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CF-105

SECR

MONTHLY PERFORMANCE REPORT

NO. 4

UNCLASSIFIED

January 1956.

TO / A

DATE

Report no.: QC-AVRO CF105 MR-4

has been ☐ downgraded to:

☒ de-classified

by (Name): J.M.D. Henrie

(Dept.): DND Coordinate, Access to Information

Date: Aug 4, 1992

Renee Heuger
Signature

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

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PERFORMANCE

AIRCRAFT: CF-105

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CF-105 MONTHLY PERFORMANCE REPORT

(Issued Mid-Monthly)

This is Copy Number ....22.....

Issued to ......RCAF......

Date ......JAN/56......

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PREPARED BY DATE

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

FORM 1316A

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CF-105 MONTHLY PERFORMANCE REPORT - 4

PERFORMANCE

INTRODUCTION

This is the fourth of a series of monthly performance reports for internal usage, to be issued from the Aerodynamics Department.

Only the maximum performance in the stratosphere has been revised since the third report. The alterations are due to

- Revision of the trim drag estimate
- Revision of Orenda PS 13 maximum thrust estimate

The pertinent changes are noted in their appropriate sections.

A note on the effect of installing Sparrow II Missiles in place of Falcon missiles has been included as subsequent performance reports are to be based on the CF-105 with a sparrow missile pack.

Successive reports will present the latest data, with the alterations from the previous report noted. The report is divided into three major sections

1. CF-105 Performance

2. CF-105 Drag

3. Engine Data

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PERFORMANCE

PERFORMANCE NOTE ON THE

EFFECT OF INSTALLING SPARROW II MISSILES IN PLACE OF FALCONS

The latest weight and c.g. estimate (by no means finalized) for the CF-105 with 4 Sparrow II missiles submerged in the armament bay shows the following changes over that of the CF-105 carrying 8 fully submerged Falcons.

	Weight Increase	Fwd. Shift in C.G.
CF-105 - P.S. 13	1243 Lb.	1.09% M.A.C.
CF-105 - J-75	1243 Lb.	1.04% M.A.C.

The performance in this and previous Monthly Reports have been based on Falcon missile armament.

Based on the above data then, the CF-105 will suffer a 6% reduction in 'g' at 1.5 M.N. at 50,000 ft. on installing Sparrow Missiles. Subsequent Monthly Performance Reports will be based on Sparrow missile armament.

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PERFORMANCE

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1. CF-105 PERFORMANCE

The performance in this issue is sub-divided into two parts:

1A. CF-105 Performance with Pratt and Whittney JT4A-25 Engines

1B. CF-105 Performance with Orenda PS 13 Engines

1A: CF-105 PERFORMANCE WITH PRATT AND WHITNEY (J-75) JT 4A-25 ENGINES

(C.G. = 29% M.A.C.)

The following CF-105 - (J-75) JT 4A-25 performance estimate is based on the Wind Tunnel configuration designated $B_2V_1W_1E_{10}N_5D_{8-4}$ (except that the nose cone angle has been reduced to 30°). The particular feature of this configuration is the extended, notched and cambered leading edge of the wing.

The drag of this configuration is summarized (Extract P/Perf/112) and is presented in section 2 of this report. A more direct approach of estimating supersonic trim drag has been employed, resulting in reduced drag.

No revision has been made to the installed engine data.

Corrections for the above alteration has been applied directly to the maximum performance data in the stratosphere only. No revision has been made to the mission profiles.

The pertinent CF-105 Performance Changes are listed below:

Δ Combat 'g' at 1.50 M.N. at 50,000 feet	= + .09
Δ Maximum Speed at 50,000 feet	= + 3 knots
Δ Combat Ceiling at 1.50 M.N.	= + 1100 feet

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LOADING AND PERFORMANCE - 4

Performance Under N.A.C.A. Standard Atmospheric Conditions

To R.C.A.F. Specification AIR 7-4

(With 2 J-75 Engines)

WEIGHT:

Take-Off Weight with 15,356 Lb. Fuel (77.1% Max.)	Lb.	59,228
Operational Weight Empty	Lb.	43,872
Combat Weight (1/2 Fuel)	Lb.	51,550
Landing Weight (With Reserve Fuel + Missiles)	Lb.	44,390
Wing Loading at Normal Take-Off Weight	Lb./sq/Ft.	47.2
Power Loading at Normal Take-Off Weight	Lb./Lb. Thrust	1.60

SPEED

True Air Speed in Level Flight
At Sea Level at Combat Weight

Maximum Thrust	Kts.	* 755
Military Thrust	Kts.	640

True Air Speed in Level Flight
At 50,000 Ft. at Combat Weight

Maximum Thrust	Kts.	1,073

CEILING

Combat Ceiling at Combat Weight, Rate of Climb = 500 F.P.M.

Maximum Thrust at 1.5 M.N.	Ft.	56,600

RATE OF CLIMB

Steady Rate of Climb at Sea Level, Combat Weight

Maximum Thrust at M.N. = .92	F.P.M.	51,400
Military Thrust at 530 Kts.	F.P.M.	15,800

Steady Rate of Climb at 50,000 Ft., Combat Weight

Maximum Thrust at M.N. = 1.5	F.P.M.	6,100

TIME TO HEIGHT

Time to 50,000 Ft. M.N. = 1.5 from Engine Start at Take-Off
Weight = 59,228

Maximum Thrust	Mins.	4.9

MANOEUVRABILITY

Combat Load Factor at Combat Weight
Maximum Thrust at M.N. = 1.50 at 50,000 Ft. 1.48

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* Placard Speed = 720 Kts.

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TAKE-OFF DISTANCE

Take-Off Distance over 50 Ft. Obstacle at Sea Level
Take-Off Weight = 59,228 Lb.

Maximum Thrust	Ft.	3,400
Military Thrust	Ft.	6,700
Maximum Thrust, Hot Day	Ft.	4,600

LANDING DISTANCE

Landing Distance over 50 Ft. Obstacle at Sea Level at Combat Wt.	Ft.	5,300

STALLING SEPPED

True Stalling Speed in Landing Configuration at Combat Weight at Sea Level	Kts.	110

RANGE

Combat Radius of Action at 50,000 Ft., Climb at M.N. = .92, Cruise out at M.N. = 1.5, Combat for 5 Mins. at M.N. = 1.50, Cruise Back at M.N. = .92, 15 Min. Stack at 40,000 Ft., 5 Min. Fuel Reserve on Landing

High Speed Mission with 15,356 Lb. Fuel	N.M.	200
High Speed Mission with Full Internal Fuel	N.M.	309

Combat Radius of Action at 50,000 Ft., Mission as above except climb at 530 Kts. and cruise out at M.N. = .92

Maximum Range Mission with 15,298 Lb. Fuel	N.M.	406
Maximum Range Mission with Full Internal Fuel	N.M.	605

Combat Radius of Action at Sea Level, Cruise out at .6 M.N. and Combat at M.N. = .92 at Sea Level, Cruise Back at .92 M.N. at 40,000 Ft., 15 Min. Stack, 5 Min. Fuel Reserve on Landing

Sea Level Mission with 15,356 Lb. of Fuel	N.M.	325
Sea Level Mission with Full Internal Fuel	N.M.	470

Ferry Range Mission at Economical Cruise Speed (M = .92 and Height, including 15 Mins. Stacking at 40,000 Ft., 5 Min. Fuel Reserve on Landing

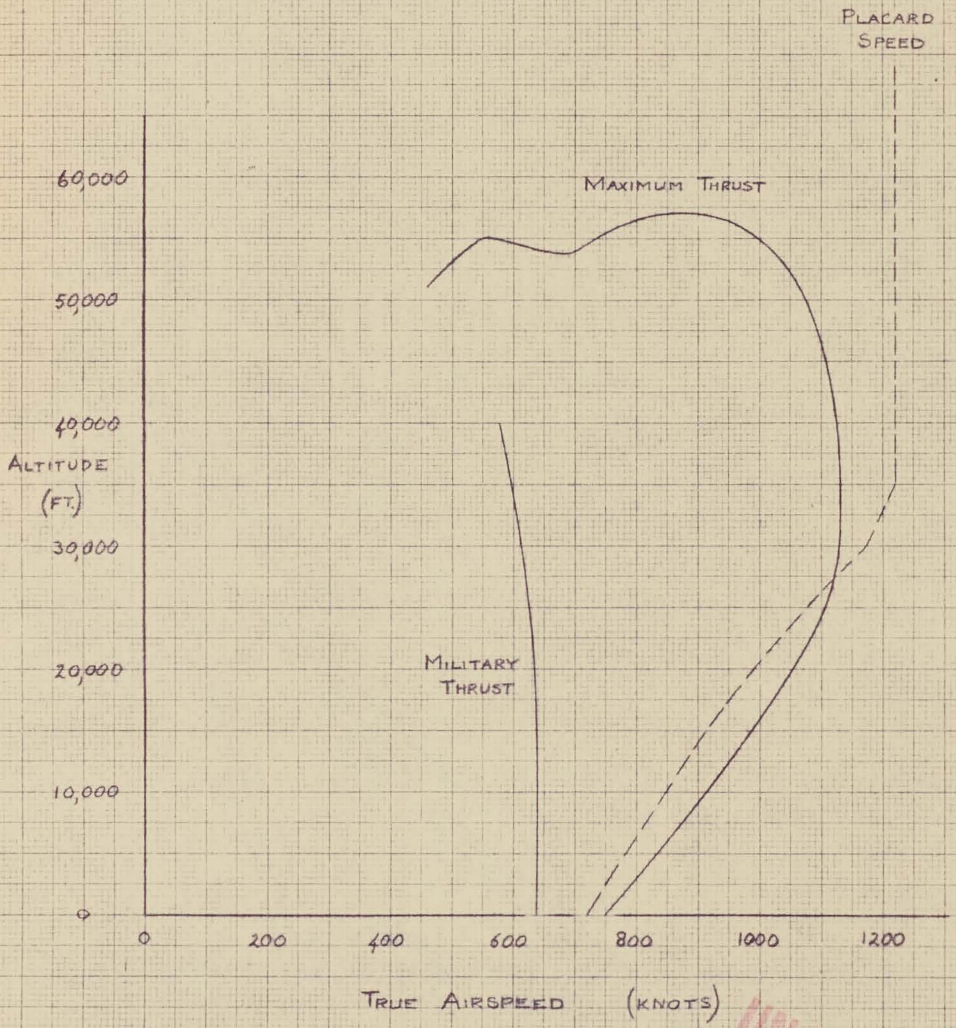
Range with Full Internal Fuel and 500 Gal. - External Tank .	N.M.	1,859
Range with Full Internal Fuel	N.M.	1,609

P/PERF/112

C105

J75 ENGINES

LEVEL FLIGHT TRUE AIRSPEED
COMBAT WT.



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January 1956.

1B: CF-105 PERFORMANCE WITH ORENDA PS 13 ENGINES

(C.G. = 29% M.A.C.)

The following CF-105 - PS 13 performance estimate is based on the Wind Tunnel configuration designated $B_2V_1W_1E_{10}N_5D_{8-4}$ (except that the nose cone angle has been reduced to 30°). The particular feature of this configuration is the extended, notched and cambered leading edge of the wing.

The drag of this configuration is summarized (Extract P/Perf/112) and is presented in section 2 of this report. A more direct approach of estimating supersonic trim drag has been employed, resulting in reduced drag.

The installed stratosphere thrust of the PS 13 with maximum afterburning has been re-estimated using the latest non-dimensional curves.

