P/WT/116

N.A. ... LOW SPEED REDUCTION DATA

.07 SCALE MODEL

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Date 27 Sept 06
Signature [signature]
Unit / Rank / Appointment AVRSS

A. V. ROE CANADA LIMITED

MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: CF-105

REPORT NO. P/WT/116

FILE NO.

NO. OF SHEETS

TITLE

N.A.E. LOW SPEED REDUCTION DATA

.07 SCALE MODEL

PREPARED BY J. P. C. Clark DATE Nov. 1956

CHECKED BY DATE

SUPERVISED BY DATE

APPROVED BY DATE

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

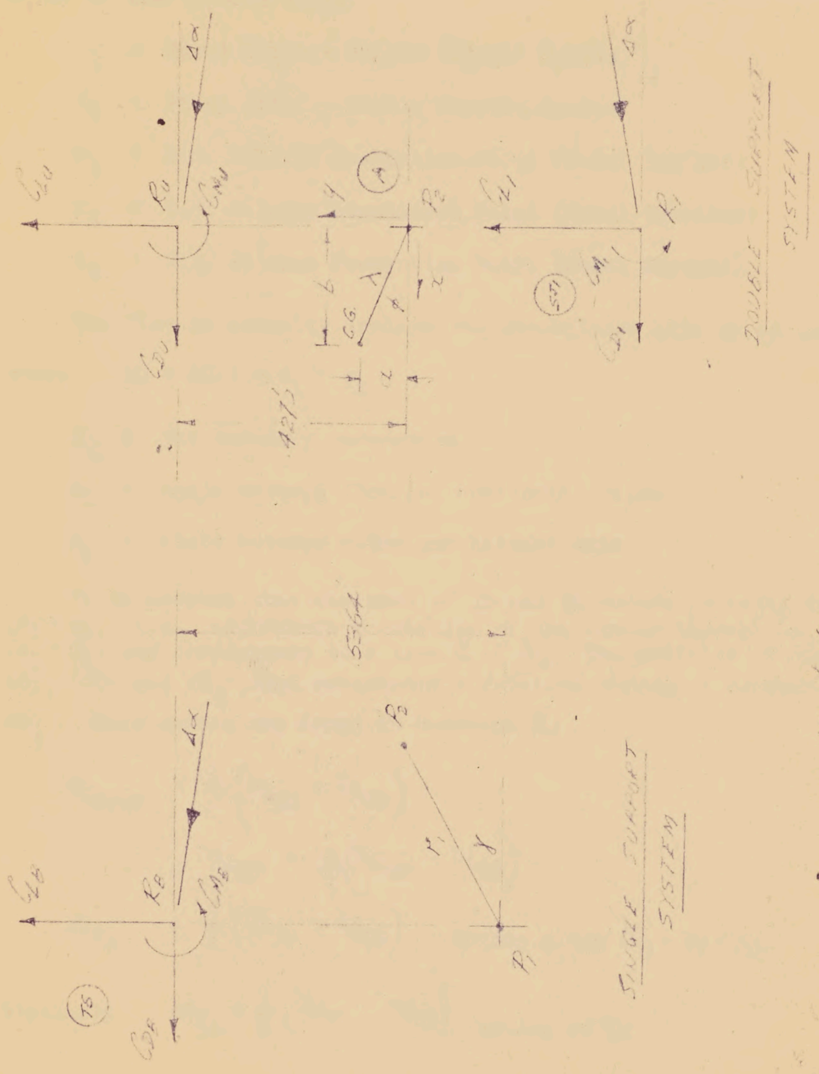
FORM 1316 A

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

REPORT No.	P/WIND TUNNEL/116
SHEET No.	1.1
PREPARED BY	CLARK
DATE	FEB. 56.
CHECKED BY	
DATE	

AIRCRAFT: C-105 ·07 SCALE MODEL

N.A.E. LOW SPEED REDUCTION DATA.



N.B. φ & γ ARE TRUE AT α=0.

C_l & C_{m_1} HAVE BEEN REVERSED IN SIGN TO AGREE WITH VALUES GIVEN IN N.A.E. DATA SHEETS.

FORM 1319A

TWIN STRUT SUPPORT RUNS (1 - 54)

In the diagram on Sheet 1, all forces are parallel or perpendicular to the balance axis.

P_1 = Pivot Point - Single Support System

P_2 = Pivot Point - Double Support System

R_U = D.S. Balance Resolution Point (Model Upright)

R_I = D.S. Balance Resolution Point (Model Inverted)

R_B = S.S. Balance Resolution Point (Model Upright)

The flow is actually inclined to the balance axis by an angle $\Delta\alpha$

where $\Delta\alpha = \Delta\alpha_j + \varepsilon_1 + \varepsilon_2$

α_j = jet boundary correction

ε_1 = angle between flow and horizontal datum

ε_2 = angle between datum and balance axis

It is assumed that the mean of ID and UD Curves corrects for $(\varepsilon_1 + \varepsilon_2)$ i.e. represents a rotation of the forces through an angle $(\varepsilon_1 + \varepsilon_2)$ and corresponds to a true α of α_d. The addition of ΔC_{D_j}, ΔC_{L_j} (=0) and $\Delta\alpha_j$ then represents a rotation through a further angle $\Delta\alpha_j$. Mean curves are found at constant α_d.

$$C_{L_{mean}} = \frac{1}{2}\left(C_{L_{UD}} + C_{L_{ID}}\right)$$

$$= C_{L_{UD}} + \frac{1}{2}\left(C_{L_{ID}} - C_{L_{UD}}\right)$$

$$\Delta C_{L_A} = \frac{1}{2}\left(C_{L_{ID}} - C_{L_{UD}}\right) \quad \text{acting along } (R_1 - P_2 - R_U)$$

Similarly $\Delta C_{D_A} = \frac{1}{2}\left(C_{D_{ID}} - C_{D_{UD}}\right)$ acting at R_U

FORM 1319A

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

REPORT NO. P/WIND TUNNEL/116
SHEET NO. 13

AIRCRAFT:		PREPARED BY	DATE
		J.P.C. Clark	February 1956
		CHECKED BY	DATE

$$C_{M_{mean}} = \frac{1}{2}\left[\left(C_{M_{UD}} + C_{M_{ID}}\right) + C_{D_{UD}}\, y\,(R_U) + C_{D_{ID}}\, y\,(R_1)\right]$$

$$= \frac{1}{2}\left[\left(C_{M_{UD}} + C_{M_{ID}}\right) + \frac{.427}{\bar{c}}\left(C_{D_{UD}} - C_{D_{ID}}\right)\right]$$

$$= C_{M_{UD}} + \frac{1}{2}\left(C_{M_{ID}} - C_{M_{UD}}\right) - \frac{.427}{2\bar{c}}\left(C_{D_{ID}} + C_{D_{UD}}\right)$$

$\frac{1}{2}\left(C_{M_{ID}} - C_{M_{UD}}\right) - \frac{.427}{2\bar{c}}\left(C_{D_{ID}} + C_{D_{UD}}\right)$ is called ΔC_{M_A}

and represents a corrective moment about P_2.

Strut tare and interference values are found from ID & I runs.

$$\Delta C_{L_{STI}} = -\left(C_{L_{ID}} - C_{L_I}\right)$$

Similarly

$$\Delta C_{D_{STI}} = -\left(C_{D_{ID}} - C_{D_I}\right)$$

and

$$\Delta C_{M_{STI}} = -\left(C_{M_{ID}} - C_{M_I}\right)$$

These forces and moments are about point R_1

Tail sting corrections about R_B are

$$\Delta C_{L_{TS}} = -\left(C_{L_{BTS}} - C_{L_B}\right)$$

$$\Delta C_{D_{TS}} = -\left(C_{D_{BTS}} - C_{D_B}\right)$$

and $\Delta C_{M_{TS}} = -\left(C_{M_{BTS}} - C_{M_B}\right)$

Forces and moments transferred to P_2 are:

$$C_{L_{P_2}} = C_{L_U} + \Delta C_{L_A} + \Delta C_{L_{STI}} + \Delta C_{L_{TS}}$$

$$C_{D_{P_2}} = C_{D_U} + \Delta C_{D_A} + \Delta C_{D_{STI}} + \Delta C_{D_{TS}}$$

$$C_{M_{P_2}} = C_{M_U} + \Delta C_{M_A} + \Delta C_{M_{STI}} + \Delta C_{M_{TS}} + \frac{.4270}{\bar{c}} C_{D_U}$$

$$- \Delta C_{D_{STI}} \frac{y}{\bar{c}} (R_1) + \Delta C_{D_{TS}} \frac{y}{\bar{c}} (R_B)$$

$$- \Delta C_{L_{TS}} \frac{x}{\bar{c}} (R_B)$$

where $y(R_1) = .4270'$

$$y(R_B) = .5364' - r_1 \sin (\gamma + \alpha_d)$$

$$x(R_B) = r_1 \cos (\gamma + \alpha_d)$$

Forces and moments about C.G. are:

$$C_{L_{CG}} = C_{L_{P_2}}$$

$$C_{L_{CG}} = C_{L_U} + \Delta C_{L_A} + \Delta C_{L_{STI}} + \Delta C_{L_{TS}}$$

$$C_{D_{CG}} = C_{D_{P_2}}$$

$$C_{D_{CG}} = C_{D_U} + \Delta C_{D_A} + \Delta C_{D_{STI}} + C_{D_{TS}} + \Delta C_{D_j}$$

$$C_{M_{CG}} = C_{M_{P_2}} + C_{L_{P_2}} \frac{b}{\bar{c}} - C_{D_{P_2}} \frac{a}{\bar{c}} + \frac{.4270}{\bar{c}} C_{D_U}$$

where $b = \lambda \cos (\phi - \alpha_d)$ $\quad a = \lambda \sin (\phi - \alpha_d)$

