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CURRENT PAPERS

# Tests on A.W. Apollo (Brab 11B) in the N.P.L. Compressed Air Tunnel

By

C. Salter, M.A., C. J. W. Miles and P. S. Pusey, B. Sc.,
of the Aerodynamics Division, N.P.L.



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## Corrigenda

| | | |
|---|---|---|
| Page 1. | Summary. | Add "Because of mechanical failure of the blades in the course of the tests the results obtained with windmilling airscrews were not regarded as being reliable nor the differences large enough to be significant. Making use of the observations however the effect on neutral point does in fact lead to close agreement with the results of full scale tests. <br><br> Some comparisons with full scale tests are appended. |
| Page 1. | Model, line 5. | The wing section was similar to NACA 65-2-318 but not quite identical with it. |
| Page 5. | Airscrew. | See Appendix I. |
| Page 17. | Set J. Heading | Omit "Normal". |
| Fig.3. | Lower diagram. | "30° Flaps" should read "38° Flaps" |

C.P. No.40

# Tests on A.W. Apollo (Brab IIB) in the N.P.L. Compressed Air Tunnel.

- By -
C. Salter, M.A., C. J. W. Miles and P. S. Pusey, B.Sc.,
of the Aerodynamics Division, N.P.L.

22nd December, 1949

Summary

The report describes results of tests on a 1/25-scale model up to a Reynolds number of 5 millions. The investigation covered the effect of slotted flaps, (32° and 38°), elevators, tail plane, body-wing fillets and freely rotating airscrews.

Except for those cases where the flap setting was 32° a general tendency was found for a large decrease in the slope of the lift curve at an angle of incidence considerably lower than that corresponding to $C_{L\ max}$.

The values found for $C_{L\ max}$ were disappointingly low and none of the changes of body-wing fillets or alterations of flap shapes or angles led to any appreciable increase. $\Delta C_{L\ max}$ due to flaps was of the order of 0.3.

## Model

The model was constructed by Messrs. Armstrong Whitworth Aircraft Ltd. to a scale of 1/25 full-size. The wings were made of metal and the body of phenoglazed wood. An outline drawing with main dimensions is given in Fig. 1.

The wing section NACA 65-2-318 had a maximum thickness of 18% at 0.421c and a maximum camber of 2.24% at 0.441c. It was derived from a Goldstein "roof-top" fairing with an NACA camber giving constant loading to 0.5c decreasing linearly to zero at the trailing edge. It was similar to that previously used for the root section of the Hurricane except for an increase in the camber in the ratio 30/25 giving a value of $C_L$ (optimum) of 0.30. Ordinates for the section are based on chord measured to the "nominal" trailing edge on A.W. drawing W.T.M. 1308. The actual trailing edge is a little farther back and the tail of the section therefore slightly cusped.

As a result of preliminary work at the R.A.E. and at the N.P.L. a number of body-wing fillets were supplied later for comparative examination. Outline sketches are reproduced in Fig. 2.

Slotted/

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Slotted flaps of 34% mean chord and total length equal to 53.7% of the span of the machine extended across the body and were adjustable for flap angles of 0°, +32° and +38°. Being in three parts the centre portion (25.8% span) could be retained in the zero position so that it was possible to examine, the effect of the out-board sections(27.9% span) only. The flaps are illustrated in Fig. 3.

A variety of brackets allowed the elevators to be set in turn at +10°, 0°, -10° and -20°, and provision was made for fitting airscrew blades to the freely rotating spinners while the four jet exits were paired off in the usual way.

The normal tail unit ($\eta_t$ = -1°) was detachable and could be replaced either by an alternative unit ($\eta_t$ = +2°) or by a tail fairing block without fin or tail plane.

## Range of Tests

As the mean chord of the model was only 0.429 feet a maximum Reynolds number of 5 millions was all that could be obtained but tests were also made at lower values and in particular at 0.2 and 0.5 millions for comparison with results obtained in Messrs. Armstrong Whitworth's tunnel and at the R.A.E. respectively.

For a number of reasons including the need to examine the influence of the various body-wing fillets the programme had to be somewhat restricted but it is hoped that the information obtain is reasonably comprehensive.

The various arrangements considered are listed in the following table:-

| Set | Fillet No. | Tail | Flaps (degrees) | Elevators (degrees) | |
|---|---|---|---|---|---|
| A | 9 | $\eta_t$ = -1° | 0 | 0 | |
| B | 9 | " | 32 | 0 | |
| C | 9 | " | 32 (outer flaps)<br>0 (inner flaps) | 0 | |
| D | 8 | " | 32 | 0 | |
| E | 2 | " | 32 | 0 | |
| F | 10 | " | 0 | 0 | |
| G | 10 | " | 0 | 0 | With airscrews |
| H | 10 | " | 38 | 0 | |
| J | 10 | $\eta_t$ = +2° | 0 | 0 | |
| K | 10 | $\eta_t$ = -1° | 0 | +10 | |
| L | 10 | " | 0 | -10 | |
| M | 10 | " | 38 | -10 | |
| N | 8 | No Tail | 0 | - | |
| P | 10 | " | 38 | - | |

Tables/

Tables and Figures

The appended tables contain the results of various sets of observations and the figures illustrate the main characteristics. In some cases the results were so nearly alike those of one or other of the tables that they are omitted; for example sets E and G were closely similar to D and F respectively. In the first case the only change was the replacement of fillet No.8 by No.2 and in the second the attachment of the airscrew blades.

Other tests (including set C) of an exploratory or comparative nature are not recorded but are referred to in the text.

Results

Lift coefficient and $C_{L\ max}$ curves

A few typical curves of $C_L$ against $\alpha$ are given in Fig.4 for a value of R of roughly $3.8 \times 10^6$. An interesting feature is that with nearly all the variations and adjustments that were examined the slope of the curves decreased considerably at an angle of incidence much earlier than that corresponding to $C_{L\ max}$, (see curves F and H of Fig.4). The points at which the slope fell off could always be repeated with good consistency but there was often difficulty in repeating the observations at higher values of $\alpha$.

The two exceptions to this general tendency occurred with a flap setting of 32° when the model was fitted with body wing fillets Nos. 2 and 8. Curve D in Fig.4 refers to the latter. The curve for the former is closely similar. In these cases $C_{L\ max}$ was attained at two angles of incidence, one at the commencement of stalling and the other at a much higher angle. This will be referred to later in the discussion of the effect of flaps.

The variations of $C_{L\ max}$ with R are given in Fig.5. The tables include the values of $\alpha$ at which these maxima occur.

Pitching Moment and Drag Coefficients

Except in the investigation of elevator power no difficulty was experienced in obtaining consistent values of pitching moment at various angles of incidence. The curves of Fig.6 illustrate $C_m/C_L$ for various conditions at a Reynolds number of about $3.8 \times 10^6$. This value of R has been chosen as giving the best set of curves for purposes of comparison.

The coefficients are given about a point 0.25 $\bar{c}$ from the leading edge of the centre wing section and one inch below the body datum (model right way up).

Minimum drag coefficients for the sets of observations where the flaps were set in the zero position are plotted in Fig.7.

Body-Wing Fillets

When first delivered to the N.P.L. the model was fitted with small body-wing fillets No.1 and as the earlier observations showed disappointingly low maximum lift coefficients at high Reynolds Numbers some attention was given to a comparison in this respect of different shapes of fillets (Fig.2).

It/

It has already been mentioned that, on the model with 32° flap settings, fillets Nos. 2 and 8 showed no difference. Similarly under these conditions there was little to choose between Nos. 8 and 10, while curves B and D in Fig.5 show the similarity as regards Nos. 8 and 9.

At zero flap angles a comparison between curves A and F suggests that fillet No.10 might be a slight improvement on No.9 at high values of R. A consideration of the shape of the $C_L$ against $\alpha$ curves will however show that the difference is not significant.

In the preliminary measurements made with the small fillet the results were much the same as those recorded for set A. Generally speaking there is nothing to show that one fillet is appreciably better than another.

Other Fillets

As a result of a few visual tests at low Reynolds numbers which indicated that flow troubles might be occurring at the inboard nacelles, the latter were built up with plasticine fillets, apparently leading to a considerably improvement of the flow. Subsequent measurements of lift did not however show any significant gain. These were necessarily made only at moderate values of R because of the inability of plasticine to retain its shape in the high pressure stream.

Effect of Flaps

In conjunction with other variables the model was examined with flaps at 0°, 32° and 38°. Halfway through the experiments the model was returned for modification of the flap brackets to permit a flap angle of 38°. At the same time alterations were made to the flap and frize profiles and to the backward travel (Fig.3). Sets A to E, which include all the 32° settings, and also N were carried out before modification and the remainder which include the 38° flaps afterwards.

Circumstances did not permit a close investigation into the effect of the alterations but a repeat of set C (outboard portions of flaps at 32°, centre portion at 0°) with modified 32° flaps showed that the only difference was an increase in the values of $\alpha$ by approximately one degree.

Details of the flaps, frizes and slots are given in the firm's drawings Nos. WTM 1494-6 and 1592 and typical sketches are reproduced in Fig.3. Using the templates employed in construction a check was made of the accuracy of the model in relation to the drawings. The deviations were found to be too small to allow figures to be specified but to illustrate the sort of error found, the 38° flaps were correctly set as regards angle but the backward travel was slightly inadequate while the downward movement was slightly excessive.

A comparison based on actual values of $\Delta C_{L\,max}$ is not entirely satisfactory in view of the large associated values of $\alpha$ for all cases except those where the complete flaps (centre and outside portions) were set at 32°. The following table however gives the approximate increases obtained.