Corrections for the above alterations have been applied directly to the maximum performance data in the stratosphere only. No revision has been made to the mission profiles.

The pertinent CF-105 performance changes are listed below:

Δ Combat 'g' at 1.5 M.N. at 50,000 feet	=	+ .15
Δ Maximum Speed at 50,000 feet	=	+ 30 knots
Δ Combat Ceiling at 1.5 M.N.	=	+ 1800 feet

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LOADING AND PERFORMANCE - 4

P/PERF/112

January 1956.

Performance Under N.A.C.A. Standard Atmospheric Conditions

To R.C.A.F. Specification AIR 7-4

With Two PS 13 Engines

IGHT:

Take-Off Weight with 15,510 Lb. Fuel (78.2% Max)	Lb.	55,889
Operational Weight Empty	Lb.	40,379
Combat Weight (1/2 Fuel)	Lb.	48,130
Landing Weight (With Reserve Fuel + Missile)	Lb.	42,200
Wing Loading at Normal Take-off Weight	Lb./Sq.Ft.	44.5
Power Loading at Normal Take-off Weight	Lb./Lb. Thrust.	1.19

PEED

True Air Speed in Level Flight At Sea Level at Combat Weight Maximum Thrust	Kts.	* 720
Military Thrust	Kts.	650
True Air Speed in Level Flight At 50,000 Ft. at Combat Weight Maximum Thrust	Kts.	1,140

CEILING

Combat Ceiling at Combat Weight, Rate of Climb = 500 F.P.M. Maximum Thrust at 1.5 M.N.	Ft.	64,000

RATE OF CLIMB

Steady Rate of Climb at Sea Level, Combat Weight Maximum Thrust at M.N. = .92	F.P.M.	50,000
Military Thrust at 530 Kts.	F.P.M.	25,200
Steady Rate of Climb at 50,000 Ft., Combat Weight Maximum Thrust at M.N. = 1.5	F.P.M.	15,000

TIME TO HEIGHT

Time to 50,000 Ft. M.N. = 1.5 from Engine Start at Take-Off Weight = 55,889 Lb. Maximum Thrust	Mins.	4.0

MANOEUVRABILITY

Combat Load Factor at Combat Weight Maximum Thrust at M.N. = 1.50 at 50,000 Ft.		1.99

* Placard Speed = 720 Kts.

TAKE-OFF DISTANCE

Take-Off Distance over 50 Ft. Obstacel at Sea Level ....
Take-Off Weight = 55,889 Lb.

Maximum Thrust	Ft.	2,500
Military Thrust	Ft.	3,800
Maximum Thrust Hot Day	Ft.	3,300

LANDING DISTANCE

Landing Distance over 50 Ft. Obstacle at Sea Level at Combat Weight Ft. 5,000

STALLING SPEED

True Stalling Speed in Landing Configuration at Combat Weight at Sea Level .... Kts. 105

RANGE

Combat Radius of Action at 50,000 Ft., Climb at M.N. = .92, Cruise out at M.N. = 1.5, Combat for 5 mins. at M.N. = 1.50, Cruise Back at M.N. = .92, 15 Min. Stack at 40,000 Ft.,5Min. Fuel Reserve on Landing

High Speed Mission with 15,510 Lb. Fuel	N.M.	200
High Speed Mission with Full Internal Fuel	N.M.	318

Combat Radius of Action at 50,000 Ft. Mission as above except Cruise Out at M.N. = .92

Maximum Range Mission with 15,510 Lb. Fuel	N.M.	315
Maximum Range Mission with Full Internal Fuel	N.M.	491

Combat Radius of Action at Sea Level, Cruise Out at .6 M.N. and Combat at M.N. = .92 at Sea Level, Cruise Back at .92 M.N. at 40,000 Ft., 15 Min. Stack, 5 Min. Fuel Reserve on Landing

Sea Level Mission with 15,510 Lb. of Fuel	N.M.	217
Sea Level Mission with Full Internal Fuel	N.M.	318

Ferry Range Mission at Economical Cruise Speed (M = .92 and Height, including 15 Mins. Stacking at 40,000 Ft., 5 Min. Fuel Reserve on Landing

Range with Full Internal Fuel and 500 Gal. - External Tank.	N.M.	1,675

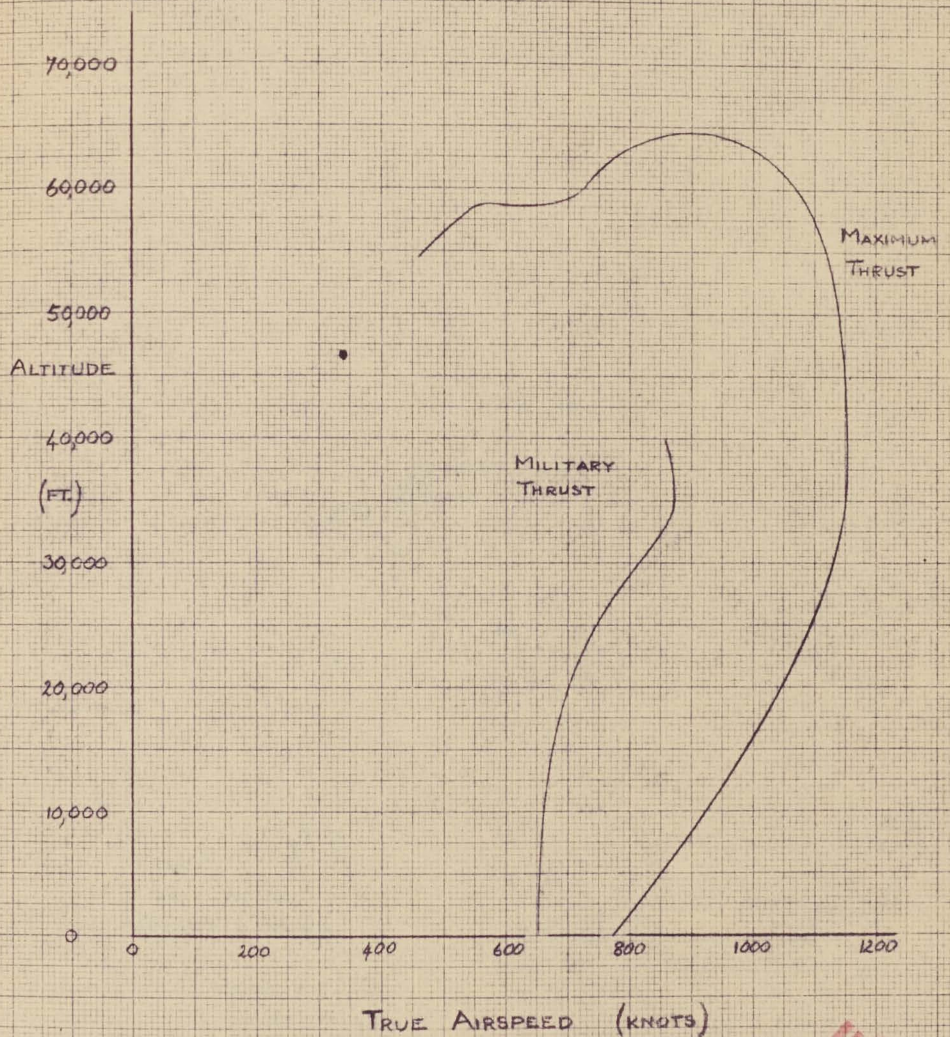
P/PERF/112

C 105

PS 13 ENGINES

LEVEL FLIGHT TRUE AIRSPEED

COMBAT WT.



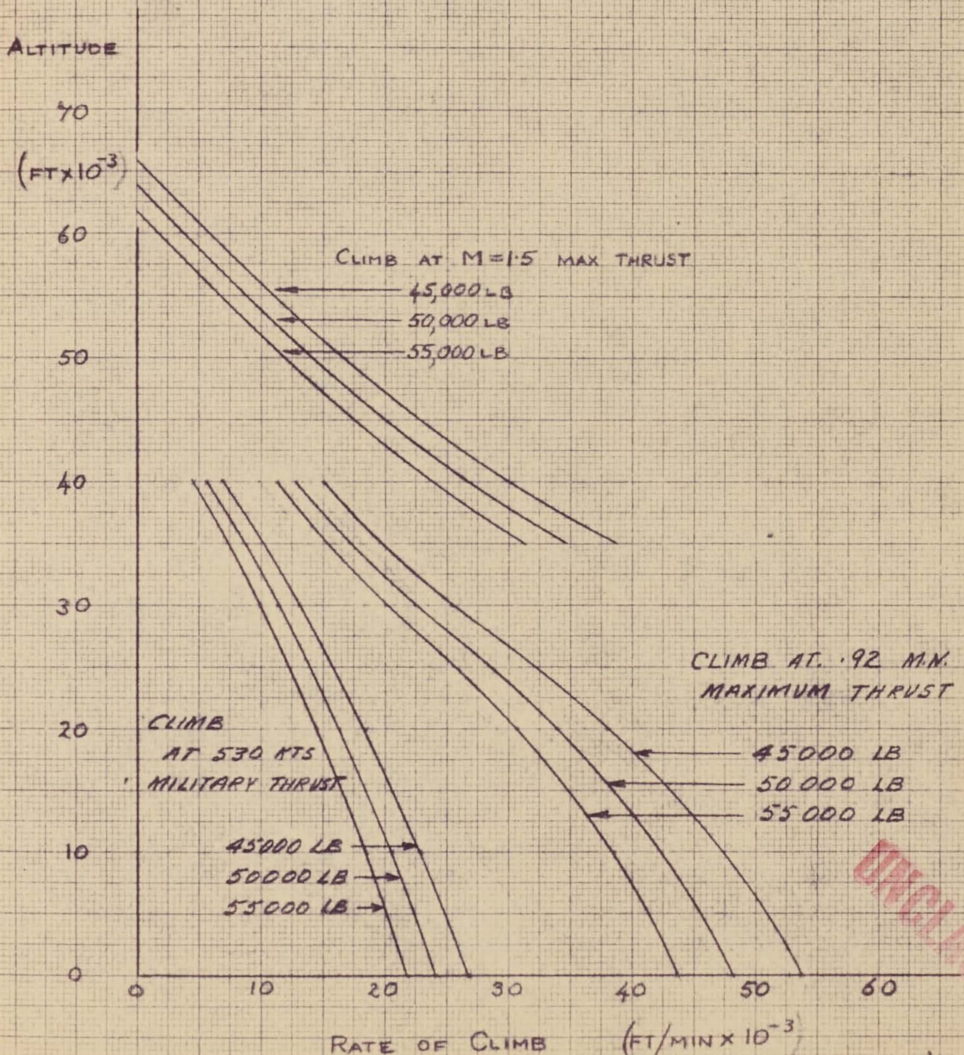
JAN 56
J. DUBBURY.

DRAG

C 105

PS 13 ENGINES

RATE OF CLIMB (STEADY STATE)



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J. DUBBURY.

