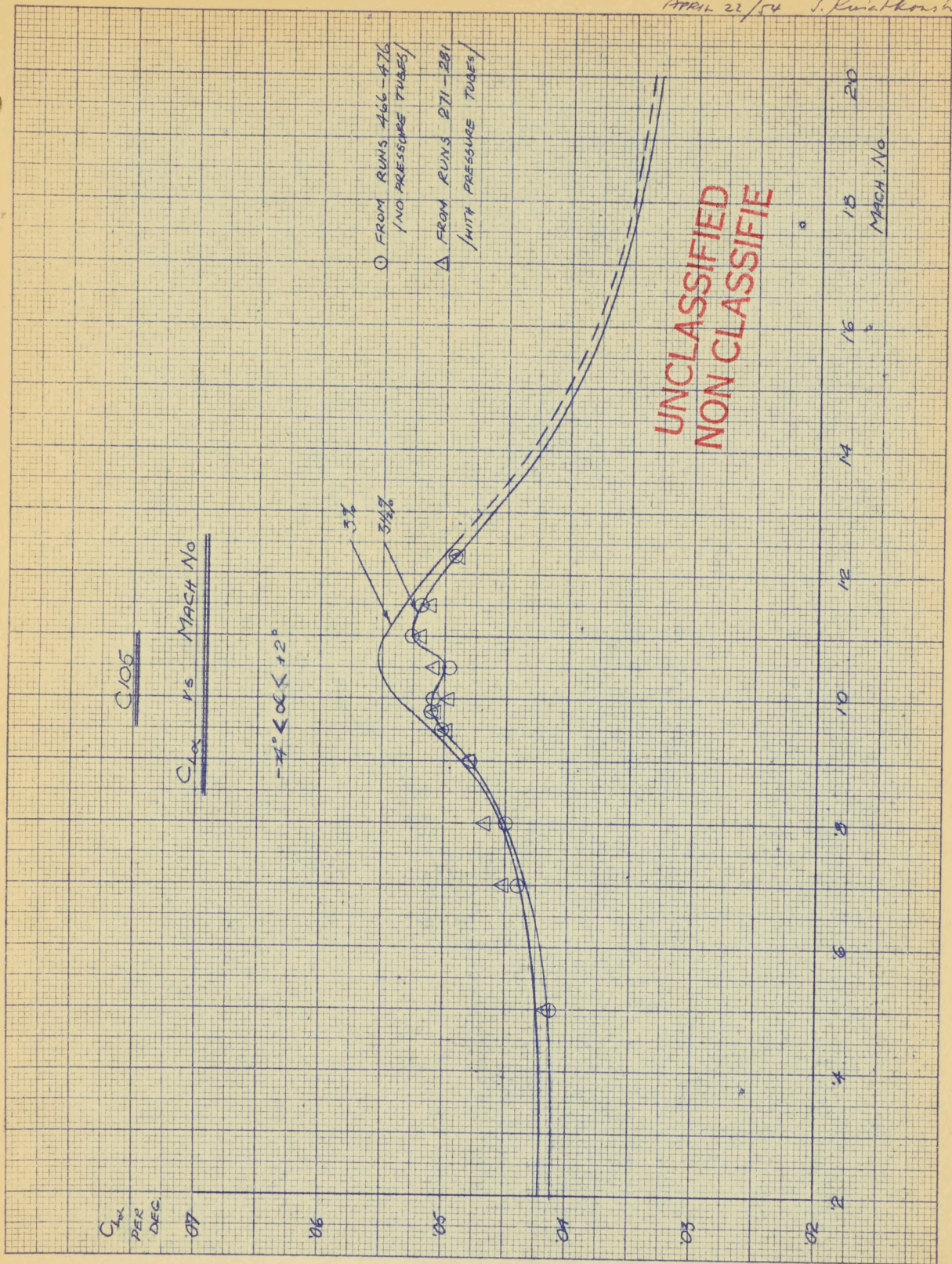
3.2 Vertical Tail

$a_1(V)$		3.2.1
a.c. (V)		3.2.2
η a.c. (V)		3.2.3

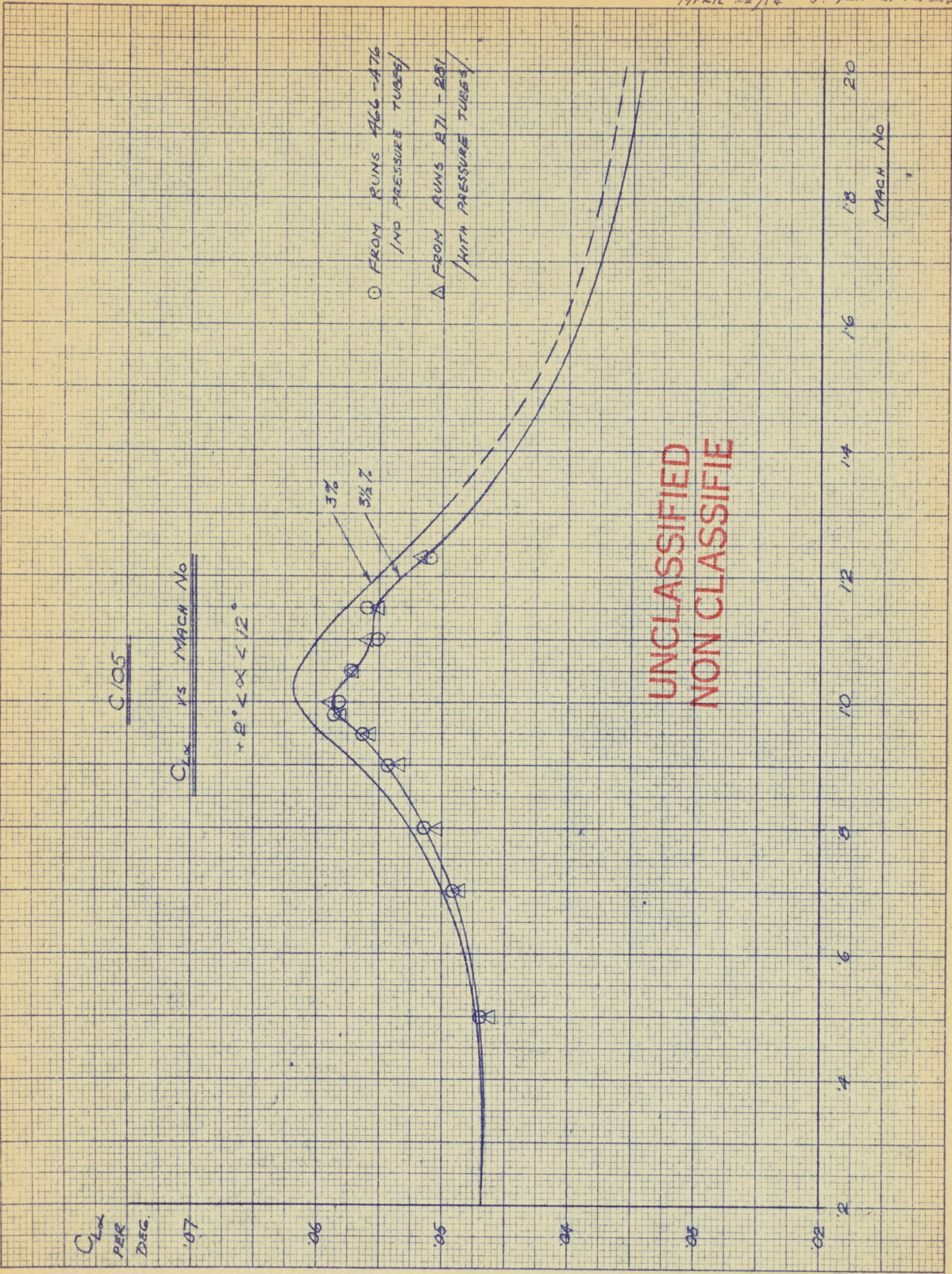
3.3 Rudder

$a_2(V)$		3.3.1
c.p. (V)		3.3.2
η c.p. (V)		3.3.3
$C_{l\delta_R}$		3.3.4
$C_{n\beta}$		3.3.5
$C_{n\delta_R}$		3.3.6

P/W.T./21 1.1.1.
APRIL 22/54 J. Kniatkowski



P/H.T./21 1.1.2.
 APRIL 20/53 J. Knickhork



D/W.T./21 1.1.3
APRIL 21/57 J. Kriatunki

C105

0.0 1/5 MARCH No

0.0

+2°

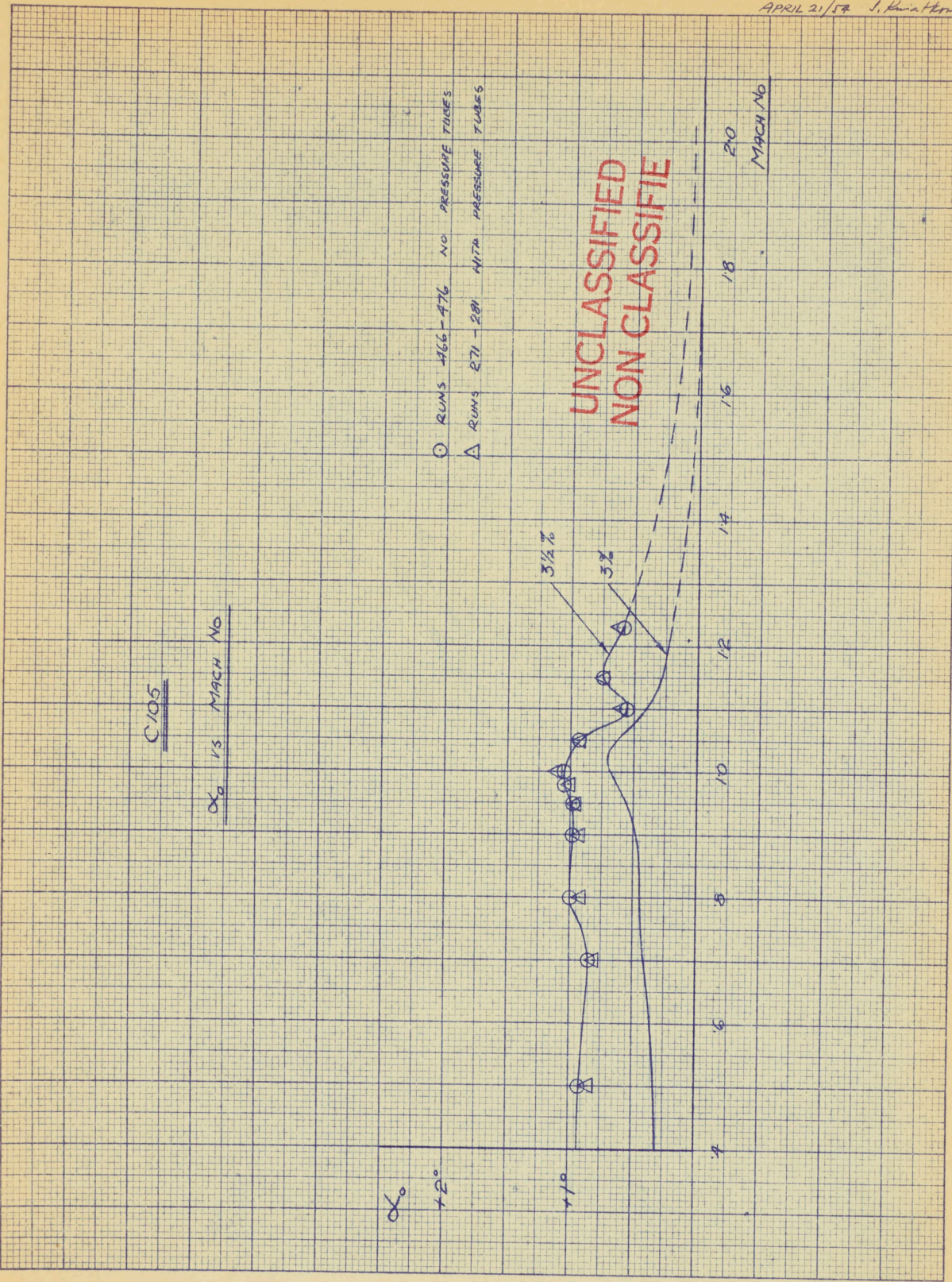
+1.0

○ RUNS 466-476 NO PRESSURE TUBES
△ RUNS 271-281 AITA PRESSURE TUBES

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3 1/2 %
3 %

20
MACH No



P/W.T./21 1.2.1.
APRIL 21/54 J. K. K. K.

