CF-105 ~~CONFIDENTIAL~~ UNCLASSIFIED P/Aero Data/82

~~28~~ 27

ELASTIC LONGITUDINAL DERIVATIVES.

V. Baddeley Nov. 1956

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A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

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AIRCRAFT: CF-105

REPORT NO P/Aero Data/82

FILE NO

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TITLE:

ELASTIC LONGITUDINAL DERIVATIVES.

PREPARED BY V. Baddeley DATE Nov. 1956

CHECKED BY DATE

SUPERVISED BY DATE

APPROVED BY DATE

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ISSUE No	REVISION No	REVISED BY	APPROVED BY	DATE	REMARKS

FORM 1316 A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT NO P/Aero Data/82	
CF-105		SHEET NO	
		PREPARED BY	DATE
		V. Baddeley	Nov. 1956
		CHECKED BY	DATE

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ELASTIC LONGITUDINAL DERIVATIVES

☆ Derivatives Modified Due To Elastics

CONTENTS

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		Section Reference	No. Of Sheets
2.	Control Derivatives		
☆	$C_{L_{\delta_R}}$, $C_{L_{\delta_E}}/C_{L_{\delta_R}}$, and $C_{L_{\delta_E}}$ for		
	1 'g', c.g. at .31 A.M.C. Weight = 47,000 lb.	2.1	5
☆	C_{P_R}, $\Delta CP_{(C_L)}$, $\Delta CP_{(\alpha)}$	2.2	6
☆	$C_{M_{\delta(C_L)}}$, 1 'g' c.g. at .31 A.M.C. Weight = 47,000 lb.	2.3	1
☆	$C_{M_{\delta(\alpha)}}$ 1 'g' c.g. at .31 A.M.C. Weight = 47,000 lb.	2.4	1
	C_{h_α}	2.5	1
	$C_{h_{\delta_e}}$	2.6	1
	C_{h_o}	2.7	1
3.	Appendix		
	α_{TR}, 1 'g', c.g. at .31 A.M.C. Weight = 47,000 lb.	3.1	1
	δ_{TR}, 1 'g', c.g. at .31 A.M.C. Weight = 47,000 lb.	3.2	1

N.B. $C_{M_{\delta(C_L)}} = C_{L_{\delta_{Rigid}}} \left(a.c. - cp_{E_{(C_L)}}\right)$

$$C_{M_{\delta(\alpha)}} = C_{L_{\delta_{Rigid}}} \left(h - cp_{E_{(\alpha)}}\right)$$

REMARKS

One general remark, it is assumed that the effects of elasticity, on all derivatives are felt immediately some small disturbance is made. This is obviously not correct for high frequency oscillations, but corrections for this are beyond the scope of this report.

Apart from this Section 1 is self explanatory with the following minor comments.

(a) $\Delta C_{L_{C_{M_o}}}$ could have been expressed as a change in α_o

$$\text{viz.} \quad \Delta \alpha_o = \frac{-\Delta C_{L_{C_{M_o}}}}{C_{M_o}}$$

(b) Similarily a change in C_{M_o} due to C_{M_o} with the revised α_o could have been given

$$\text{viz.} \quad \Delta C_{M_{o_{C_{M_o}}}} = C_{L_{C_{M_o}}} (\text{a.c.} - \text{c.p.}_{C_{M_o}})$$

However the more fundamental treatment of figs. 1.10, & 1.11 was considered more desirable, but it should be remembered that basically all the effects are, is a change in α_o & C_{M_o}.

(c) The change in C_{M_o} shown in fig. 1.5.2 is for c.g. at .31 A.M.C. However since most of this change is due to the vertical shift of c.g., from test model to aircraft the curve could be used for other c.g.'s with very little loss of accuracy.

Section 2

(a) It is most important that in estimating

$$C_{M_\delta} \text{ at constant } \alpha = C_{L_\delta} (h - \text{c.p.})$$

$$C_{M_\delta} \text{ at constant lift} = C_{L_\delta} (\text{a.c.} - \text{c.p.})$$

that the RIGID values of C_{L_δ} be used since the changes in c.p. due to elastics are based on the rigid values of C_{L_δ}.

Section 2 (Continued)

(b) In obtaining c.p. elastic from figs 2.2.1 - 2.2.6, it will be noted that Δ c.p. due to elastics is shown positive forwards, and hence $c.p._E$ = $c.p._R$ from (2.2.1, 2.2.2) - Δ c.p. from 2.2.3 - 2.2.6.

Section 3

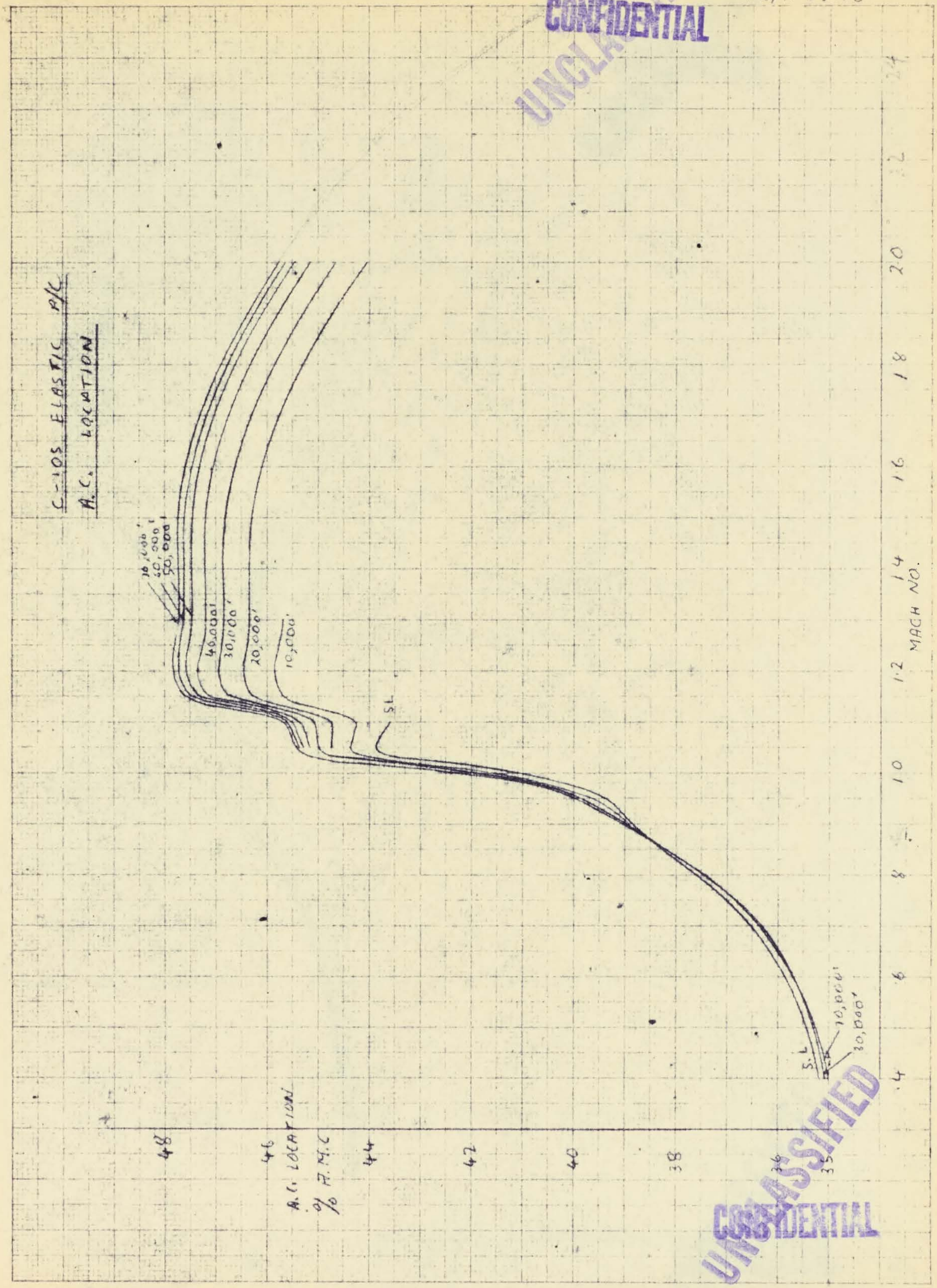
The values of α_{TR}, and δ_{TR} for 1 'g', were obtained by adding the increments due to elastics, from calculations using the derivatives, to the rigid values obtained directly from $C_M \sim C_L \sim \delta$ plots.

In this manner errors due to linearization were minimized. However this does mean, that calculations using the derivatives of the report will not agree exactly with the values of α_{TR} and δ_{TR} quoted.

It will also be noted, that the α_{TR} curve is for the rigid aircraft. This is because the change is α due to elastics at 1 'g' is so small as to be not significant, hence the rigid curve.