DRAG

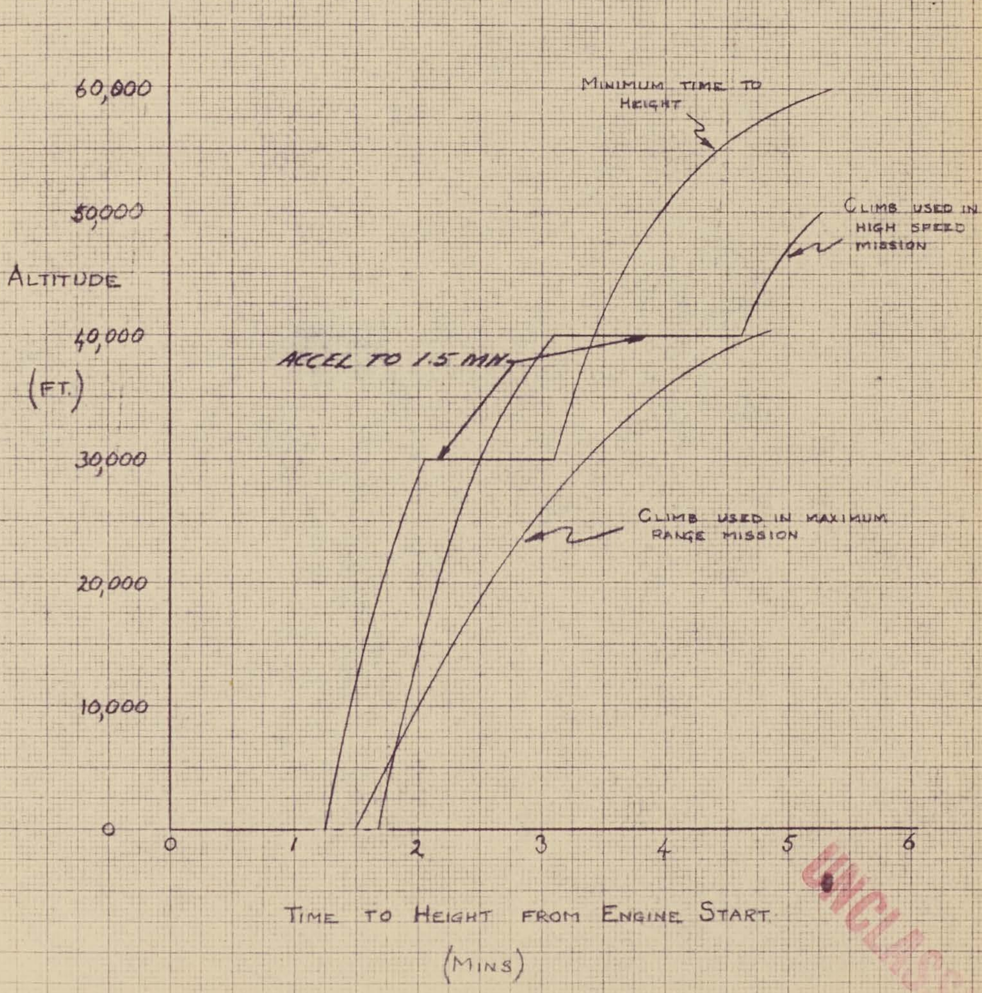
P/PERF/112

C 105

PS 13 ENGINES

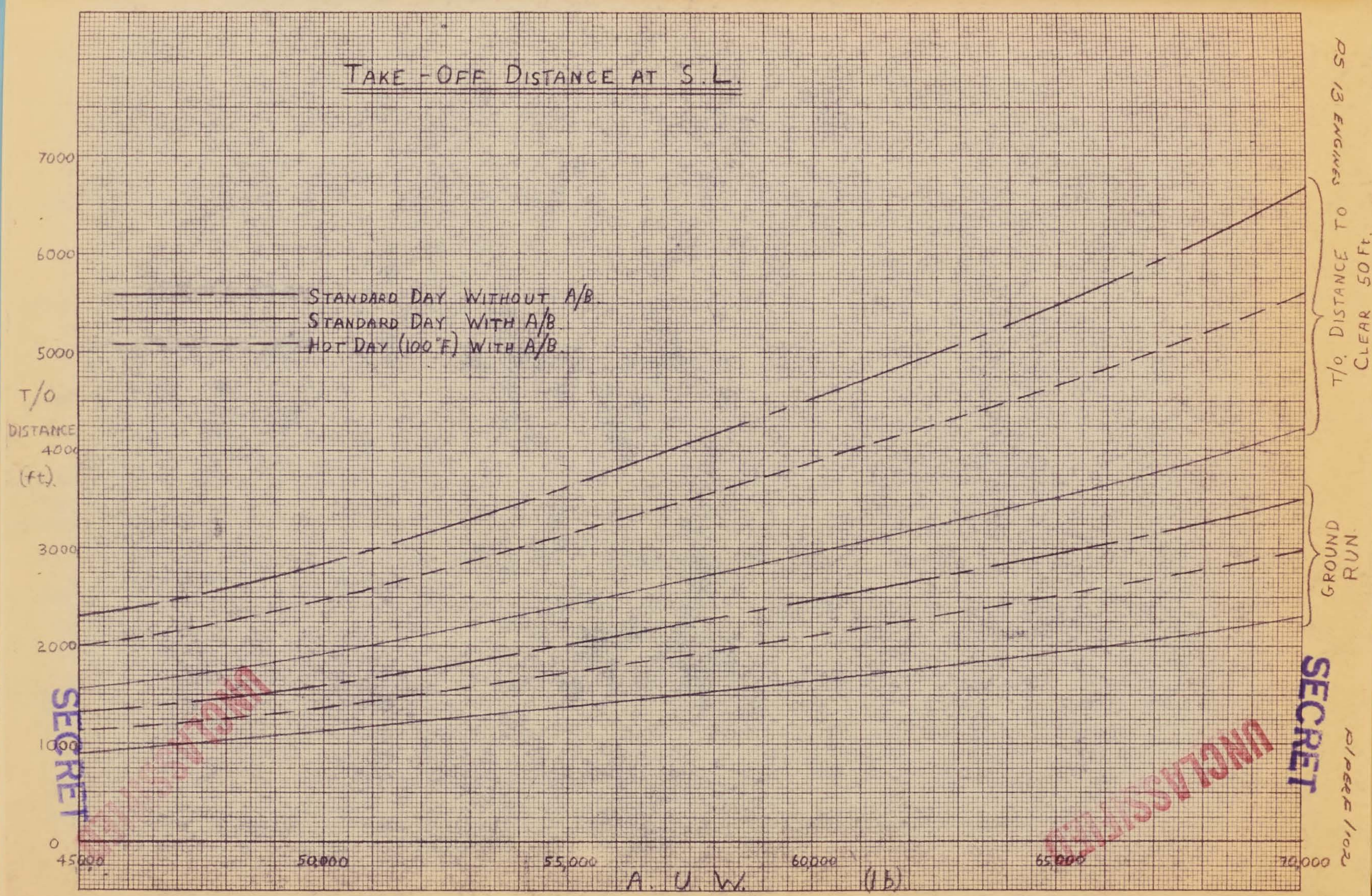
TIME TO HEIGHT

TAKE OFF WEIGHT



DRAG

JAN 66
J. DUBBURY

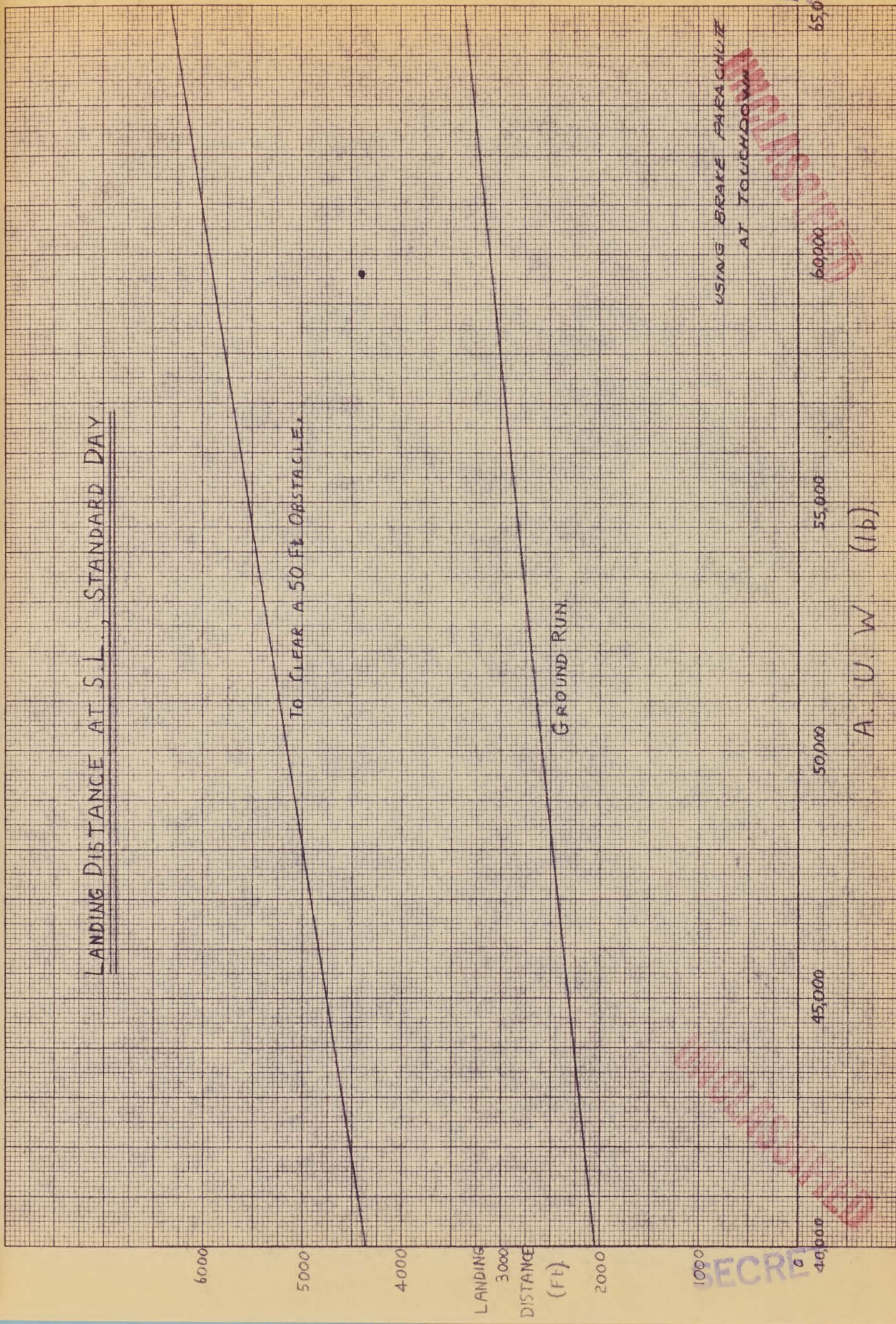


TAKE-OFF DISTANCE AT S.L.
STANDARD DAY WITHOUT A/B.
STANDARD DAY WITH A/B.
HOT DAY (100°F) WITH A/B.
T/O DISTANCE (ft).
7000
6000
5000
4000
3000
2000
1000
0
45,000
50,000
55,000
60,000
65,000
70,000
A. U. W. (lb)
T/O. DISTANCE TO CLEAR 50 Ft.
GROUND RUN.
PS 13 ENGINES
R/PERF/102
SECRET
UNCLASSIFIED

DRAG

RS 13 ENGINES

PIPER F/102



DRAG

DRAG

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SECRET Extract P/Perf/112

January 1956.

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CF-105 DRAG NOTE

This extract contains the latest CF-105 drag data used for performance estimations. The particular feature of this configuration is the extended, notched, and cambered leading edge of the wing, and can be identified by the wind tunnel designation $B_2V_1W_1E_{10}N_5D_{8-4}$ except that the nose cone angle has been reduced to 30°.