C105
AERODYNAMIC CENTRE

Q.C.
% MAC

60

50

40

30

20

4

6

8

10

12

14

15

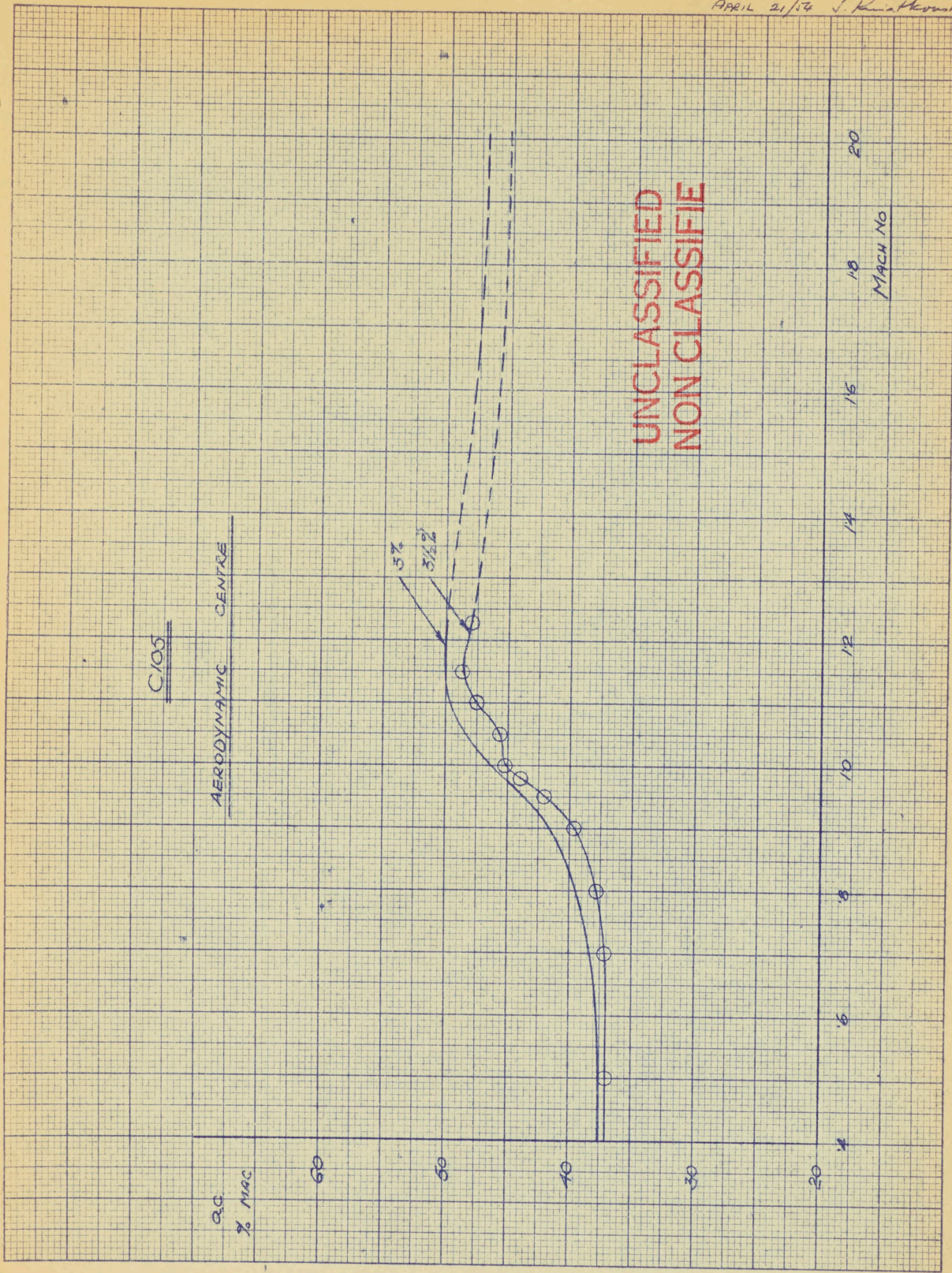
18

20

MACH No

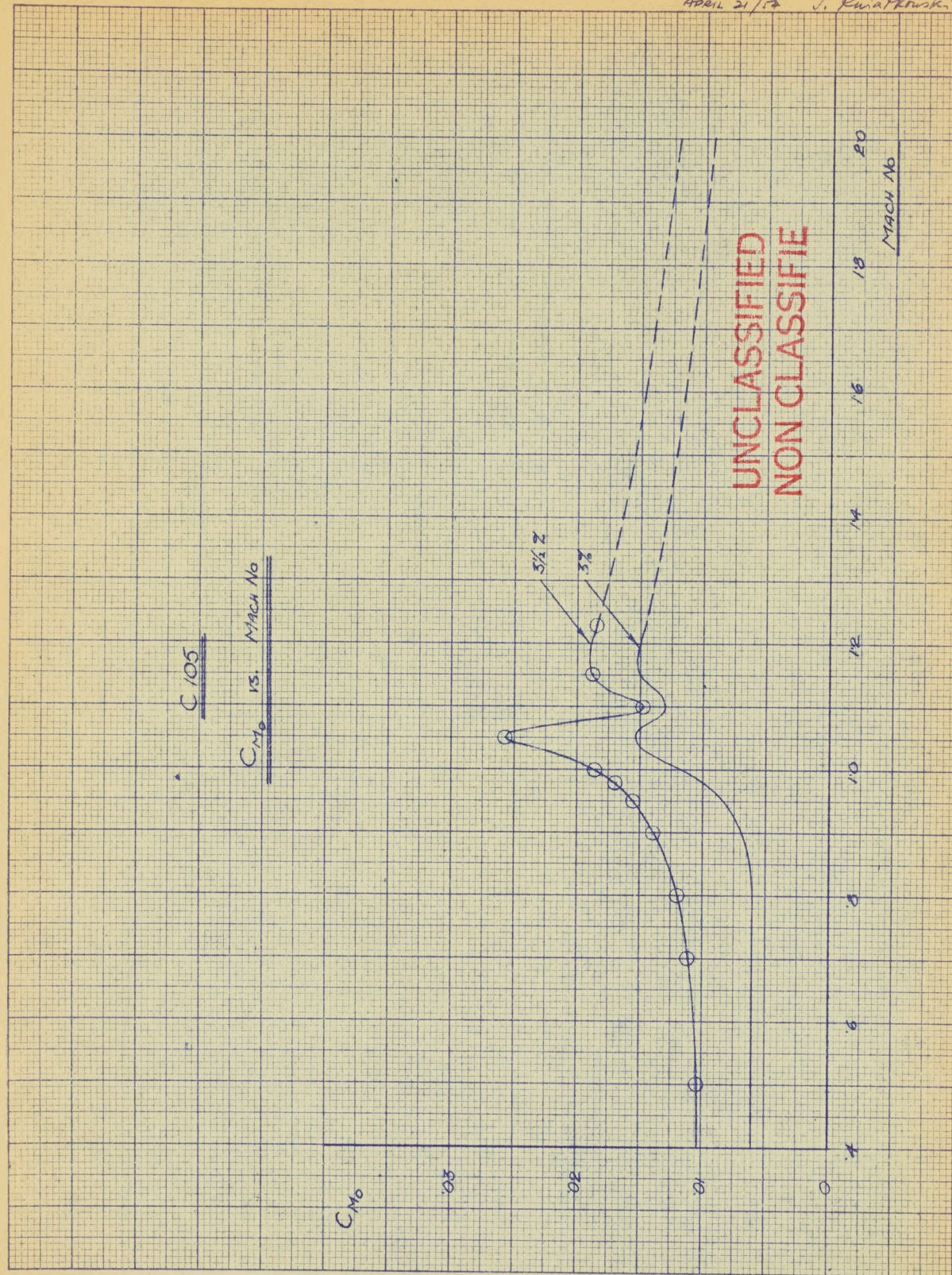
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5%
3 1/2%