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

REPORT NO. P/WIND TUNNEL/116
SHEET NO. 15

AIRCRAFT:

PREPARED BY	DATE
J.P.C. Clark	February 1956
CHECKED BY	DATE

$$C_{M_{CG}} = C_{M_U} + \Delta C_{M_A} + \Delta C_{M_{STI}} + \Delta C_{M_{TS}} + \frac{.4270}{\bar{c}} C_{D_U}$$

$$- \Delta C_{D_{STI}} \frac{.4270}{\bar{c}} + \Delta C_{D_{TS}} \left[\frac{.5364 - r_1 \sin(\gamma + \alpha_d)}{\bar{c}} \right]$$

$$- \Delta C_{L_{TS}} \frac{r_1}{\bar{c}} \cos(\gamma + \alpha_d)$$

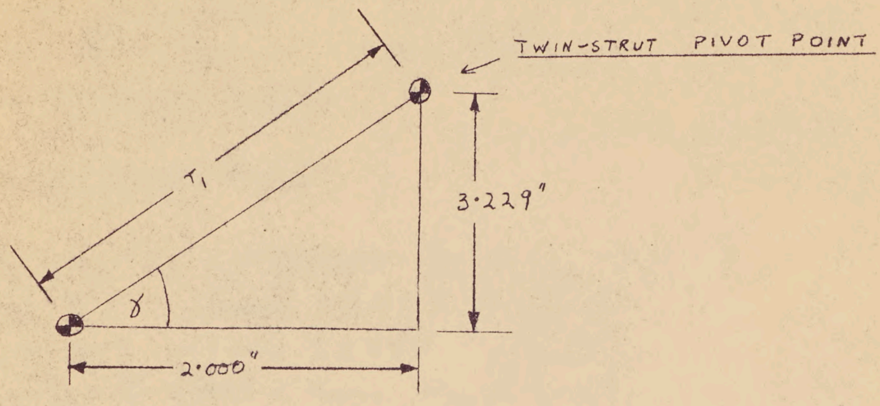
$$+ C_{L_{CG}} \frac{\lambda}{\bar{c}} \cos(\phi - \alpha_d) - C_{D_{CG}} \frac{\lambda}{\bar{c}} \sin(\phi - \alpha_d)$$

Finally $\alpha_{CG} = \alpha_{P_2} = \alpha_d + \Delta\alpha_j$

A, STI and ST corrections are evaluated in P/WT/97. Blockage corrections are found on Sheet 7 and the final reduction equations given on Sheet 8.

From a comparison of C_M vs C_L with Cornell runs (Sheet 9) it was decided to ignore all A corrections, which seemed somewhat unrealistic.

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. P/WT/97 SHEET NO. 1.6	
AIRCRAFT: C-105	SUPPORT	PREPARED BY	DATE
		E.R.F.	14th MARCH 1956
·07 SCALE MODEL	DIMENSIONS	CHECKED BY	DATE



$$r_1 = \sqrt{(2.000)^2 + (3.229)^2}'' = 3.798'' = .14964\,\tau$$

WHERE $\tau = 25.3829''$

$$\gamma = \tan^{-1}\frac{3.229}{2.000} = 58.23^\circ$$

Solid Blockage

$$\varepsilon_s = \frac{\sqrt{\pi}}{2}\,\tau\,\frac{V}{C^{3/2}}$$ — from Pankhurst P 344

$$K_w = \frac{1}{(1-(M')^2)^{3/2}}\,\frac{K_1 \tau V_w}{C^{3/2}}$$

$$K_b = \frac{1}{\{1-(M')^2\}^{3/2}}\,\frac{K_3 \tau V_b}{C^{3/2}}$$

— from N.A.C.A. TR 995.

$$\varepsilon_s = K_w + K_b = \frac{1}{\{1-(M')^2\}^{3/2}}\,\frac{\tau}{C^{3/2}}\left(K_1 V_w + K_3 V_b\right)$$

$K_1 < \cdot 938$ — from TR 995 Table II

$K_3 \simeq \cdot 909$ — from TR 995 Table IV

$K_1 = K_3 = \frac{\sqrt{\pi}}{2} = \cdot 885$ — from Pankhurst

Formula taken as $\varepsilon_s = \frac{1}{\{1-(M')^2\}^{3/2}}\,\frac{\tau}{C^{3/2}}\left(\frac{\sqrt{\pi}}{2} V\right)$

τ taken as ·94 for rectangular tunnel. — TR 995 Table I

τ for 9×7 rect. tunnel is ·83
τ for 9×7 octagonal tunnel is ·75 } Pankhurst P341

Hence τ for octagonal tunnel is $\cdot 94 \times \frac{\cdot 75}{\cdot 83} = \cdot 85$

$V = 1\cdot 280$ cu ft $C = 49\cdot 6$ sq ft (without ground board)

$C = 45$ sq ft (with ground board)

Hence $\varepsilon_s = \cdot 0029$ (without ground board) or $\cdot 0034$ (with ground board)

Wake Blockage

$$\varepsilon_w = \frac{1}{4}\,\frac{S}{C}\,C_D'\left(\frac{1+\cdot 4M^2}{1-M^2}\right)$$ — from TR 995

$S = 6\cdot 003$ sq. ft.

Hence $\varepsilon_w = \cdot 0324\, C_D$ (without ground board) or $\cdot 0354$ (with ground board)

Method of Application

$U_F = U_T(1+\varepsilon)$ — from Pankhurst P348

U_F is free air speed and U_T is tunnel air speed. $\varepsilon = \varepsilon_s + \varepsilon_w$

A generalised force, or moment $C_F = f\left(\frac{1}{U^2}\right)$

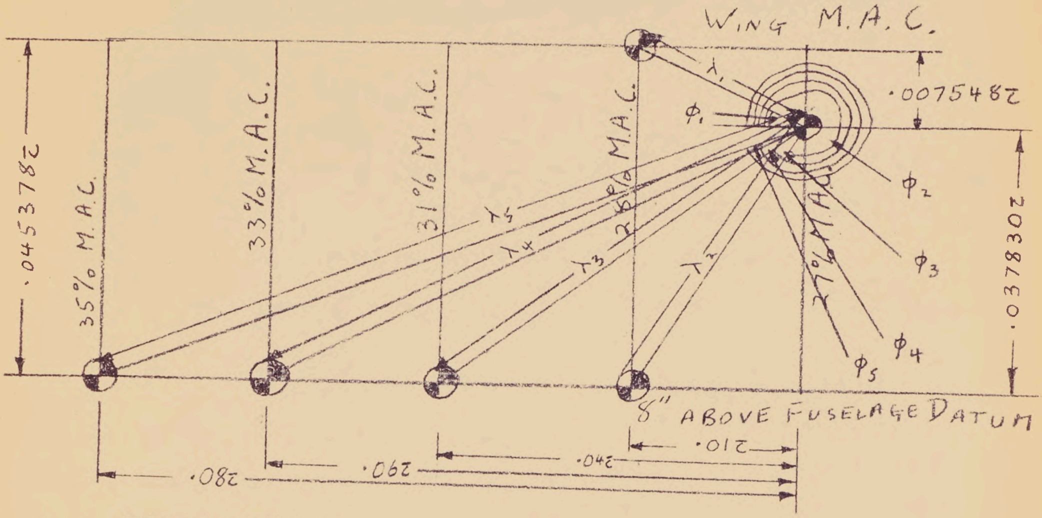
$\therefore\ (C_F)_{\text{free air}} = \frac{1}{(1+\varepsilon)^2}\,(C_F)_{\text{in tunnel}}$

where $\varepsilon = \cdot 0029 + \cdot 0324\, C_D$ (without ground board)

and $\varepsilon = \cdot 0034 + \cdot 0354\, C_D$ (with ground board)

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

AIRCRAFT: C-105	CENTRE OF GRAVITY	REPORT No. P/WT/97	
.07 SCALE MODEL	TRANSFER	SHEET No. 2.5	
		PREPARED BY: E.R.F.	DATE: 14th MARCH 1956
		CHECKED BY	DATE



$\lambda_1 = \sqrt{(.01)^2 + (.007548)^2}\,\bar{c} = .012529\,\bar{c}$

$\lambda_2 = \sqrt{(.01)^2 + (.037830)^2}\,\bar{c} = .039129\,\bar{c}$

$\lambda_3 = \sqrt{(.04)^2 + (.037830)^2}\,\bar{c} = .055056\,\bar{c}$

$\lambda_4 = \sqrt{(.06)^2 + (.037830)^2}\,\bar{c} = .070931\,\bar{c}$

$\lambda_5 = \sqrt{(.08)^2 + (.037830)^2}\,\bar{c} = .088494\,\bar{c}$

$\phi_1 = \left(\tan^{-1} \frac{.007548}{.01}\right)^\circ = \left(\tan^{-1} .7548\right)^\circ = 37.045^\circ$

$\phi_2 = 360^\circ - \left(\tan^{-1} \frac{.037830}{.01}\right)^\circ = 360^\circ - \left(\tan^{-1} 3.7830\right)^\circ = 284.807^\circ$