Table/

| Comparison | Increase | Flaps |
|---|---|---|
| A & B | 0.3 | 32° |
| A & D | 0.3 | " |
| N & P (No Tail) | 0.35 | 38° at high Reynolds numbers |
| F & H | 0.24 | " " " " " |
| L & M (with elevators) | 0.26 | " |
| Sundry other tests (a) | 0.33 | " |
| Sundry other tests (b) | 38° slightly better than 32° | |

An examination of the model with only the outboard sections of flap at 32° resulted in nearly as high a value of maximum lift as with the complete flaps at 32° but at an angle of incidence of 20° (curve similar to H in Fig.4).

The lift curve D in Fig.4 and the corresponding curves for B, taken in conjunction with the other evidence, is sufficient to demonstrate that the original arrangement at 32° is the best one.

It will be noticed however that in curve B of Fig.5, the values of $C_{L\,max}$ at $R = 1.4 \times 10^6$ and $2.2 \times 10^6$ are greater than at the top Reynolds numbers. In this region with sets B and D, and as found in sundry other unrecorded observations, all with flaps at 32°, there was a tendency to double values of $C_{L\,max}$.

The influence of the flaps on pitching moment $C_m$ is indicated in Fig.6.

<u>Tail Plane</u>

Sets F and A (normal tail), J (alternative tail unit) and N (plain tail fairing) were obtained for the estimation of downwash and tail plane constant $a_1$. Typical pitching moment curves are given in Fig.6.

<u>Elevators</u>

Measurements of pitching moment with elevator settings ±10° showed an unusual variation with change of Reynolds number, thought to be due to the bending of the elevators under load as they could easily be distorted with the fingers. As a check on this, stiffening brackets were attached to the under surface but no improvement followed and the consistency of repeat observations, usually extremely good in the C.A.T. when conditions are unaltered, was poor. The scatter of points however did not seem to be great enough to justify further investigation. The actual elevator settings were measured and found to be approximately 0°, +9°, $-10\frac{1}{2}$°.

Elevator power is obtained from sets F, K and L, (unflapped) and H and M (with 38° flaps).

<u>Airscrews</u>

The effect of freely rotating airscrews was examined by a repetition of set F with no other modification than the addition of the blades. The differences were found to be negligible.

Table/

Set A

Fillets No.9 — Flaps at 0°

Normal Tail $\eta_t = -1°$ — Elevators at 0°

$P = 1.015$ Atmos $\rho V^2 = 13.22$ lb./sq.ft. $V = 74.3$ FPS $R = 0.203 \times 10^6$

| | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -6.1 | -0.458 | 0.0496 | 0.1925 |
| -3.6 | -0.239 | 0.0387 | 0.144 |
| -2.3 | -0.125 | 0.0363 | 0.1087 |
| -1.0 | -0.010 | 0.0353 | 0.0819 |
| +0.25 | +0.104 | 0.0351 | 0.0560 |
| 1.5 | 0.216 | 0.0364 | 0.0317 |
| 4.0 | 0.457 | 0.0409 | -0.0138 |
| 6.5 | 0.705 | 0.0489 | -0.0593 |
| 9.05 | 0.896 | 0.0699 | -0.1037 |
| 11.45 | 1.084 | 0.0968 | -0.190 |
| 12.7 | 1.118 | 0.118 | -0.204 |
| 14.0 | 1.118 | 0.153 | -0.217 |
| 15.3 | 1.094 | 0.197 | -0.237 |
| 16.65 | 1.025 | 0.253 | -0.258 |
| 19.35 | 0.923 | 0.326 | -0.264 |
| 21.9 | 0.942 | 0.389 | -0.288 |
| 24.5 | 0.947 | 0.452 | -0.328 |

$C_{L\ max}$ 1.12 at 13°

$P = 2.71$ Atmos $\rho V^2 = 29.2$ lb./sq.ft. $V = 67.3$ FPS $R = 0.493 \times 10^6$

| α | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -2.35 | -0.131 | 0.0279 | 0.0999 |
| -1.05 | -0.021 | 0.0255 | 0.0777 |
| +0.2 | +0.101 | 0.0244 | 0.0519 |
| 1.45 | 0.223 | 0.0250 | 0.0278 |
| 2.7 | 0.350 | 0.0275 | 0.0018 |
| 5.2 | 0.591 | 0.0371 | -0.0444 |
| 7.7 | 0.832 | 0.0528 | -0.0953 |
| 10.2 | 1.04 | 0.0764 | -0.1595 |
| 11.4 | 1.11 | 0.0926 | -0.1925 |
| 12.65 | 1.155 | 0.112 | -0.208 |
| 13.95 | 1.17 | 0.141 | -0.223 |
| 15.25 | 1.155 | 0.191 | -0.250 |
| 16.55 | 1.12 | 0.225 | -0.272 |
| 19.25 | 1.00 | 0.281 | -0.277 |

$C_{L\ max}$ 1.17 at 14°

$P = 12.63$ Atmos $\rho V^2 = 135.4$ lb./sq.ft. $V = 68.8$ FPS $R = 2.19 \times 10^6$

| α | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -2.35 | -0.147 | 0.0229 | 0.1083 |
| -1.05 | -0.019 | 0.0216 | 0.0815 |
| +0.2 | +0.099 | 0.0199 | 0.0593 |
| 1.45 | 0.221 | 0.0212 | 0.0350 |
| 2.7 | 0.343 | 0.0237 | 0.0099 |
| 5.2 | 0.599 | 0.0337 | -0.0428 |
| 7.7 | 0.835 | 0.0497 | -0.0924 |
| 10.2 | 1.04 | 0.0738 | -0.133 |
| 12.6 | 1.225 | 0.107 | -0.199 |
| 13.9 | 1.30 | 0.122 | -0.218 |
| 15.2 | 1.31 | 0.158 | -0.245 |
| 16.45 | 1.32 | 0.202 | -0.281 |
| 17.8 | 1.37 | 0.233 | -0.309 |
| 19.1 | 1.395 | 0.252 | -0.322 |
| 20.4 | 1.38 | 0.301 | -0.339 |
| 21.7 | 1.375 | 0.347 | -0.360 |
| 24.3 | 1.325 | 0.427 | -0.395 |

$C_{L\ max}$ 1.39 at 19°

Set A (Contd.)/

Set A (Contd.)

P = 19.35 Atmos $\rho V^2$ = 179.6 lb./sq.ft.
V = 63.6 FPS R = $3.18 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -2.4 | -0.149 | 0.0223 | 0.106 |
| -1.1 | -0.025 | 0.0209 | 0.0726 |
| +0.25 | +0.099 | 0.0204 | 0.0596 |
| 1.5 | 0.224 | 0.0212 | 0.0349 |
| 2.75 | 0.349 | 0.0240 | 0.0096 |
| 5.25 | 0.596 | 0.0340 | -0.0374 |
| 7.75 | 0.833 | 0.0498 | -0.0852 |
| 10.25 | 1.048 | 0.0717 | -0.1324 |
| 12.65 | 1.235 | 0.103 | -0.198 |
| 13.85 | 1.328 | 0.133 | -0.241 |
| 15.15 | 1.267 | 0.170 | -0.257 |
| 16.45 | 1.325 | 0.203 | -0.285 |
| 17.8 | 1.375 | 0.229 | -0.310 |
| 19.1 | 1.41 | 0.258 | -0.326 |
| 20.3 | 1.40 | 0.300 | -0.342 |
| 21.7 | 1.38 | 0.344 | -0.365 |
| 23.0 | 1.355 | 0.385 | -0.384 |
| 25.65 | 1.305 | 0.463 | -0.430 |

$C_L$ max 1.41 at 19°

P = 21.4 Atmos $\rho V^2$ = 230 lb./sq.ft.
V = 69.15 FPS R = $3.59 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -2.45 | -0.140 | | +0.1075 |
| +5.35 | +0.590 | | -0.0327 |
| 11.4 | 1.147 | | -0.1550 |
| 12.55 | 1.243 | | -0.187 |
| 13.75 | 1.254 | | -0.225 |
| 15.05 | 1.27 | | -0.263 |
| 16.35 | 1.310 | | -0.282 |
| 17.6 | 1.375 | | -0.310 |
| 18.85 | 1.40 | | -0.326 |
| 20.15 | 1.405 | | -0.345 |
| 21.45 | 1.38 | | -0.366 |
| 22.8 | 1.335 | | -0.386 |
| 24.1 | 1.31 | | -0.404 |

$C_L$ max 1.41 at 19°

P = 24.95 Atmos $\rho V^2$ = 359 lb./sq.ft.
V = 79.6 FPS R = $5.01 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -2.4 | -0.105 | 0.0227 | 0.0990 |
| -1.00 | +0.016 | 0.0214 | 0.0746 |
| +0.3 | 0.130 | 0.0212 | 0.0526 |
| 1.55 | 0.233 | 0.0227 | 0.0322 |
| 2.8 | 0.341 | 0.0254 | 0.0133 |
| 5.3 | 0.582 | 0.0355 | -0.0308 |
| 7.8 | 0.813 | 0.0518 | -0.0740 |
| 10.3 | 1.04 | 0.0778 | -0.1215 |
| 11.5 | 1.15 | 0.0898 | -0.1525 |
| 12.65 | 1.23 | 0.105 | -0.1845 |
| 13.95 | 1.22 | 0.128 | -0.218 |
| 15.2 | 1.265 | 0.158 | -0.260 |
| 16.5 | 1.315 | 0.193 | -0.288 |
| 17.8 | 1.35 | 0.228 | -0.310 |
| 19.1 | 1.39 | 0.269 | -0.329 |
| 20.35 | 1.41 | 0.318 | -0.353 |
| 21.65 | 1.37 | | -0.370 |
| 22.95 | 1.32 | | -0.386 |
| 25.6 | 1.23 | | -0.415 |