P/W.T./21 1.2.2.
APRIL 21/72 J. Kwiatkowski

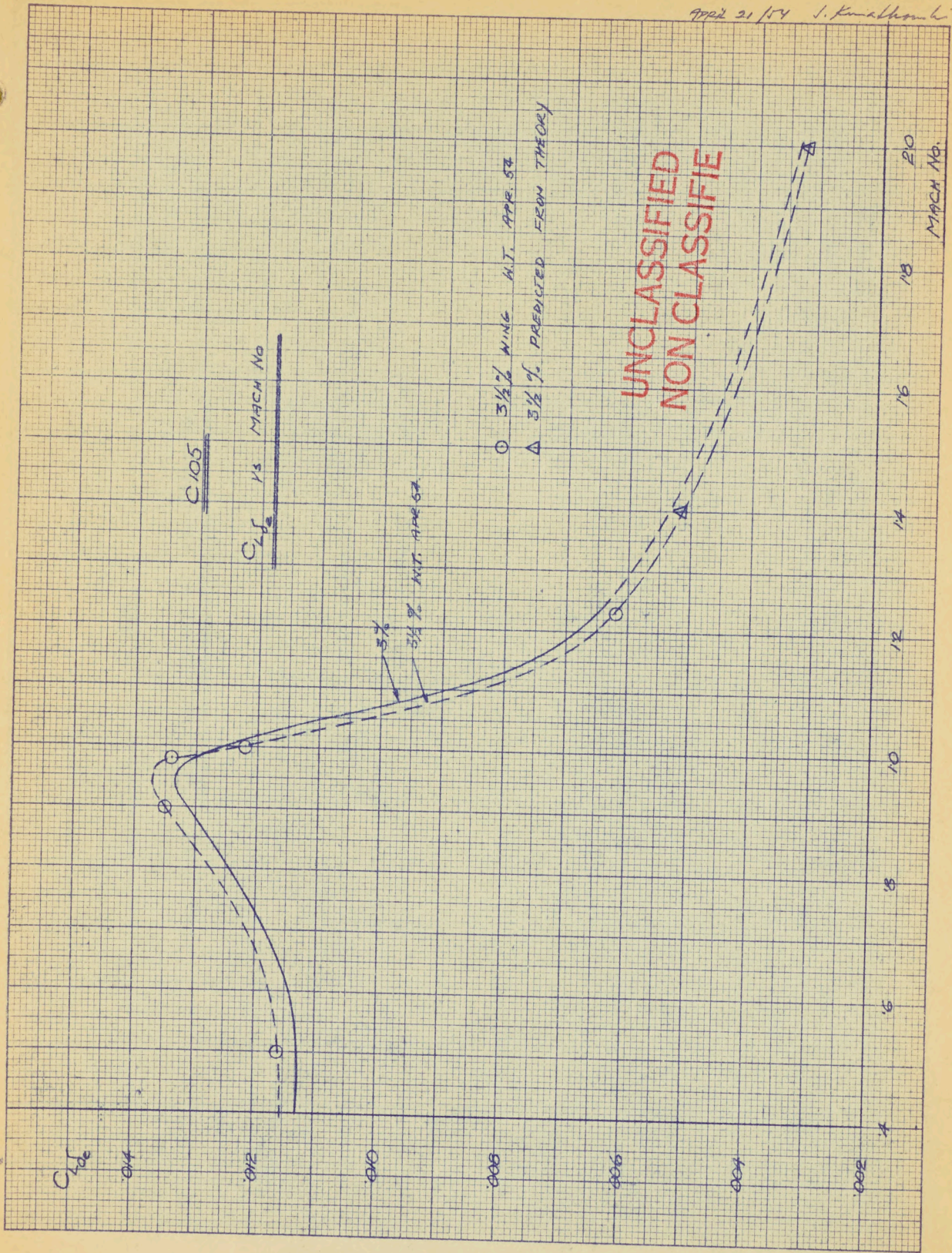
C 105
 $C_{M\alpha}$ vs. MACH No



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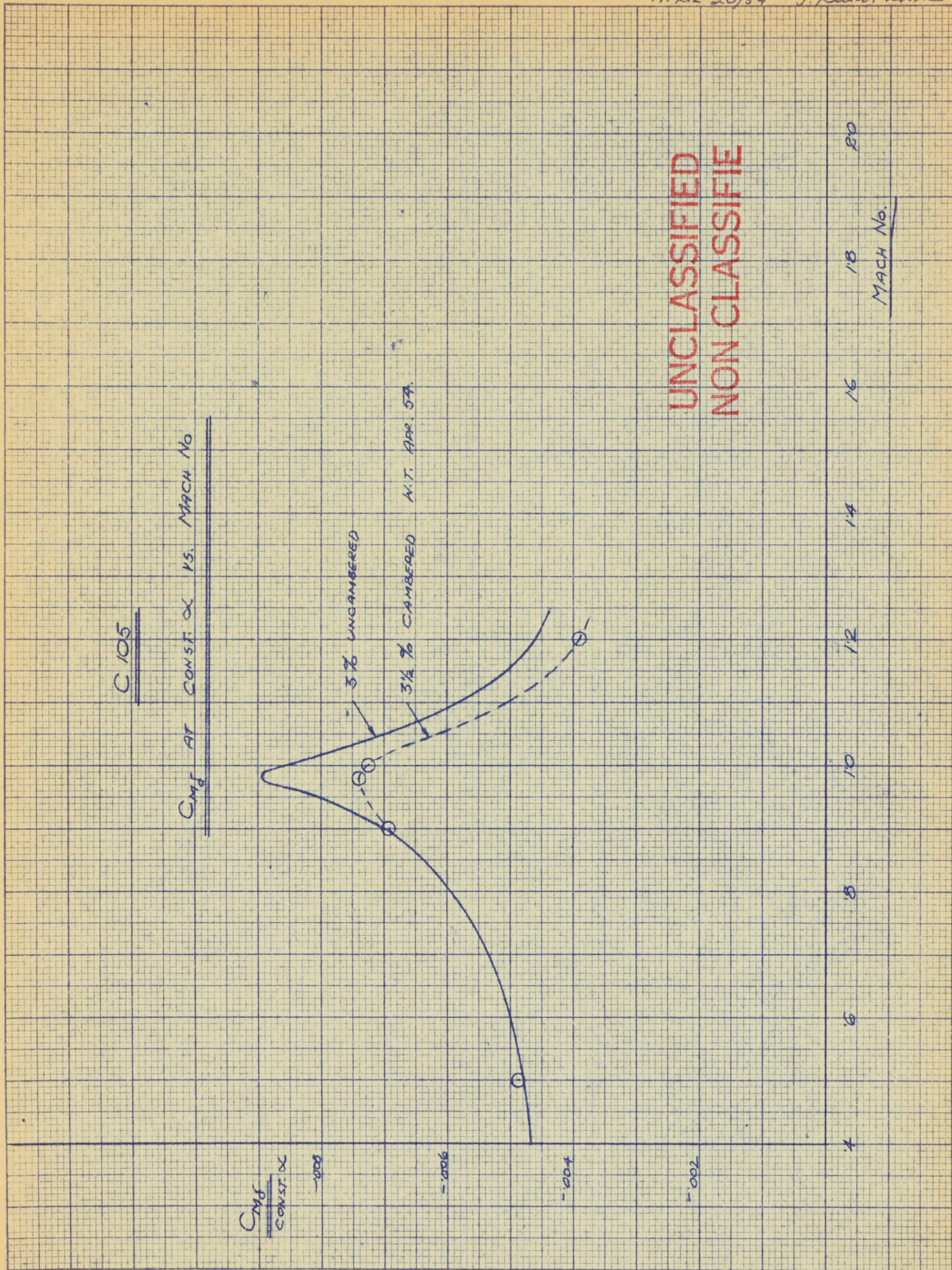
MACH No

P/W.T./21 1.3.1.
APR 21/54 J. Knuth



P/H.T./21 1.32.
 APRIL 20/59 S. Kniatkovsk.

559-12 KEUFFEL & ESSER CO.
 10 X 10 TO THE 1/2 INCH, 5TH LINE ACCURACY
 MADE IN U.S.A.



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MACH No.

P/W.T./21 1.3.3.
 APRIL 20/54 J. Knudsen

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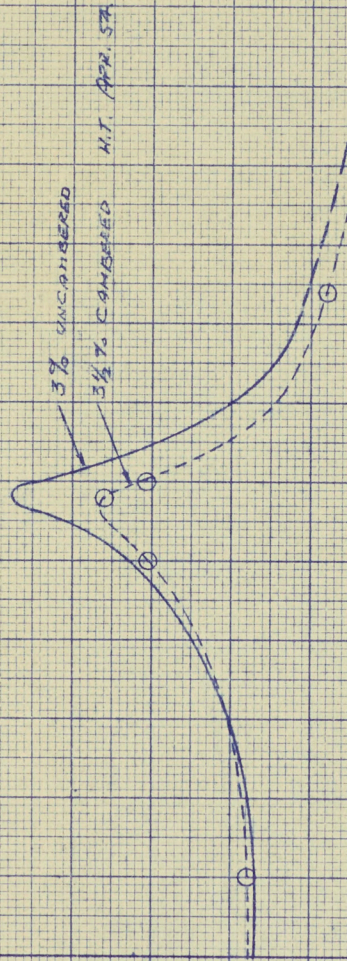
C105
 C_{mf} AT CONST S_L VS MACH No.

C_{mf}
CONST S_L

- .000
 - .002
 - .004
 - .006

20
 MACH No

18
 16
 14
 12
 10
 8
 6

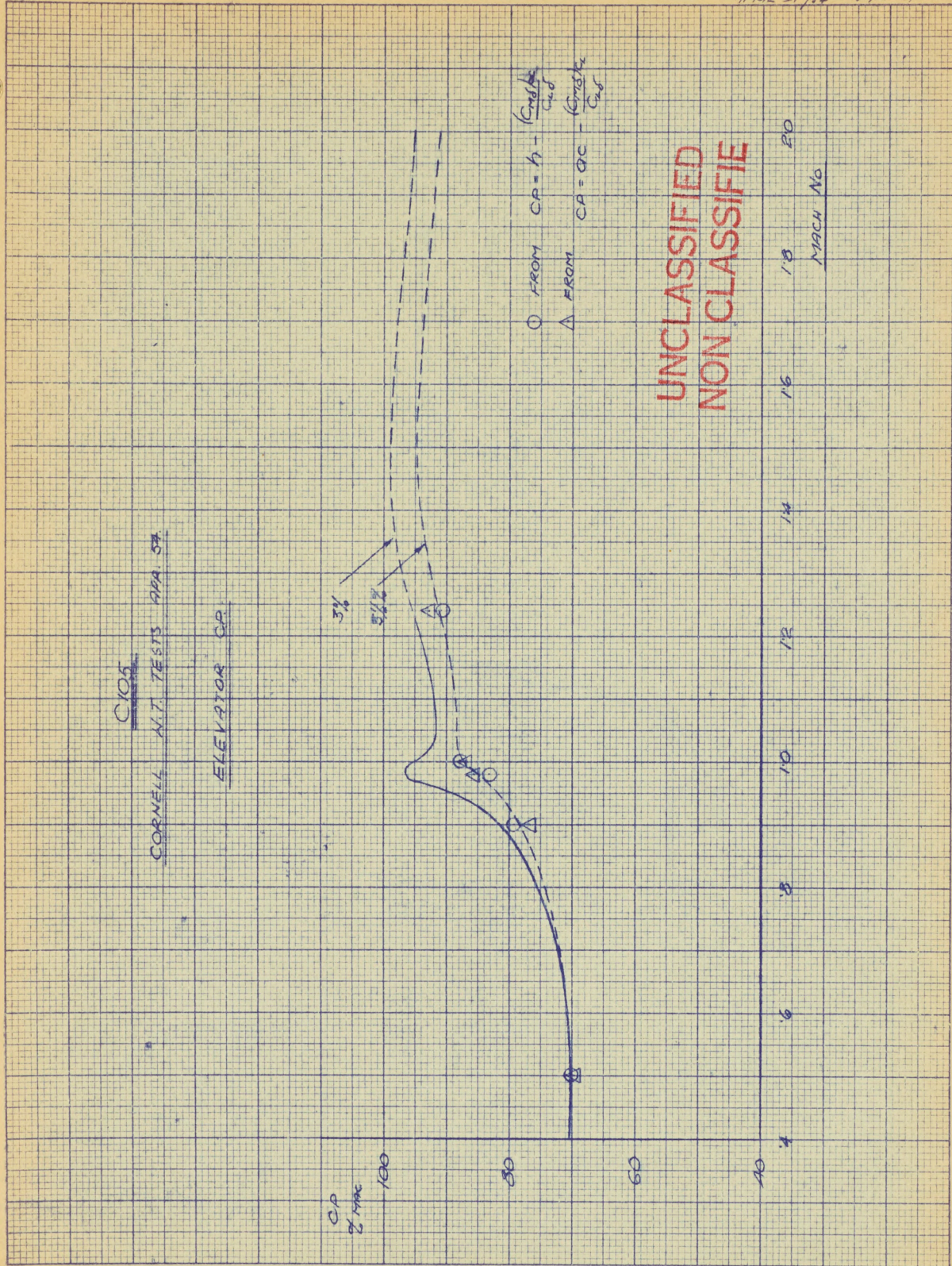


H.T. APR. 57

P/H.T./21 1.3.4.
 APRIL 21/72 J. Knuth

389-12 KEUFFEL & ESSER CO.
 10 X 10 TO 1/2 INCH, 25th LINE ACCENTED.
 MADE IN U.S.A.

C105
 CORNELL A.I.T. TESTS APPA 57A
 ELEVATOR CP



○ FROM $CP = h - \frac{C_{ref} h}{C_{ref}}$
 △ FROM $CP = OC - \frac{C_{ref} h}{C_{ref}}$

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18 20
 MACH No

P/H.T./21

1.3.5.