$\phi_3 = 360^\circ - \left(\tan^{-1} \frac{.037830}{.04}\right)^\circ = 360^\circ - \left(\tan^{-1} .94575\right)^\circ = 316.597^\circ$

$\phi_4 = 360^\circ - \left(\tan^{-1} \frac{.037830}{.06}\right)^\circ = 360^\circ - \left(\tan^{-1} .63050\right)^\circ = 327.768^\circ$

$\phi_5 = 360^\circ - \left(\tan^{-1} \frac{.037830}{.08}\right)^\circ = 360^\circ - \left(\tan^{-1} .47288\right)^\circ = 334.692^\circ$

FORM 1319A

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

AIRCRAFT C-105	REDUCTION	REPORT NO. P/WT/97	SHEET NO. 2.2 1.9
07 SCALE MODEL	DATA	PREPARED BY	DATE 12 MAR '56
		CHECKED BY	DATE 13 MAR '56

TRANSFER OF CENTRE OF GRAVITY

$$C_{L_{CG}} = C_{L_U} + \Delta C_{L_{STI}} + \Delta C_{L_{TS}}$$

$$C_{D_{CG}} = C_{D_U} + \Delta C_{D_{STI}} + \Delta C_{D_{TS}} + \Delta C_{D_\delta}$$

$$C_{M_{CG}} = \{C_{M_U} + \cdot 20187\, C_{D_U}\} + \{\Delta C_{M_{STI}} - \cdot 20187\, \Delta C_{D_{STI}}\}$$
$$+ \{\Delta C_{M_{TS}} + [\cdot 25362 - \cdot 14964 \sin(58\cdot 23^\circ + \alpha_d)]\Delta C_{D_{TS}}$$
$$- \cdot 14964 \cos(58\cdot 23^\circ + \alpha_d)\Delta C_{L_{TS}}\}$$
$$+ \lambda \cos(\psi - \alpha_d)\, C_{L_{CG}} - \lambda \sin(\psi - \alpha_d)\, C_{D_{CG}}$$

$$\alpha_{CG} = \alpha_d + \alpha_\delta$$

$\Delta\alpha_\delta = \cdot 755\, C_{L_{CG}}$ $\quad$ $\Delta C_{D_\delta} = \cdot 01318\,(C_{L_{CG}})^2$

For ·28c̄ on M.A.C. $\psi_1 = 37\cdot 045$ $\quad \lambda_1 = \cdot 012529$

For ·28c̄ 8" above F.D. $\psi_2 = 284\cdot 807^\circ$ $\quad \lambda_2 = \cdot 034129$

For ·31c̄ 8" above F.D. $\psi_3 = 316\cdot 597^\circ$ $\quad \lambda_3 = \cdot 055056$

For ·33c̄ 8" above F.D. $\psi_4 = 327\cdot 768^\circ$ $\quad \lambda_4 = \cdot 070931$

For ·35c̄ 8" above F.D $\psi_5 = 334\cdot 692^\circ$ $\quad \lambda_5 = \cdot 088494$

BLOCKAGE CORRECTIONS

$$C_{L_F} = C_{L_{CG}} / (1+\varepsilon)^2$$
$$C_{D_F} = C_{D_{CG}} / (1+\varepsilon)^2$$
$$C_{M_F} = C_{M_{CG}} / (1+\varepsilon)^2$$
$$\alpha_F = \alpha_{CG}$$

$\varepsilon = \cdot 0029 + \cdot 0324\, C_{D_{CG}}$

WITH GROUND BOARD

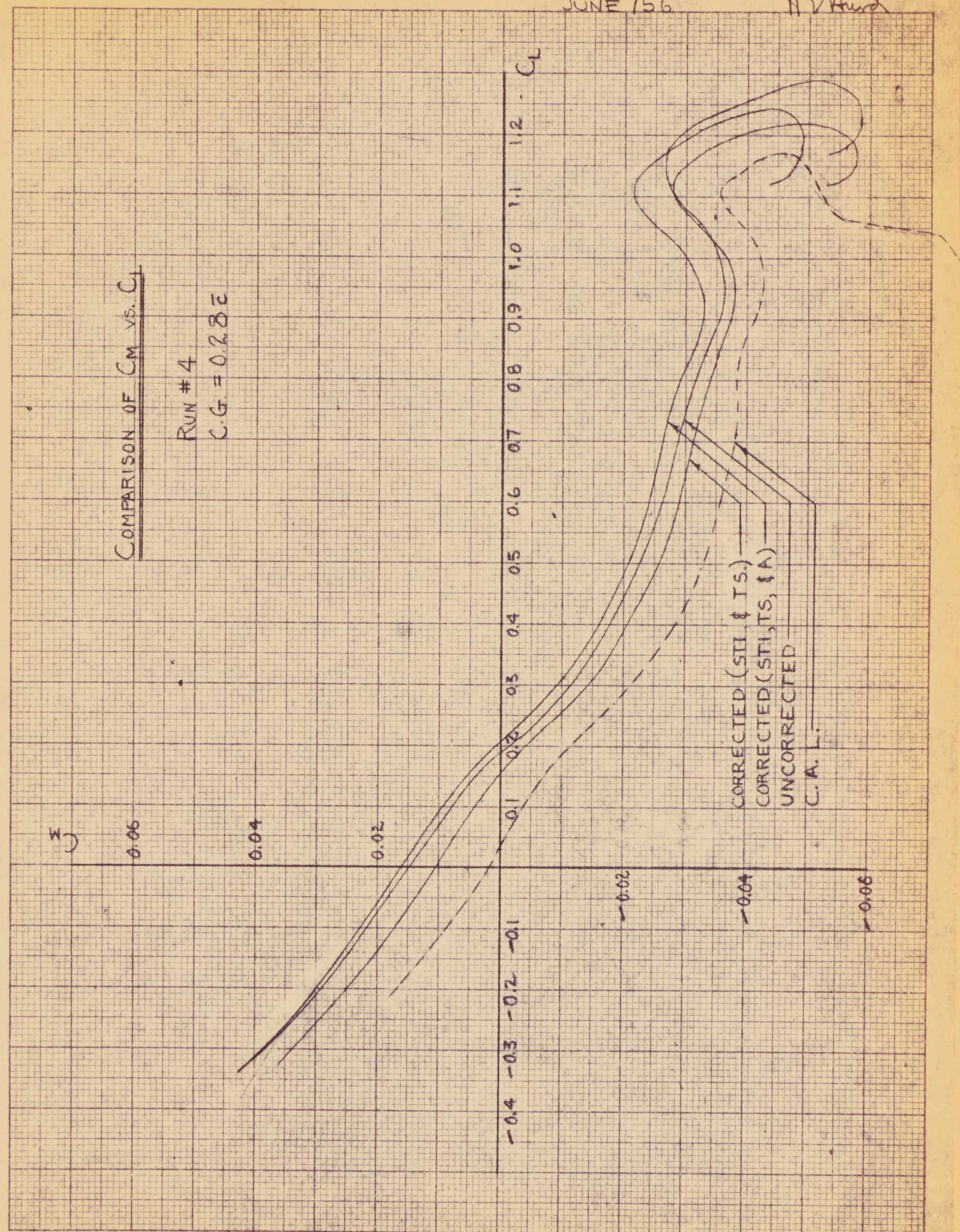
$\Delta\alpha_\delta = \Delta C_{D_\delta} = 0$ also $\varepsilon = \cdot 0034 + \cdot 0354\, C_{D_{CG}}$

C_{L_U}; C_{D_U}; C_{M_U}; α_d — Given in P/WT/96

$\Delta C_{L_{STI}}$; $\Delta C_{L_{TS}}$; $\Delta C_{D_{STI}}$; $\Delta C_{D_{TS}}$; $\Delta C_{M_{STI}}$; $\Delta C_{M_{TS}}$ — Given in P/WT/97.

C_{L_F}; C_{D_F}; C_{M_F}; α_F — To be found.