$C_L$ max 1.41 at 20°



Set B/

Set B

Fillets No.9
Flaps at 32°

Normal Tail $\eta_t = -1°$
Elevators at 0°

| $P = 1.0$ Atmos $\rho V^2 = 13.21$ lb./sq.ft. $V = 74.2$ FPS $R = 0.205 \times 10^6$ | | | | $P = 2.78$ Atmos $\rho V^2 = 29.2$ lb./sq.ft. $V = 66.1$ FPS $R = 0.507 \times 10^6$ | | | | $P = 4.56$ Atmos $\rho V^2 = 49.0$ lb./sq.ft. $V = 67.9$ FPS $R = 0.845 \times 10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -5.05 | 0.117 | 0.0977 | 0.119 | -5.05 | 0.132 | 0.0937 | 0.0846 | -5.1 | 0.148 | | +0.0857 |
| -2.45 | 0.361 | 0.102 | 0.0836 | -2.5 | 0.368 | 0.0961 | 0.0551 | +5.05 | 1.11 | | -0.0515 |
| +0.05 | 0.594 | 0.113 | 0.0373 | +0.05 | 0.599 | 0.102 | 0.0272 | 8.8 | 1.45 | | -0.115 |
| 2.55 | 0.828 | 0.124 | 0.0002 | 2.55 | 0.835 | 0.116 | -0.0098 | 10.05 | 1.535 | | -0.135 |
| 5.05 | 1.080 | 0.141 | -0.0446 | 5.05 | 1.084 | 0.136 | -0.0510 | 11.25 | 1.525 | | -0.189 |
| 7.6 | 1.305 | 0.163 | -0.0852 | 7.6 | 1.308 | 0.157 | -0.0897 | 12.5 | 1.535 | | -0.1925 |
| 8.85 | 1.41 | 0.180 | -0.1127 | 8.85 | 1.42 | 0.175 | -0.117 | 13.8 | 1.525 | | -0.265 |
| 10.05 | 1.46 | 0.211 | -0.180 | 10.05 | 1.47 | 0.201 | -0.1645 | 15.1 | 1.52 | | -0.270 |
| 11.3 | 1.445 | 0.257 | -0.241 | 11.3 | 1.45 | 0.246 | -0.238 | 16.4 | 1.45 | | -0.276 |
| 12.6 | 1.41 | 0.298 | -0.254 | 12.6 | 1.425 | 0.288 | -0.253 | | | | |
| 13.9 | 1.41 | 0.326 | -0.252 | 13.9 | 1.415 | 0.321 | -0.257 | | | | |
| 15.2 | 1.435 | 0.358 | -0.250 | 15.2 | 1.415 | 0.363 | -0.268 | | | | |
| 16.55 | 1.31 | 0.443 | -0.260 | 16.5 | 1.345 | 0.425 | -0.270 | | | | |
| | | | | 17.9 | 1.255 | 0.466 | -0.231 | | | | |
| $C_{L\,max}$ 1.46 at 10° | | | | $C_{L\,max}$ 1.47 at 10° | | | | $C_{L\,max}$ 1.54 at $10\frac{1}{2}$° | | | |



Set B (Contd.)/

Set B (Contd.)

**P = 8.16 Atmos $\rho V^2$ = 81.3 lb./sq.ft.
V = 65.5 FPS R = 1.40 x $10^6$**

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -5.05 | 0.152 | 0.0927 | 0.090 |
| 0.05 | 0.637 | 0.101 | 0.022 |
| +5.05 | 1.12 | 0.133 | -0.053 |
| 8.8 | 1.48 | 0.174 | -0.119 |
| 10.0 | 1.58 | 0.189 | -0.140 |
| 11.25 | 1.67 | 0.207 | -0.164 |
| 12.45 | 1.755 | 0.235 | -0.197 |
| 13.8 | 1.67 | 0.283 | -0.222 |
| 15.05 | 1.60 | 0.340 | -0.284 |
| 16.35 | 1.60 | 0.383 | -0.285 |
| 17.7 | 1.59 | 0.423 | -0.270 |
| 20.45 | 1.305 | 0.540 | -0.246 |

$C_{L\,max}$ 1.75 at $12\frac{1}{2}^\circ$

**P = 13.15 Atmos $\rho V^2$ = 135.5 lb./sq.ft.
V = 67.6 FPS R = 2.22 x $10^6$**

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -4.95 | 0.152 | 0.0912 | 0.0965 |
| -2.5 | 0.393 | 0.092 | 0.061 |
| +0.05 | 0.645 | 0.101 | 0.0217 |
| 2.55 | 0.882 | 0.114 | -0.0128 |
| 5.05 | 1.115 | 0.134 | -0.0522 |
| 7.55 | 1.365 | - | -0.1087 |
| 10.0 | 1.57 | 0.191 | -0.140 |
| 11.25 | 1.675 | 0.209 | -0.165 |
| 12.5 | 1.74 | 0.232 | -0.190 |
| 13.75 | 1.70 | 0.310 | -0.304 |
| 15.05 | 1.69 | 0.338 | -0.301 |
| 16.4 | 1.65 | 0.367 | -0.291 |
| 17.75 | 1.66 | 0.403 | -0.284 |
| 20.35 | 1.64 | 0.474 | -0.299 |
| 22.95 | 1.46 | 0.578 | -0.286 |

$C_{L\,max}$ 1.74 at $13^\circ$

**P = 19.35 Atmos $\rho V^2$ = 180.0 lb./sq.ft.
V = 64.2 R = 3.10 x $10^6$**

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -5.05 | 0.181 | 0.089 | 0.0992 |
| -0.1 | 0.642 | 0.101 | 0.0238 |
| 5.1 | 1.115 | 0.132 | -0.0504 |
| 8.85 | 1.465 | 0.175 | -0.116 |
| 10.05 | 1.575 | 0.192 | -0.140 |
| 11.3 | 1.685 | 0.209 | -0.164 |
| 12.55 | 1.65 | 0.258 | -0.218 |
| 13.8 | 1.63 | 0.308 | -0.288 |
| 15.1 | 1.64 | 0.340 | -0.295 |
| 16.4 | 1.655 | 0.367 | -0.295 |
| 17.75 | 1.66 | 0.395 | -0.296 |
| 20.35 | 1.66 | 0.455 | -0.300 |

$C_{L\,max}$ 1.69 at $11\frac{1}{2}^\circ$



Set B (Contd.)/

Set B (Contd.)

| $P = 21.6$ Atmos $\rho V^2 = 230$ lb./sq.ft. $V = 68.8$ FPS $R = 3.69 \times 10^6$ | | | |
|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -5.05 | 0.189 | 0.090 | 0.1003 |
| -2.5 | | 0.094 | 0.0574 |
| +0.05 | | 0.103 | 0.0110 |
| 2.6 | | 0.118 | -0.0238 |
| 5.15 | 1.14 | 0.135 | -0.0588 |
| 7.65 | 1.375 | 0.160 | -0.1017 |
| 10.1 | 1.59 | 0.193 | -0.1427 |
| 11.25 | 1.70 | 0.215 | -0.170 |
| 12.55 | 1.655 | 0.252 | -0.215 |
| 13.8 | 1.645 | 0.311 | -0.293 |
| 15.1 | 1.64 | 0.341 | -0.293 |
| 16.4 | 1.65 | 0.372 | -0.296 |
| 17.75 | 1.65 | 0.398 | -0.292 |
| 19.05 | 1.69 | 0.431 | -0.305 |
| 20.25 | 1.70 | 0.465 | -0.311 |
| 21.6 | 1.585 | 0.526 | -0.305 |
| 22.95 | 1.50 | 0.565 | -0.301 |

$C_{L\,max}$ 1.71 at $11\frac{1}{2}°$

Set D/

Set D (E almost identical)