APRIL 25/54

J. Kurathowski

C/05

Ch₂
15 MACH No

Ch_{0.4}EL.
'08

'06

'04

'02

'4

'6

'8

'10

'12

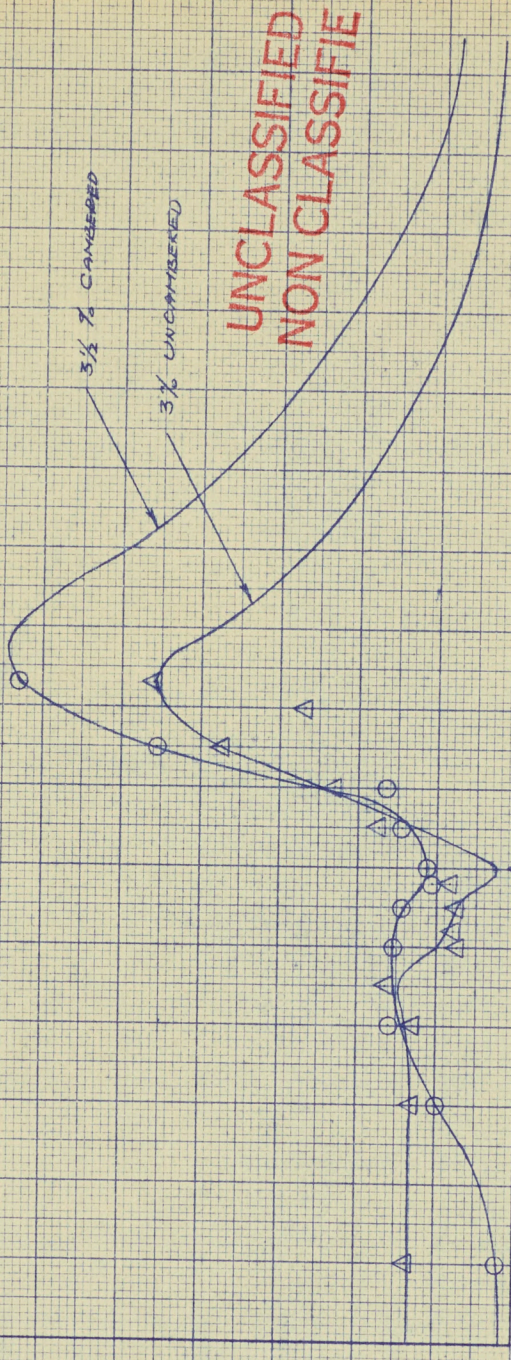
'14

'16

'18

'20

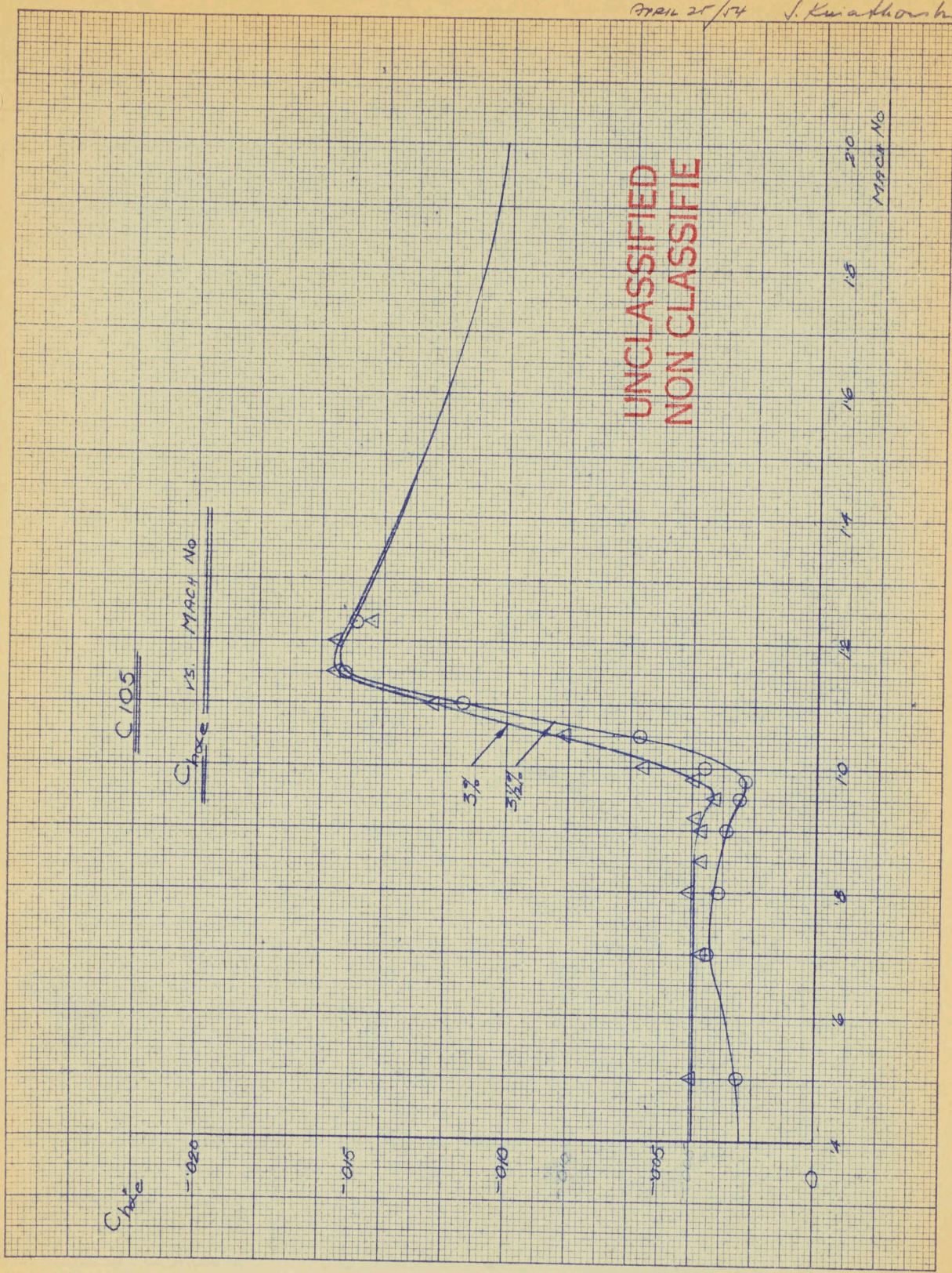
MACH No

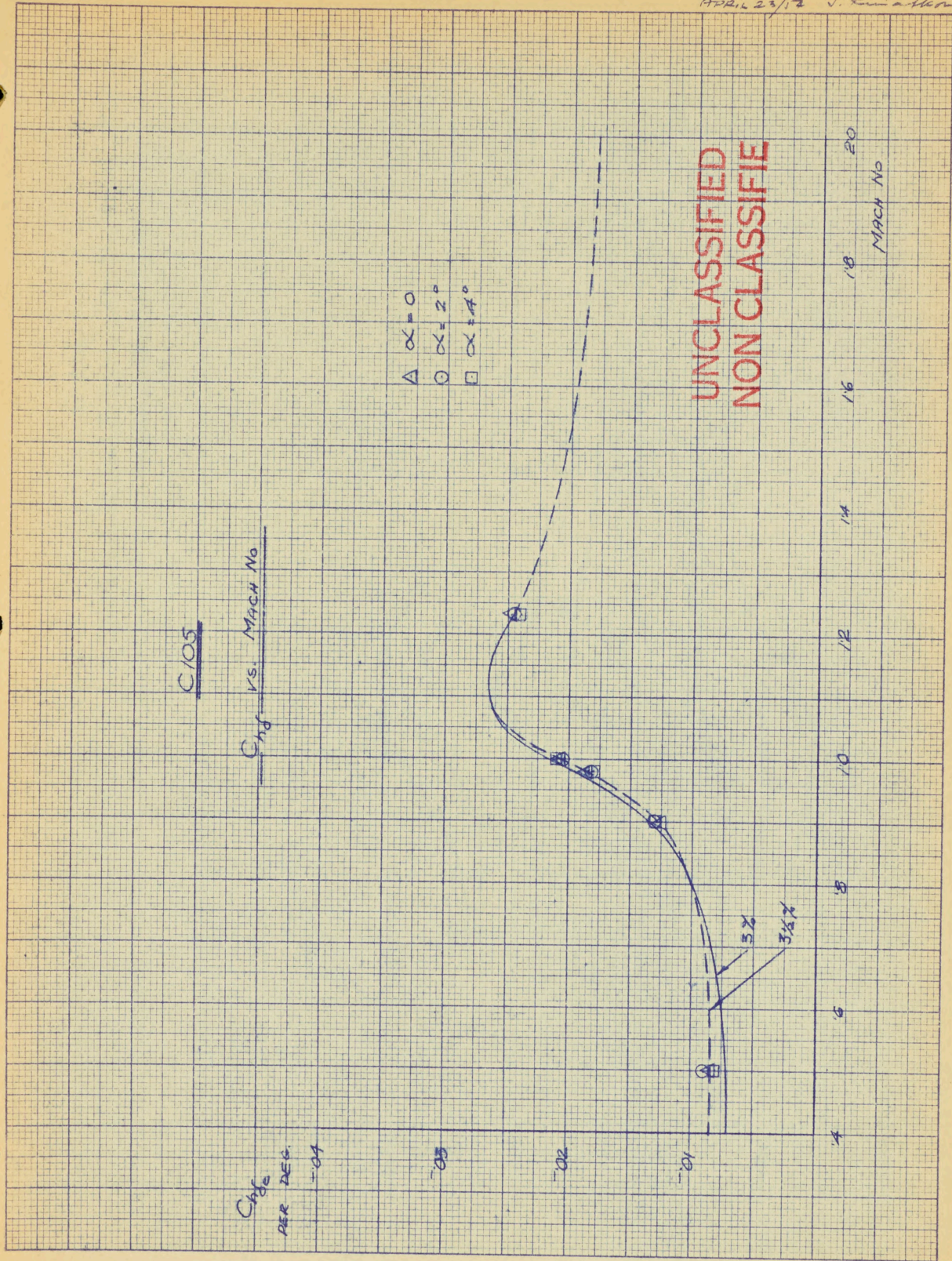


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P/H.T./21
APRIL 25/74

1.3.6.
J. Kwiatkowski





C-105
C.A.L. Wind Tunnel Tests, Apr. 1 1954

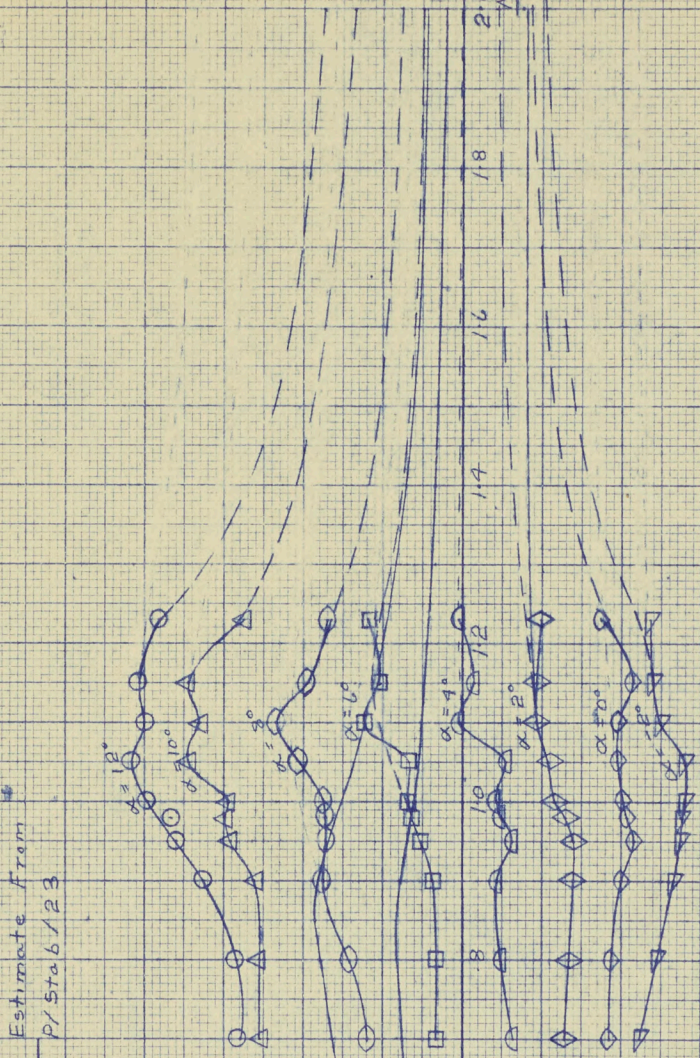
$C_{N\delta A}$ vs Mach No.
 $-10^\circ < \delta A < +10^\circ$

$C_{N\delta A}$
Per 2° Incl.

Estimate from
P/5tab/23

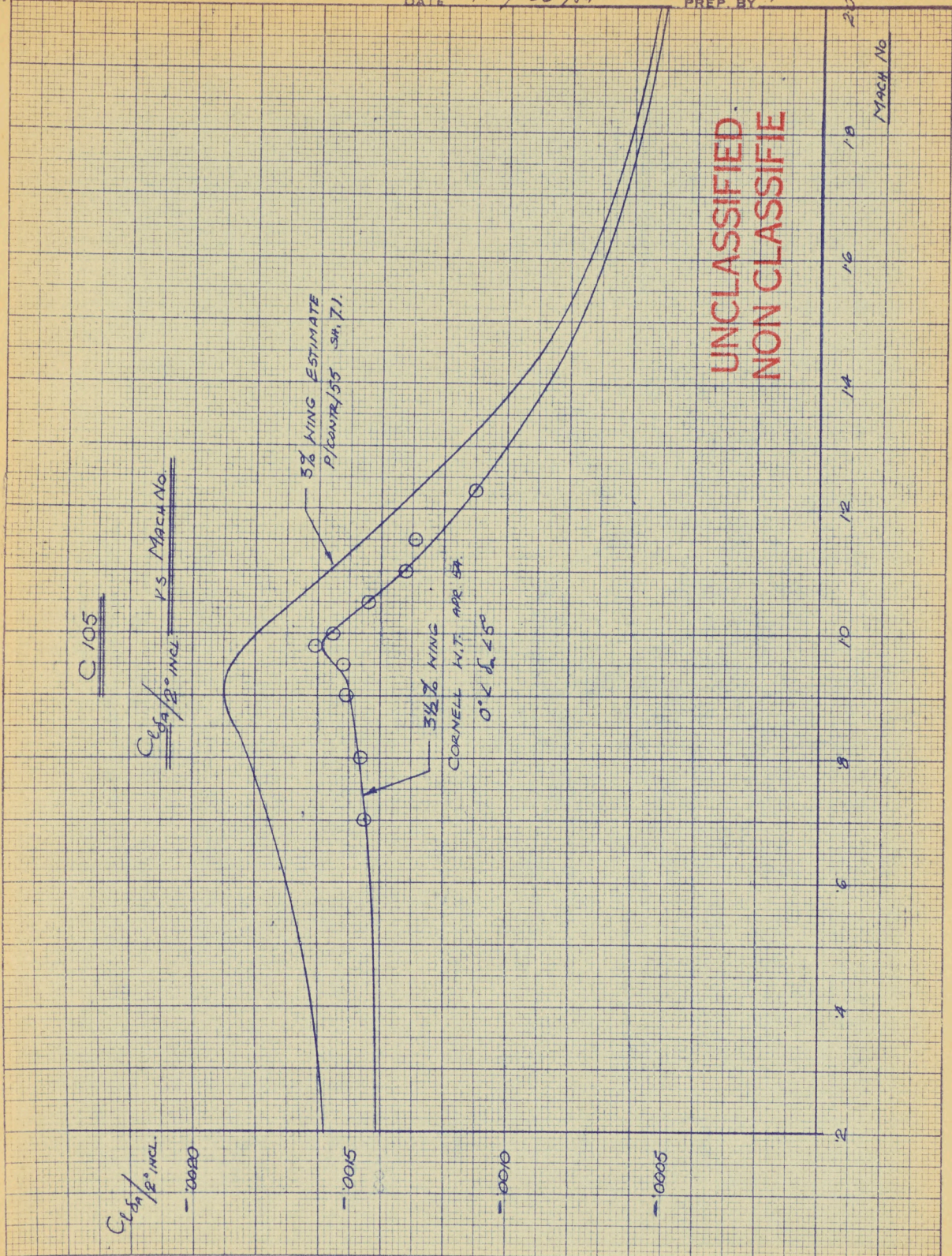
0.0006
0.0004
0.0002
0
-0.0002
-0.0004

Mach No.
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6



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35912 - REUFTEL & ESSER CO.
10 X 10 to the 1/2 inch, 50 lines accented.
MADE IN U.S.A.



15-4412 KEUFFEL & ESSER CO.
10 x 10 to 18 x 12 inch, 500 lines accounted.
MADE IN U.S.A.

C105
C. A. L. WIND TUNNEL TESTS
APRIL 07

CY 18 MACH No
 $-10^\circ \leq \delta \leq +10^\circ$

CY 16
SEE 2P INCL.