JUNE /56 A S Hurd



C-105 NAE WIND TUNNEL TESTS (DEC 55 ~

CORRECTIONS TO BE APP[illegible] TO

	1	2	3	4	5	6	7	8	9	10	11
α_{DIAL}	$-6°$	-4	-2	0	2	4	6	8	[illegible]	12	1[illegible]
$\Delta C_{L_{TS}}$	.0065	.0059	.0054	.0051	.0049	.0048	.0048	.0050	.00[illegible]	.0056	.00[illegible]
$\Delta C_{L_{STI}}$	.0052	.0057	.0061	.0064	.0067	.0068	.0069	.0068	.00[illegible]	.0058	.00[illegible]
$\Delta C_{D_{TS}}$	$-.0048$	$-.0045$	$-.0041$	$-.0039$	$-.0035$	$-.0033$	$-.0030$	$-.0027$	$-.002$[illegible]	.0023	$-.00$[illegible]
$\Delta C_{D_{STI}}$	$-.0068$	$-.0063$	$-.0058$	$-.0054$	$-.0050$	$-.0046$	$-.0042$	$-.0039$	$-.00$[illegible]	.0036	$-.00$[illegible]
$\Delta C_{M_{STI}} + \Delta C_{M_{TS}}$ $\delta_e = 10°$	$\overline{.0072}$	$\overline{.0069}$	$\overline{.0066}$	$\overline{.0064}$	$\overline{.0061}$	$\overline{.0058}$	$\overline{.0055}$	$\overline{.0053}$	[illegible]	$\overline{.0047}$	$\overline{.00}$[illegible]
5°	$\overline{.0062}$	$\overline{.0059}$	$\overline{.0057}$	$\overline{.0055}$	$\overline{.0053}$	$\overline{.0050}$	$\overline{.0048}$	$\overline{.0046}$	[illegible]	$\overline{.0042}$	$\overline{.00}$[illegible]
2.5°	$\overline{.0060}$	$\overline{.0058}$	$\overline{.0056}$	$\overline{.0054}$	$\overline{.0051}$	$\overline{.0048}$	$\overline{.0046}$	$\overline{.0044}$	[illegible]	$\overline{.0040}$	$\overline{.00}$[illegible]
0°	$\overline{.0062}$	$\overline{.0059}$	$\overline{.0057}$	$\overline{.0054}$	$\overline{.0051}$	$\overline{.0048}$	$\overline{.0046}$	$\overline{.0043}$	[illegible]	$\overline{.0038}$	$\overline{.00}$[illegible]
$-2.5°$	$\overline{.0067}$	$\overline{.0064}$	$\overline{.0061}$	$\overline{.0057}$	$\overline{.0053}$	$\overline{.0050}$	$\overline{.0047}$	$\overline{.0043}$	[illegible]	$\overline{.0036}$	$\overline{.00}$[illegible]
$-5°$	$\overline{.0073}$	$\overline{.0069}$	$\overline{.0064}$	$\overline{.0060}$	$\overline{.0055}$	$\overline{.0052}$	$\overline{.0048}$	$\overline{.0043}$	[illegible]	$\overline{.0034}$	$\overline{.002}$[illegible]
$-10°$	$\overline{.0085}$	$\overline{.0079}$	$\overline{.0073}$	$\overline{.0067}$	$\overline{.0061}$	$\overline{.0056}$	$\overline{.0050}$	$\overline{.0044}$	$\overline{.003}$[illegible]	$\overline{.0032}$	$\overline{.002}$[illegible]
$-15°$	$\overline{.0094}$	$\overline{.0089}$	$\overline{.0084}$	$\overline{.0077}$	$\overline{.0071}$	$\overline{.0065}$	$\overline{.0059}$	$\overline{.0053}$	[illegible]	$\overline{.0041}$	$\overline{.00}$[illegible]
$-20°$	$\overline{.0098}$	$\overline{.0093}$	$\overline{.0088}$	$\overline{.0083}$	$\overline{.0078}$	$\overline{.0072}$	$\overline{.0067}$	$\overline{.0062}$	$\overline{.005}$[illegible]	$\overline{.0052}$	$\overline{.004}$[illegible]
$-25°$	$\overline{.0093}$	$\overline{.0089}$	$\overline{.0083}$	$\overline{.0078}$	$\overline{.0073}$	$\overline{.0067}$	$\overline{.0061}$	$\overline{.0057}$	[illegible]	$\overline{.0047}$	$\overline{.00}$[illegible]
$-30°$	$\overline{.0070}$	$\overline{.0065}$	$\overline{.0060}$	$\overline{.0054}$	$\overline{.0049}$	$\overline{.0044}$	$\overline{.0039}$	$\overline{.0033}$	$\overline{.002}$[illegible]	$\overline{.0023}$	$\overline{.001}$[illegible]
~~ΔC_{L_A}~~	~~$\overline{.0125}$~~	~~$\overline{.0114}$~~	~~$\overline{.0107}$~~	~~$\overline{.0100}$~~	~~$\overline{.0098}$~~	~~$\overline{.0099}$~~	~~$\overline{.0105}$~~	~~$\overline{.0116}$~~	~~[illegible]~~	~~$\overline{.0148}$~~	~~$\overline{.016}$[illegible]~~
~~ΔC_{D_A}~~	~~$\overline{.0008}$~~	~~$\overline{.0006}$~~	~~$\overline{.0004}$~~	~~$\overline{.0002}$~~	~~0~~	~~.0001~~	~~.0001~~	~~0~~	~~[illegible]~~	~~$\overline{.0005}$~~	~~$\overline{.000}$[illegible]~~
~~ΔC_{M_A}~~	~~.0068~~	~~.0066~~	~~.0064~~	~~.0063~~	~~.0061~~	~~.0060~~	~~.0059~~	~~.0058~~	~~[illegible]~~	~~.0056~~	~~.005~~[illegible]

DEC 55 ~ JAN 56

…ED TO C_{L_u}, C_{D_u} AND C_{M_u}

AVRO AIRCRAFT …

MALTON, ONTARIO…

ENGINEERING DIVISIO…

AIRCRAFT C-10…

~~WEIGHT~~ MODEL

C. G. POSITION

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	12	14	16	18	20	22	24	26	28	30	32	34	35	
54	0056	0052	0043	0027	0017	0011	0008	0008	0010	0012	0017	0022	0026	
64	0058	0051	0052	0080	0121	0124	0116	0109	0110	0119	0134	0150	0159	
25	- 0023	- 0021	- 0020	- 0019	- 0018	- 0017	- 0017	- 0016	- 0015	- 0015	- 0015	- 0014	- 0014	
37	0036	- 0036	- 0037	- 0027	0	0009	0015	0022	0033	0049	0071	0096	0110	
5	$\overline{0047}$	$\overline{0044}$	$\overline{0041}$	$\overline{0039}$	$\overline{0036}$	$\overline{0033}$	$\overline{0030}$	$\overline{0028}$	$\overline{0025}$	$\overline{0022}$	$\overline{0019}$	$\overline{0016}$	$\overline{0015}$	
44	$\overline{0042}$	$\overline{0040}$	$\overline{0038}$	$\overline{0036}$	$\overline{0034}$	$\overline{0031}$	$\overline{0028}$	$\overline{0026}$	$\overline{0024}$	$\overline{0021}$	$\overline{0019}$	$\overline{0017}$	$\overline{0016}$	
4	$\overline{0040}$	$\overline{0038}$	$\overline{0036}$	$\overline{0034}$	$\overline{0032}$	$\overline{0029}$	$\overline{0026}$	$\overline{0024}$	$\overline{0022}$	$\overline{0019}$	$\overline{0016}$	$\overline{0013}$	$\overline{0012}$	
4	$\overline{0038}$	$\overline{0035}$	$\overline{0032}$	$\overline{0029}$	$\overline{0027}$	$\overline{0024}$	$\overline{0021}$	$\overline{0018}$	$\overline{0016}$	$\overline{0013}$	$\overline{0010}$	$\overline{0007}$	$\overline{0006}$	
3	$\overline{0036}$	$\overline{0031}$	$\overline{0027}$	$\overline{0023}$	$\overline{0018}$	$\overline{0014}$	$\overline{0009}$	$\overline{0004}$	0001	0007	0012	0017	0019	
3	0034	$\overline{0028}$	$\overline{0023}$	$\overline{0018}$	$\overline{0012}$	$\overline{0008}$	$\overline{0002}$	0004	0009	0015	0020	0025	0028	
38	$\overline{0032}$	$\overline{0026}$	$\overline{0020}$	$\overline{0014}$	$\overline{0008}$	$\overline{0003}$	0003	0009	0015	0021	0027	0033	0036	
45	$\overline{0041}$	$\overline{0034}$	$\overline{0029}$	$\overline{0023}$	$\overline{0018}$	$\overline{0011}$	$\overline{0007}$	$\overline{0003}$	0002	0008	0013	0018	0021	
57	$\overline{0052}$	$\overline{0047}$	$\overline{0042}$	$\overline{0037}$	$\overline{0032}$	$\overline{0026}$	$\overline{0021}$	$\overline{0016}$	$\overline{0011}$	$\overline{0006}$	$\overline{0001}$	0004	0006	
57	$\overline{0047}$	$\overline{0042}$	$\overline{0037}$	$\overline{0032}$	$\overline{0027}$	$\overline{0021}$	$\overline{0015}$	$\overline{0010}$	$\overline{0005}$	$\overline{0001}$	0004	0009	0012	
28	$\overline{0023}$	$\overline{0018}$	$\overline{0013}$	$\overline{0007}$	$\overline{0002}$	0003	0008	0014	0019	0024	0029	0034	0036	
~~31~~	~~$\overline{0148}$~~	~~$\overline{0151}$~~	~~$\overline{0171}$~~	~~$\overline{0177}$~~	~~$\overline{0179}$~~	~~$\overline{0176}$~~	~~$\overline{0164}$~~	~~$\overline{0140}$~~	~~$\overline{0095}$~~	~~$\overline{0038}$~~	~~$\overline{0009}$~~	~~$\overline{0001}$~~	~~0~~	}
~~62~~	~~$\overline{0005}$~~	~~$\overline{0008}$~~	~~$\overline{0013}$~~	~~$\overline{0016}$~~	~~$\overline{0019}$~~	~~$\overline{0020}$~~	~~$\overline{0018}$~~	~~$\overline{0013}$~~	~~$\overline{0002}$~~	~~0010~~	~~0023~~	~~0035~~	~~0040~~	
~~57~~	~~0056~~	~~0056~~	~~0055~~	~~0055~~	~~0056~~	~~0058~~	~~0065~~	~~0075~~	~~0087~~	~~0095~~	~~0098~~	~~0100~~	~~0100~~	

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO
ENGINEERING DIVISION

AIRCRAFT	C-105	REPORT NO	P/WT/97
~~WEIGHT~~	MODEL .07 SCALE	SHEET	2.3
C.G. POSITION		DATE	FEB 22nd 1956
		PREPARED BY	D. B. GARLAND