Fillets No.8      Normal Tail $\eta_t = -1$
Flaps at 32°      Elevators at 0°

| P = 1.00 Atmos $\rho V^2$ = 13.25 lb./sq.ft. V = 74.6 FPS R = 0.201 x $10^6$ | | | | P = 3.00 Atmos. $\rho V^2$ = 29.2 lb./sq.ft. V = 63.9 FPS R = 0.517 x $10^6$ | | | | P = 13.35 Atmos $\rho V^2$ = 135.8 lb./sq.ft. V = 66.3 FPS R = 2.31 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -5.05 | 0.132 | 0.0952 | 0.1135 | -5.15 | 0.153 | 0.0939 | 0.0845 | -5.05 | 0.171 | 0.0879 | .1009 |
| -2.5 | 0.361 | 0.0997 | 0.0910 | -2.55 | 0.397 | 0.0971 | 0.0544 | -2.45 | 0.416 | 0.0924 | .0609 |
| +0.05 | 0.596 | 0.110 | 0.0435 | 0 | 0.632 | 0.0988 | 0.0272 | +0.05 | 0.662 | 0.101 | .0225 |
| 2.5 | 0.837 | 0.122 | -0.0013 | +2.5 | 0.877 | 0.117 | -0.0141 | 2.55 | 0.906 | 0.116 | -.0131 |
| 5.05 | 1.065 | 0.139 | -0.0334 | 5.0 | 1.103 | 0.135 | -0.0465 | 5.05 | 1.145 | 0.133 | -.0518 |
| 7.6 | 1.30 | 0.162 | -0.0803 | 7.5 | 1.345 | 0.154 | -0.0889 | 7.6 | 1.38 | 0.162 | -.0922 |
| 8.85 | 1.39 | 0.181 | -0.119 | 8.8 | 1.435 | 0.178 | -0.1147 | 8.85 | 1.485 | 0.179 | -.1113 |
| 10.1 | 1.42 | 0.218 | -0.199 | 10.0 | 1.495 | 0.203 | -0.166 | 10.05 | 1.59 | 0.193 | -.1330 |
| 11.35 | 1.40 | 0.262 | -0.233 | 11.25 | 1.45 | 0.254 | -0.245 | 11.25 | 1.685 | 0.213 | -.1563 |
| 12.6 | 1.36 | 0.290 | -0.236 | 12.5 | 1.44 | 0.298 | -0.266 | 12.5 | 1.675 | 0.255 | -0.210 |
| 13.9 | 1.365 | 0.323 | -0.237 | 13.8 | 1.465 | 0.323 | -0.265 | 13.8 | 1.64 | 0.310 | -.289 |
| 15.2 | 1.365 | 0.355 | -0.239 | 15.1 | 1.445 | 0.361 | -0.263 | 15.1 | 1.645 | 0.340 | -.290 |
| 16.5 | 1.355 | - | - | 17.85 | 1.24 | 0.469 | -0.267 | 16.4 | 1.655 | 0.368 | -.290 |
| 19.25 | 1.16 | 0.499 | -0.219 | | | | | 17.75 | 1.655 | 0.401 | -.292 |
| | | | | | | | | 20.35 | 1.63 | 0.477 | -.288 |
| | | | | | | | | 23.05 | 1.44 | 0.581 | -.275 |
| $C_{L\,max}$ 1.42 at 10° | | | | $C_{L\,max}$ 1.50 at 10° | | | | $C_{L\,max}$ 1.70 at 11° | | | |



Set D (Contd.)/

Set D (Contd.)

$P = 21.8$ Atmos $\rho V^2 = 229.5$ lb./sq.ft.
$V = 68.3$ FPS $R = 3.70 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -5.05 | 0.211 | 0.0898 | 0.1018 |
| -2.5 | 0.462 | 0.0934 | 0.0680 |
| +0.05 | 0.703 | 0.102 | 0.0183 |
| 2.55 | 0.95 | 0.118 | -0.0210 |
| 5.15 | 1.17 | 0.135 | -0.0587 |
| 7.65 | 1.40 | 0.160 | -0.0999 |
| 8.9 | 1.50 | 0.174 | -0.114 |
| 10.1 | 1.61 | 0.189 | -0.135 |
| 11.3 | 1.71 | 0.208 | -0.1595 |
| 12.55 | 1.68 | 0.256 | -0.2135 |
| 13.8 | 1.615 | 0.310 | -0.287 |
| 15.1 | 1.635 | 0.338 | -0.291 |
| 16.4 | 1.66 | 0.365 | -0.293 |
| 17.75 | 1.675 | 0.398 | -0.300 |
| 19.0 | 1.70 | 0.430 | -0.314 |
| 20.35 | 1.685 | 0.468 | -0.306 |
| 23.0 | 1.495 | 0.569 | -0.290 |

$C_{L\,max}$ 1.72 at $11\frac{1}{2}°$

Set F/

Set F (G almost identical)

Fillets No.10 Normal Tail $\eta t = -1$
Flaps at 0° Elevators at 0°

| P = 1.0 Atmos $\rho V^2$ = 13.31 lb./sq.ft. V = 75.8 FPS R = 0.198 x $10^6$ | | | | P = 3.22 Atmos $\rho V^2$ = 29.4 lb./sq.ft. V = 63.15 FPS R = 0.52 x $10^6$ | | | | P = 15.05 Atmos $\rho V^2$ = 137.8 lb./sq.ft. V = 63.8 FPS R = 2.38 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.2 | -0.210 | | 0.1375 | -3.2 | -0.226 | 0.0312 | 0.127 | -3.2 | -0.230 | 0.0261 | 0.131 |
| -1.85 | -0.089 | 0.0378 | 0.107 | -1.9 | -0.111 | 0.0276 | 0.1033 | -1.9 | -0.113 | 0.0226 | 0.105 |
| -0.6 | +0.023 | 0.0361 | 0.0805 | -0.65 | +0.004 | 0.0260 | 0.0793 | -0.6 | +0.007 | 0.0211 | 0.0801 |
| +0.65 | 0.135 | 0.0371 | 0.0564 | +0.6 | 0.123 | 0.0263 | 0.0551 | +0.65 | 0.123 | 0.0201 | 0.0569 |
| 3.15 | 0.362 | 0.0403 | 0.0090 | 3.1 | 0.373 | 0.0301 | 0.0046 | 3.15 | 0.375 | 0.0246 | 0.0052 |
| 5.65 | 0.602 | 0.0469 | -0.0321 | 5.55 | 0.619 | 0.0392 | -0.0429 | 5.6 | 0.620 | 0.0374 | -0.0442 |
| 8.1 | 0.826 | 0.0575 | -0.0838 | 8.05 | 0.842 | 0.0565 | -0.0960 | 8.1 | 0.844 | 0.0527 | -0.0885 |
| 10.65 | 0.996 | 0.0897 | -0.1735 | 10.6 | 1.05 | 0.0816 | -0.1637 | 10.65 | 1.06 | 0.0772 | -0.148 |
| 11.9 | 1.055 | 0.112 | -0.195 | 11.8 | 1.10 | 0.0967 | -0.194 | 13.1 | 1.19 | 0.118 | -0.2085 |
| 13.2 | 1.07 | 0.141 | -0.208 | 13.1 | 1.08 | 0.127 | -0.2085 | 15.65 | 1.255 | 0.179 | -0.263 |
| 14.5 | 1.065 | 0.173 | -0.239 | 14.4 | 1.115 | 0.153 | -0.234 | 16.95 | 1.315 | 0.208 | -0.287 |
| 15.8 | 1.08 | 0.202 | -0.249 | 15.7 | 1.13 | 0.193 | -0.251 | 18.2 | 1.355 | 0.234 | -0.310 |
| 17.05 | 1.085 | 0.261 | -0.278 | 17.0 | 1.11 | 0.256 | -0.284 | 19.5 | 1.375 | 0.268 | -0.329 |
| 18.4 | 0.93 | 0.298 | -0.259 | 18.35 | 1.04 | 0.295 | -0.296 | 20.8 | 1.37 | 0.309 | -0.344 |
| | | | | | | | | 22.1 | 1.345 | 0.334 | -0.359 |
| | | | | | | | | 23.4 | 1.315 | 0.383 | -0.380 |
| $C_{L\,max}$ 1.09 at 17° | | | | $C_{L\,max}$ 1.13 at 16° | | | | $C_{L\,max}$ 1.38 at 20° | | | |



Set F (Contd.)/

Set F (Contd.)

| P = 24.1 Atmos $\rho V^2$ = 216 lb./sq.ft. V = 63.6 FPS R = 3.73 x $10^6$ | | | | P = 24.7 Atmos $\rho V^2$ = 366 lb./sq.ft. V = 81.4 FPS R = 4.96 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.15 | -0.227 | 0.0243 | 0.124 | -3.25 | -0.215 | 0.0256 | 0.119 |
| -1.85 | -0.108 | 0.0212 | 0.0990 | -1.95 | -0.090 | 0.0219 | 0.0926 |
| -0.6 | +0.009 | 0.0201 | 0.0753 | -0.6 | +0.031 | 0.0198 | 0.0694 |
| +0.65 | 0.128 | 0.0202 | 0.0517 | +0.7 | 0.146 | 0.0199 | 0.0476 |
| 3.15 | 0.375 | 0.0249 | 0.0022 | 3.2 | 0.380 | 0.0245 | 0.0064 |
| 5.6 | 0.620 | 0.0368 | -0.0433 | 5.65 | 0.626 | 0.0336 | -0.0366 |
| 8.1 | 0.847 | 0.0534 | -0.0856 | 8.15 | 0.866 | 0.0515 | -0.0832 |
| 10.6 | 1.07 | 0.0755 | -0.131 | 10.65 | 1.091 | 0.0743 | -0.134 |
| 13.1 | 1.21 | 0.1175 | -0.204 | 13.1 | 1.222 | 0.117 | -0.205 |
| 15.65 | 1.27 | 0.177 | -0.262 | 14.35 | 1.237 | 0.151 | -0.239 |
| 16.9 | 1.33 | 0.204 | -0.285 | 15.65 | 1.319 | 0.177 | -0.274 |
| 18.2 | 1.365 | 0.233 | -0.310 | 16.9 | 1.353 | 0.205 | -0.294 |
| 19.5 | 1.42 | 0.259 | -0.336 | 18.2 | 1.403 | 0.234 | -0.326 |
| 20.8 | 1.42 | 0.296 | -0.353 | 19.4 | 1.445 | 0.263 | -0.349 |
| 22.15 | 1.375 | 0.343 | -0.370 | 20.7 | 1.460 | 0.293 | -0.364 |
| 23.4 | 1.35 | 0.386 | -0.393 | 22.05 | 1.407 | 0.344 | -0.383 |
| | | | | 23.3 | 1.361 | 0.385 | -0.403 |
| $C_{L\ max}$ 1.43 at 20° | | | | $C_{L\ max}$ 1.46 at 21° | | | |