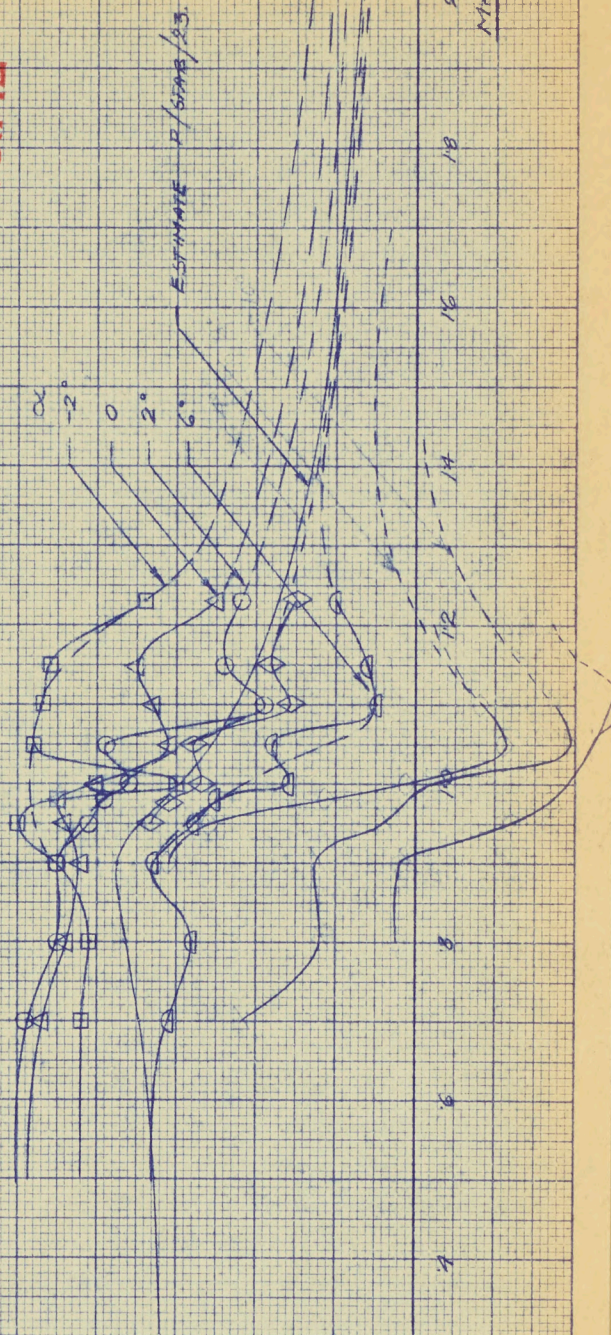
8000

9000

10000

11000

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July 12/54 Kuriathanki

C-105

[Chart] vs Mach Number

$-5^\circ < \alpha < 6^\circ$

Estimate Based on C.A.L. W-T Tests

[Chart]

-10

0.05

0

-0.05

Wind Tunnel

0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0

Mach Number

UNCLASSIFIED
NON CLASSIFIED

359-12 KEUFFEL & ESSER CO.
10 x 10 to the 1/2 inch, 5th lines accidental.
MADE IN U. S. A.

C-105

$[C_{ho}]_0$ vs Mach Number

$0^\circ < \alpha < 12^\circ$

Estimate Based on C.A.L. W-T Tests

$[C_{ho}]_0$

60

40

20

0

Wind Tunnel

UNCLASSIFIED
NON CLASSIFIE

.2

.4

.6

.8

1.0

1.2

1.4

1.6

1.8

2.0

Mach Number

C-105

Chord vs Mach Number

Estimate Based on C.A.L. W-T Tests

$-5^\circ < \alpha < 6^\circ$

Chord
per degree
0.00

0.10

0

-0.10

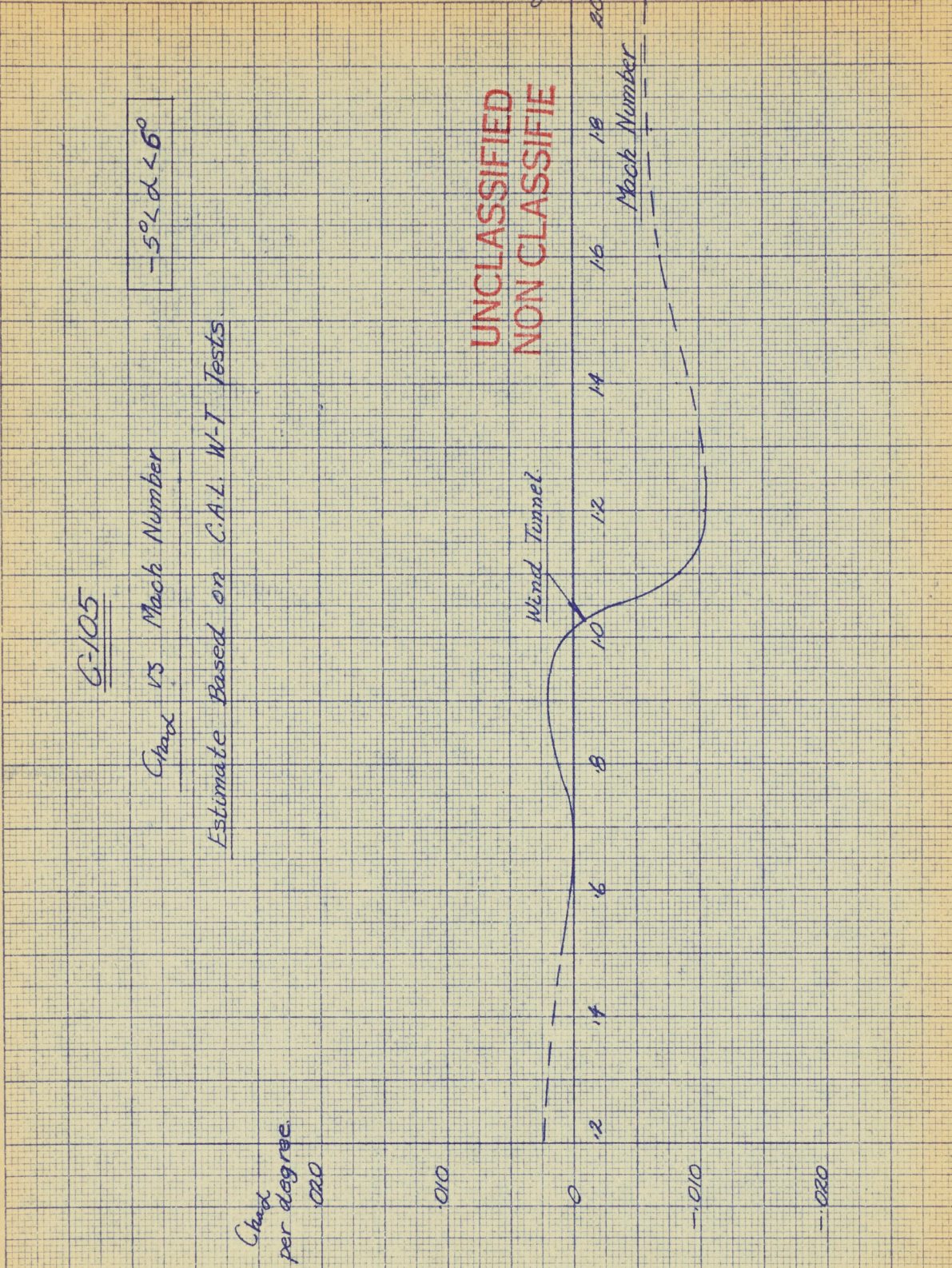
-0.20

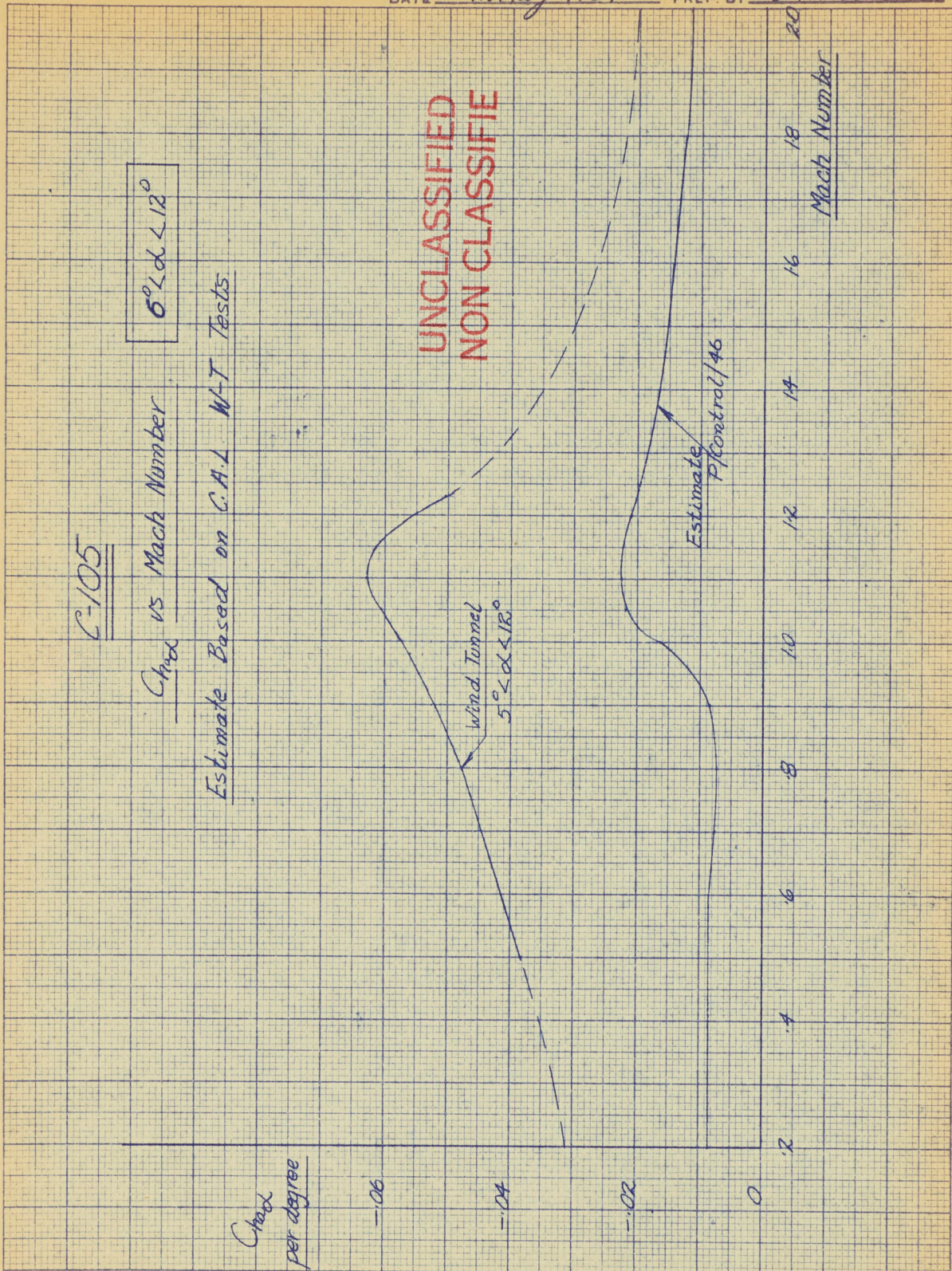
UNCLASSIFIED
NON CLASSIFIED

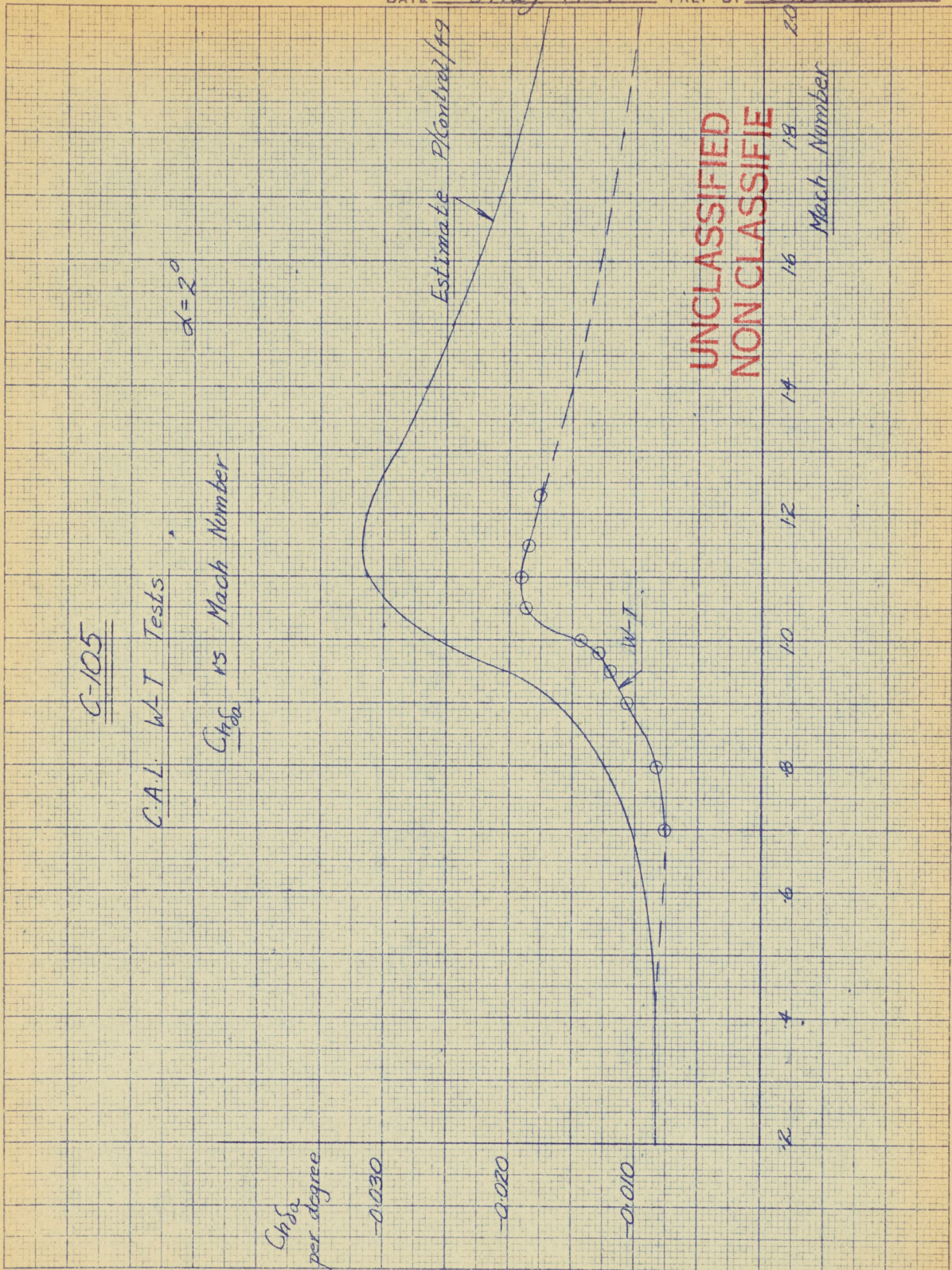
Wind Tunnel

Mach Number

12 14 16 18 20







399-12 KEUFFEL & ESSER CO.
10 x 10 to 10 x 12 inch, 5th lines accepted.
MADE IN U.S.A.