18	19	20	21	22	23	24	25	26	27	28	29
28	30	32	34	35							
.0010	.0012	.0017	.0022	.0026							
.0110	.0119	.0134	.0150	.0159							
-.0015	-.0015	-.0015	-.0014	-.0014							
.0033	.0049	.0071	.0096	.0110							
$\overline{.0025}$	$\overline{.0022}$	$\overline{.0019}$	$\overline{.0016}$	$\overline{.0015}$							
$\overline{.0024}$	$\overline{.0021}$	$\overline{.0019}$	$\overline{.0017}$	$\overline{.0016}$							
$\overline{.0022}$	$\overline{.0019}$	$\overline{.0016}$	$\overline{.0013}$	$\overline{.0012}$							
$\overline{.0016}$	$\overline{.0013}$	$\overline{.0010}$	$\overline{.0007}$	$\overline{.0006}$							
.0001	.0007	.0012	.0017	.0019							
.0009	.0015	.0020	.0025	.0028							
.0015	.0021	.0027	.0033	.0036							
.0002	.0008	.0013	.0018	.0021							
$\overline{.0011}$	$\overline{.0006}$	$\overline{.0001}$	.0004	.0006							
$\overline{.0005}$	$\overline{.0001}$	.0004	.0009	.0012							
.0019	.0024	.0029	.0034	.0036							
~~$\overline{.0095}$~~	~~$\overline{.0038}$~~	~~$\overline{.0009}$~~	~~$\overline{.0001}$~~	~~0~~	NOT APPLIED						
~~$\overline{.0002}$~~	~~.0010~~	~~.0023~~	~~.0035~~	~~.0040~~							
~~.0087~~	~~.0095~~	~~.0098~~	~~.0100~~	~~.0100~~							

N.B.

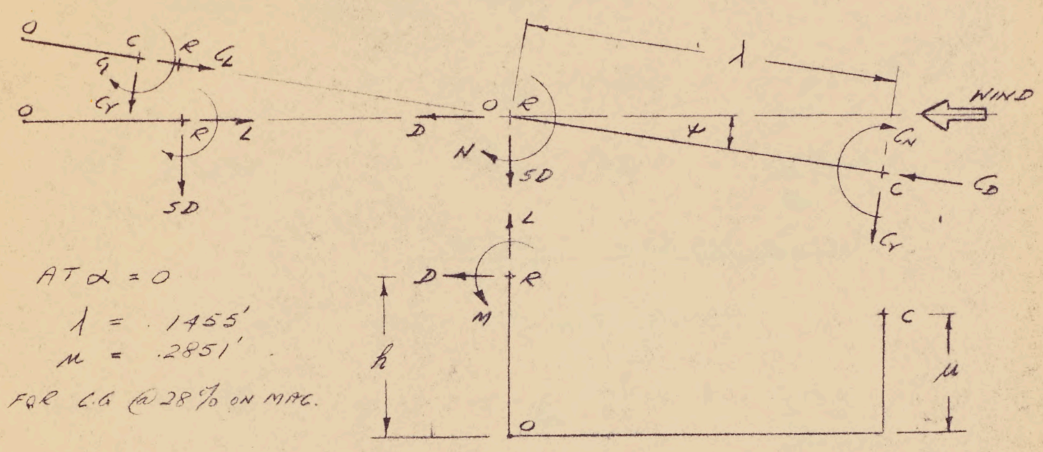
$\Delta \alpha_j = 0.755\, C_L$ (degrees)

$\Delta C_{D_j} = 0.01318\, C_L^2$

O.R.I.

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. P/WIND TUNNEL/116 SHEET NO. 2.1	
AIRCRAFT: C-105 .07 SCALE MODEL.	NAE LOW SPEED W.T. TESTS YAW RUNS	PREPARED BY CLARK.	DATE JULY 1956
		CHECKED BY	DATE

REDUCTION DATA.



AT $\alpha = 0$

$\lambda = .1455'$

$\mu = .2851'$

FOR C.G. @ 28% ON MAC.

O = SINGLE STRUT SUPPORT PIVOT POINT

R = BALANCE RESOLUTION POINT.

C = CENTER OF GRAVITY.

$$C_L \doteq \frac{L}{qS}$$

$$C_D = \frac{1}{qS}\left(D\cos\psi - SD\sin\psi\right) + \Delta C_{D_j}$$

$$C_Y = \frac{1}{qS}\left(SD\cos\psi + D\sin\psi\right) + \Delta C_{Y_j}$$

$$C_m = \frac{1}{qS\bar{c}}\left[PM + D(h-\mu)\right]\cos\psi - \frac{1}{qS\bar{c}}\left[RM + SD(h-\mu)\right]\sin\psi - \frac{L\lambda}{qS\bar{c}}$$

$$C_N = \frac{1}{qSb}\left(YM - \lambda SD\cos\psi - D\sin\psi\right)$$

$$C_l = \frac{1}{qSb}\left[RM + SD(h-\mu)\right]\cos\psi - \frac{1}{qSb}\left[PM + D(h-\mu)\right]\sin\psi$$

FORM 1319A

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

REPORT No. P/WIND TUNNEL/116
SHEET No. 22

AIRCRAFT:

PREPARED BY	DATE
CLARK	
CHECKED BY	**DATE**

WHERE $q = q_d \; .936 (1 + \epsilon)^2$

$$= .936\, q_d \left(1.0053 + \frac{.0324\, D}{q\, S}\right)^2$$

IE APPROX. $= .936\, q_d \left(1.0053 + \frac{.0346\, D}{q_d\, S}\right)^2$ — (1)

WITHOUT GROUND BOARD

SIMILARLY WITH GROUND BOARD

@ .465 b/2 $\quad q = 1.134\, q_d \left(1.0034 + \frac{.0312\, D}{q_d\, S}\right)^2$ — (2)

@ .700 b/2 $\quad q = 1.110\, q_d \left(1.0034 + \frac{.0312\, D}{q_d\, S}\right)^2$ — (3)

$\Delta C_{D_j} = .01318\, \xi^2 \cos *$

$\Delta C_{L_j} = .01318\, \xi^2 \sin *$

$\alpha = \alpha_d + .755\, \xi \cos *$

$\lambda = m \cos(\phi + \alpha_d)$

$\mu = m \sin(\phi + \alpha_d)$

$S = 6.0025$

$b = 3.500$

$\bar{c} = 2.1152$

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. P/WIND TUNNEL/116
SHEET NO. 2.3

AIRCRAFT:

PREPARED BY	DATE
J.P. Clark	Oct. 23, 1956.
CHECKED BY	DATE

VALUE OF h AND q

RUN	h	q Eqn.	RUN	h	q Eqn.
50-54	.5364	1	105	.4401	2
55-81	.5333	1	106,107	.4635	2
82	.4635	2	108	.4583	2
83	.4583	2	109-123	.5333	1
84	.4505	2	124	.4635	2
85,86	.4401	2	125	.4583	2
87	.4505	2	126	.4505	2
88	.4583	2	127,128	.4401	2
89,90	.4635	2	129	.4505	2
91	.4583	2	130	.4583	2
92	.4505	2	131,132	.4635	2
93,94	.4401	2	133	.4583	2
95	.4505	2	134	.4505	2
96	.4583	2	135	.4401	2
97,98	.4635	2	136	.2036	3
99	.4583	2	137	.2132	3
100	.4505	2	138	.2214	3
101	.4401	2	139	.2266	3
102	.4635	2	140-174	.5333	1
103	.4401	2	175-181	.4270	1
104	.4583	2			

VALUES OF m AND φ

Single Strut Support (B)			m	φ
Case 1	C.G. at 28% $\bar{c}$	on M.A.C.	.3201	62.96°
2	28% $\bar{c}$	8" above F.D.	.2387	52.44
3	31% $\bar{c}$	8" above F.D.	.2062	66.54
4	35% $\bar{c}$	8" above F.D.	.1892	90.79

Twin Strut Support (U)			m	φ
Case 5	C.G. at 28% $\bar{c}$	on M.A.C.	.0265	142.96°
6	28% $\bar{c}$	8" above F.D.	.0828	255.19
7	31% $\bar{c}$	8" above F.D.	.1164	223.40
8	35% $\bar{c}$	8" above F.D.	.1872	205.31

Note

Comparison of twin strut and single strut support runs show some wide discrepancies particularly in C_M. To correct the single strut support runs a ΔC_M, ΔC_L and ΔC_D have been found by subtracting the twin strut values from the single strut.

These corrections appear on Sheets 2.5 to 2.7 for the range of elevator angles.