P/AERO.DATA/82 1.1

VB/11 23.56



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11 23 56

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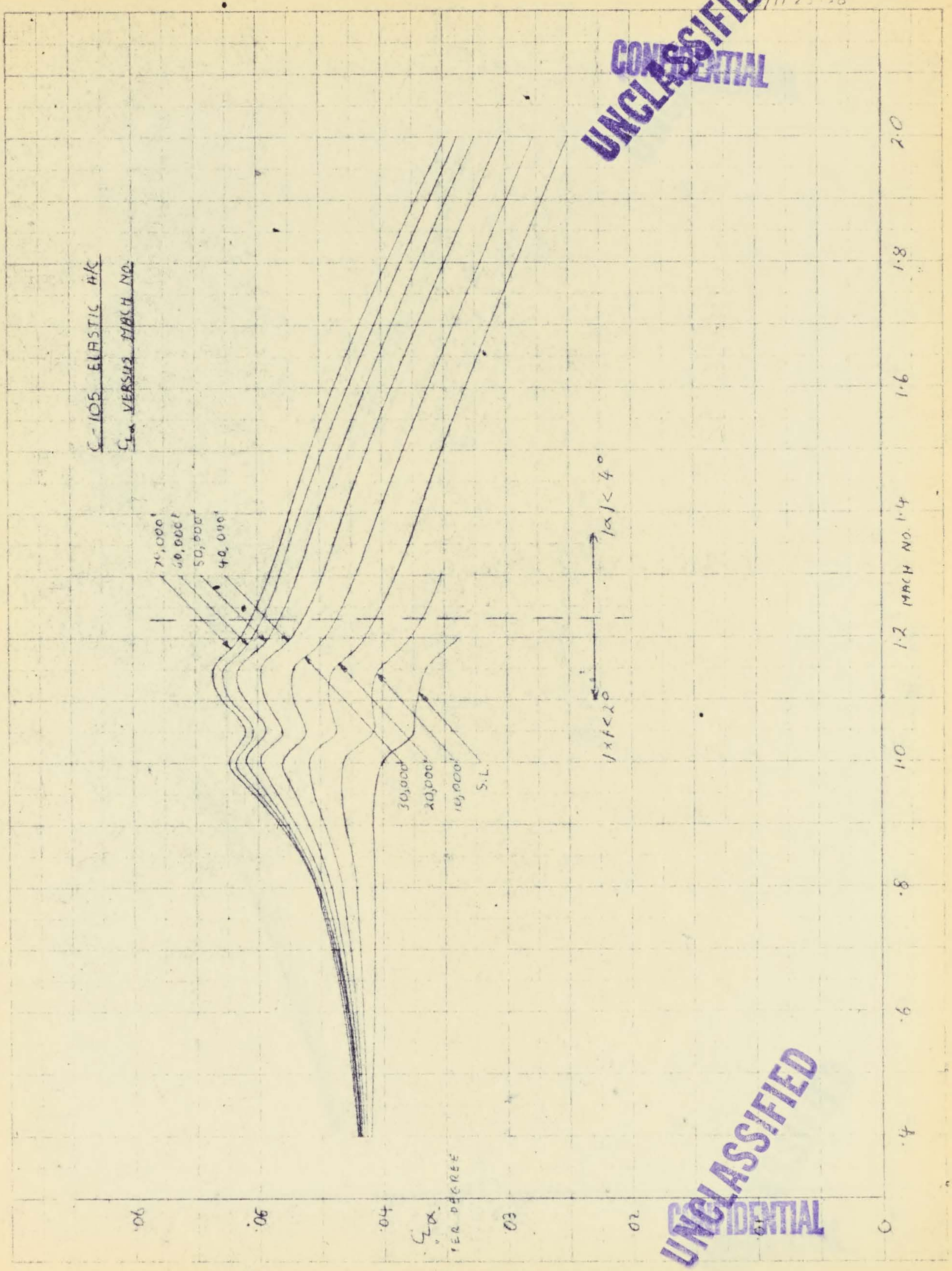

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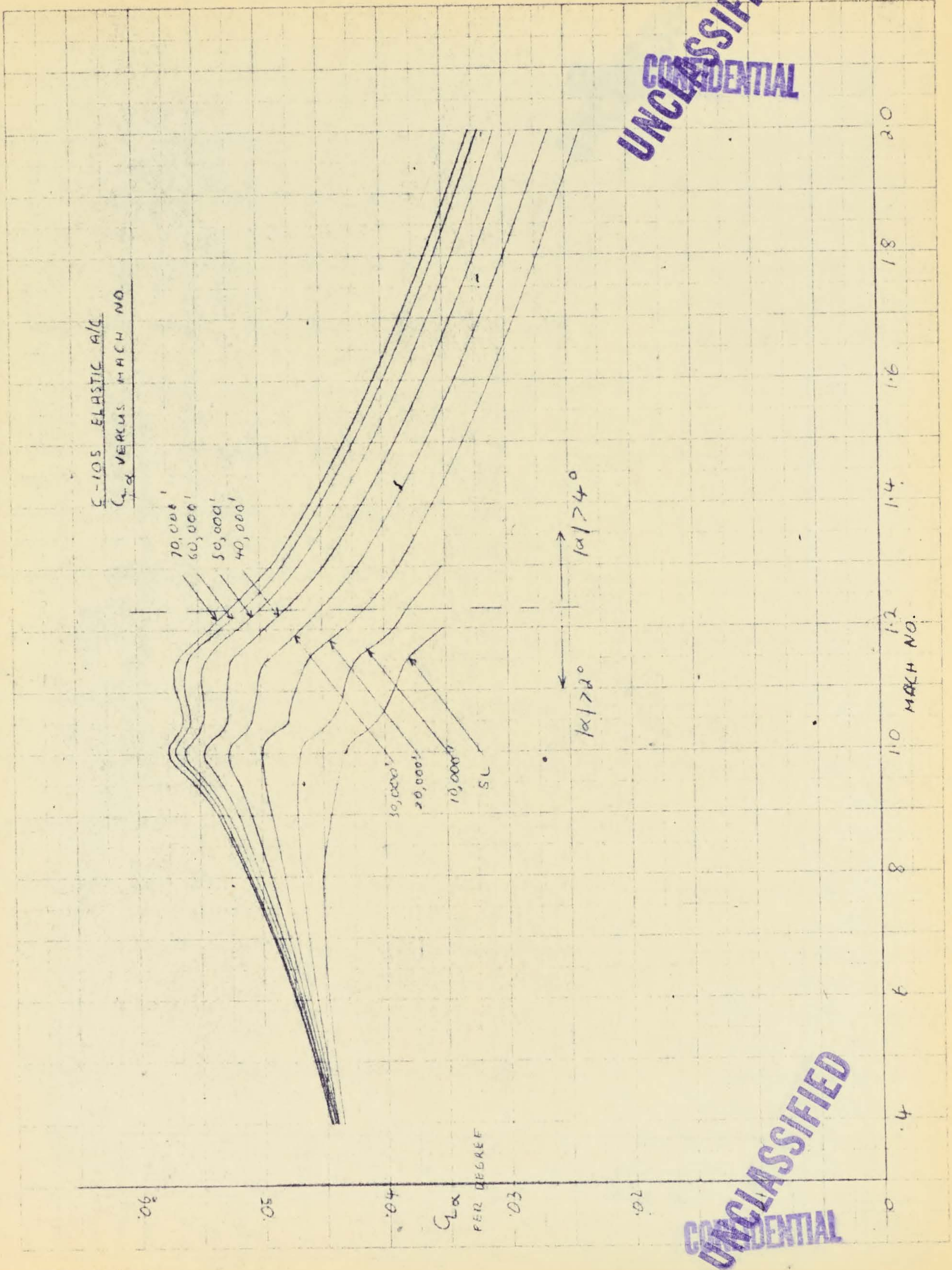
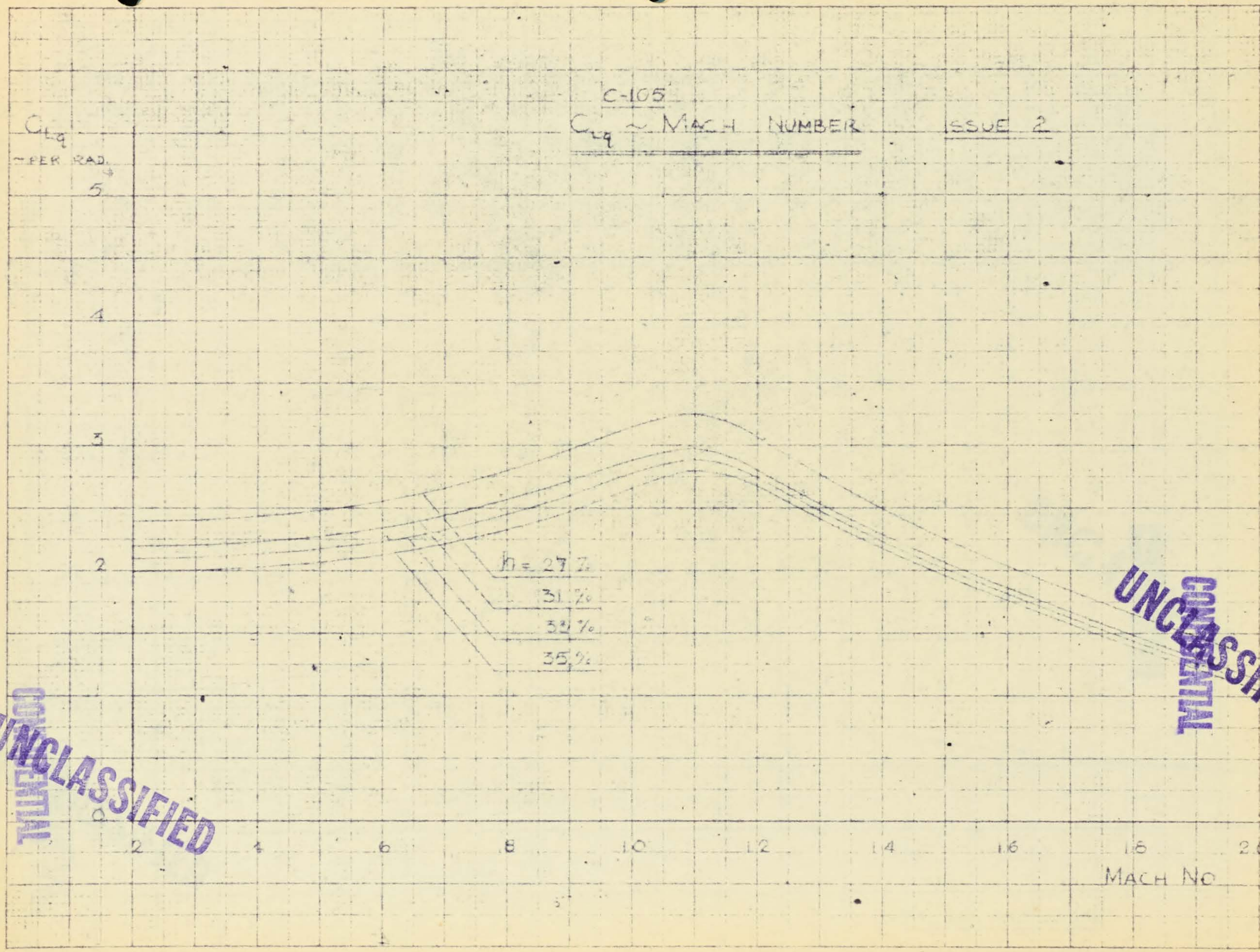

C-105 ELASTIC A/C
$C_{L\alpha}$ VERSUS MACH NO.
70,000'
60,000'
50,000'
40,000'
30,000'
20,000'
10,000'
SL
$|\alpha| > 4°$
$|\alpha| > 2°$
$C_{L\alpha}$ PER DEGREE
.06
.05
.04
.03
.02
0
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NO.