C-105

Cyp vs Mach Number (Tail on)

C.A.L. W-T Tests

Cyp
per degree

- △ $\alpha = -2^\circ$
- $\alpha = 0^\circ$
- $\alpha = 2^\circ$
- ◇ $\alpha = 6^\circ$

-0080

-0060

-0040

-0020

0

.2

.4

.6

.8

1.0

1.2

1.4

1.6

1.8

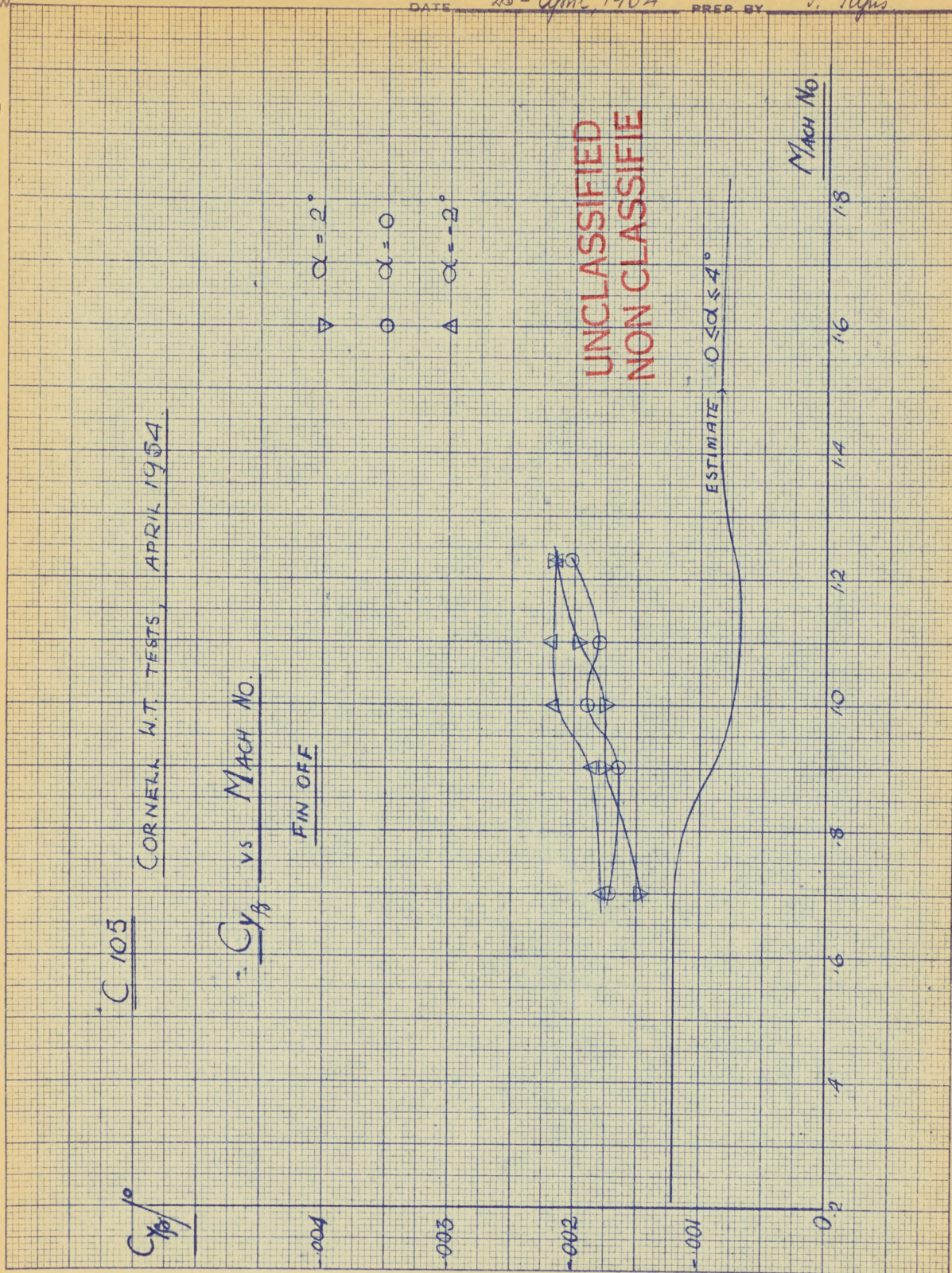
2.0

Estimate
P/Stab/40

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NON CLASSIFIED

Mach Number

359-12 KEUFFEL & ESSER CO.
10 X 10 to the 1/2 inch, 5th lines accented.
MADE IN U.S.A.



C-105
S.A.L. WIND TUNNEL TESTS APRIL '54
 $Q_1(V)$ VS MACH NO.

$Q_1(V)$
PER DEG.

.08
.07
.06
.05
.04
.03
.02
.01
0

SIDESLIP RANGE $-10^\circ < \beta < -2^\circ$

$\alpha = -2^\circ$
 $\alpha = 2^\circ$

ESTIMATED VALUE

$\alpha = -2^\circ$
 $\alpha = 2^\circ$

SIDESLIP RANGE $-2^\circ < \beta < 2^\circ$

4 6 8 10 12 14 16 18 2.0
MACH NO.

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NON CLASSIFIE

C-105

CLAL WIND TUNNEL TESTS APRIL '54

$a_1(V)$ VS MACH NO.

$a_1(V)$
PER DEG.

$\alpha = 0^\circ$, RANGE $-10^\circ < \beta < -2^\circ$

$\alpha = 6^\circ$, RANGE $-10^\circ < \beta < -2^\circ$

ESTIMATE FROM P/CONT/37

$\alpha = 0^\circ$, RANGE $-2^\circ < \beta < 2^\circ$

$\alpha = 6^\circ$, RANGE $-2^\circ < \beta < 2^\circ$

UNCLASSIFIED
NON CLASSIFIED

MACH NO.

1.8

1.4

1.2

1.0

.8

.6

.4

0

0

C-105

C.A.L. WIND TUNNEL TESTS APRIL '54

CHORDWISE O.C. VS MACH NO.

SIDESLIP RANGE $-10^\circ < \beta < -3^\circ$

O.C. POSITION
FRACTION M.A.C.

α°
0
2
4
6

ESTIMATE

UNCLASSIFIED
NON CLASSIFIED

18 20
MACH NO.

C-105

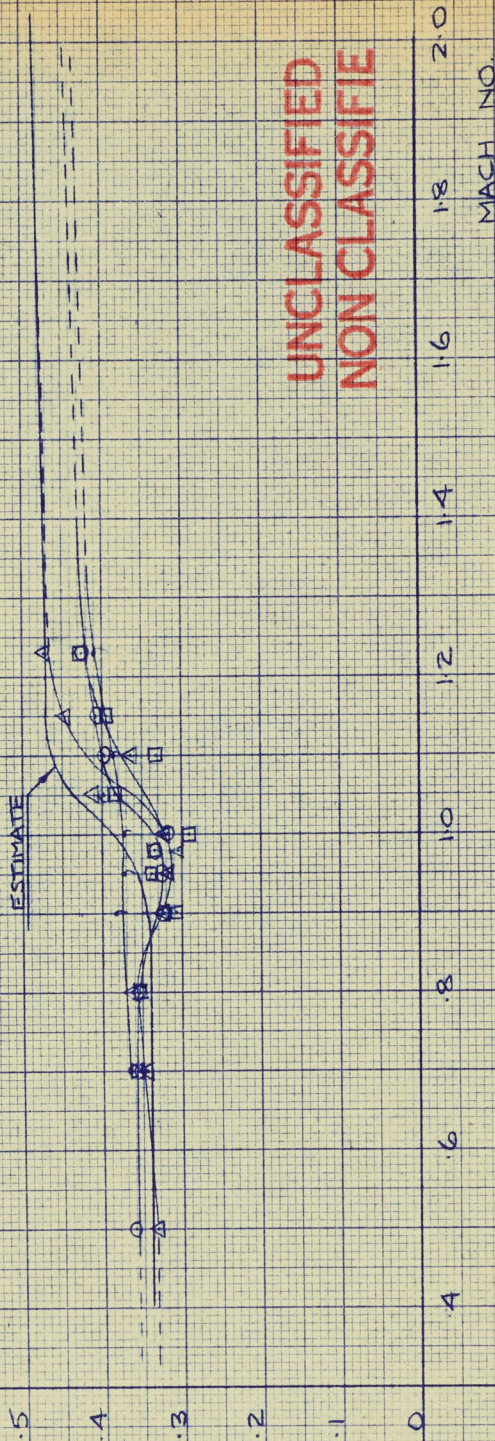
Q.C. POSITION
FRACTION M.A.C.

C.A.L. WIND TUNNEL TESTS APRIL '54

CHORDWISE Q.C. VS. MACH NO.

SIDESLIP RANGE $-2^\circ \leq \beta \leq +2^\circ$

α
○ -2
△ 0
□ 2
◇ 6



UNCLASSIFIED
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MACH NO.

S.A.L. WIND TUNNEL TESTS

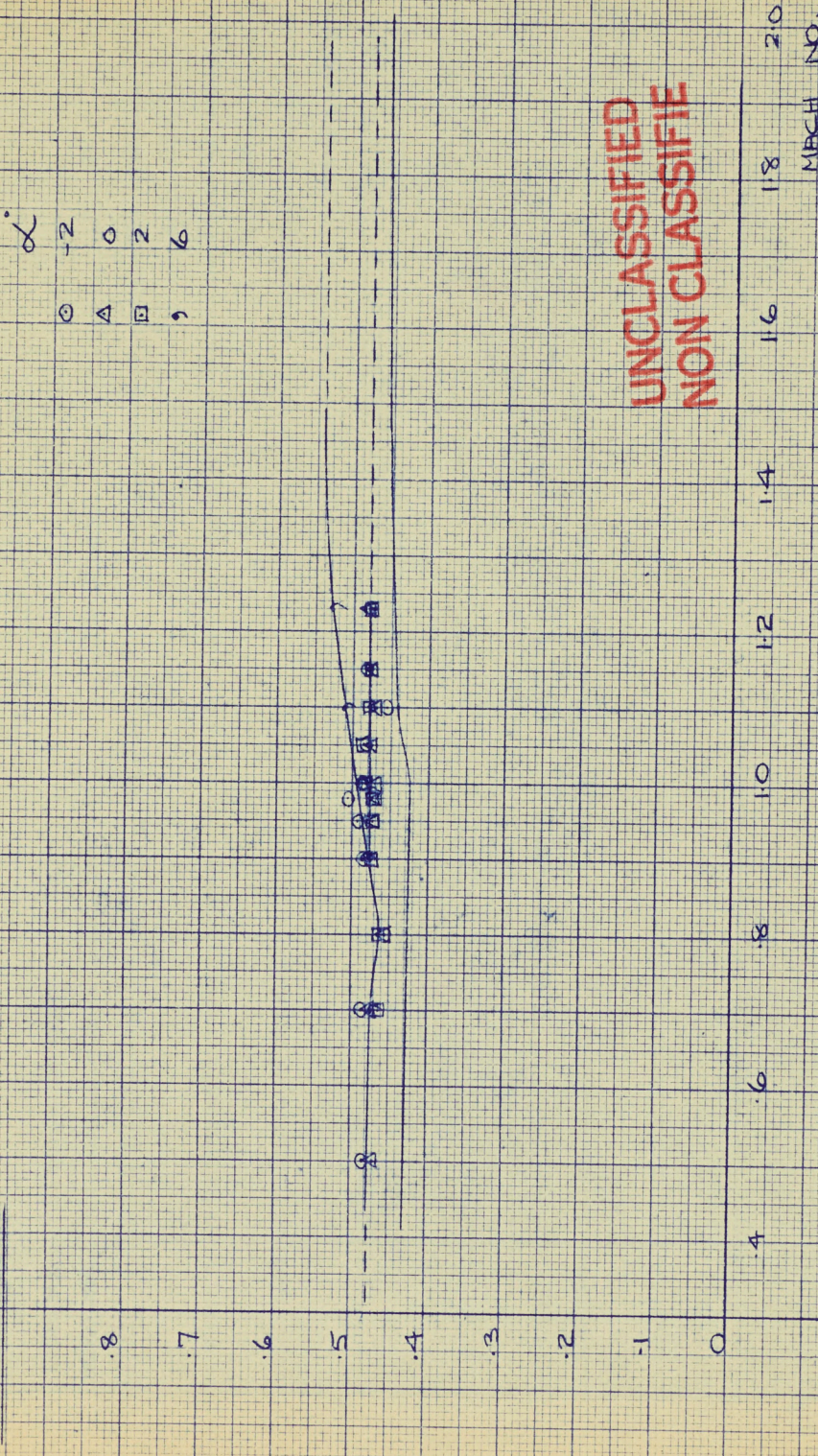
SPANWISE A.C. VS MACH NO.