Rather than apply these corrections directly to basic data it was thought simpler to apply them to longitudinal results after reduction to C.G. position and stability axes, and as separate corrections to β derivatives after the uncorrected slopes had been read.

$$\Delta C_N = -\frac{\Delta D}{qSb}\, l \sin\psi$$

$$\Delta C_{N\beta} = \frac{\Delta C_D}{b}\, l \quad \text{PER RADIAN}$$

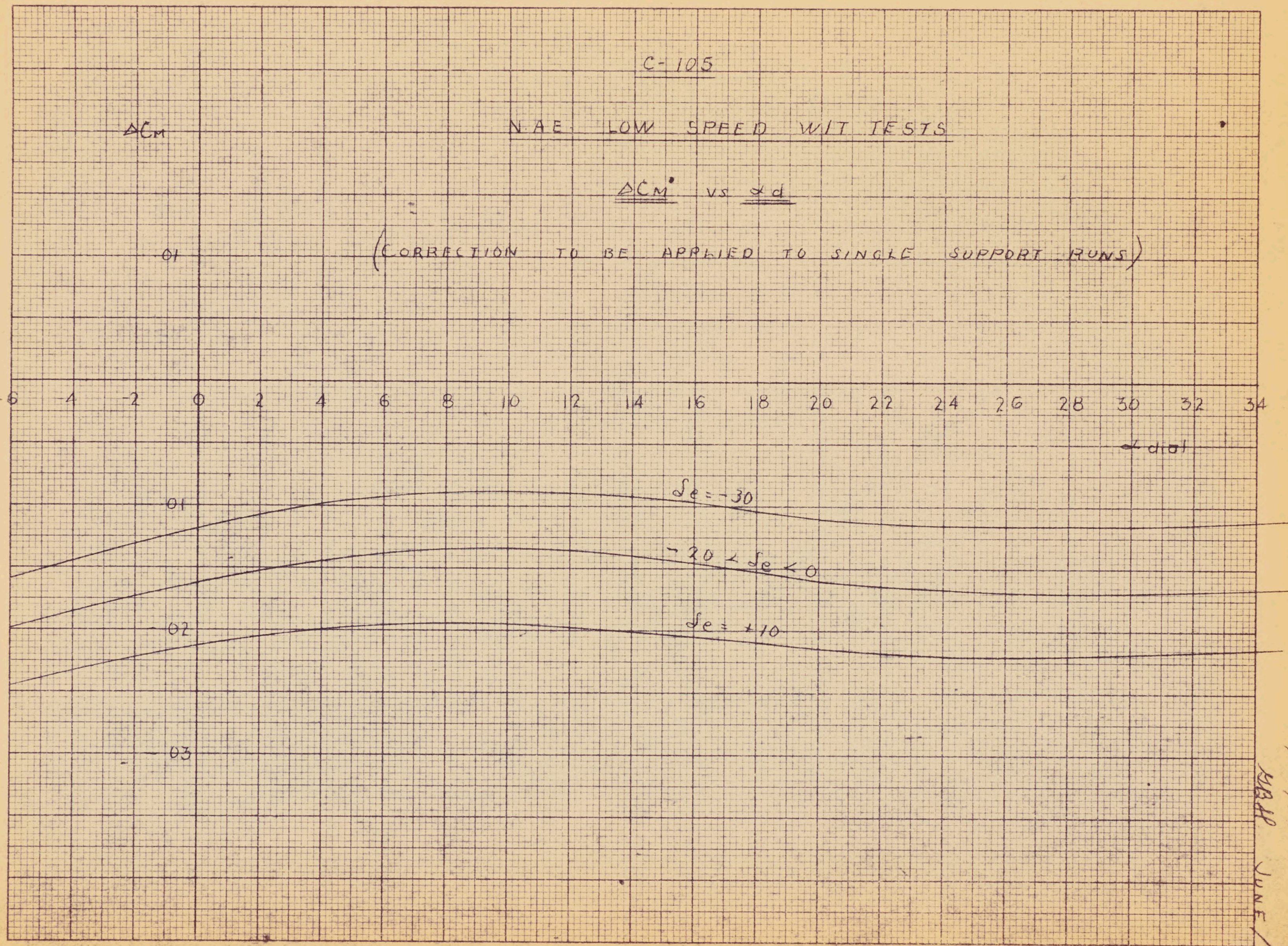
$$\Delta C_Y = \frac{\Delta D}{qS} \sin\psi$$

$$\Delta C_{Y\beta} = -\Delta C_D \quad \text{PER RADIAN}$$

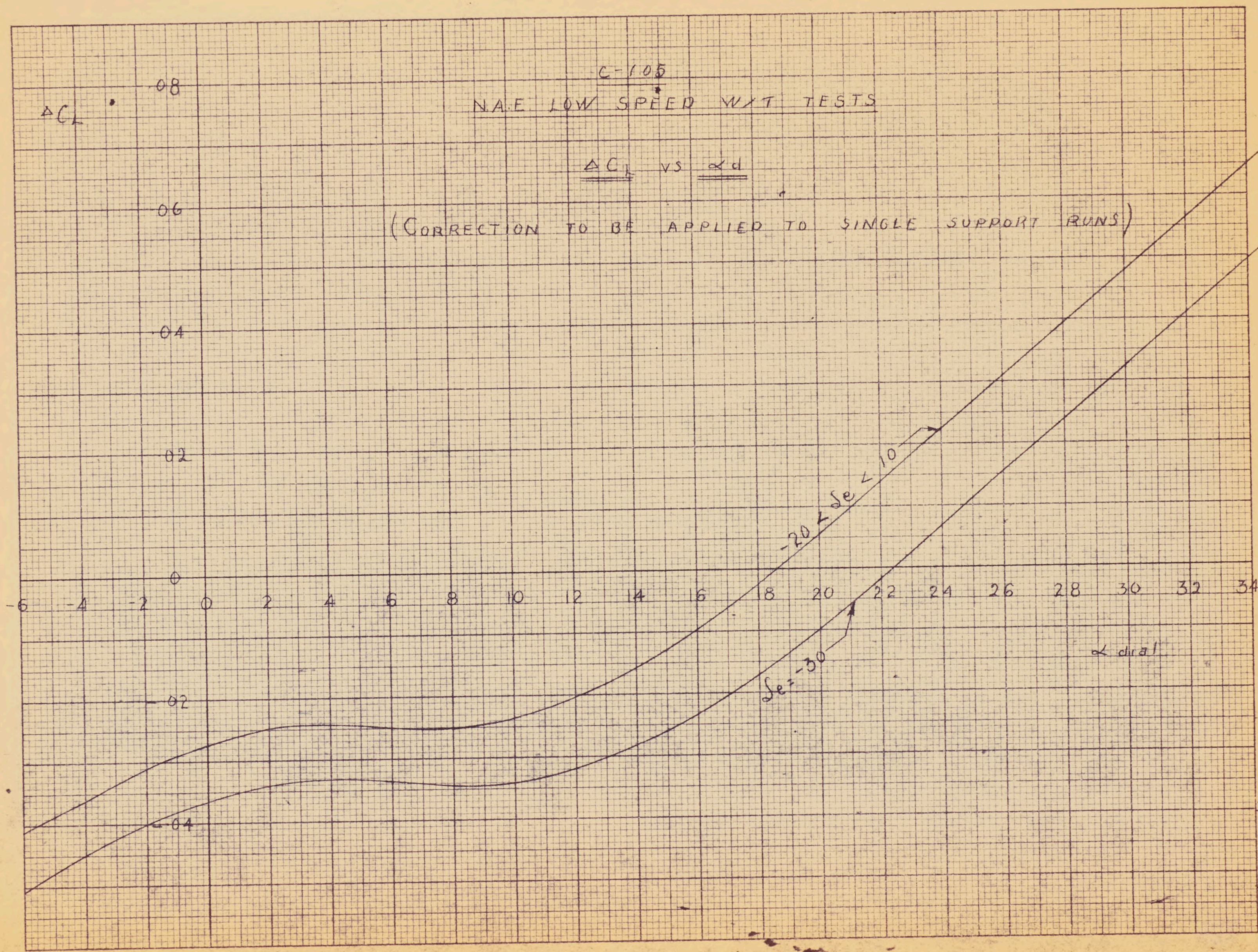
$$\Delta C_l = \frac{1}{qSb}\left[\Delta PM + \Delta D(h-\mu)\right] \sin\psi$$

$$\Delta C_{l\beta} = -\frac{1}{b}\left[\Delta C_M \bar{c} + \Delta C_D (h-\mu)\right]$$

$\Delta C_{N\beta}$ & $\Delta C_{l\beta}$ ARE GIVEN ON SHEETS 28 & [illegible]