REF. P/S/123


C-105
C_{Lq} ~ MACH NUMBER
ISSUE 2
C_{Lq}
~ PER RAD.
5
4
3
2
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH No
h = 27%
31%
33%
35%
UNCLASSIFIED
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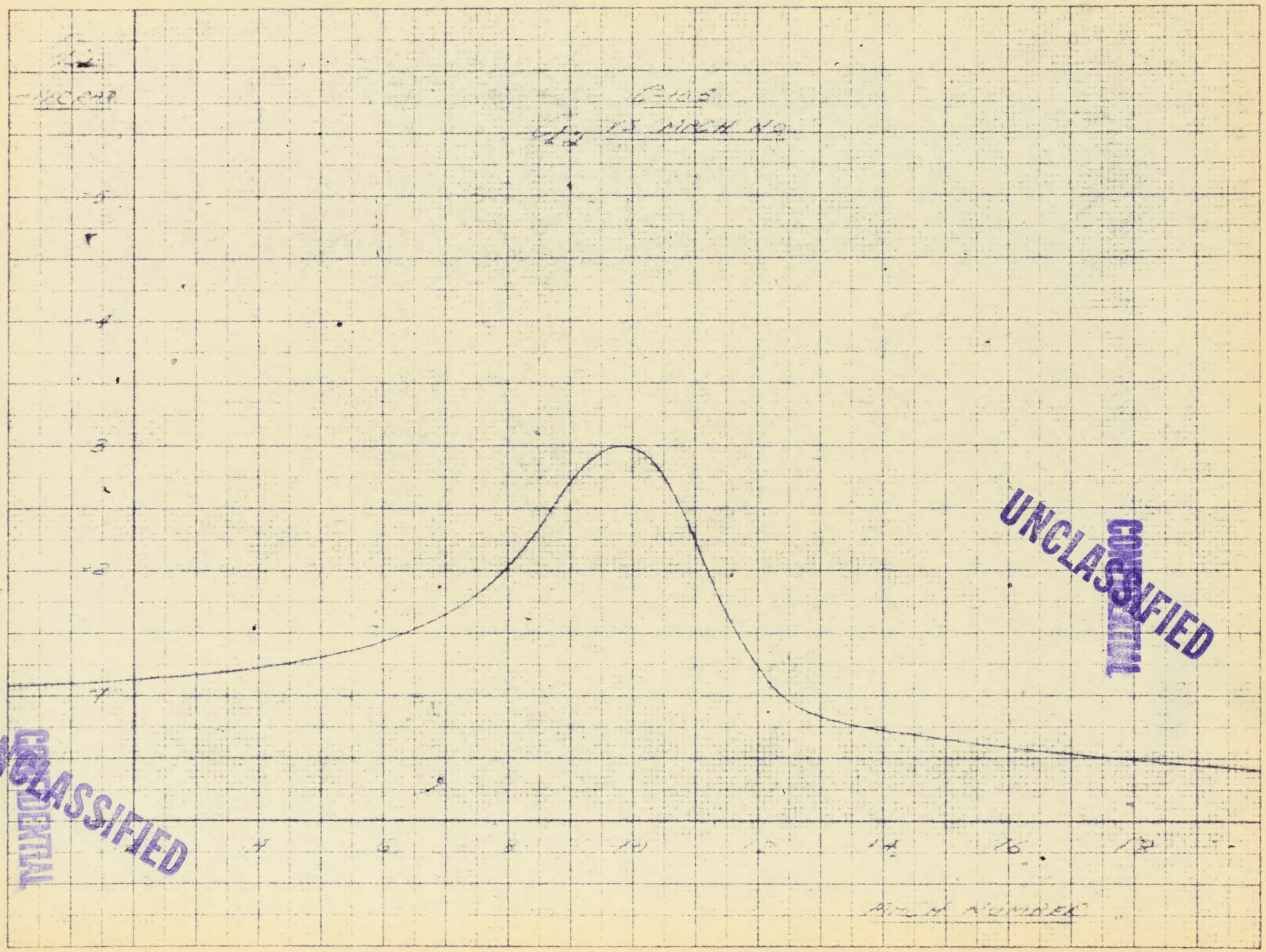
PITCH NUMBER
4
6
8
10
12
14
16
18
1
2
3
4
5
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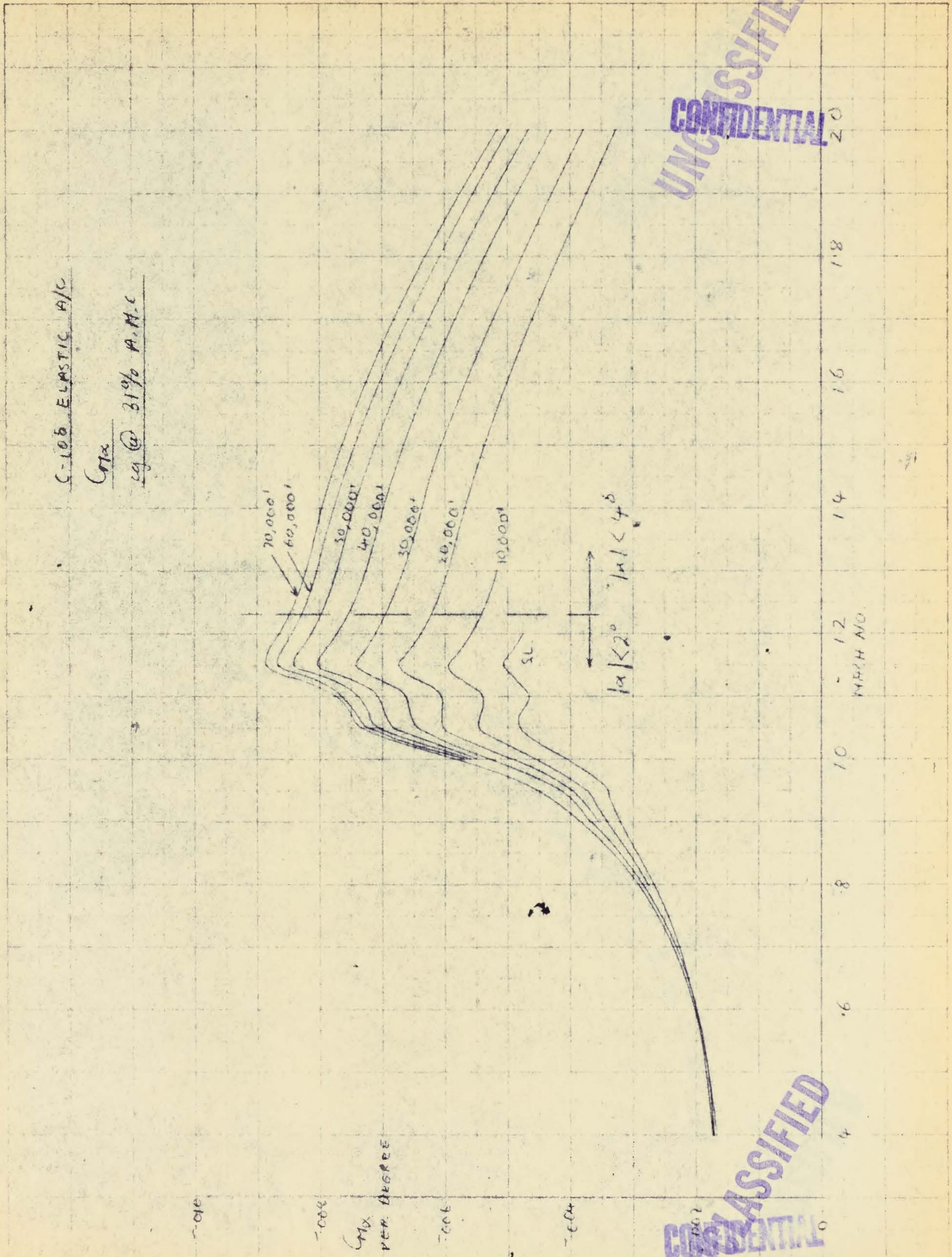
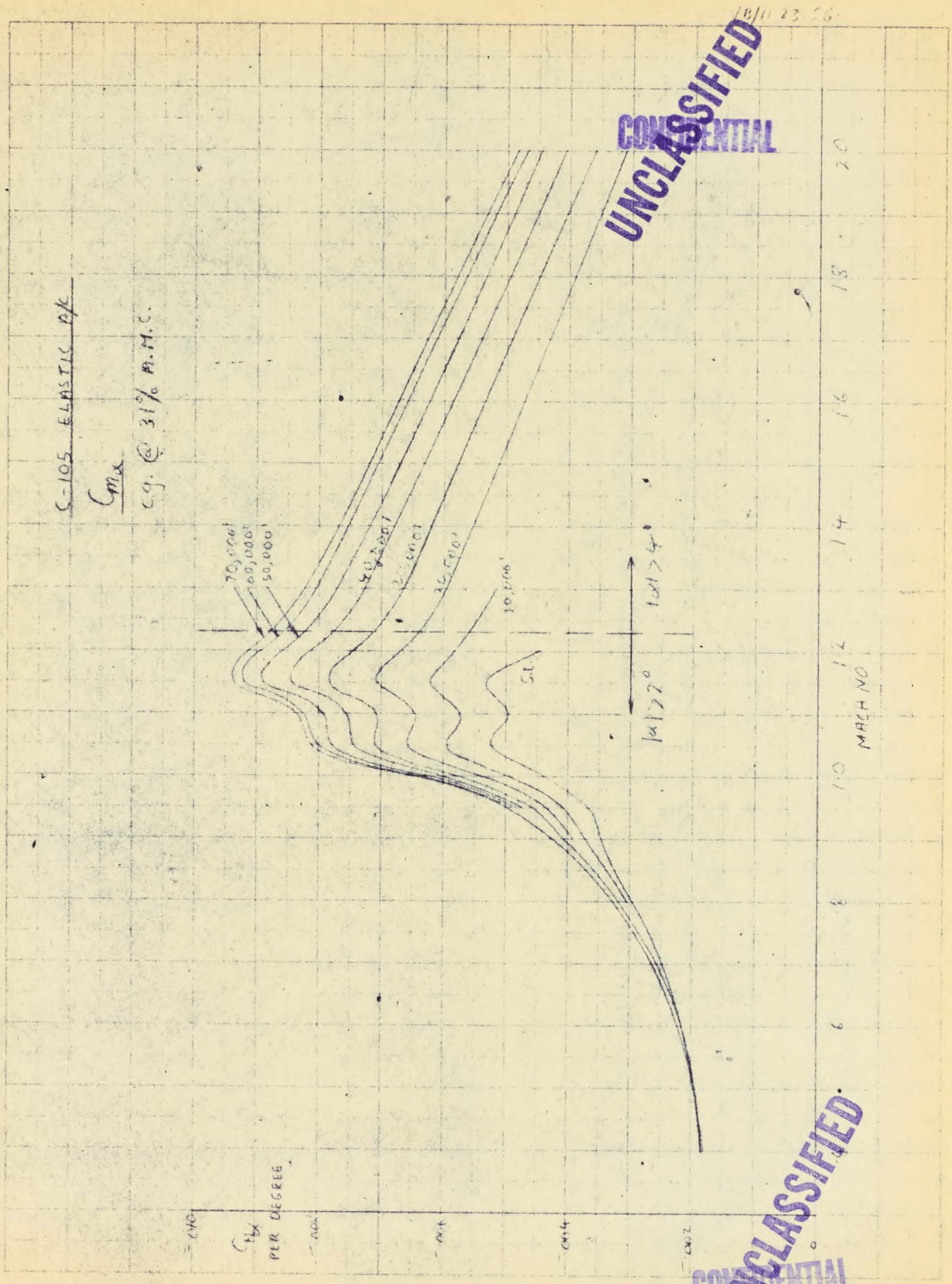
UNCLASSIFIED
CONFIDENTIAL