Set H/

Set H

Fillets No.10 Normal Tail $\eta t = -1$
Flaps at 38° Elevators at 0°

| P = 1.0 Atmos $\rho V^2$ = 13.3 lb./sq.ft. V = 75.7 FPS R = 0.198 x $10^6$ | | | | P = 14.8 Atmos $\rho V^2$ = 137.8 lb./sq.ft. V = 64.2 FPS R = 2.37 x $10^6$ | | | | P = 23.6 Atmos $\rho V^2$ = 216 lb./sq.ft. V = 64.0 FPS R = 3.72 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a | $C_L$ | $C_D$ | $C_M$ | α | $C_L$ | $C_D$ | $C_M$ | α | $C_L$ | $C_D$ | $C_M$ |
| -3.35 | 0.233 | | 0.1165 | -3.35 | 0.273 | 0.106 | 0.0812 | -3.25 | 0.297 | 0.105 | 0.0720 |
| -0.8 | 0.463 | 0.128 | 0.0724 | -0.8 | 0.511 | 0.110 | 0.0423 | -0.75 | 0.537 | 0.112 | +0.0321 |
| +1.75 | 0.684 | 0.130 | +0.0322 | +1.7 | 0.741 | 0.1215 | +0.0053 | +1.75 | 0.762 | 0.123 | -0.0078 |
| 4.25 | 0.92 | 0.1435 | -0.0087 | 4.2 | 0.973 | 0.135 | -0.0342 | 4.25 | 0.981 | 0.139 | -0.0435 |
| 6.7 | 1.16 | 0.1625 | -0.0528 | 6.65 | 1.195 | 0.157 | -0.0733 | 6.8 | 1.22 | 0.160 | -0.0848 |
| 7.95 | 1.24 | 0.172 | -0.0590 | 9.2 | 1.43 | 0.184 | -0.1205 | 9.25 | 1.435 | 0.181 | -0.124 |
| 9.2 | 1.33 | 0.195 | -0.119 | 11.7 | 1.56 | 0.240 | -0.2065 | 11.8 | 1.57 | 0.238 | -0.205 |
| 10.5 | 1.38 | 0.225 | -0.1635 | 12.95 | 1.595 | 0.271 | -0.2115 | 14.25 | 1.555 | .320 | -0.277 |
| 11.75 | 1.34 | 0.256 | -0.169 | 14.3 | 1.545 | 0.318 | -0.276 | 16.85 | 1.625 | 0.375 | -0.287 |
| 13.05 | 1.325 | 0.301 | -0.223 | 15.6 | 1.565 | 0.347 | -0.277 | 18.15 | 1.665 | 0.405 | -0.292 |
| 14.35 | 1.335 | 0.332 | -0.221 | 16.85 | 1.60 | 0.381 | -0.284 | 19.45 | 1.685 | 0.446 | -0.296 |
| | | | | 18.15 | 1.60 | 0.410 | -0.279 | 20.75 | 1.06 | 0.485 | -0.293 |
| | | | | 19.45 | 1.62 | 0.448 | -0.285 | 22.05 | 1.575 | 0.541 | -0.295 |
| | | | | 20.75 | 1.60 | 0.497 | -0.283 | | | | |
| | | | | 22.1 | 1.515 | 0.547 | -0.274 | | | | |
| | | | | 23.4 | 1.455 | 0.590 | -0.265 | | | | |
| $C_{L\ max}$ 1.38 at 1 ½° | | | | $C_{L\ max}$ 1.62 at 19° | | | | $C_{L\ max}$ 1.69 at 19° | | | |



Set H (Contd.)/

Set H (Contd.)

| P = 24.2 Atmos<br>V = 82.0 FPS | $\rho V^2$ = 366 lb./sq.ft.<br>R = 4.92 x $10^6$ | | |
|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.25 | 0.298 | 0.104 | 0.0810 |
| -0.7 | 0.532 | 0.110 | +0.0378 |
| +1.85 | 0.778 | 0.115 | -0.0063 |
| 4.35 | 1.02 | 0.139 | -0.0509 |
| 6.7 | 1.25 | 0.160 | -0.0917 |
| 9.3 | 1.45 | 0.188 | -0.1275 |
| 11.8 | 1.55 | 0.240 | -0.202 |
| 13.05 | 1.53 | 0.293 | -0.274 |
| 14.3 | 1.53 | 0.321 | -0.280 |
| 15.6 | 1.575 | 0.345 | -0.283 |
| 16.9 | 1.68 | 0.379 | -0.291 |
| 18.2 | 1.64 | 0.402 | -0.292 |
| 19.5 | 1.67 | 0.445 | -0.298 |
| 20.75 | 1.705 | 0.487 | -0.305 |
| 22.1 | 1.57 | 0.533 | -0.288 |
| 23.4 | 1.47 | 0.585 | -0.282 |

$C_{L\ max}$ 1.71 at 21°

Set J/

Set J

Fillets No.10 Normal Tail $\eta_t$ = +2
Flaps at 0° Elevators at 0°

| P = 1.0 Atmos $\rho V^2$ = 13.3 lb./sq.ft. V = 75.2 FPS R = 0.201 x $10^6$ | | | | P = 3.2 Atmos $\rho V^2$ = 29.5 lb./sq.ft. V = 62.9 FPS R = 0.533 x $10^6$ | | | | P = 14.85 Atmos $\rho V^2$ = 137.8 lb./sq.ft. V = 63.5 FPS R = 2.44 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -1.9 | -0.051 | 0.0386 | -0.0183 | -3.15 | -0.194 | 0.0271 | +0.0144 | -3.25 | -0.193 | 0.0241 | +0.0026 |
| -0.65 | +0.069 | 0.0389 | -0.0460 | -1.85 | -0.078 | 0.0259 | -0.0136 | -1.95 | -0.063 | 0.0205 | -0.0256 |
| +0.65 | 0.180 | 0.0408 | -0.0702 | -0.6 | +0.045 | 0.0246 | -0.0429 | -0.65 | +0.048 | 0.0192 | -0.0498 |
| 3.15 | 0.406 | 0.0441 | -0.1157 | +0.65 | 0.159 | 0.0250 | -0.0671 | +0.6 | 0.165 | 0.0193 | -0.0734 |
| 5.6 | 0.648 | 0.0533 | -0.1635 | 3.15 | 0.406 | 0.0310 | -0.118 | 3.1 | 0.412 | 0.0251 | -0.1225 |
| 8.1 | 0.881 | 0.0690 | -0.217 | 5.65 | 0.652 | 0.0398 | -0.1665 | 5.6 | 0.667 | 0.0371 | -0.173 |
| 10.65 | 1.03 | 0.0991 | -0.291 | 8.1 | 0.882 | 0.0597 | -0.222 | 8.05 | 0.899 | 0.0556 | -0.222 |
| 11.85 | 1.085 | 0.120 | -0.297 | 10.5 | 1.08 | 0.0859 | -0.282 | 10.45 | 1.135 | 0.0821 | -0.282 |
| 13.15 | 1.095 | 0.150 | -0.295 | 11.85 | 1.12 | 0.106 | -0.311 | 12.95 | 1.225 | 0.1255 | -0.324 |
| 14.45 | 1.09 | 0.182 | -0.313 | 13.05 | 1.11 | 0.135 | -0.306 | 14.25 | 1.24 | 0.161 | -0.344 |
| 15.75 | 1.10 | 0.209 | -0.311 | 14.45 | 1.135 | 0.164 | -0.312 | 15.55 | 1.295 | 0.185 | -0.359 |
| 17.1 | 1.015 | 0.272 | -0.328 | 15.65 | 1.15 | 0.201 | -0.323 | 16.8 | 1.335 | 0.214 | -0.376 |
| | | | | 16.95 | 1.115 | 0.259 | -0.345 | 18.1 | 1.38 | 0.243 | -0.393 |
| | | | | 18.3 | 1.035 | 0.299 | -0.342 | 19.35 | 1.405 | 0.264 | -0.400 |
| | | | | | | | | 20.65 | 1.395 | 0.313 | -0.410 |
| | | | | | | | | 22.0 | 1.35 | 0.375 | -0.422 |
| $C_{L\,max}$ 1.1 at 13° | | | | $C_{L\,max}$ 1.15 at 15° | | | | $C_{L\,max}$ 1.41 at 20° | | | |



Set J (Contd.)/

Set J (Contd.)