P/WT/116 2.5
GBH JUNE/56

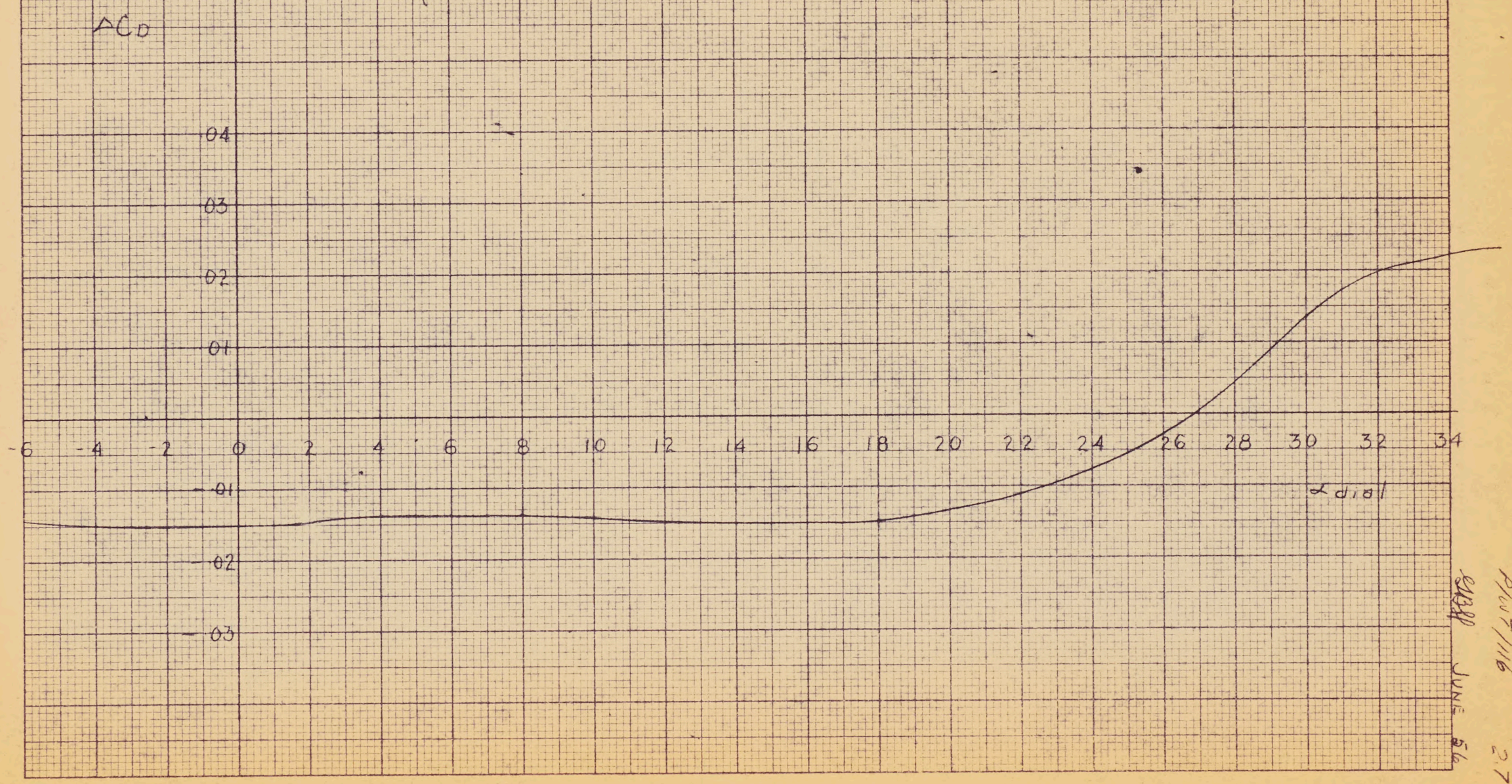

C-105
N.A.E LOW SPEED W/T TESTS
ΔCL VS αd
(CORRECTION TO BE APPLIED TO SINGLE SUPPORT RUNS)
ΔCL
·08
·06
·04
·02
0
-·02
-·04
-6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
α dial
-20 < δe < 10
δe = -30

C-105

NAE LOW SPEED WIT TESTS

ΔC_D vs α_d

(CORRECTION TO BE APPLIED TO SINGLE SUPPORT RUNS)



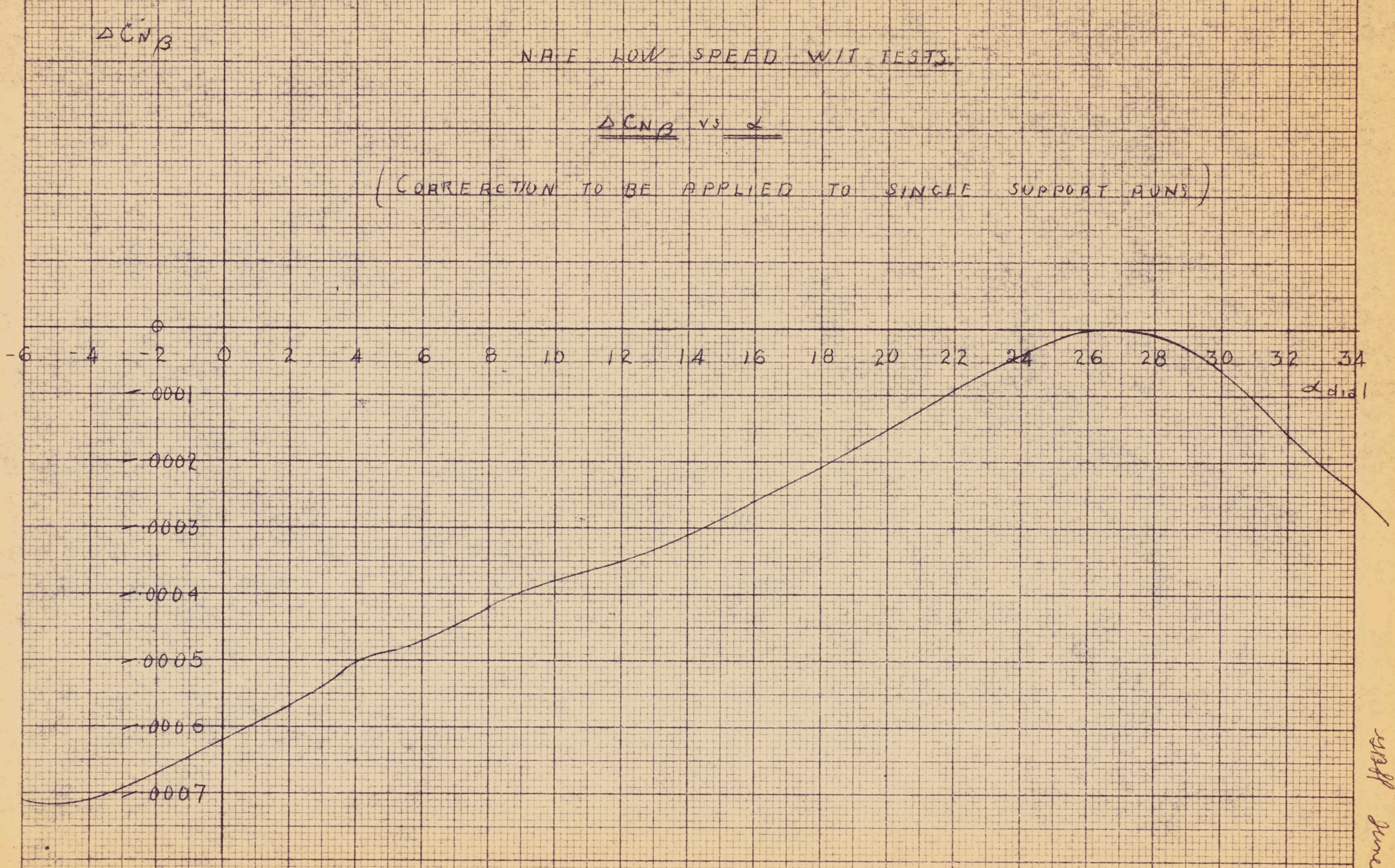
K+E 10 X 10 TO THE ½ INCH 359-12 KEUFFEL & ESSER CO. MADE IN U.S.A.

C-105

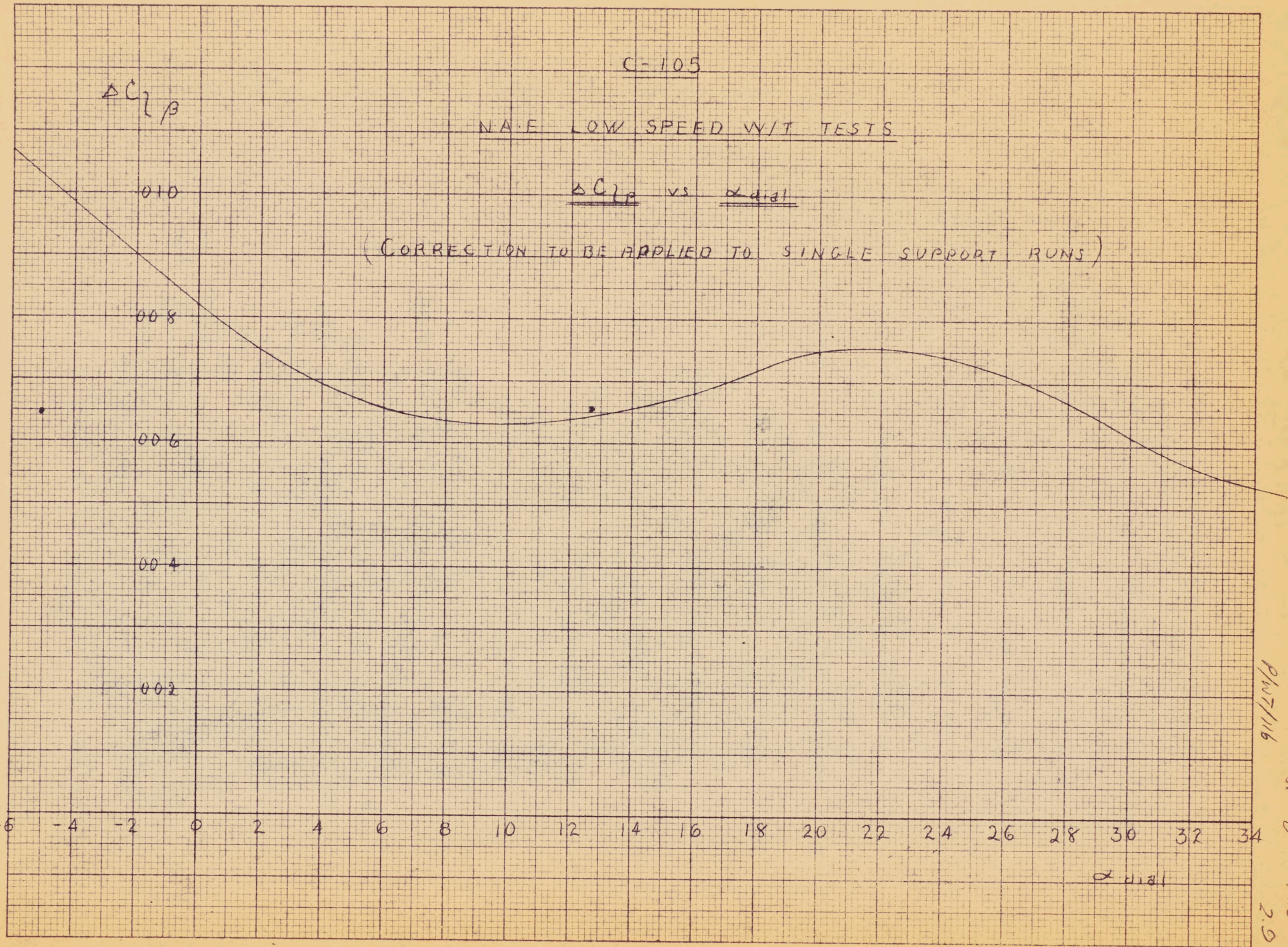
NAE LOW SPEED WIT TESTS.