Q.C. POSITION

FRACTION SPAN

α
-2
0
2
6

⊙
△
□
,



UNCLASSIFIED
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MARCH NO.

C-105

C.A.I. WIND TUNNEL TESTS APRIL '54

$\alpha_2(V)$ VS MACH NO.

$\delta_x = 5^\circ$

$\alpha_2(V)$
PER DEG.

α°
○ -2
△ 0
□ 2
, 6

.03

.02

.01

0

ESTIMATE

20

18

16

14

12

10

.8

.6

.4

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C-105

C. A. L. WIND TUNNEL TEST APRIL '54

α_2 (V) VS MACH NO.

$\delta_c = 10^\circ$

α°
 0 -2 0 2 6
 ○ △ □ , 6

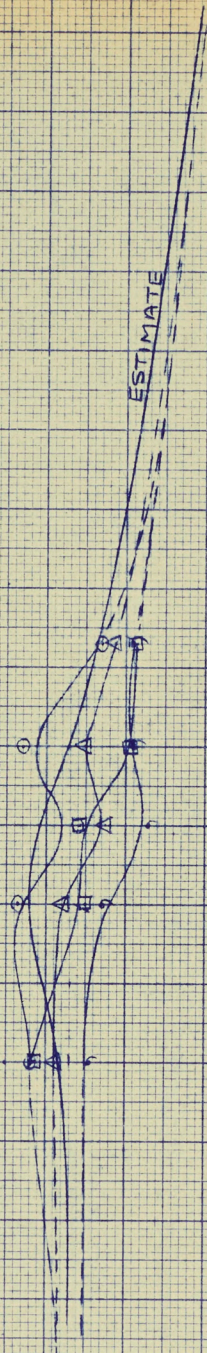
α_2 (V)
PER DEG

.03

.02

.01

0



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MACH NO.
18 20

C-105

S.A.L. WIND TUNNEL TESTS APRIL '54

α_2 (V) vs. MACH NO.

$\delta\gamma = 15^\circ$

α
-2 0 2 6
○ △ □ ♯

α_2 (V)
PER DEG

.03

.02

.01

0

.4

.6

.8

1.0

1.2

1.4

1.6

1.8

2.0

MACH NO

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C-105

C. A. L. WIND TUNNEL TESTS APRIL '54

$\alpha_2(V)$ VS MACH NO.

$\delta_T = 20^\circ$

$\alpha_2(V)$
PER DEG.

α°
-2
0
2
6

0
A
B
C

.03

.02

.01

0

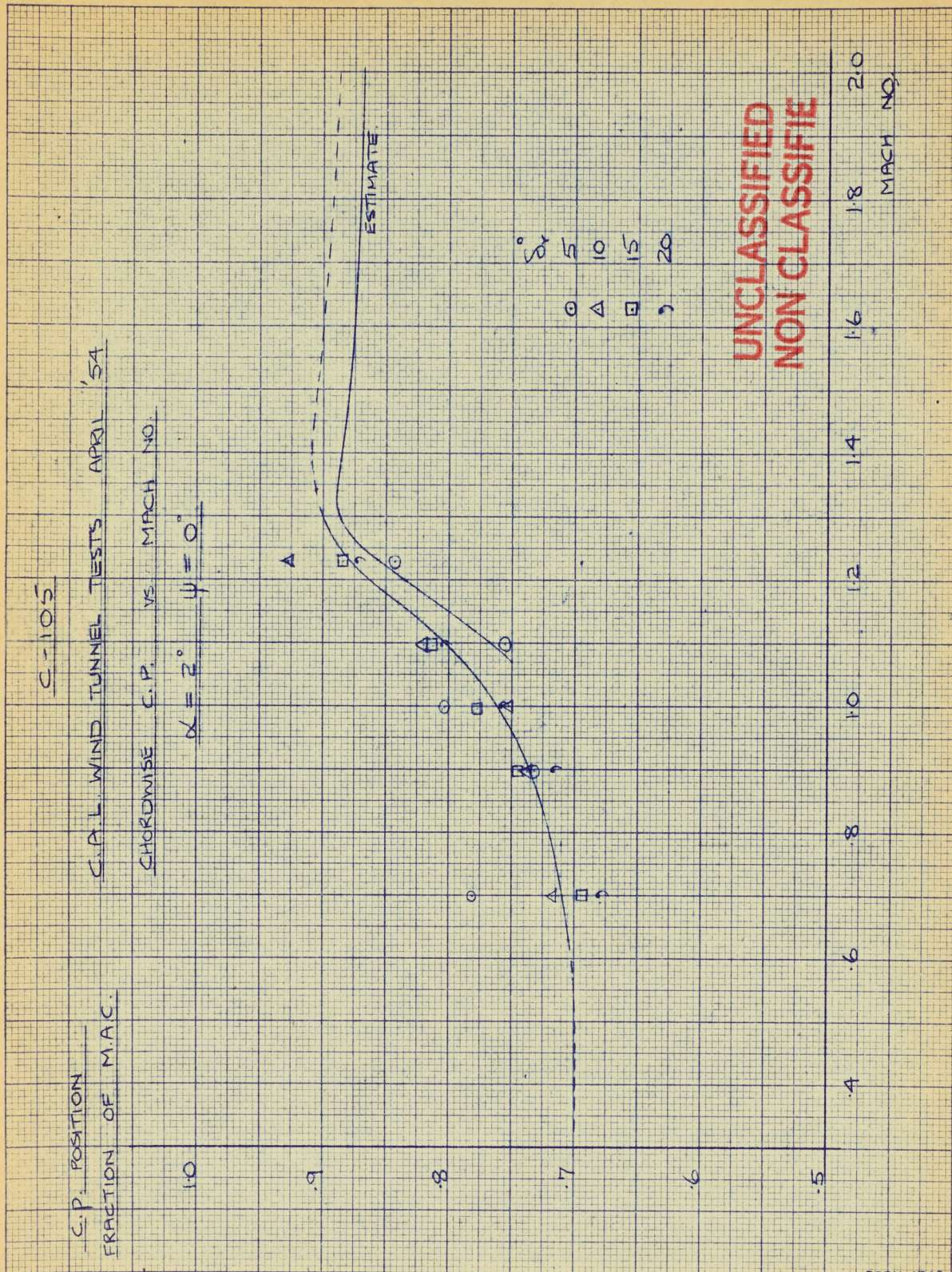
ESTIMATE

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18 20
MACH NO.

389-12 KEUFFEL & ESSER CO.
10 X 10 to the 1/2 inch. 5th lines accuracy.
MADE IN U.S.A.

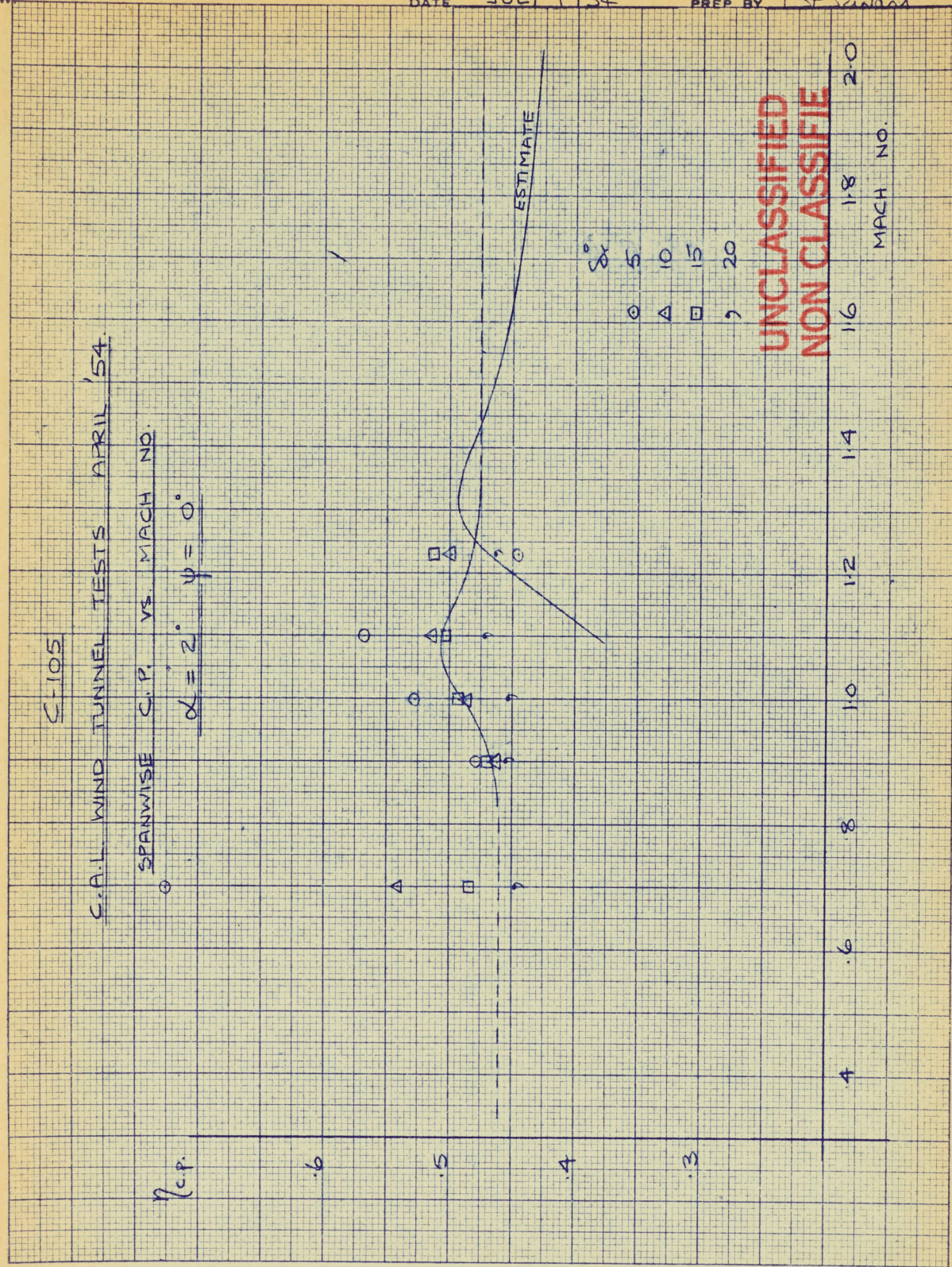
359.12 KEUFFEL & ESSER CO.
10 X 10 to the 1/2 inch, 5th lines accented.
MADE IN U.S.A.



C-105
S.A.L. WIND TUNNEL TESTS APRIL '54

SPANWISE C.P. VS. MACH NO.