C-105 ELASTIC A/C
$C_{m\alpha}$
cg @ 31% M.A.C
70,000'
60,000'
50,000'
40,000'
30,000'
20,000'
10,000'
SL
$|\alpha| < 2°$
$|\alpha| < 4°$
MACH NO.
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
$C_{m\alpha}$ PER DEGREE
-.002
-.004
-.006
-.008
-.010
0

REF. P/S/123

18/11 23.56



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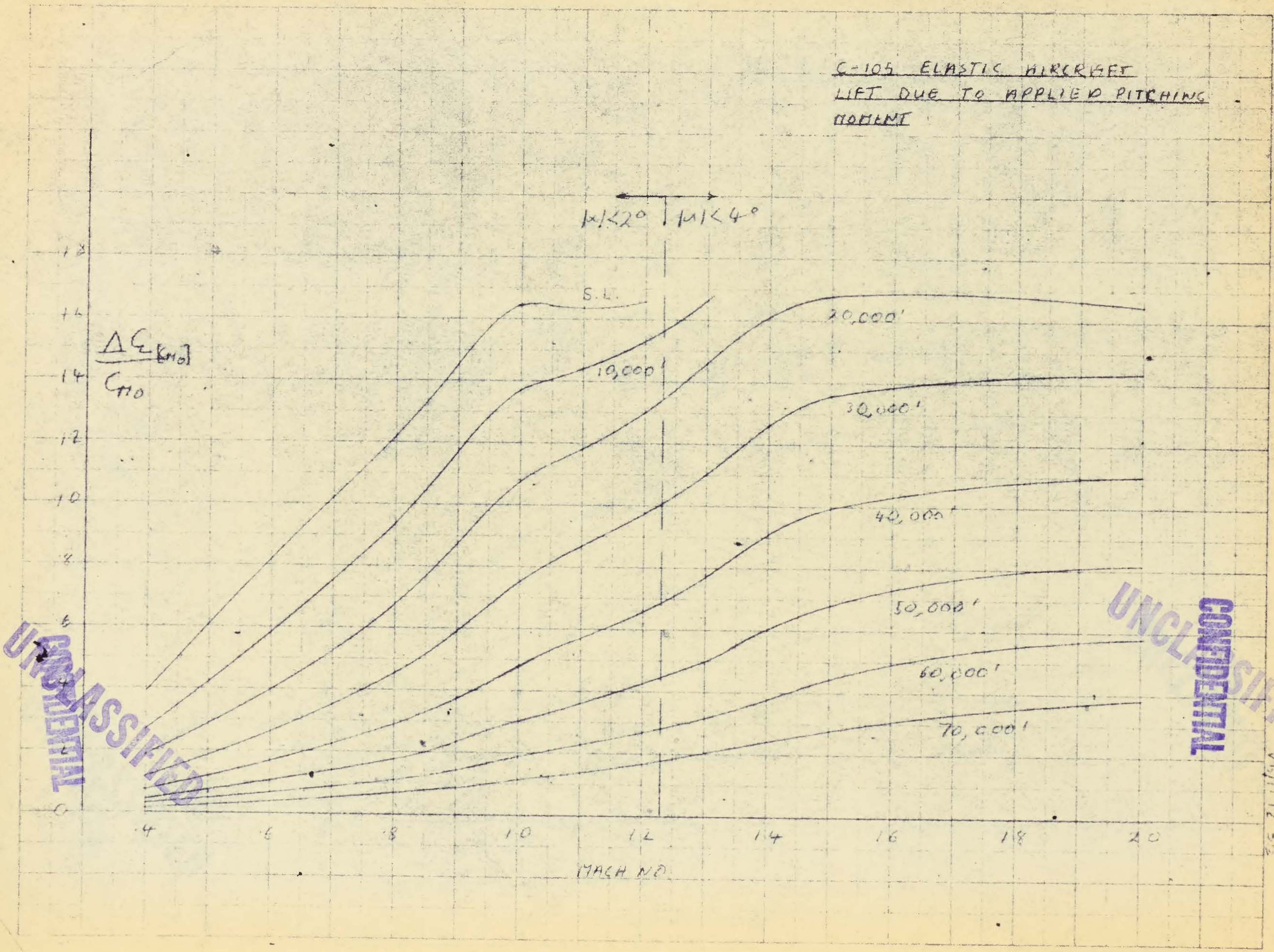
C-105 ELASTIC AIRCRAFT
LIFT DUE TO APPLIED PITCHING
MOMENT
μ < 2° | μ < 4°
$\frac{\Delta C_{L[M_0]}}{C_{M_0}}$
S.L.
10,000'
20,000'
30,000'
40,000'
50,000'
60,000'
70,000'
MACH NO.
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0

P/AERO. DATA/82 1.10.2.
P/STAB/123 FIG 11

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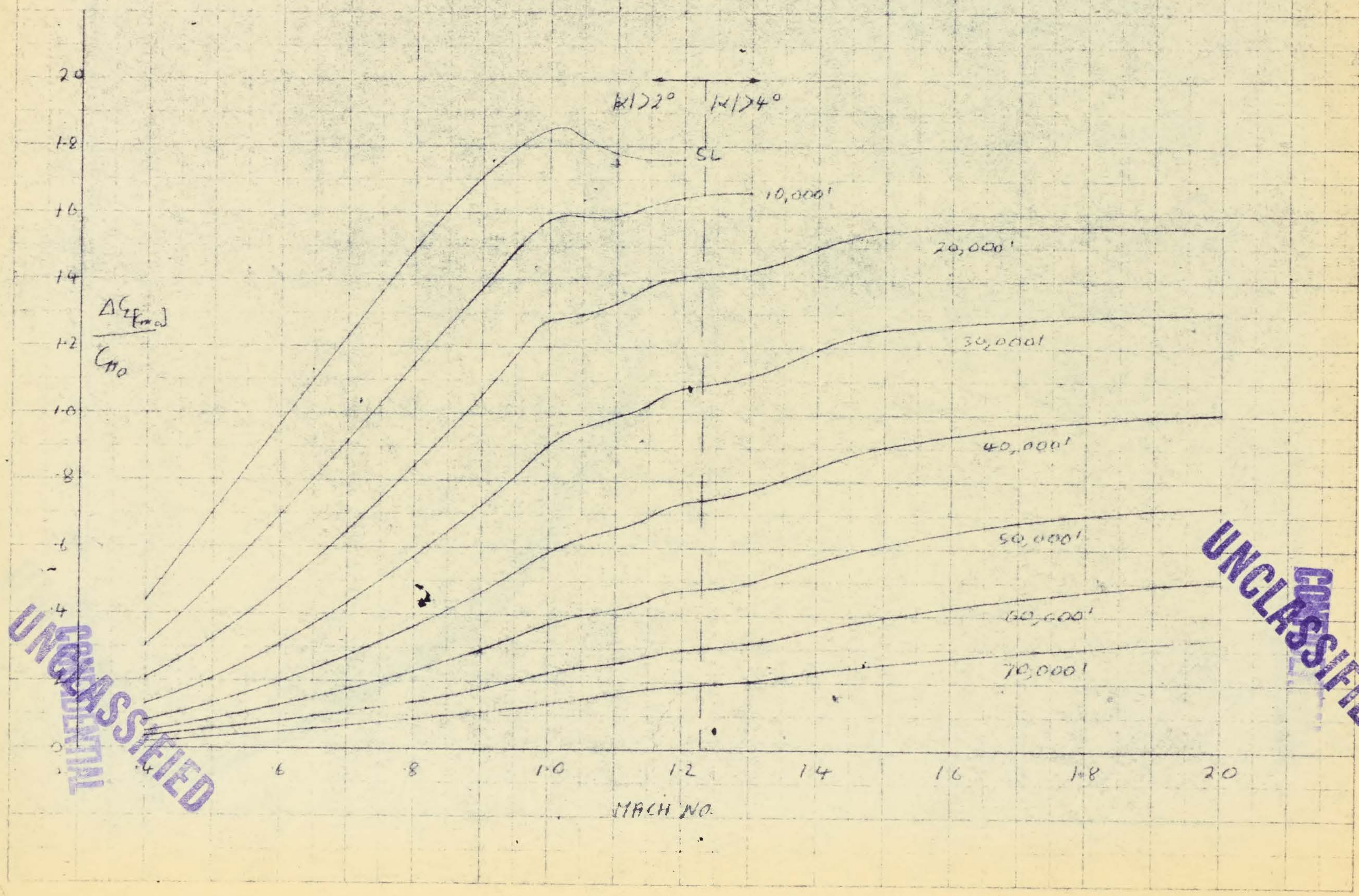
C-105 ELASTIC AIRCRAFT