The supersonic $C_{D_{Min}}$ has been anchored by the selection of $C_{D_{Min}} = .02$ at 1.5 M.N. This is based on the first CF-105 free flight model test and 'area rule' estimate. Similarly, the subsonic value is based on the free flight model test and estimates.

The drag due to lift, including elevator drag to trim, has been obtained (up to 1.23 M.N.) from C.A.L. Wind Tunnel Project No. W.A.844-DD3 results. The model was .04 scale, the Mach number range was from .5 M.N. to 1.23 M.N. with the corresponding Reynolds' number range going from 1.6 to 2.5 x 10^6. No allowance has been made for scale effect.

At Mach numbers greater than 1.23, the drag coefficients have been extrapolated where possible by data from N.A.C.A. reports. Of particular interest is the method of estimating trim drags at supersonic speeds. A preliminary note (extract P/Perf/114) on this subject is included in this report following the drag curves.

The subsonic drags are unaltered from that given in Monthly Report No. 1. However, the supersonic drag is now determined from -

$$D/P = 126800M^2 \left/ \left(\left\{ C_{D_{Min}} + \frac{\left(C_{L_A} - C_{L_{C_{D_{Min}}}}\right)^2}{\pi \, ARe} \right\}_{\delta=0} + \left\{ \left(\frac{K_2}{a_2} - \frac{2K_2}{a_1} + \frac{1}{\pi ARe} \right) \left(a_2 \delta \right)^2 + \left(\frac{K_2}{a_1} - \frac{1}{\pi ARe} \right)^2 \left(C_{L_A} - C_{L_{C_{D_{Min}}}} \right) a_2 \delta \right\}_{\text{Trim Drag}} \right) \right.$$

$$\text{and } -K\delta = \frac{C_{L_A}\left(h - a.c.\right) + C_{M_o}}{C_{M_{\delta C_L}}}$$

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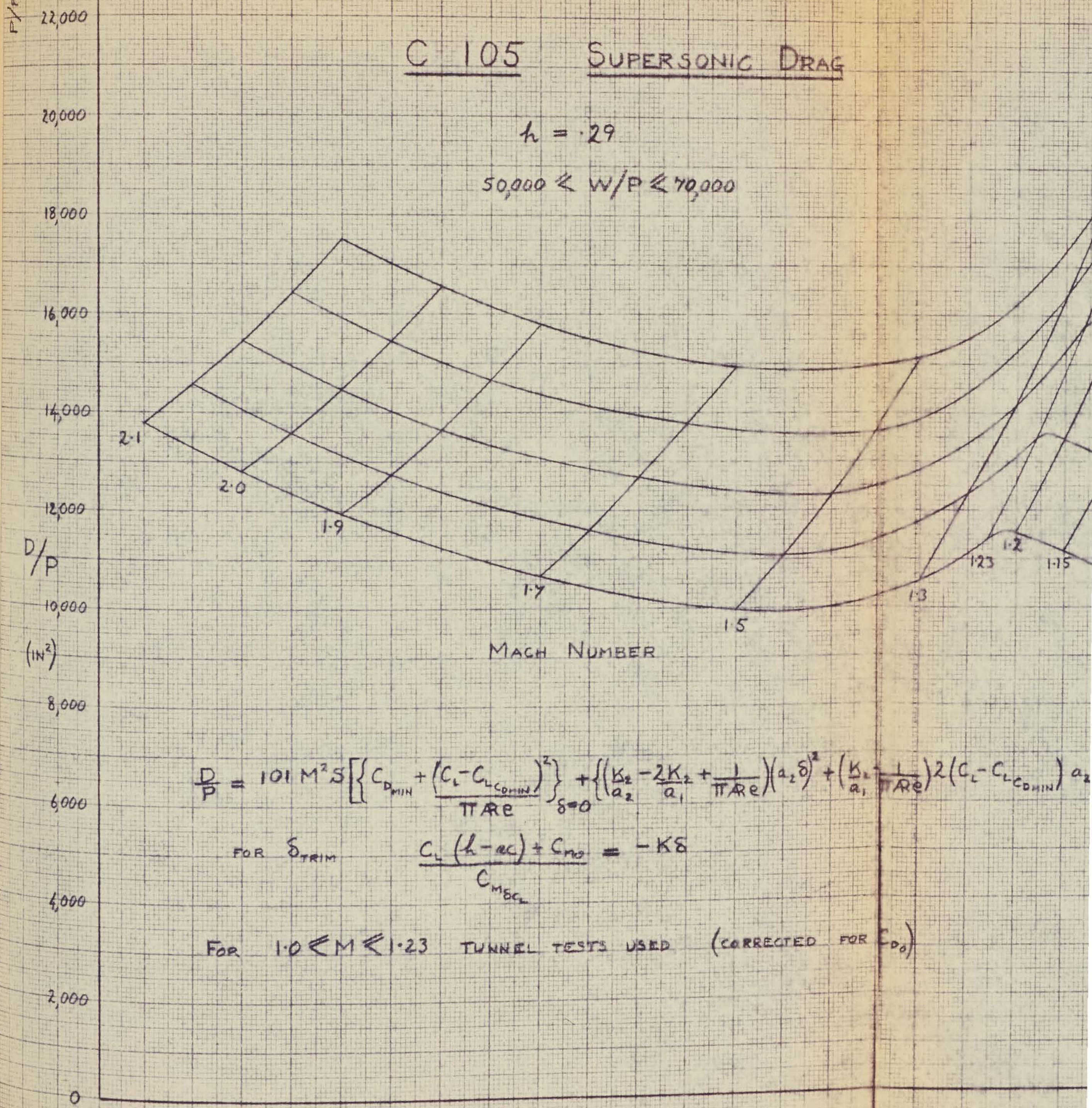
Where -

D	-	Total Drag - Lb.
P	-	Ambient Pressure - Lb./Sq.In.
M	-	Mach Number
$C_{D_{Min}}$	-	Minimum Drag Coefficient
C_{L_A}	-	Aircraft Lift Coefficient
$C_{L_{C_{D_{Min}}}}$	-	Lift coefficient at $C_{D_{Min}}$
e	-	Aerodynamic Drag Efficiency Factor ($\delta = 0$)
AR	-	Aspect Ratio (1.995)
a_2	-	$\partial C_{LA}/\partial \delta$
a_1	-	$\partial C_{LA}/\partial \alpha$
δ	-	Control Angle
α	-	Angle of attack
h	-	Centre of Gravity % M.A.C.
a.c.	-	Aerodynamic centre % M.A.C.
C_{M_o}	-	Pitching moment coefficient at $C_L = 0$, $\delta = 0$
C_{M_δ}	-	Elevator Pitching Effectiveness at constant C_L
K	-	Non-linearity factor for C_{M_δ}
K_2	-	Lift increment on control/lift increment on wing (see Extract P/Perf/114)

C 105 SUPERSONIC DRAG

$h = \cdot 29$

$50{,}000 \leqslant W/P \leqslant 70{,}000$



$$\frac{D}{P} = 101\, M^2 S \left[\left\{ C_{D_{MIN}} + \frac{\left(C_L - C_{L_{C_{DMIN}}}\right)^2}{\pi A\!R e} \right\}_{\delta=0} + \left\{ \left(\frac{K_2}{a_2} - \frac{2K_2}{a_1} + \frac{1}{\pi A\!R e} \right) (a_2 \delta)^2 + \left(\frac{K_2}{a_1} - \frac{1}{\pi A\!R e} \right) 2 \left(C_L - C_{L_{C_{DMIN}}} \right) a_2 \right.$$

FOR δ_{TRIM} $\quad \dfrac{C_L (h - ac) + C_{m_0}}{C_{M_{\delta C_L}}} = -K\delta$

FOR $1{\cdot}0 \leqslant M \leqslant 1{\cdot}23$ TUNNEL TESTS USED (CORRECTED FOR C_{D_0})

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C 105

P/PERF/1/2

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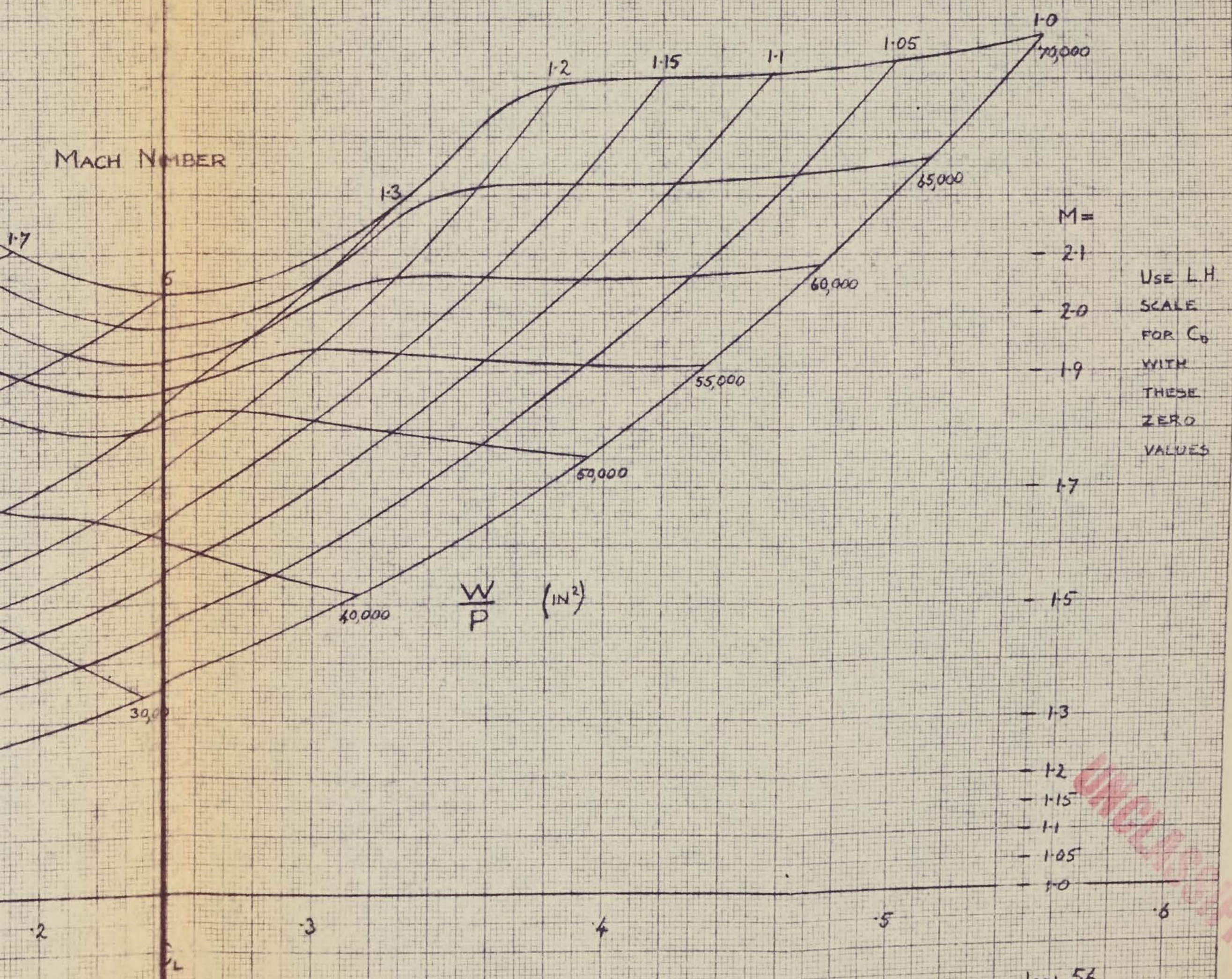
~ C_L RELATIONSHIPS FOR $h = \cdot 29$