$P = 22.4$ Atmos $\rho V^2 = 216$ lb./sq.ft.
$V = 65.5$ FPS $R = 3.65 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.2 | -0.192 | 0.0232 | -0.0023 |
| -1.9 | -0.073 | 0.0207 | -0.0234 |
| -0.65 | +0.050 | 0.0201 | -0.0505 |
| +0.6 | 0.167 | 0.0204 | -0.0748 |
| 3.1 | 0.415 | 0.0257 | -0.1215 |
| 5.55 | 0.666 | 0.0374 | -0.1693 |
| 8.05 | 0.897 | 0.0538 | -0.215 |
| 10.55 | 1.115 | 0.0808 | -0.271 |
| 13.05 | 1.24 | 0.1245 | -0.320 |
| 15.6 | 1.31 | 0.184 | -0.364 |
| 18.15 | 1.415 | 0.236 | -0.407 |
| 19.4 | 1.45 | 0.266 | -0.430 |
| 20.7 | 1.45 | 0.309 | -0.429 |
| 22.05 | 1.415 | 0.352 | -0.430 |
| 23.35 | 1.39 | 0.400 | -0.456 |

$C_{L\ max}$ 1.45 at 20°

$P = 24.0$ Atmos $\rho V^2 = 366$ lb./sq.ft.
$V = 82.3$ FPS $R = 4.9 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.25 | -0.200 | 0.0234 | +0.0057 |
| -1.95 | -0.078 | 0.0205 | -0.0195 |
| -0.65 | +0.045 | 0.0198 | -0.0444 |
| +0.6 | 0.163 | 0.0202 | -0.0682 |
| 3.1 | 0.415 | 0.0259 | -0.1182 |
| 5.6 | 0.658 | 0.0377 | -0.163 |
| 8.05 | 0.894 | 0.0560 | -0.211 |
| 10.45 | 1.107 | 0.0791 | -0.263 |
| 12.9 | 1.255 | 0.124 | -0.318 |
| 15.5 | 1.315 | 0.184 | -0.370 |
| 16.75 | 1.39 | 0.209 | -0.396 |
| 18.0 | 1.43 | 0.238 | -0.408 |
| 19.25 | 1.465 | 0.269 | -0.432 |
| 20.55 | 1.49 | 0.304 | -0.442 |
| 21.95 | 1.44 | 0.360 | -0.455 |
| 23.3 | 1.37 | 0.401 | -0.454 |

$C_{L\ max}$ 1.49 at 21°



Set K/

Set K

Fillets No.10 Normal Tail $\eta_t$ = -1
Flaps at 0° Elevators at +10°

| P = 1.0 Atmos $\rho V^2$ = 13.3 lb./sq.ft. V = 75.5 FPS R = 0.20 x $10^6$ | | | | P = 3.31 Atmos $\rho V^2$ = 29.55 lb./sq.ft. V = 62.0 FPS R = 0.534 x $10^6$ | | | | P = 14.9 Atmos $\rho V^2$ = 137.5 lb./sq.ft. V = 63.4 FPS R = 2.34 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.2 | -0.155 | 0.0399 | -0.0238 | -3.25 | -0.165 | 0.0314 | -0.0635 | -3.3 | -0.177 | 0.0259 | -0.0479 |
| -1.9 | -0.043 | 0.0386 | -0.0487 | -1.95 | -0.051 | 0.0285 | -0.0923 | -2.0 | -0.060 | 0.0229 | -0.0723 |
| -0.65 | +0.068 | 0.0399 | -0.0688 | -0.7 | +0.065 | 0.0279 | -0.1195 | -0.65 | +0.059 | 0.0214 | -0.0963 |
| +0.65 | 0.174 | 0.0412 | -0.0836 | +0.6 | 0.186 | 0.0279 | -0.146 | +0.6 | 0.172 | 0.0229 | -0.117 |
| 3.15 | 0.403 | 0.0461 | -0.130 | 3.1 | 0.432 | 0.0345 | -0.197 | 3.1 | 0.409 | 0.0283 | -0.1605 |
| 5.6 | 0.636 | 0.0544 | -0.168 | 5.55 | 0.675 | 0.0464 | -0.246 | 5.55 | 0.653 | 0.0403 | -0.205 |
| 8.1 | 0.886 | 0.0706 | -0.255 | 8.05 | 0.903 | 0.0652 | -0.303 | 8.05 | 0.884 | 0.0569 | -0.248 |
| 10.65 | 1.047 | 0.1017 | -0.339 | 10.55 | 1.095 | 0.0926 | -0.355 | 10.55 | 1.085 | 0.0847 | -0.295 |
| 11.85 | 1.09 | 0.123 | -0.346 | 11.8 | 1.145 | 0.1063 | -0.359 | 13.05 | 1.21 | 0.127 | -0.342 |
| 13.15 | 1.11 | 0.149 | -0.344 | 13.1 | 1.12 | 0.136 | -0.357 | 15.6 | 1.28 | 0.189 | -0.409 |
| 14.45 | 1.095 | 0.180 | -0.362 | 14.4 | 1.14 | 0.162 | -0.361 | 16.85 | 1.33 | 0.215 | -0.430 |
| 15.75 | 1.11 | 0.207 | -0.366 | 15.7 | 1.15 | 0.196 | -0.369 | 18.15 | 1.385 | 0.245 | -0.459 |
| 17.1 | 1.02 | 0.267 | -0.380 | 17.0 | 1.135 | 0.255 | -0.401 | 19.45 | 1.41 | 0.277 | -0.466 |
| | | | | 18.3 | 1.08 | 0.300 | -0.409 | 20.75 | 1.39 | 0.314 | -0.473 |
| | | | | | | | | 22.05 | 1.375 | 0.359 | -0.489 |
| | | | | | | | | 23.35 | 1.35 | 0.398 | -0.504 |
| $C_{L\,max}$ 1.11 at 13° | | | | $C_{L\,max}$ 1.15 at 16° (possibly 12°) | | | | $C_{L\,max}$ 1.41 at 19.5° | | | |



Set K (Contd.)/

Set K (Contd.)

$P = 23.75$ Atmos $\rho V^2 = 216.0$ lb./sq.ft.
$V = 64.2$ FPS $R = 3.665 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.3 | -0.184 | 0.0256 | -0.0556 |
| -2.0 | -0.058 | 0.0240 | -0.0823 |
| +0.55 | 0.179 | 0.0235 | -0.127 |
| 3.05 | 0.421 | 0.0295 | -0.172 |
| 5.55 | 0.673 | 0.0418 | -0.220 |
| 8.05 | 0.894 | 0.0595 | -0.260 |
| 10.55 | 1.106 | 0.0843 | -0.306 |
| 13.0 | 1.23 | 0.128 | -0.362 |
| 15.6 | 1.30 | 0.185 | -0.412 |
| 16.85 | 1.375 | 0.211 | -0.444 |
| 18.15 | 1.41 | 0.237 | -0.466 |
| 19.4 | 1.465 | 0.267 | -0.480 |
| 20.7 | 1.45 | 0.306 | -0.491 |
| 22.0 | 1.44 | 0.348 | -0.510 |
| 23.3 | 1.40 | 0.396 | -0.528 |

$C_{L\,max}$ 1.465 at 19.5°

$P = 24.9$ Atmos $\rho V^2 = 365.5$ lb./sq.ft.
$V = 81.2$ FPS $R = 4.95 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.35 | -0.184 | 0.0229 | -0.0443 |
| -1.95 | -0.063 | 0.0209 | -0.0688 |
| -0.75 | +0.066 | 0.0201 | -0.0951 |
| +0.55 | 0.175 | 0.0215 | -0.1155 |
| 3.05 | 0.417 | 0.0280 | -0.1603 |
| 5.55 | 0.661 | 0.0401 | -0.204 |
| 8.0 | 0.905 | 0.0579 | -0.250 |
| 10.45 | 1.106 | 0.0818 | -0.295 |
| 13.0 | 1.215 | 0.1535 | -0.371 |
| 15.5 | 1.33 | 0.187 | -0.427 |
| 16.8 | 1.385 | 0.214 | -0.458 |
| 18.1 | 1.43 | 0.239 | -0.483 |
| 19.35 | 1.47 | 0.269 | -0.496 |
| 20.6 | 1.515 | 0.304 | -0.512 |
| 21.9 | 1.45 | 0.350 | -0.512 |
| 23.2 | 1.405 | 0.400 | -0.540 |

$C_{L\,max}$ 1.52 at 21°



Set L/

## Set L

Fillets No. 10 — Normal Tail $i_t = -1$

Flaps at $0°$ — Elevators at $-10°$

$P = 1.0$ Atmos $\rho V^2 = 13.32$ lb./sq.ft.
$V = 75.8$ FPS $R = 0.198 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.15 | -0.287 | 0.0457 | 0.391 |
| -1.85 | -0.173 | 0.0449 | 0.368 |
| -0.6 | -0.056 | 0.0435 | 0.314 |
| +0.7 | +0.060 | 0.0423 | 0.309 |
| 3.2 | 0.305 | 0.0443 | 0.232 |
| 5.65 | 0.551 | 0.0486 | 0.172 |
| 8.15 | 0.791 | 0.0606 | 0.129 |
| 10.65 | 0.949 | 0.0846 | 0.0598 |
| 11.9 | 1.01 | 0.102 | 0.0348 |
| 13.2 | 1.035 | 0.135 | 0.0071 |
| 14.5 | 1.015 | 0.164 | -0.0289 |
| 15.8 | 1.035 | 0.191 | -0.0508 |
| 17.1 | 0.945 | 0.250 | -0.0674 |

$C_{L\,max}$ 1.035 at 13°

$P = 3.25$ Atmos $\rho V^2 = 29.5$ lb./sq.ft.
$V = 63.0$ FPS $R = 0.527 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.2 | -0.295 | 0.0393 | 0.355 |
| -1.9 | -0.185 | 0.0365 | 0.344 |
| -0.6 | -0.081 | 0.0324 | 0.351 |
| +0.7 | +0.033 | 0.0302 | 0.338 |
| 5.6 | 0.539 | 0.0386 | 0.218 |
| 8.1 | 0.772 | 0.0554 | 0.153 |
| 10.6 | 0.967 | 0.0767 | 0.106 |
| 11.85 | 1.027 | 0.0954 | 0.066 |
| 13.15 | 1.02 | 0.1245 | 0.0074 |
| 14.45 | 1.045 | 0.1515 | -0.0258 |
| 15.7 | 1.075 | 0.186 | -0.0605 |
| 17.05 | 1.04 | 0.244 | -0.0945 |