$\alpha = 2^\circ$, $\psi = 0^\circ$



α°
 O 5
 A 10
 □ 15
 ; 20

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NON CLASSIFIED

MACH NO.
1.6 1.8 2.0

35015 KEUFFEL & ESSER CO.
10 x 10 1/2 in. 1/2 inch 5th Ed. Rev. 10/54
MADE IN U.S.A.

P/W.T./21 3.3.A.
July 9/54 Kurathwork

C105
C.A.L. MIND TUNNEL TESTS APRIL 54

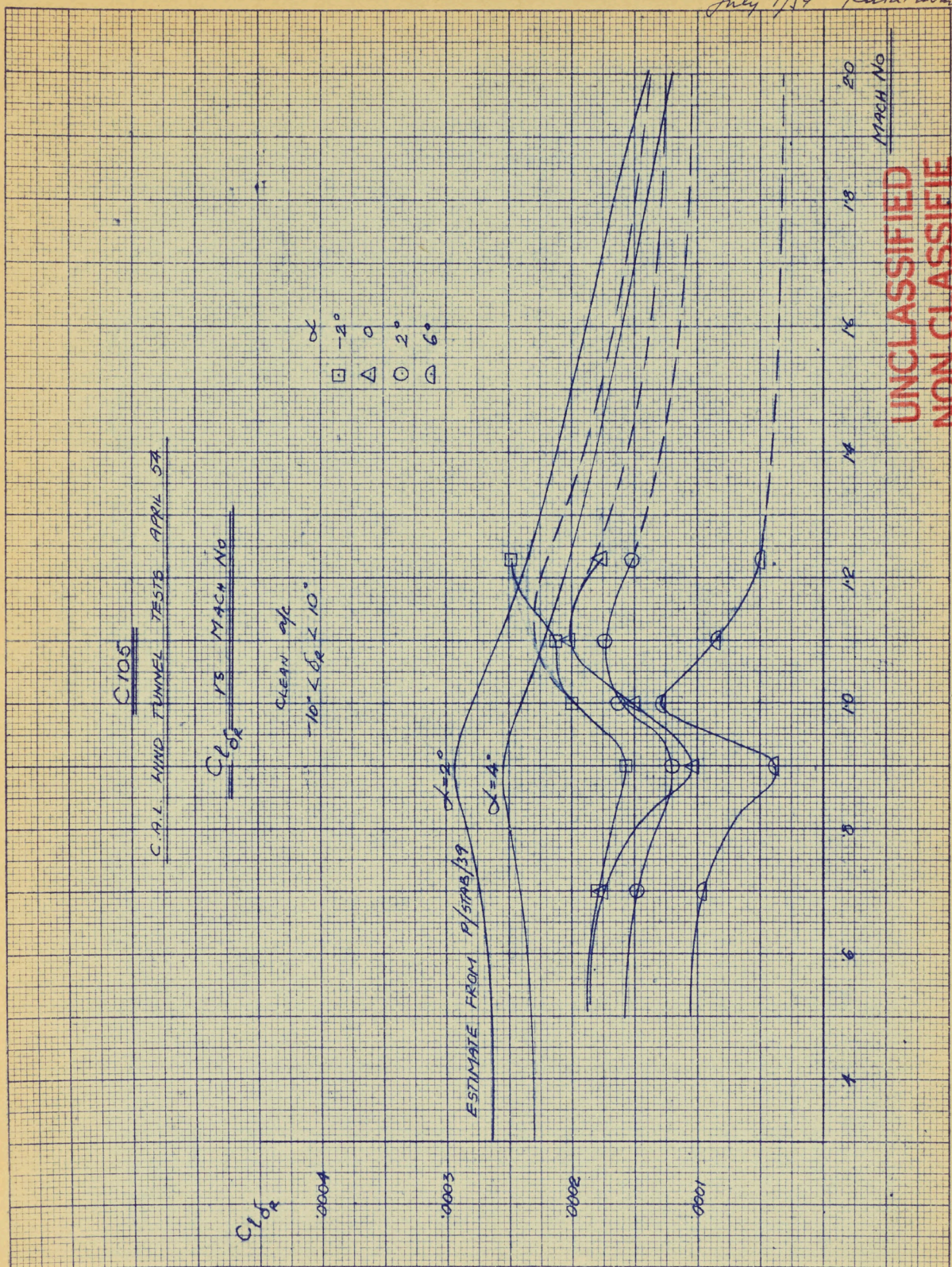
C102 VS MARCH No

CLEAN up
100° < δ_r < 110°

C102

\square	α
\triangle	-2°
\circ	0
\ominus	2°
\triangle	6°

ESTIMATE FROM P/519A/39
 $\alpha=2^\circ$
 $\alpha=4^\circ$



MARCH No

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58012. METUPEL & ESSEX CO.
10 x 10 to 1/8" x 1/2" inch, 513 lines accurate.
MADE IN U.S.A.

C-105
C.A.L. WIND TUNNEL TESTS APRIL '54.

$C_{H\beta}$ VS MACH NO.

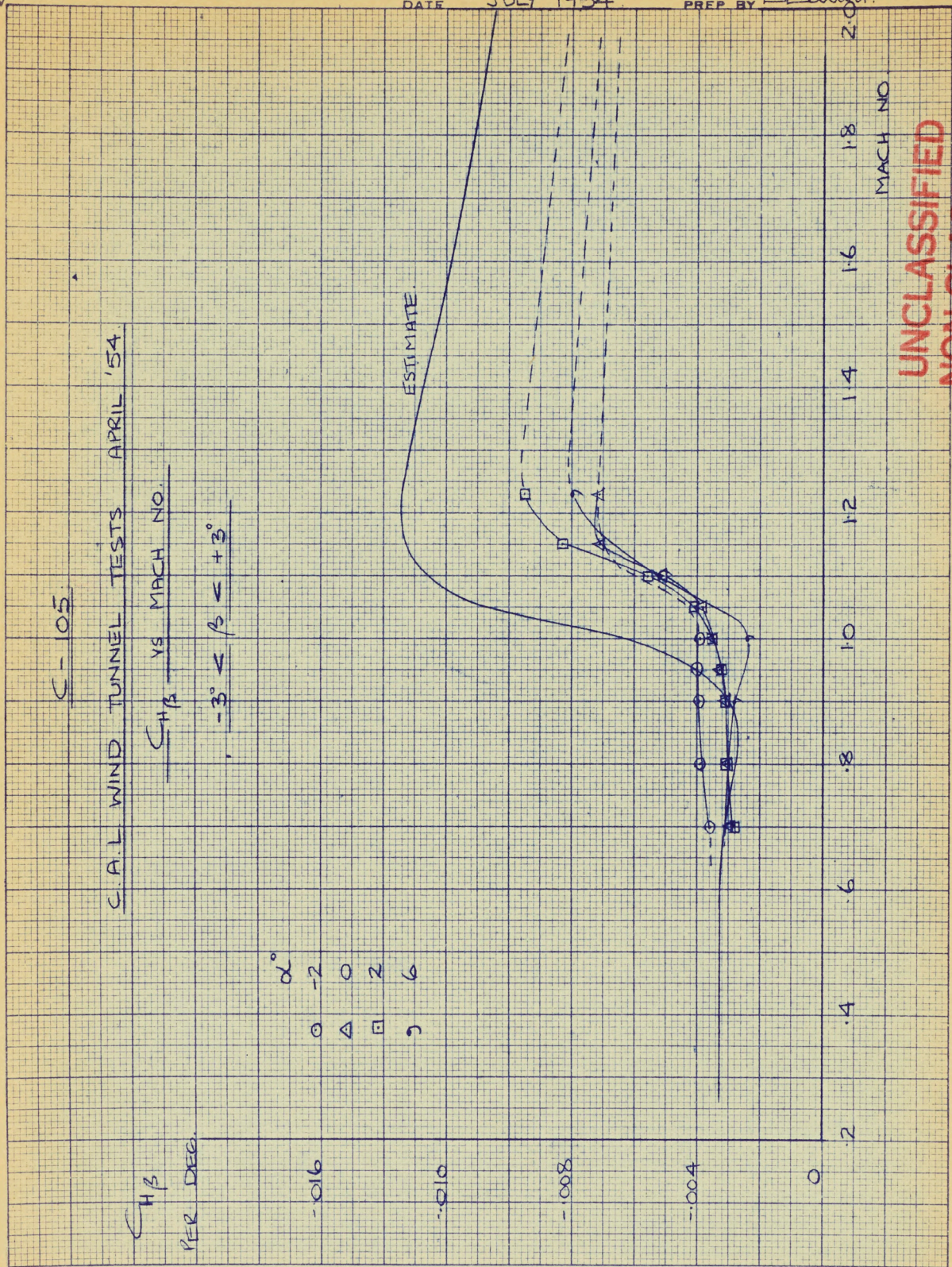
$-3^\circ < \beta < +3^\circ$

$C_{H\beta}$
PER DEG.

α°
0 Δ \square \circ
-2 0 2 6

-016
-010
-008
-004
0

ESTIMATE.



MACH NO.

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NON CLASSIFIE

399-12 KEUFFEL & ESSER CO.
10 X 10 to the 1/2 inch, 5th times accurate.
MADE IN U.S.A.

C-105

S.A. WIND TUNNEL TESTS APRIL '54

$C_{H\beta}$ VS MACH NO.

$|\beta| > 3^\circ$

$C_{H\beta}$

PER DEG.

α°
 0 -2
 Δ 0
 □ 2 6
 ?

-0.16

-0.12

-0.08

-0.04

.2

.4

.6

.8

1.0

1.2

1.4

1.6

1.8

2.0

MACH NO.

ESTIMATE

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C-105

C.A.L. W-T Tests

6.65r vs Mach Number

$10^\circ \pm \alpha \pm 20^\circ$

$\beta = \delta = 0$

$\beta = 0$

Configuration B G W 1/2 B

Chor
per degree

-04
-03
-02
-01
0

$\alpha = 2^\circ$
 $\alpha = 6^\circ$

Estimate
P/Control/57

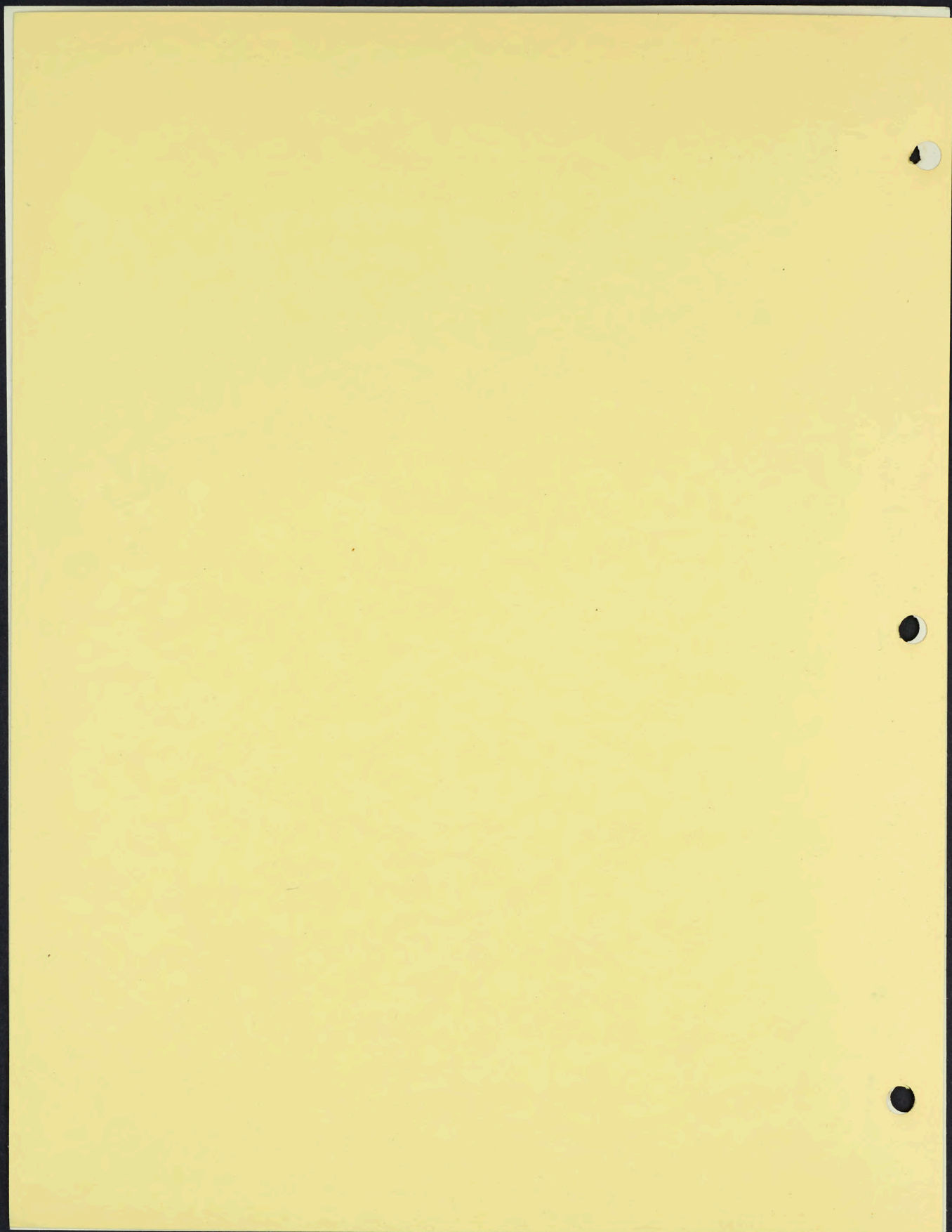
Mach Number

14 16 18 20

4 6 8 10 12

UNCLASSIFIED
NON CLASSIFIED

359-12 KEUFFEL & ESSER CO.
10 x 10 to the 15 inch, 5th lines spaced.
MADE IN U. S. A.



THE
3-5-53
MADE IN U.S.A.