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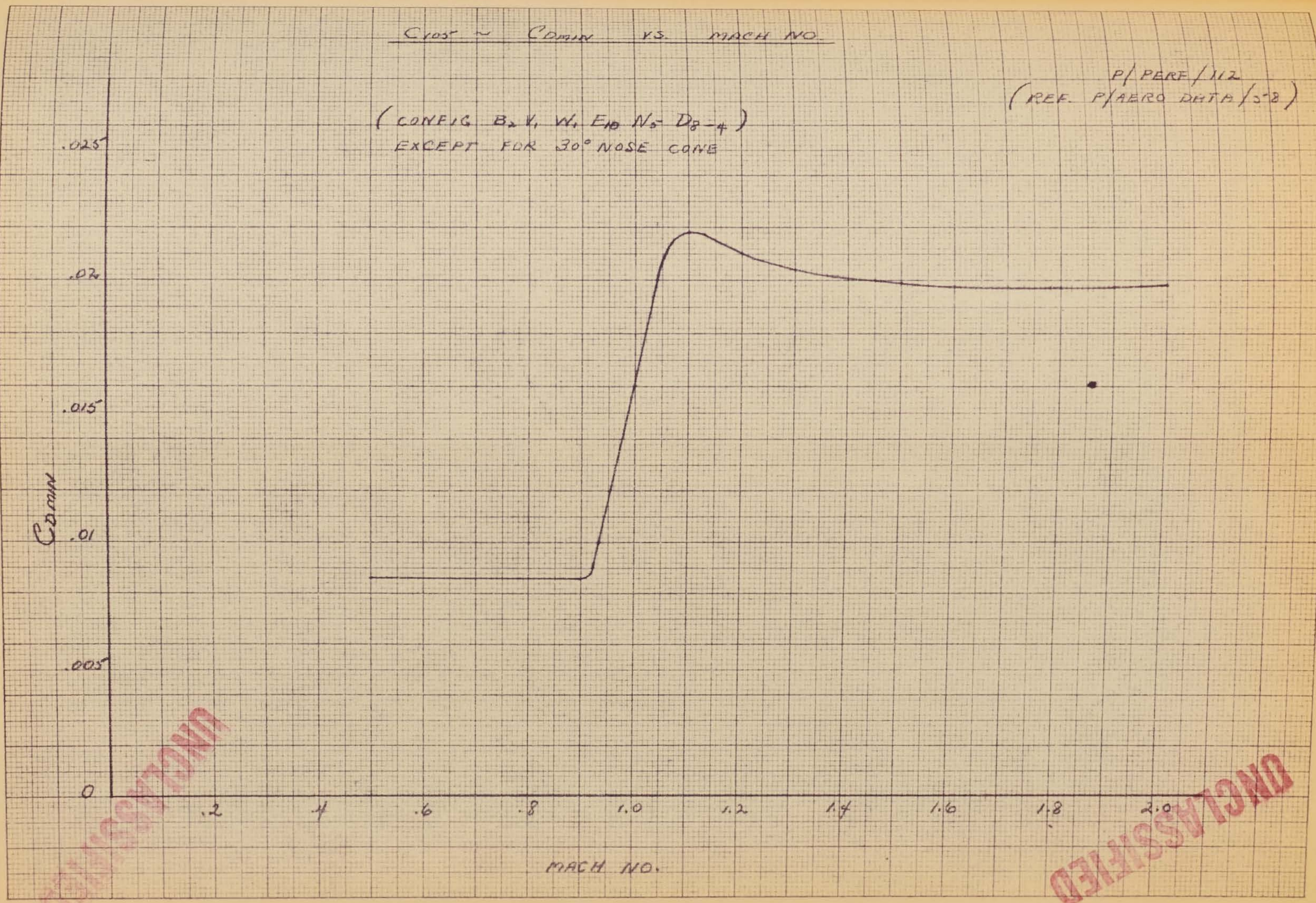

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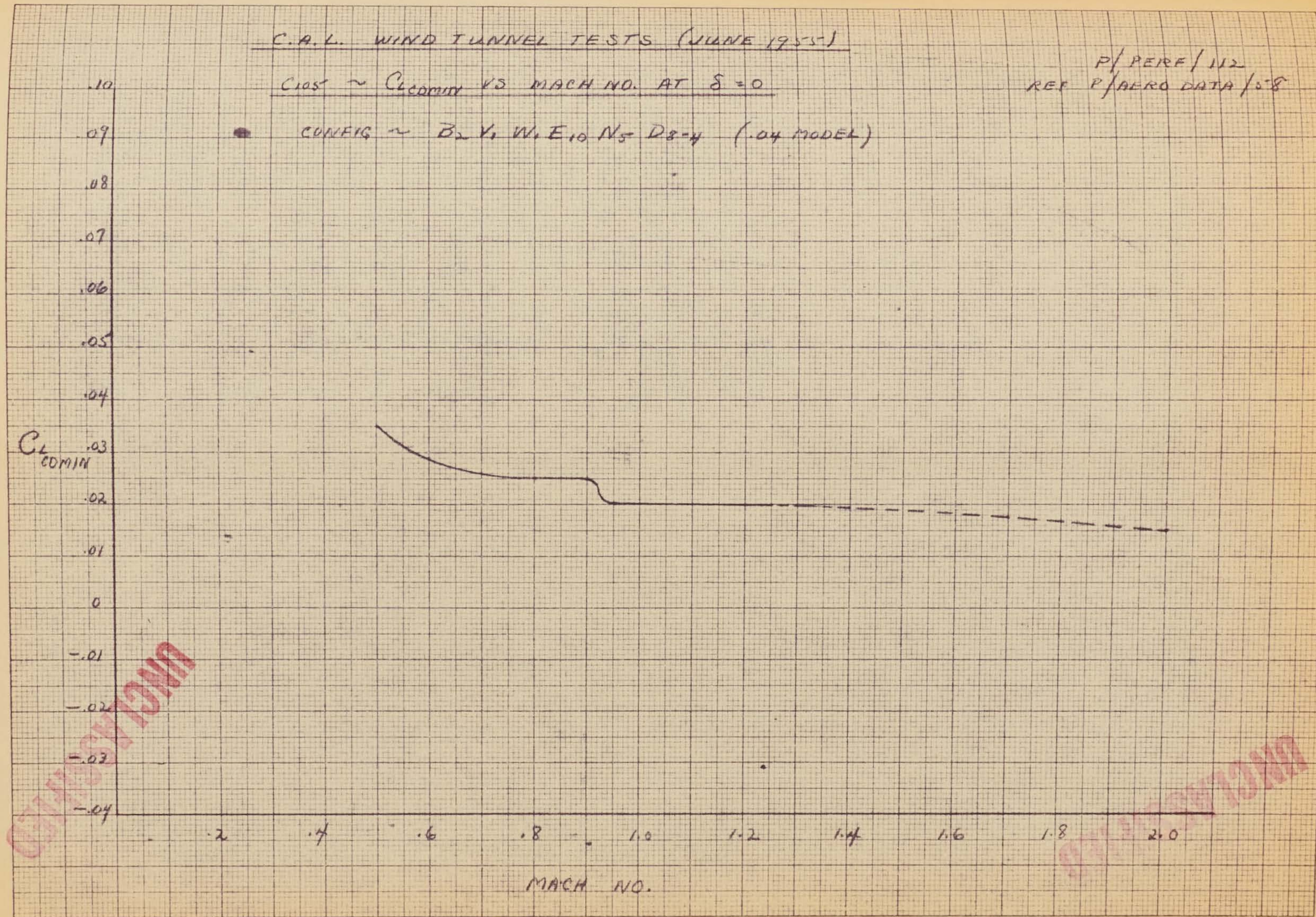
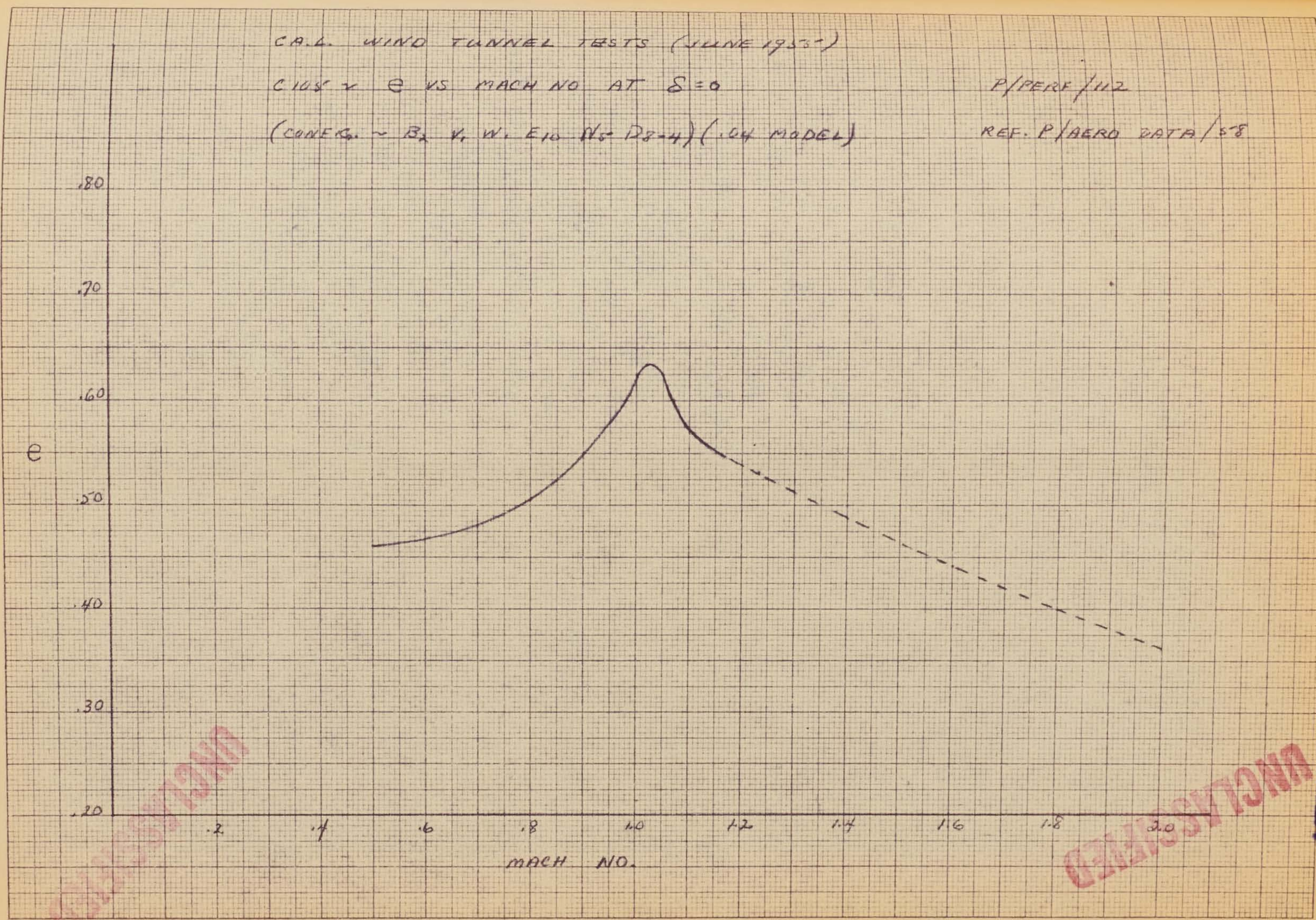
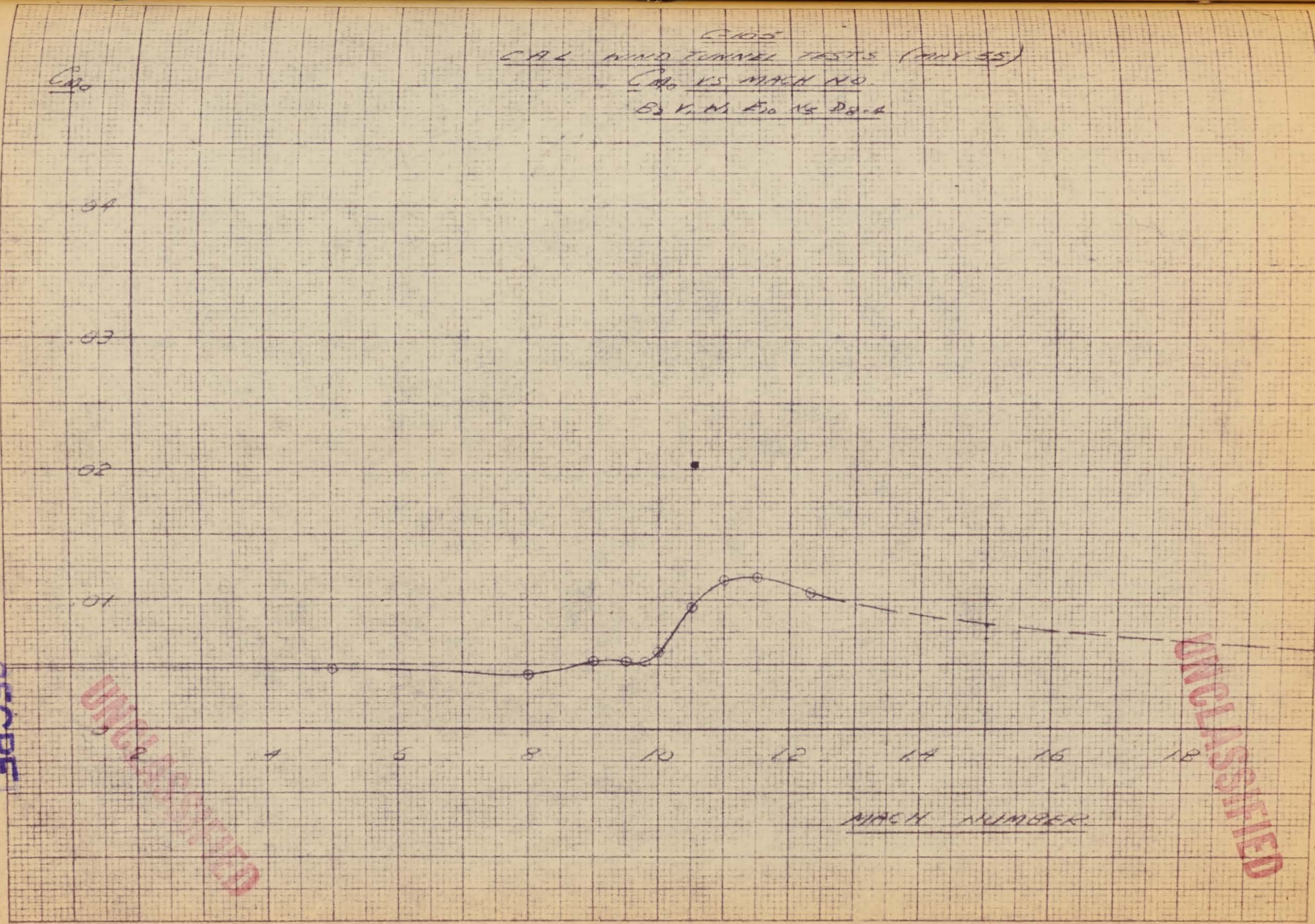
ENGINE