$C_{L\,max}$ 1.08 at 16°

$P = 14.9$ Atmos $\rho V^2 = 137.8$ lb./sq.ft.
$V = 63.7$ FPS $R = 2.42 \times 10^6$

| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
|---|---|---|---|
| -3.15 | -0.269 | 0.0324 | 0.325 |
| -1.85 | -0.151 | 0.0298 | 0.306 |
| -0.6 | -0.037 | 0.0267 | 0.288 |
| +0.7 | +0.085 | 0.0265 | 0.269 |
| 3.2 | 0.222 | 0.0299 | 0.248 |
| 5.7 | 0.562 | 0.0376 | 0.219 |
| 8.2 | 0.794 | 0.0533 | 0.176 |
| 10.7 | 0.998 | 0.0749 | 0.1265 |
| 13.2 | 1.104 | 0.112 | 0.0407 |
| 15.7 | 1.19 | 0.176 | -0.0593 |
| 18.3 | 1.295 | 0.227 | -0.1115 |
| 19.55 | 1.32 | 0.260 | -0.1345 |
| 21.35 | 1.30 | 0.297 | -0.150 |
| 22.65 | 1.29 | 0.337 | -0.175 |

$C_{L\,max}$ 1.32 at 20°



Set L (Contd.)/

Set L (Contd.)

| $P = 24.05$ Atmos $\rho V^2 = 216.5$ lb./sq.ft. $V = 63.0$ FPS $R = 3.82 \times 10^6$ | | | |
|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.1 | -0.267 | 0.0336 | 0.315 |
| -1.8 | -0.147 | 0.0287 | 0.303 |
| -0.55 | -0.0283 | 0.0261 | 0.281 |
| +0.75 | +0.091 | 0.0247 | 0.261 |
| 3.25 | 0.331 | 0.0288 | 0.220 |
| 5.7 | 0.570 | 0.0388 | 0.185 |
| 8.25 | 0.800 | 0.0512 | 0.147 |
| 10.75 | 1.01 | 0.0750 | 0.101 |
| 13.25 | 1.17 | 0.116 | 0.0143 |
| 15.75 | 1.21 | 0.174 | -0.0659 |
| 17.05 | 1.275 | 0.199 | -0.0914 |
| 18.3 | 1.32 | 0.230 | -0.119 |
| 19.7 | 1.355 | 0.255 | -0.139 |
| 20.85 | 1.355 | 0.290 | -0.158 |
| 22.15 | 1.325 | 0.331 | -0.179 |
| 23.5 | 1.275 | 0.375 | -0.199 |

$C_{L\ max}$ 1.36 at 20°

Set M/

Set M

Fillets No.10 Normal Tail $\eta t = -1°$

Flaps at 38° Elevators at $-10°$

| P = 1.0 Atmos $\rho V^2$ = 13.35 lb./sq.ft. V = 76.1 FPS R = 0.197 x 10$^6$ | | | | P = 3.02 Atmos $\rho V^2$ = 29.5 lb./sq.ft. V = 64.75 FPS R = 0.516 x 10$^6$ | | | |
|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.35 | 0.194 | 0.119 | 0.254 | -3.4 | 0.194 | 0.115 | 0.252 |
| -0.75 | 0.407 | 0.125 | 0.242 | -0.75 | 0.432 | 0.120 | 0.219 |
| +1.75 | 0.621 | 0.135 | 0.234 | +1.75 | 0.654 | 0.127 | 0.202 |
| 4.25 | 0.858 | 0.142 | 0.217 | 4.25 | 0.869 | 0.140 | 0.191 |
| 6.7 | 1.075 | 0.160 | 0.177 | 6.7 | 1.085 | 0.157 | 0.171 |
| 8.0 | 1.185 | 0.172 | 0.133 | 8.0 | 1.185 | 0.166 | 0.155 |
| 9.25 | 1.255 | 0.195 | 0.089 | 9.25 | 1.275 | 0.185 | 0.123 |
| 10.55 | 1.285 | 0.230 | +0.0[illegible]7 | 10.45 | 1.30 | 0.222 | 0.037 |
| 11.8 | 1.30 | 0.258 | -0.046 | 11.65 | 1.30 | 0.254 | -0.0225 |
| 13.1 | 1.29 | 0.296 | -0.116 | 12.9 | 1.34 | 0.292 | -0.105 |
| 14.4 | 1.29 | 0.326 | -0.136 | 14.2 | 1.36 | | |
| 15.7 | 1.305 | 0.361 | -0.154 | 15.6 | 1.14 | | |
| | | | | 16.9 | 1.18 | | |
| $C_{L\,max}$ 1.3 at 12° | | | | $C_{L\,max}$ 1.36 at 14° | | | |

| P = 15.25 Atmos $\rho V^2$ = 137.8 lb./sq.ft. V = 62.8 FPS R = 2.45 x 10$^6$ | | | | P = 23.8 Atmos $\rho V^2$ = 216 lb./sq.ft. V = 63.3 FPS R = 3.80 x 10$^6$ | | | |
|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.3 | 0.236 | 0.114 | 0.269 | -3.2 | 0.240 | 0.112 | 0.276 |
| -0.75 | 0.476 | 0.117 | 0.224 | -0.65 | 0.472 | 0.115 | 0.230 |
| +1.8 | 0.706 | 0.125 | 0.188 | +1.85 | 0.704 | 0.124 | 0.191 |
| 4.35 | 0.932 | 0.143 | 0.148 | 4.35 | 0.941 | 0.141 | 0.147 |
| 6.8 | 1.15 | 0.159 | 0.119 | 6.85 | 1.17 | 0.159 | 0.111 |
| 9.3 | 1.37 | 0.181 | +0.091 | 9.35 | 1.395 | 0.191 | +0.068 |
| 11.75 | 1.52 | 0.231 | -0.019 | 11.7 | 1.505 | 0.248 | -0.036 |
| 12.95 | 1.53 | 0.256 | -0.037 | 12.95 | 1.48 | 0.288 | -0.108 |
| 14.2 | 1.52 | 0.312 | -0.150 | 14.25 | 1.485 | 0.317 | -0.155 |
| 15.5 | 1.53 | 0.340 | -0.175 | 15.55 | 1.545 | 0.348 | -0.185 |
| 16.85 | 1.57 | 0.364 | -0.190 | 16.85 | 1.565 | 0.374 | -0.195 |
| 18.15 | 1.58 | 0.402 | -0.203 | 18.1 | 1.61 | 0.405 | -0.209 |
| 19.45 | 1.62 | 0.431 | -0.219 | 19.4 | 1.63 | 0.438 | -0.216 |
| 20.8 | 1.555 | 0.482 | -0.215 | 20.7 | 1.61 | 0.487 | -0.224 |
| 22.1 | 1.51 | 0.530 | -0.220 | 22.05 | 1.525 | 0.548 | -0.242 |
| $C_{L\,max}$ 1.62 at 19° | | | | $C_{L\,max}$ 1.63 at 19° | | | |



Set N/

Set N

Fillets No.8 No Tail.
Flaps at 0°

| $P = 1.0$ Atmos, $\rho V^2 = 13.22$ lb./sq.ft., $V = 74.7$ FPS, $R = 0.20 \times 10^6$ | | | | $P = 3.15$ Atmos, $\rho V^2 = 29.2$ lb./sq.ft., $V = 62.7$ FPS, $R = 0.518 \times 10^6$ | | | | $P = 4.44$ Atmos, $\rho V^2 = 49.0$ lb./sq.ft., $V = 68.6$ FPS, $R = 0.806 \times 10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -4.9 | -0.255 | 0.0379 | -0.0877 | -4.95 | -0.285 | 0.0293 | -0.0854 | -4.95 | -0.289 | 0.0234 | -0.0803 |
| -2.35 | -0.058 | 0.0301 | -0.0645 | -2.35 | -0.068 | 0.0215 | -0.0686 | -2.35 | -0.076 | 0.0199 | -0.0773 |
| +0.25 | +0.147 | 0.0305 | -0.0464 | +0.2 | +0.147 | 0.0212 | -0.0494 | +0.2 | +0.145 | 0.0185 | -0.0488 |
| 2.75 | 0.352 | 0.0344 | -0.0292 | 2.7 | 0.367 | 0.0256 | -0.0306 | 2.7 | 0.368 | 0.0214 | -0.0273 |
| 5.25 | 0.570 | 0.0419 | -0.0087 | 5.2 | 0.587 | 0.0346 | -0.0118 | 5.2 | 0.597 | 0.0323 | -0.0104 |
| 7.8 | 0.776 | 0.0518 | +0.0173 | 7.75 | 0.796 | 0.0494 | +0.0083 | 7.75 | 0.795 | 0.0473 | +0.0123 |
| 9.05 | 0.852 | 0.0633 | 0.0285 | 9.0 | 0.882 | 0.0593 | 0.0207 | 9.0 | 0.899 | 0.0581 | 0.0182 |
| 10.3 | 0.899 | 0.0746 | 0.0466 | 10.2 | 0.968 | 0.0706 | 0.0297 | 10.2 | 0.977 | 0.0691 | 0.0270 |
| 11.5 | 0.957 | 0.0897 | 0.0578 | 11.45 | 1.001 | 0.0859 | 0.0466 | 11.45 | 1.042 | 0.0837 | 0.0376 |
| 12.75 | 0.959 | 0.117 | 0.0532 | 12.7 | 1.008 | 0.107 | 0.0595 | 12.65 | 1.086 | 0.0991 | 0.0490 |
| 14.05 | 0.960 | 0.154 | 0.0379 | 14.0 | 1.014 | 0.148 | 0.0346 | 13.95 | 1.076 | 0.135 | 0.0447 |
| 15.35 | 0.955 | 0.180 | 0.0408 | 15.3 | 1.030 | 0.180 | 0.0309 | 15.25 | 1.088 | 0.170 | 0.0380 |
| 16.7 | 0.910 | 0.235 | 0.0245 | 16.6 | 1.006 | 0.229 | 0.0180 | 16.55 | 1.088 | 0.210 | 0.0320 |
| 18.0 | 0.840 | 0.274 | 0.0115 | 17.95 | 0.961 | 0.270 | 0.0050 | 17.95 | 1.017 | 0.268 | 0.0104 |
| | | | | 19.3 | 0.932 | 0.304 | -0.0015 | 19.25 | 0.962 | 0.300 | 0.0109 |
| | | | | | | | | 20.6 | 0.918 | 0.339 | 0.0050 |
| | | | | | | | | 21.9 | 0.890 | 0.366 | 0.0030 |
| $C_{L\,max}$ 0.96 at 12° | | | | $C_{L\,max}$ 1.03 at 15° | | | | $C_{L\,max}$ 1.09 at 16° | | | |