LIFT DUE TO APPLIED PITCHING MOMENT



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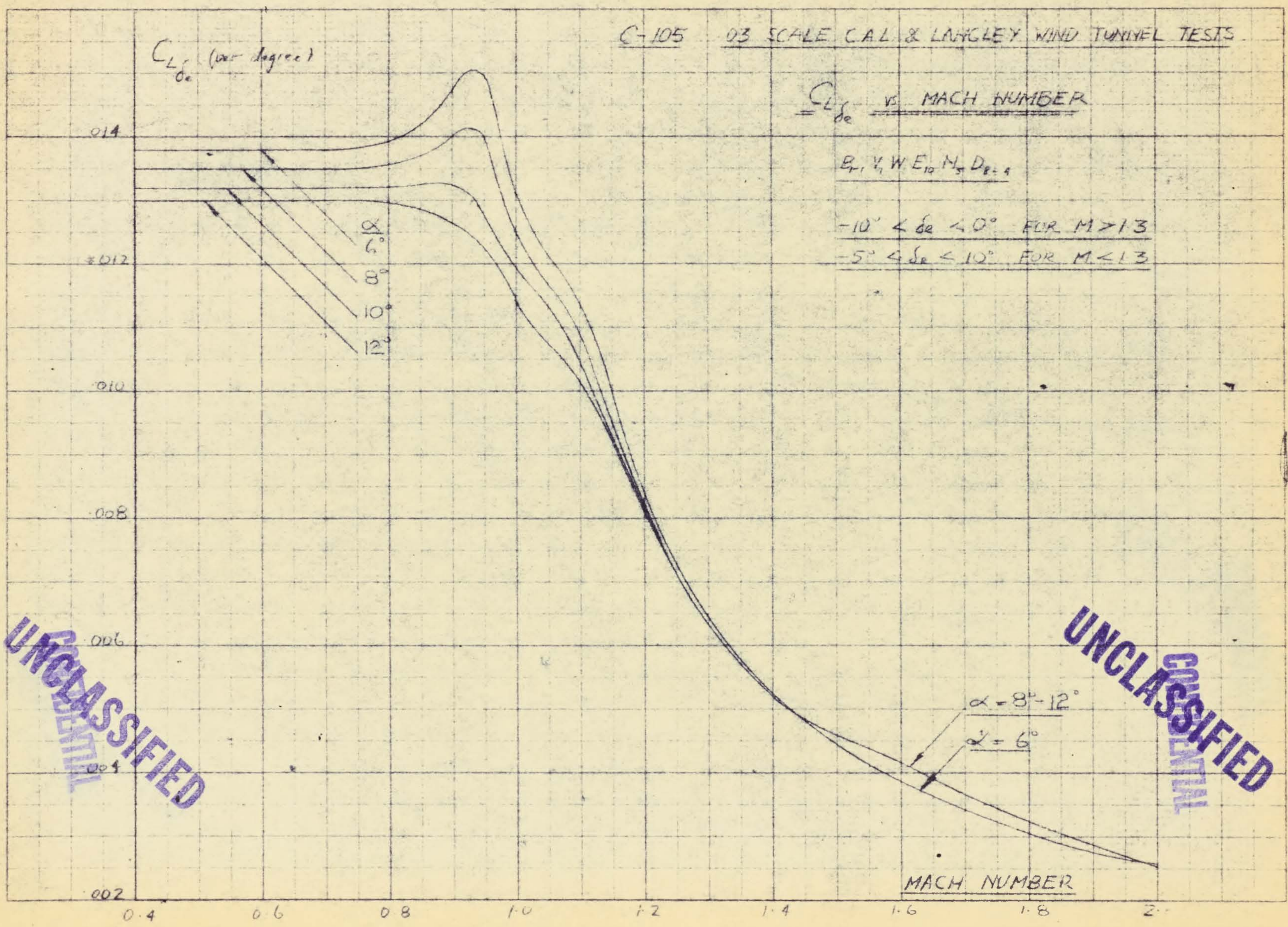
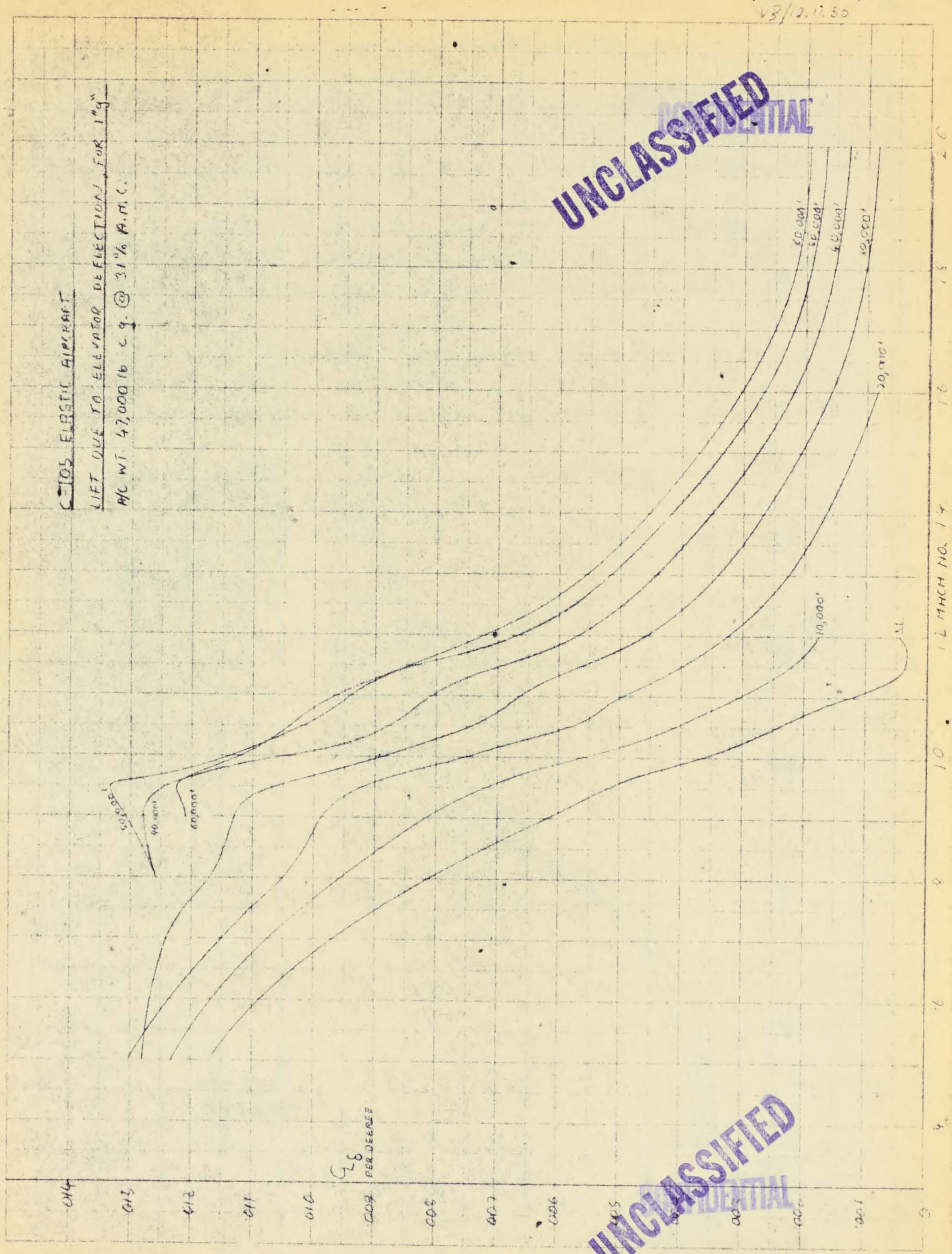


D.E.G. 5 NOV 56

P/Aero Data/18[redacted]2 2.1[redacted]2

P/AERO DATA/82. 2.1.5.