C.A.L. WIND TUNNEL TESTS (JUNE 1955)
C105 ~ $C_{L_{COMIN}}$ VS MACH NO. AT δ = 0
P/PERF/112
REF P/AERO DATA/0.8
CONFIG ~ $B_2 V_1 W_1 E_{10} N_5 D_{8-4}$ (.04 MODEL)
$C_{L_{COMIN}}$
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
-.01
-.02
-.03
-.04
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NO.

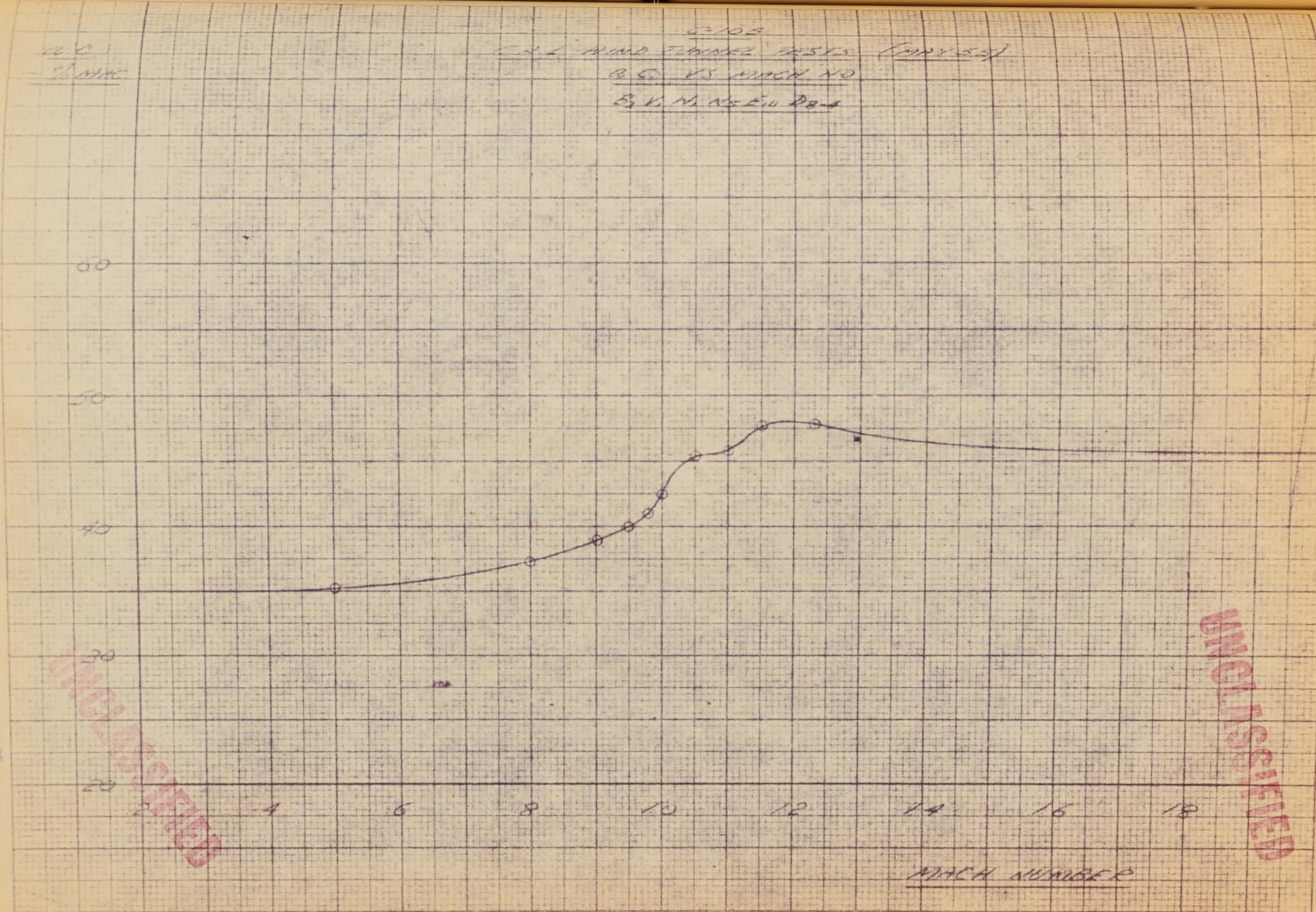
ENGINE

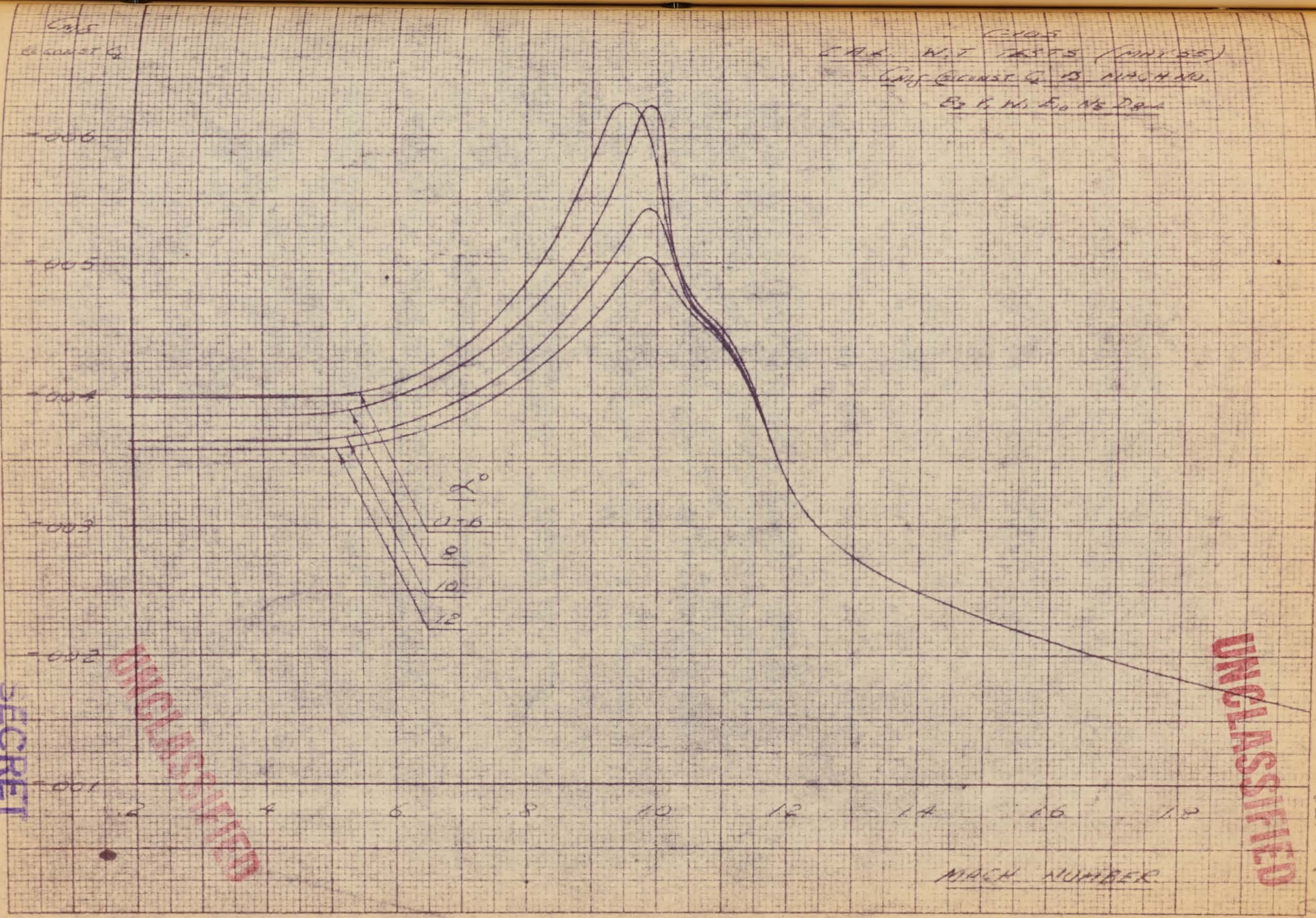

C.A.L. WIND TUNNEL TESTS (JUNE 1955)
C105 ~ e VS MACH NO AT δ=0
(CONFIG. ~ B2 V1 W1 E10 N5 D8-4)(.04 MODEL)
P/PERF/112
REF. P/AERO DATA/58
e
.80
.70
.60
.50
.40
.30
.20
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NO.