$\Delta C_{N\beta}$ vs α

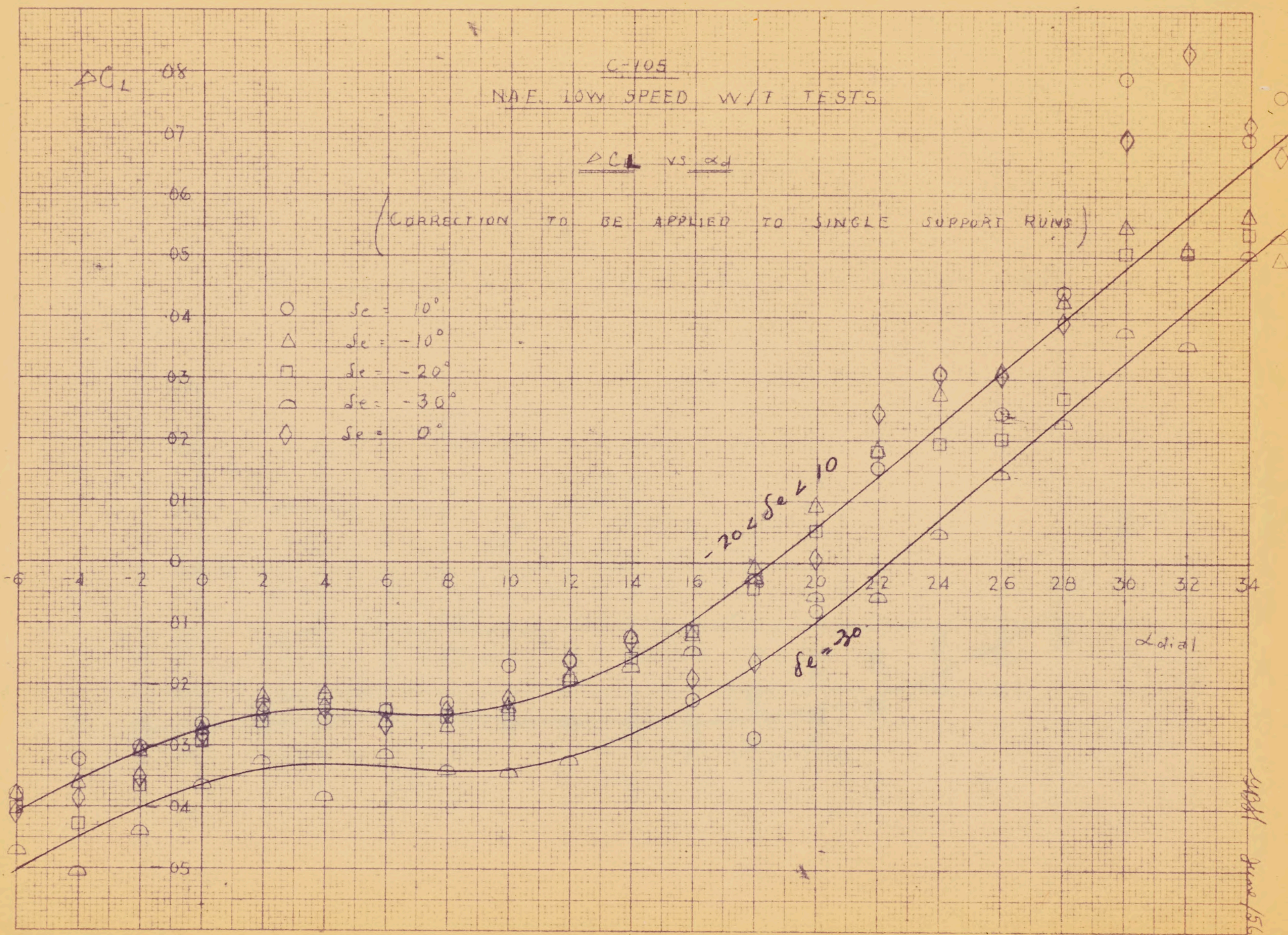
(CORRECTION TO BE APPLIED TO SINGLE SUPPORT RUNS)

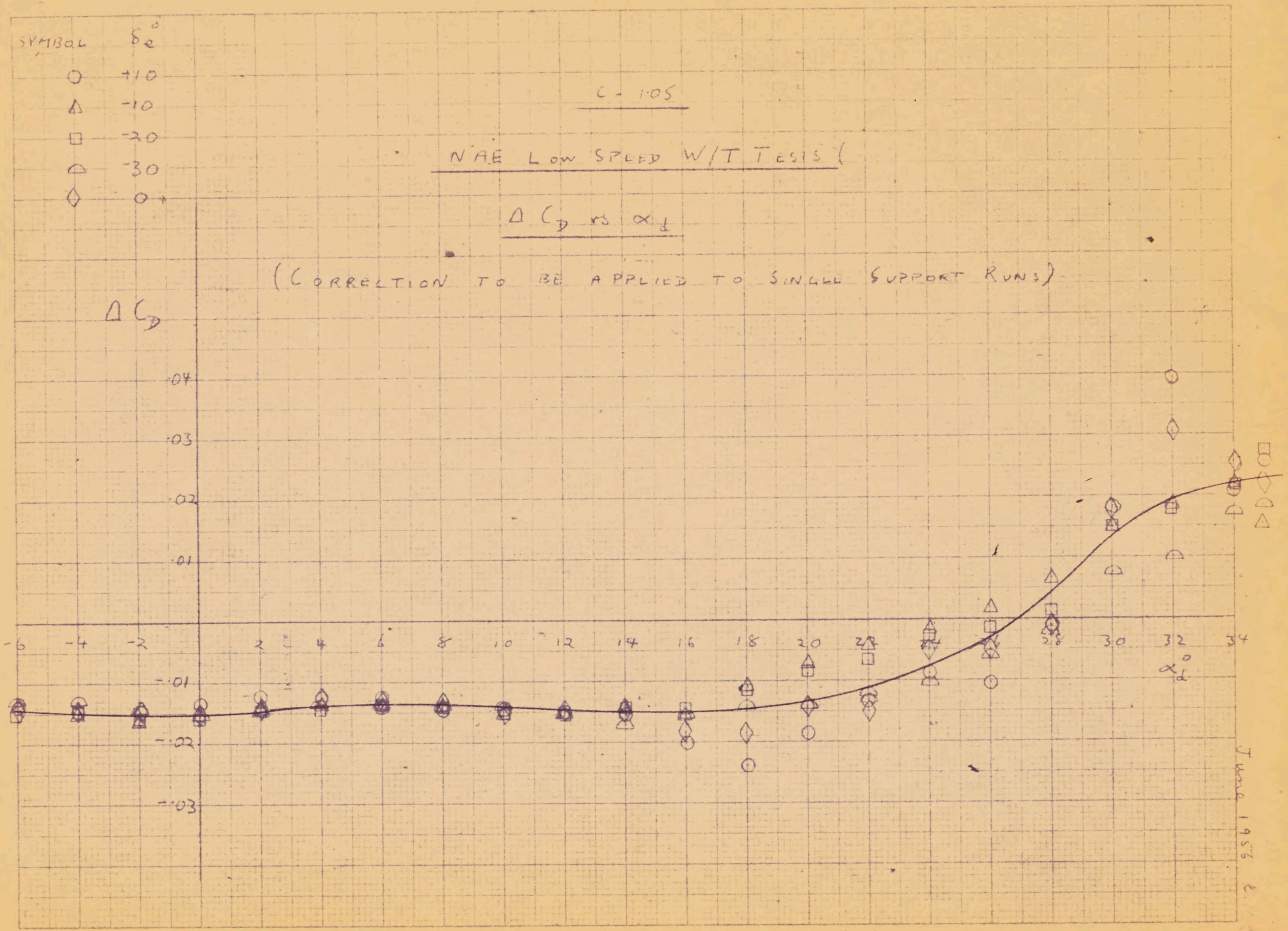


M/WT/116 GBff June 56 2.8



P/WT/116 June /56
2.9


C-105
N.A.E. LOW SPEED W/T TESTS
ΔCL vs αd
(CORRECTION TO BE APPLIED TO SINGLE SUPPORT RUNS)
ΔCL
αdial
○ δe = 10°
△ δe = -10°
□ δe = -20°
⌓ δe = -30°
◇ δe = 0°
-20 < δe < 10
δe = -30°
June /56



SYMBOL δ_e^o
○ +10
△ −10
□ −20
⌓ −30
◇ 0
C - 1·05
NAE Low Speed W/T Tests (
ΔC_D vs α_d
(Correction to be applied to single support runs)
ΔC_D
·04
·03
·02
·01
−·01
−·02
−·03
−6
−4
−2
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
α_d^o
June 1956