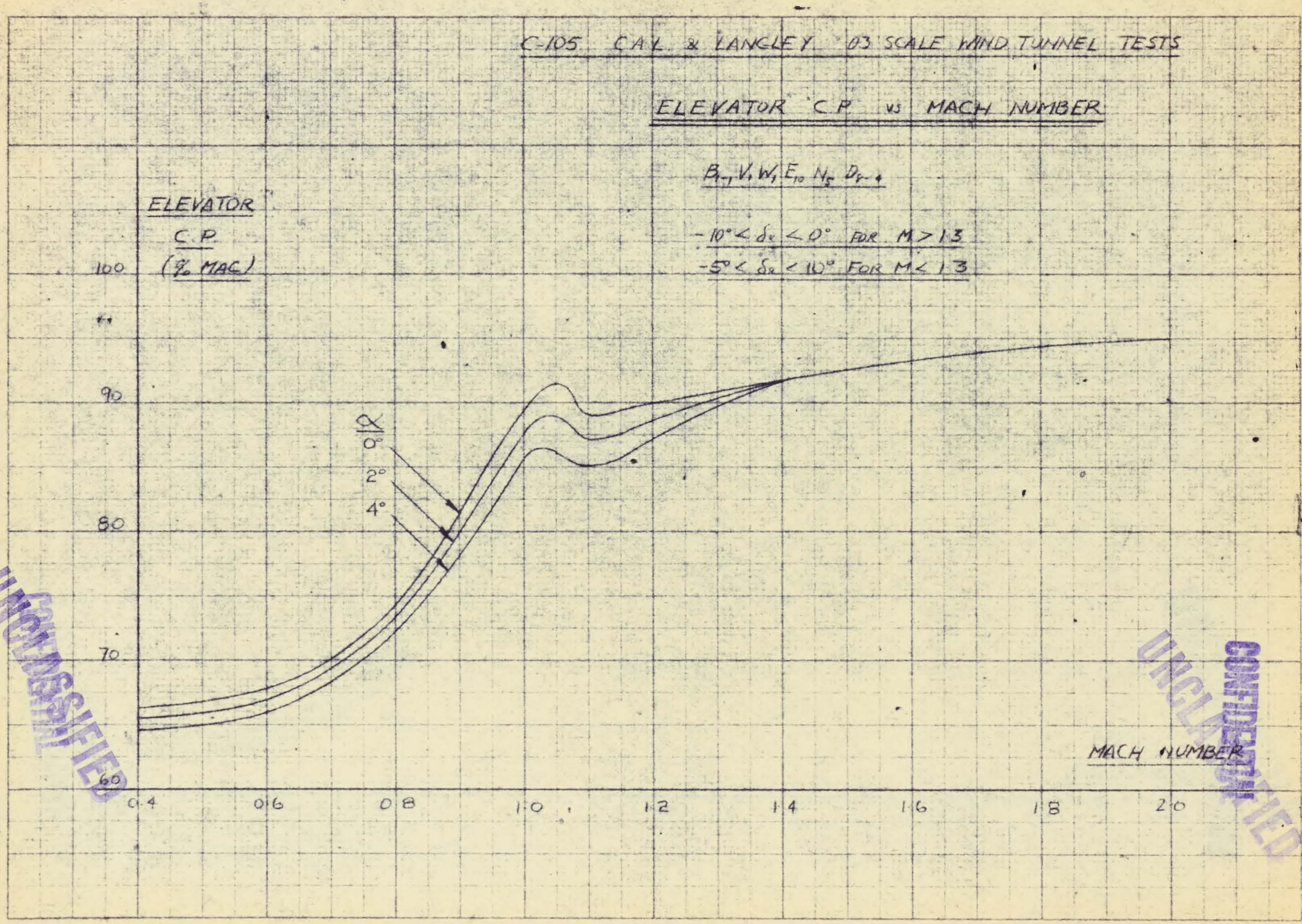
VB/12.12.50



P/STAB/123

P/Aero Data/8?2 2.2 ?.1

LBG 5 Nov 52



P/AERO DATA/82 2.2.3
P/STAB/123 FIG 4
VP/11 12.56

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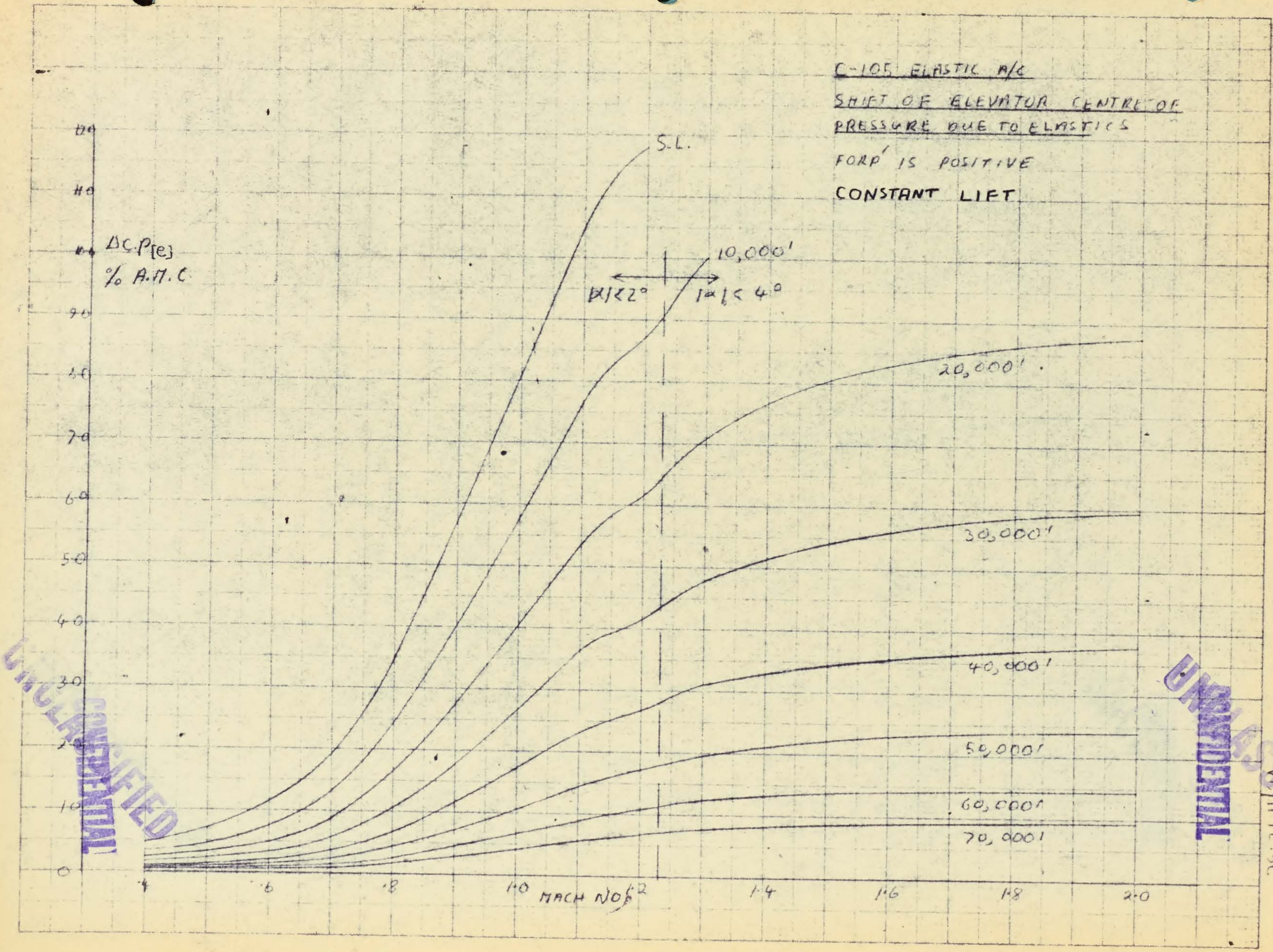

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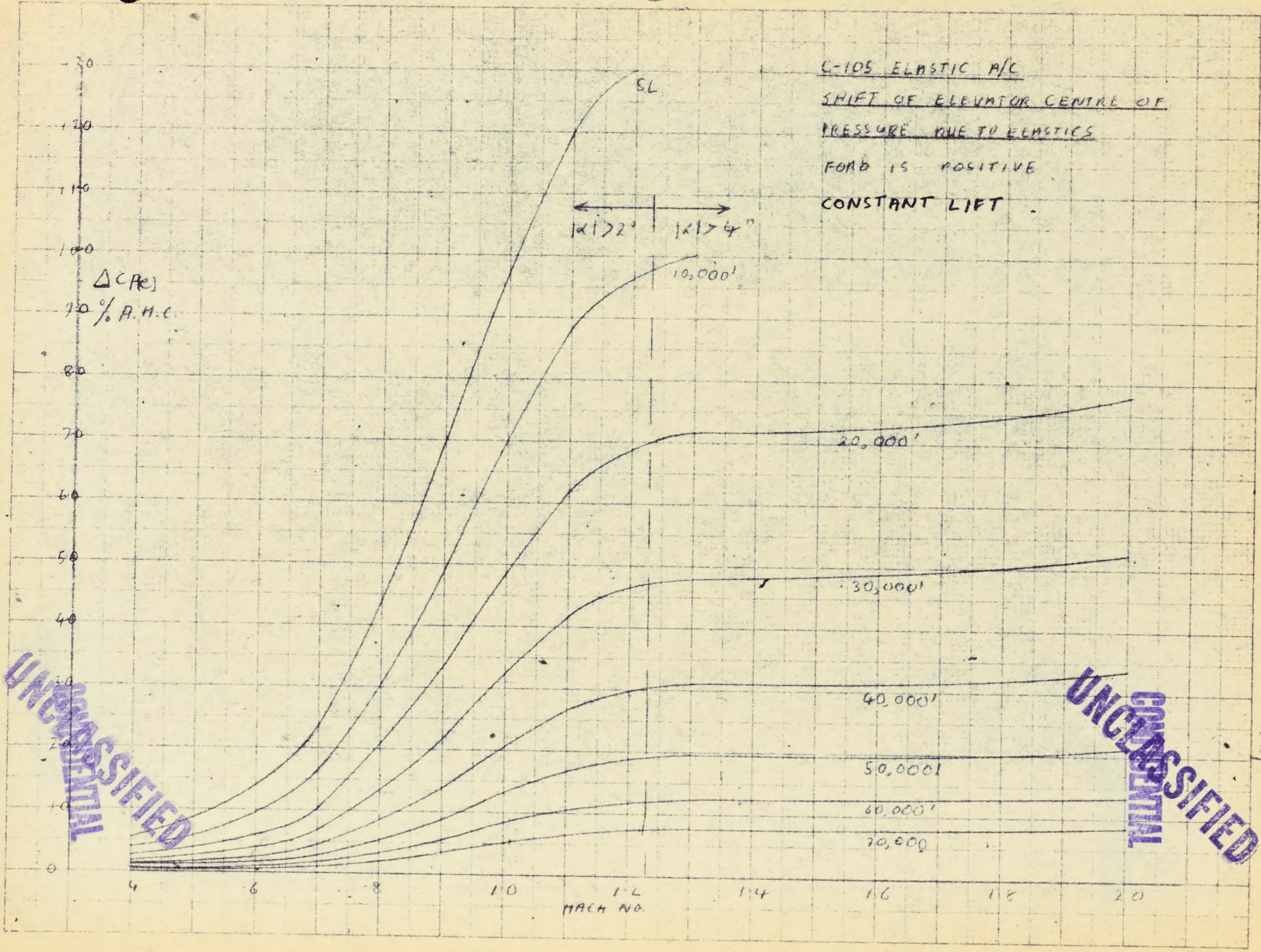
P/AERO DATA/82 2.2.4
P/STAB/123 FIG 5
VB/11.12.56