MAY 55
CLARK



ENGINE


C-105
C.A.L. WIND TUNNEL TESTS (MAY 55)
A.C. VS MACH NO
A.C.
% MAC
60
50
40
30
20
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
MACH NUMBER


C105
C.A.L. W.T. TESTS (MAY 55)
MACH NUMBER
.001
.002
.003
.004
.005
.006
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
0-6
8
10
12

AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT		REPORT No	P/Performance/114
CF-105		SHEET No	1
		PREPARED BY	DATE
		J. Morris	Jan. '56
		CHECKED BY	DATE

PRELIMINARY NOTE ON A METHOD OF

ESTIMATING TRIM DRAG AT SUPERSONIC SPEEDS

It can easily be shown that the theoretical drag, at supersonic speeds, of a two dimensional airfoil with a control surface is as follows:-

$$C_D = C_{D_o} + \frac{\partial C_D}{\partial \alpha^2} \alpha^2 + \frac{\partial C_D}{\partial (\delta+\alpha)^2} \delta^2 + \frac{\partial C_D}{\partial (\delta+\alpha)^2} 2\delta\alpha \qquad (1)$$

Obviously, the equation will have a similar form in the three dimensional case.

The first thing to establish is that the equation has the right form when compared with experimental results. The data of RM A52L04 has been used to make this comparison and is presented in Figures 1 and 2. It can be seen that the equation compares very well with the experimental data up to $\alpha = 12^o$ & $\delta = -15^o$; above $\delta = -15^o$, the experimental drags are lower than the equation would predict.

The object of this note is to devise a method of estimating $\frac{\partial C_D}{\partial (\delta+\alpha)^2}$.

In the theoretical two dimensional case, the drag of the control surface is equal to the component of the normal force on the control in the flight direction, i.e.

$$\Delta C_{D_c} = \Delta C_{L_c} (\delta + \alpha) \cos\theta \text{ to the first order}$$

where $-\Delta C_{L_c}$ is the lift on the control divided by qc and θ is the control leading edge sweep.

and $$\Delta C_{D_c} = \frac{\partial C_L}{\partial \delta} (\delta + \alpha)^2 \cos\theta = a_2 (\delta + \alpha)^2 \cos\theta$$

$$\frac{\partial C_D}{\partial (\delta+\alpha)^2} = a_2 \cos\theta$$

ENGINE

In the three dimensional case -

$$\Delta C_{D_c} = \frac{\Delta C_{L_c}}{\Delta C_{L_W}} \Delta C_{L_W} (\delta + \alpha) \cos\theta$$

where $-\Delta C_{L_W}$ is the lift coefficient on the aircraft due to the control.

$$\therefore \frac{\partial C_D}{\partial (\delta + \alpha)^2} = K_2 \, a_2 \cos\theta$$

where $- K_2 = \frac{\Delta C_{L_c}}{\Delta C_{L_W}}$

The ratio of experimental to theoretical K_2 vs Mach number has been plotted in Figure 3. From these results, it would appear that the theoretical K_2's agree very well with these obtained from experiments.

The estimated K_2's for the CF-105 are shown in Figure 4, and the experimental K_2's from the Cornell tests are also plotted.

It is sometimes convenient to re-arrange equation (1), substituting for α from the lift equation,

$$C_L = a_1 \alpha + a_2 \delta$$

We then have -

$$C_D = C_{D_o} + \frac{C_L^2}{e\pi A} + \left(\frac{K_2}{a_2} + \frac{1}{e\pi A} - \frac{2K_2}{a_1}\right)(a_2\delta)^2 + \left(\frac{K_2}{a_1} - \frac{1}{e\pi A}\right) 2C_L \, a_2 \delta \qquad (2)$$

The first two terms in the above equation represents the minimum drag coefficients and the conventional induced drag and what remains we define as the trimming drag $C_D{}^{\delta}$.

The pitching moment due to controls at constant $C_L = (h_o - h_\delta)\, a_2{}^{\delta} = C_M{}^{\delta}$ and

$$C_D{}^{\delta} = \left(\frac{K_2}{a_2} - \frac{2k_2}{a_1} + \frac{1}{e\pi A}\right)\left(\frac{C_M{}^{\delta}}{h_o - h_\delta}\right)^2 + \left(\frac{k_2}{a_1} - \frac{1}{e\pi A}\right)\frac{C_M{}^{\delta}}{(h_o - h_\delta)} 2C_L \qquad (3)$$

and in trimmed flight $-C_M{}^{\delta} = C_{M_o} + (h - h_o)\, C_L$

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If we include the facts that the minimum drag does not occur at $C_L = 0$ and that C_L is more generally $C_L = a_1 (\alpha - \alpha_0) + a_2\delta$ then the drag equation becomes -

$$C_D = C_{DMin} + \frac{\left(C_L - C_{L_{CDMin}}\right)^2}{e\pi A} + \left(\frac{K_2}{a_2} - \frac{2K_2}{a_1} + \frac{1}{e\pi A}\right)\left(\frac{C_M^{\delta}}{h_o - h_\delta}\right)^2 + \left(\frac{K_2}{a_1} - \frac{1}{e\pi A}\right) \frac{C_M^{\delta} 2\left(C_L - C_{L_{CDMin}}\right)}{(h_o - h_\delta)}$$

The drag coefficient vs C_L curve for the CF-105 at $M = 1.5$ has been evaluated using the above equation and is presented in Figure 5; the C_D vs C_L curve using the method outlined in CF-105 Performance Report No. 1 is also shown.