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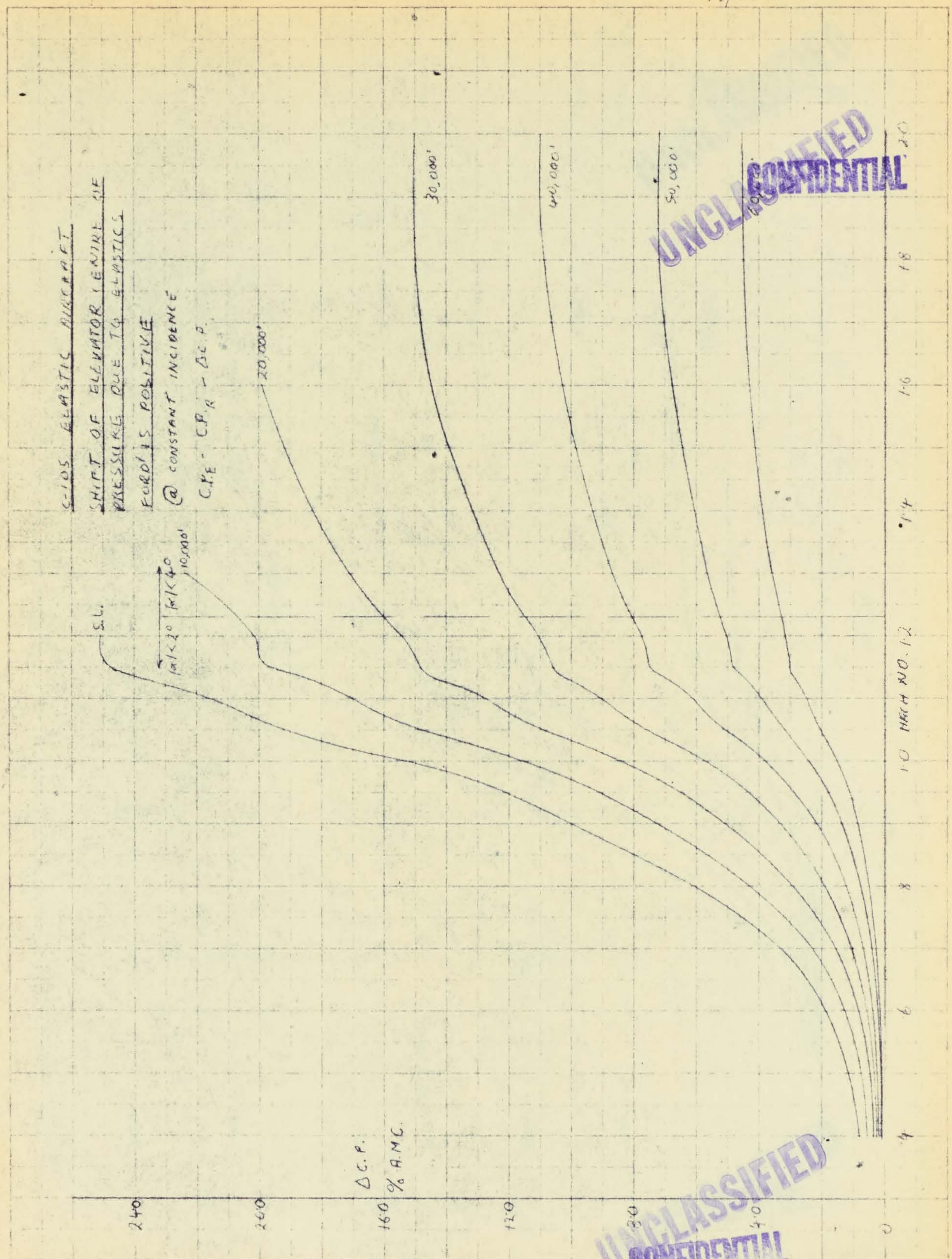

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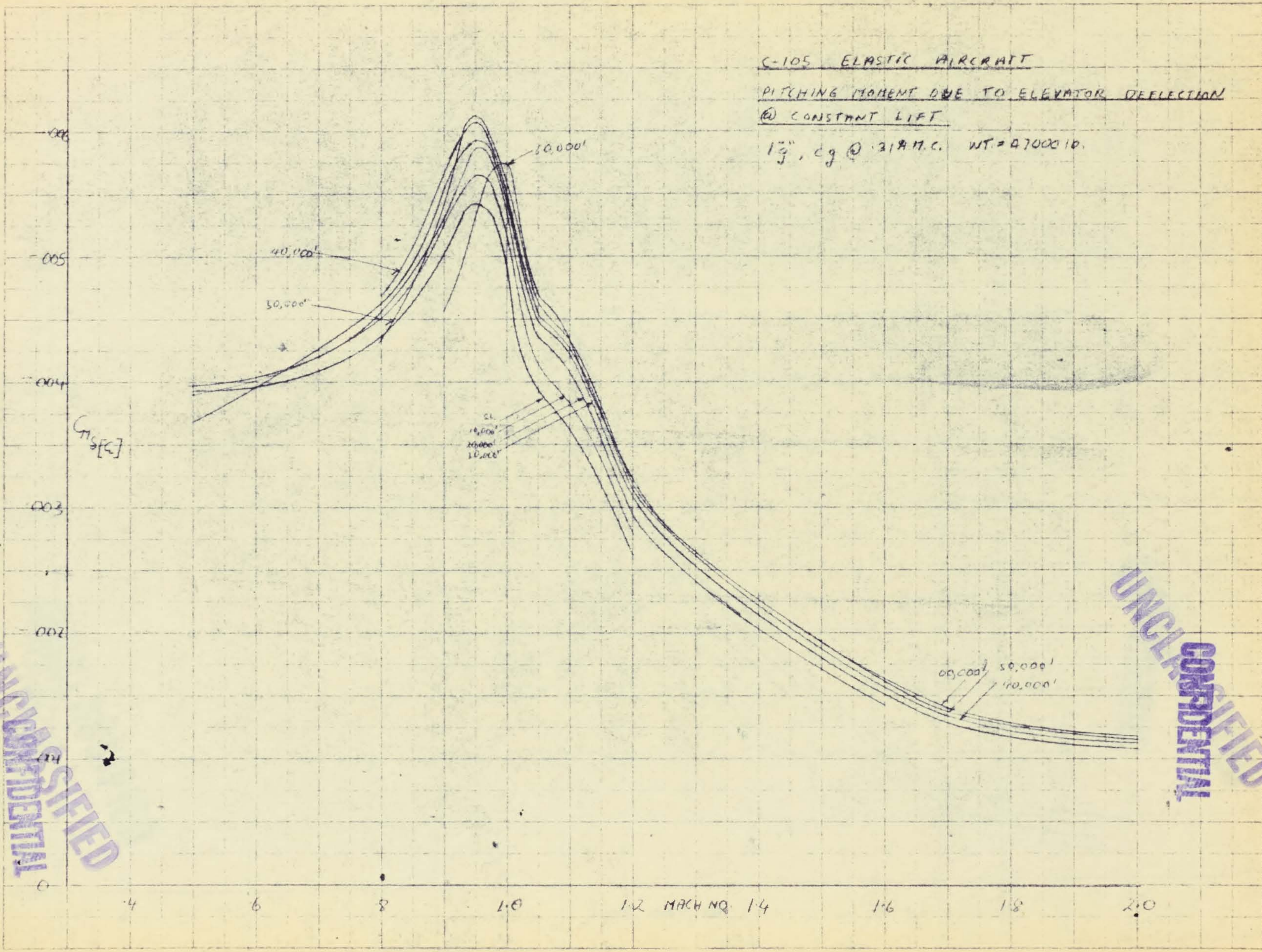
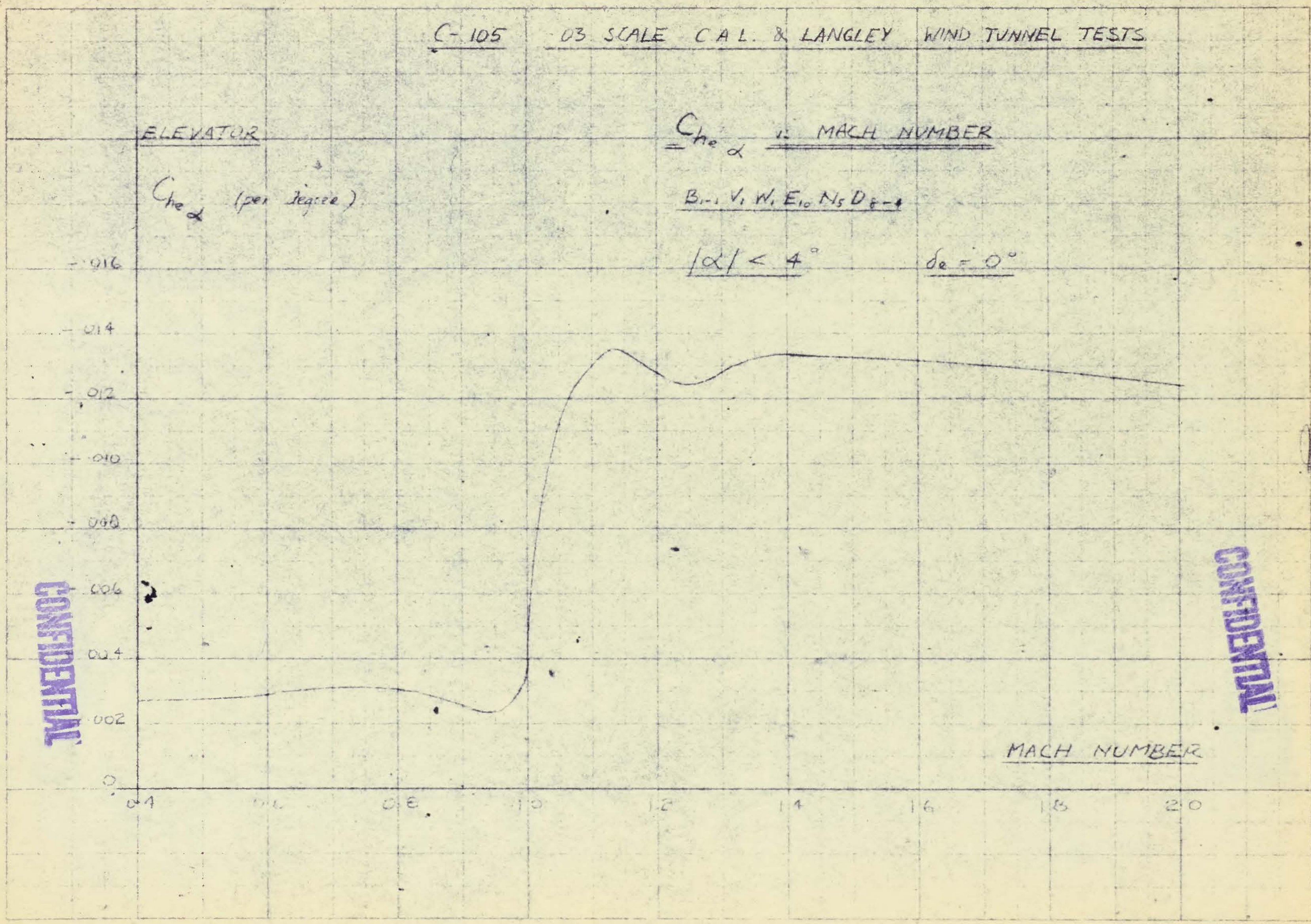
P/STAB/123

VB/1.12.56.