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SYMBOLS

C_D - Drag coefficient

C_{D_o} - Drag coefficient at zero C_L

$C_{D_{Min}}$ - Minimum drag coefficient

C_L - Lift coefficient

$C_{L_{C_{DMin}}}$ - Lift coefficient for minimum drag

C_M - Pitching moment coefficient

$C_M{}^{\delta}$ - Pitching moment coefficient due to controls

C_{M_o} - Pitching moment coefficient at $C_L = 0$, $\delta = 0$

a_1 - $\frac{\partial C_L}{\partial \alpha}$

a_2 - $\frac{\partial C_L}{\partial \delta}$

h_o - Aerodynamic centre

h_δ - Centre of elevator lift

e - Induced drag factor

A - Aspect ratio

α - Angle of attack

δ - Control angle

$C_D{}^{\delta}$ - Trim drag coefficient

 Fig 1

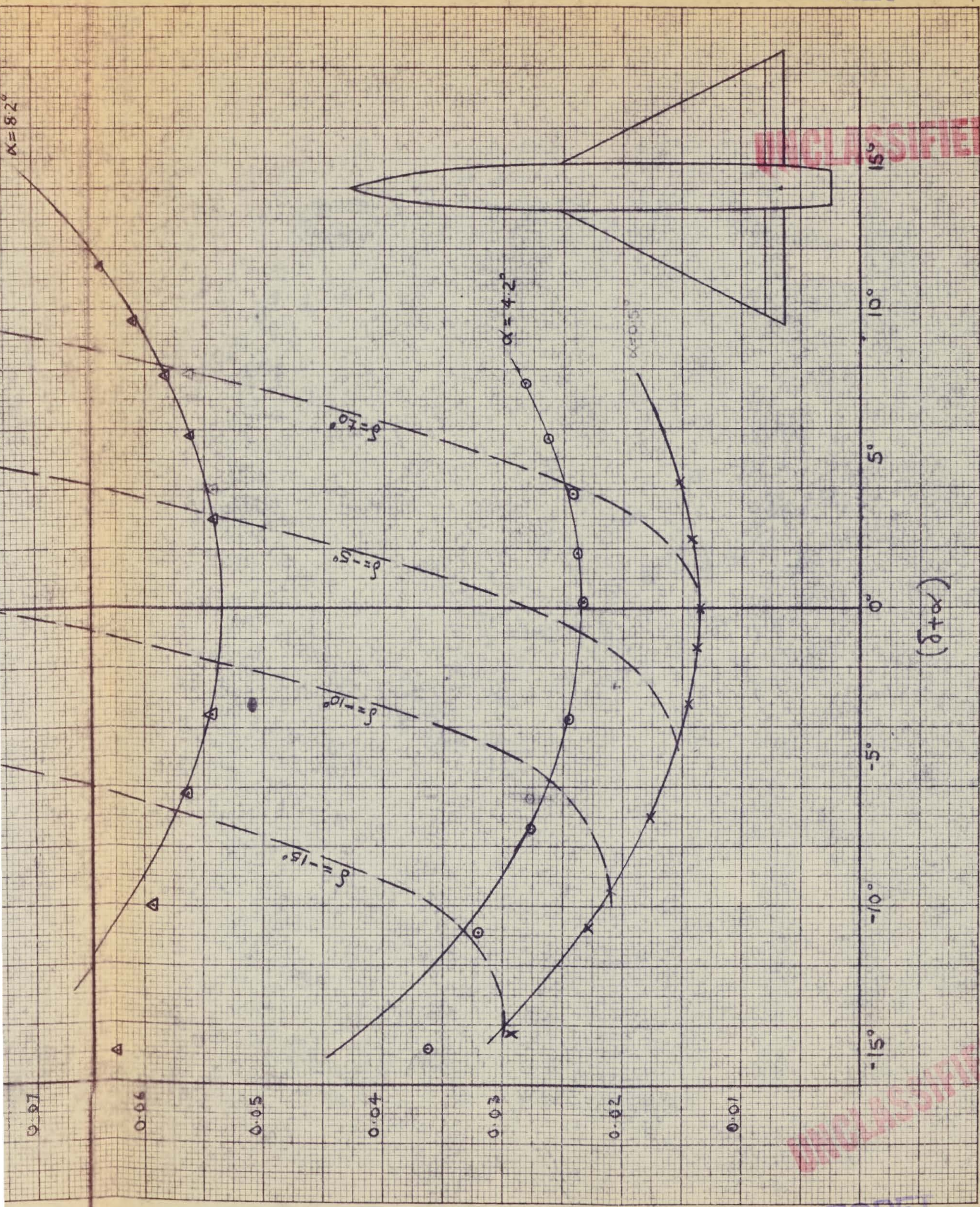

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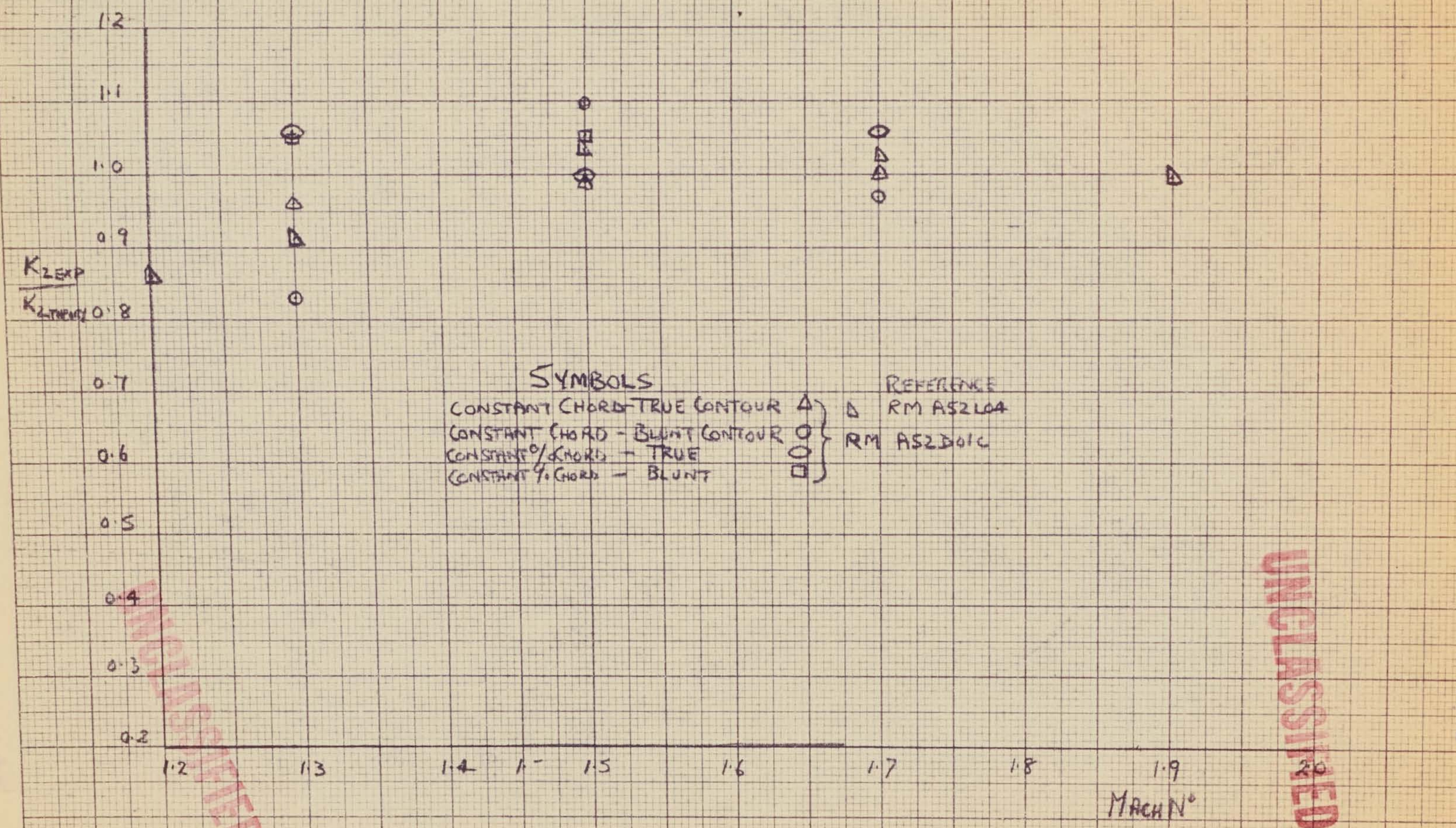
Fig 3

VARIATION OF EXPERIMENTAL TO THEORETICAL K_2 WITH MACH N°



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VARIATION OF K_2 WITH MACH N°

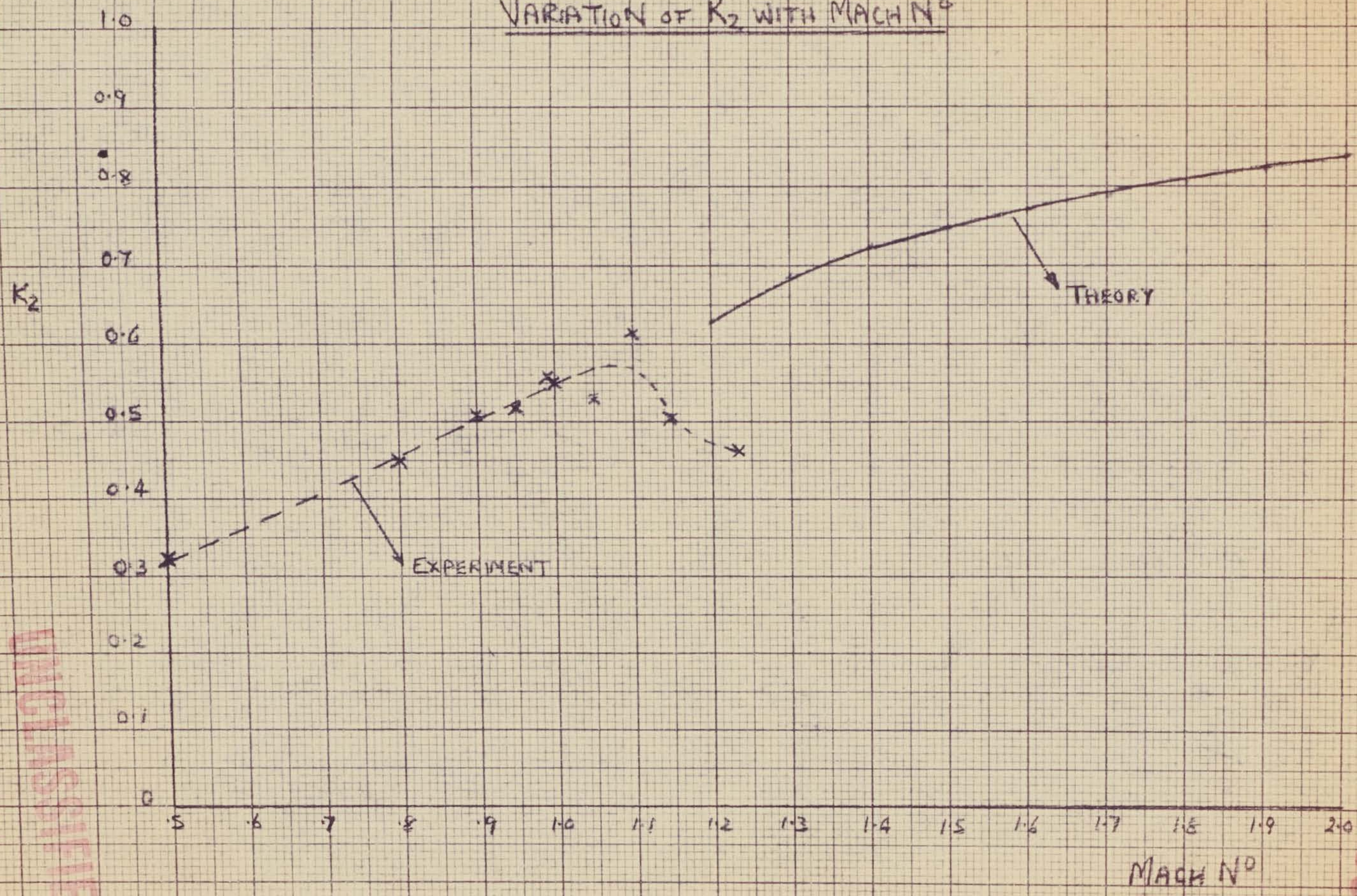

Fig 4

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 FIG 5

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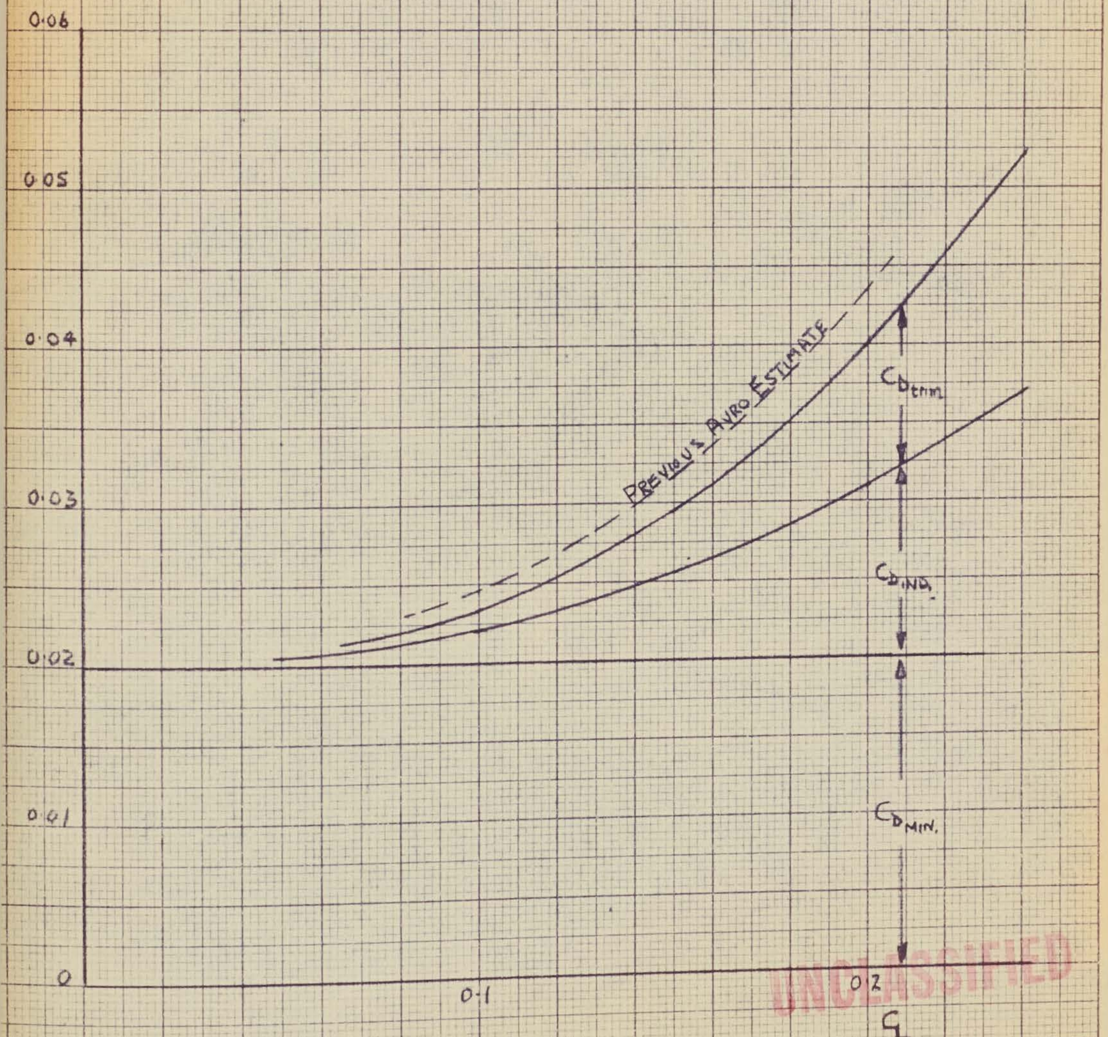
ESTIMATED C_D vs. C_L AT $M=1.5$ ($h=0.24$)



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3. CF-105 INSTALLED ENGINE DATA

The methods of estimating installed engine data (extract P/Power/51) has been presented in section 3 of CF-105 Monthly Report No. 1, with minor revisions noted in Report No. 2 and 3.

No further revisions have been made to the J-75.

The Orenda PS 13 maximum thrust in the stratosphere has been re-estimated (P/Power/56) based on the latest Orenda non-dimensional data - curves 12907 to 12916.