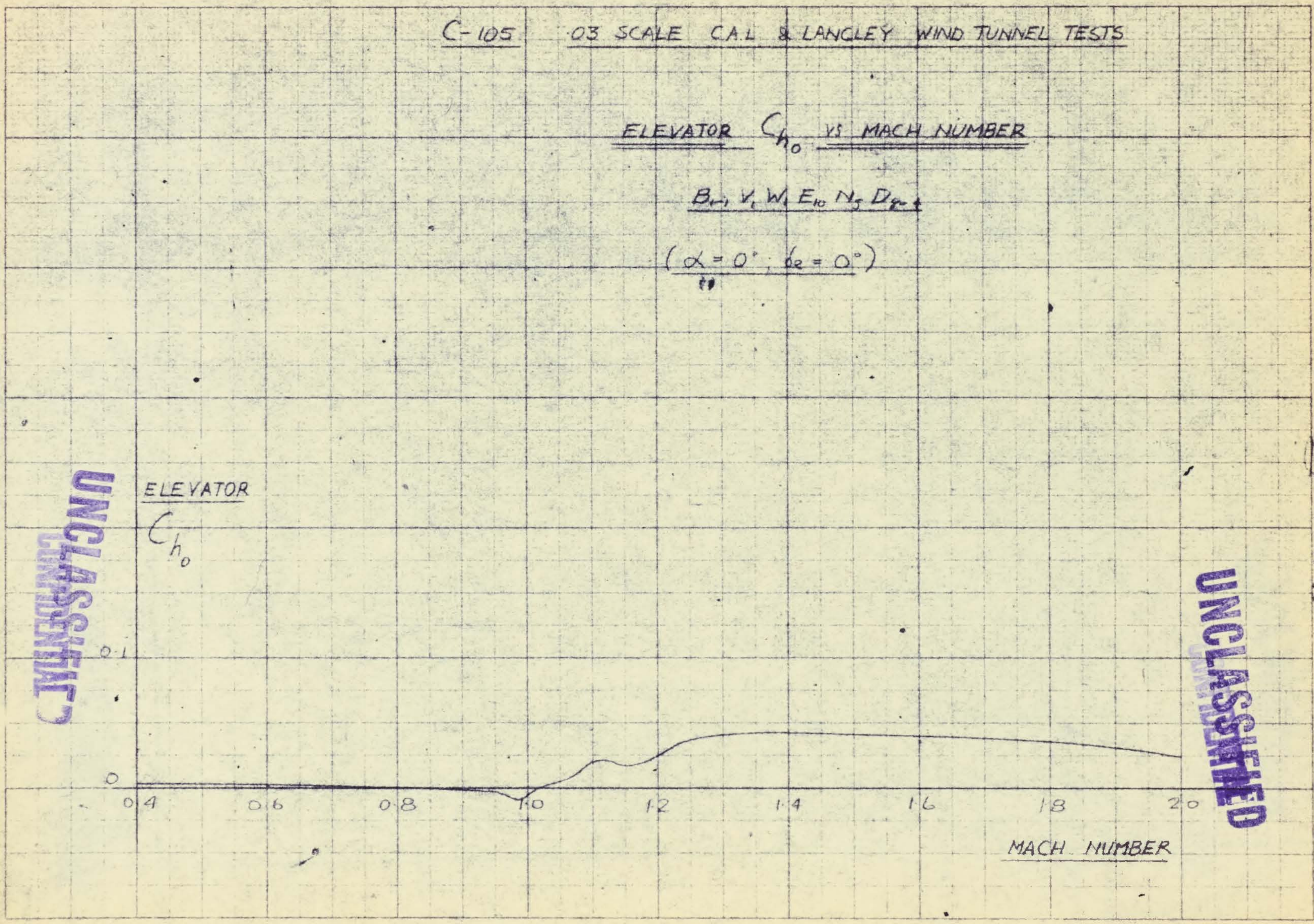


P/STAB/123

DRE 6 Nov 56


C-105 .03 SCALE C.A.L. & LANGLEY WIND TUNNEL TESTS
ELEVATOR
$C_{h_{e\alpha}}$ v. MACH NUMBER
$C_{h_{e\alpha}}$ (per degree)
$B_{1-1} V_1 W_1 E_{10} N_5 D_{8-4}$
$|\alpha| < 4°$
$\delta_e = 0°$
.016
.014
.012
.010
.008
.006
.004
.002
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NUMBER

DBC 7 NOV 56


C-105 .03 SCALE C.A.L & LANGLEY WIND TUNNEL TESTS
ELEVATOR C_{h_0} VS MACH NUMBER
$B_{-1}\ V_1\ W_1\ E_{10}\ N_5\ D_{g-4}$
$(\alpha = 0°;\ \delta_e = 0°)$
ELEVATOR
C_{h_0}
0.1
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NUMBER

P/AERO DATA/82 3.2
VB/11 30.56

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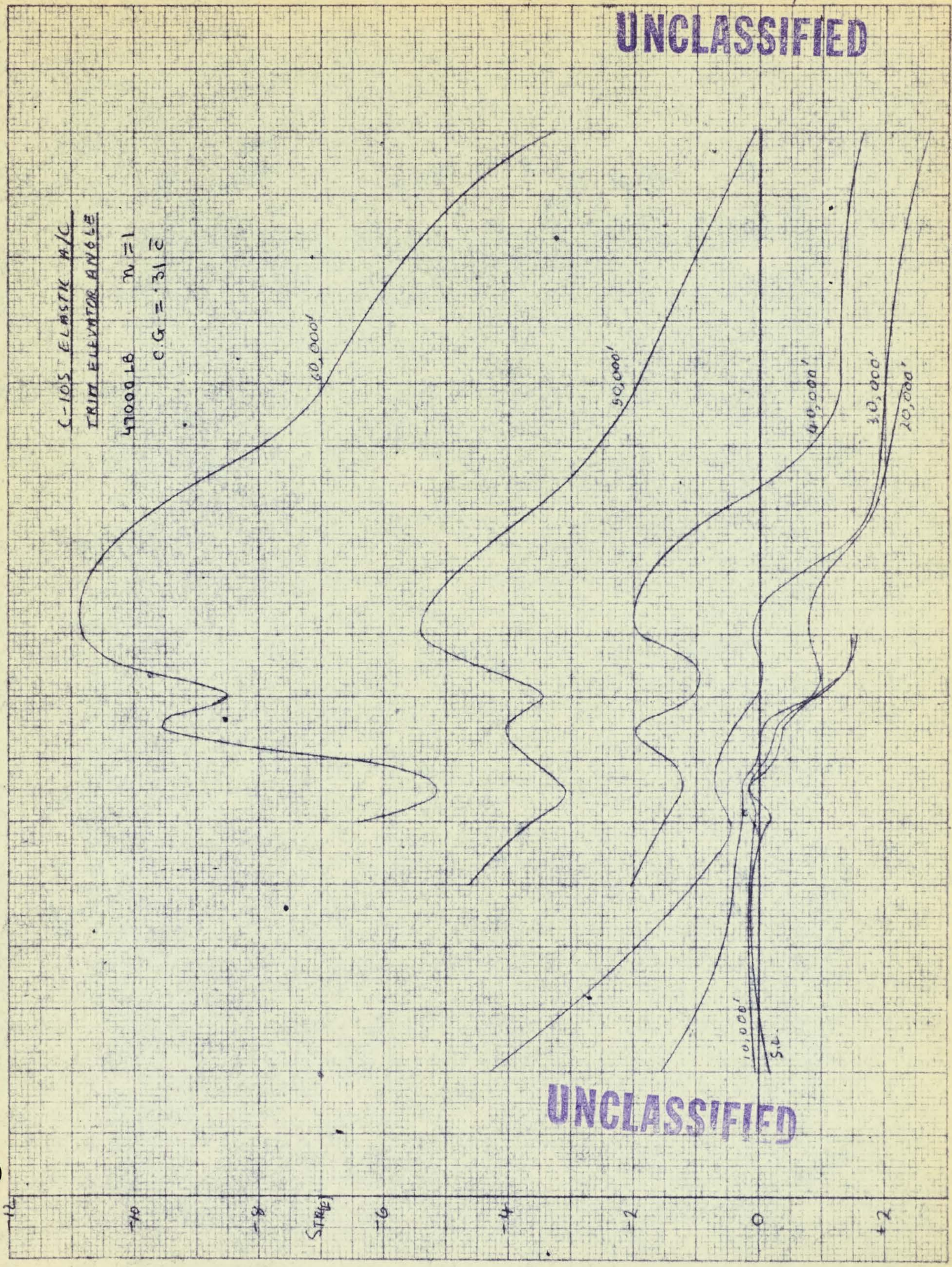

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