Set N (Contd.)/

Set N (Contd.)

| P = 13.6 Atmos, $\rho V^2$ = 135.7 lb./sq.ft., V = 65.6 FPS, R = 2.22 x $10^6$ | | | | P = 21.8 Atmos, $\rho V^2$ = 230 lb./sq.ft., V = 68.6 FPS, R = 3.7 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -4.9 | -0.304 | 0.0239 | -0.0861 | -4.85 | -0.307 | 0.0246 | -0.0853 |
| -2.35 | -0.083 | 0.0169 | -0.0654 | -2.3 | -0.079 | 0.0191 | -0.0693 |
| + .2 | +0.144 | 0.0162 | -0.0473 | +0.2 | +0.145 | 0.0172 | -0.0472 |
| 2.7 | 0.370 | 0.0202 | -0.0265 | 2.75 | 0.366 | 0.0218 | -0.0256 |
| 5.25 | 0.608 | 0.0306 | -0.0062 | 5.3 | 0.627 | 0.0349 | -0.0051 |
| 7.8 | 0.844 | 0.0492 | +0.0228 | 7.8 | 0.839 | 0.0492 | +0.0167 |
| 9.0 | 0.942 | 0.0593 | +0.0254 | 9.1 | 0.946 | 0.0520 | 0.0213 |
| 10.25 | 1.024 | 0.0713 | 0.0331 | 10.35 | 1.025 | 0.0696 | 0.0375 |
| 11.4 | 1.116 | 0.0851 | 0.0390 | 11.55 | 1.110 | 0.0827 | 0.0464 |
| 12.7 | 1.180 | 0.1037 | 0.0465 | 12.8 | 1.165 | 0.107 | 0.0448 |
| 14.0 | 1.185 | 0.137 | 0.0410 | 14.1 | 1.14 | 0.151 | 0.0295 |
| 15.3 | 1.17 | 0.175 | 0.032 | 15.4 | 1.185 | 0.173 | 0.0338 |
| 16.55 | 1.225 | 0.200 | 0.024 | 16.65 | 1.23 | 0.198 | 0.0368 |
| 17.9 | 1.26 | 0.230 | 0.0335 | 18.0 | 1.27 | 0.222 | 0.0387 |
| 19.2 | 1.26 | 0.262 | 0.0295 | 19.35 | 1.305 | 0.241 | 0.0367 |
| 20.5 | 1.255 | 0.299 | 0.020 | 20.6 | 1.28 | 0.292 | 0.0232 |
| 21.8 | 1.23 | 0.344 | 0.006 | 21.9 | 1.25 | 0.336 | 0.0127 |
| 24.45 | 1.13 | 0.432 | -0.015 | 23.2 | 1.215 | 0.375 | 0.0038 |
| | | | | 24.55 | 1.18 | 0.410 | -0.0017 |
| $C_{L\ max}$ 1.26 at 18° | | | | $C_{L\ max}$ 1.31 at $19\frac{1}{2}$° | | | |



Set P/

Set P

Fillets No.10 No Tail
Flaps at 38°

| P = 1.0 Atmos, $\rho V^2$ = 13.3 lb./sq.ft., V = 76.3 FPS, R = 0.194 x $10^6$ | | | | P = 3.26 Atmos, $\rho V^2$ = 29.5 lb./sq.ft., V = 63.2 FPS, R = 0.518 x $10^6$ | | | | P = 14.9 Atmos, $\rho V^2$ = 137.8 lb./sq.ft., V = 64.4 FPS, R = 2.36 x $10^6$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.4 | 0.366 | 0.107 | -0.248 | -3.45 | 0.372 | 0.102 | -0.257 | -3.4 | 0.381 | 0.102 | -0.263 |
| -0.85 | 0.572 | 0.118 | -0.231 | -0.9 | 0.582 | 0.108 | -0.240 | -0.9 | 0.600 | 0.109 | -0.246 |
| +1.7 | 0.781 | 0.130 | -0.214 | +1.65 | 0.813 | 0.1215 | -0.227 | +1.65 | 0.816 | 0.122 | -0.230 |
| 4.2 | 0.994 | 0.142 | -0.1885 | 4.15 | 1.02 | 0.135 | -0.207 | 4.15 | 1.025 | 0.138 | -0.211 |
| 6.65 | 1.205 | 0.1620 | -0.172 | 6.6 | 1.23 | 0.156 | -0.1880 | 6.65 | 1.225 | 0.160 | -0.189 |
| 9.2 | 1.345 | 0.202 | -0.1475 | 9.15 | 1.385 | 0.191 | -0.160 | 9.15 | 1.445 | 0.185 | -0.173 |
| 10.5 | 1.375 | 0.239 | -0.155 | 11.7 | 1.40 | 0.258 | -0.1485 | 11.7 | 1.56 | 0.239 | -0.1705 |
| 11.75 | 1.37 | 0.265 | -0.1405 | 13.0 | 1.375 | 0.304 | -0.1565 | 14.3 | 1.51 | 0.317 | -0.168 |
| 13.05 | 1.335 | 0.309 | -0.1555 | 14.3 | 1.375 | 0.333 | -0.154 | 15.6 | 1.53 | 0.344 | -0.1635 |
| 14.35 | 1.34 | 0.338 | -0.1495 | 15.6 | 1.37 | 0.382 | -0.170 | 16.9 | 1.55 | 0.376 | -0.1645 |
| 15.65 | 1.34 | 0.374 | -0.1605 | 16.95 | 1.31 | 0.445 | -0.185 | 18.15 | 1.58 | 0.411 | -0.166 |
| | | | | 18.25 | 1.23 | 0.491 | -0.1875 | 19.45 | 1.58 | 0.445 | -0.161 |
| | | | | | | | | 20.8 | 1.55 | 0.495 | -0.172 |
| | | | | | | | | 22.1 | 1.48 | 0.538 | -0.179 |
| $C_{L\,max}$ 1.38 at 11° | | | | $C_{L\,max}$ 1.42 at 11° | | | | $C_{L\,max}$ 1.58 at 19° | | | |



Set P (Contd.)/

Set P (Contd.)

| P = 24.3 Atmos, V = 63.5 FPS | $\rho V^2$ = 216 lb./sq.ft., R = 3.70 x $10^6$ | | | P = 24.75 Atmos, V = 82.9 FPS | $\rho V^2$ = 365 lb./sq.ft., R = 4.67 x $10^6$ | | |
|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_M$ | $\alpha$ | $C_L$ | $C_D$ | $C_M$ |
| -3.5 | 0.381 | 0.101 | -0.264 | -3.35 | 0.376 | 0.101 | -0.263 |
| -0.95 | 0.600 | 0.1085 | -0.248 | -0.95 | 0.595 | 0.108 | -0.246 |
| +1.6 | 0.818 | 0.120 | -0.229 | +1.6 | 0.822 | 0.120 | -0.232 |
| 4.2 | 1.028 | 0.139 | -0.211 | 4.2 | 1.035 | 0.1375 | -0.211 |
| 6.65 | 1.245 | 0.156 | -0.192 | 6.7 | 1.255 | 0.1585 | -0.191 |
| 9.2 | 1.455 | 0.185 | -0.176 | 9.25 | 1.475 | 0.190 | -0.174 |
| 11.75 | 1.555 | 0.243 | -0.184 | 11.75 | 1.58 | 0.253 | -0.177 |
| 14.35 | 1.52 | 0.319 | -0.173 | 14.3 | 1.53 | 0.310 | -0.171 |
| 16.9 | 1.59 | 0.375 | -0.163 | 17.0 | 1.60 | 0.383 | -0.169 |
| 18.2 | 1.61 | 0.405 | -0.157 | 18.3 | 1.63 | 0.418 | -0.174 |
| 19.5 | 1.65 | 0.438 | -0.162 | 19.6 | 1.645 | 0.450 | -0.171 |
| 20.8 | 1.605 | 0.490 | -0.175 | 20.85 | 1.61 | 0.505 | -0.188 |
| 22.15 | 1.515 | 0.544 | -0.185 | 22.2 | 1.48 | 0.555 | -0.193 |
| $C_{L\,max}$ 1.65 at 19° | | | | $C_{L\,max}$ 1.65 at 19° | | | |

## Appendix I

### Comparison of C.A.T. Tests with Preliminary Flight Tests

$C_L$ max (Flaps and undercarriage up)

| C.A.T. (No Propellers) | Flight (Windmilling Propellers) |
|---|---|
| 1.46 at $R = 5 \times 10^6$ (still rising) (Curve F, Fig.5) | 1.44 at $R = 9 \times 10^6$ |

$C_L$ max (38° Flaps)

| C.A.T. (including centre flap) (No Propellers) | Flight (less centre flap) (Windmilling Propellers) |
|---|---|
| 1.705 at $R = 5 \times 10^6$ (still rising) (Curve H, Fig.5) | 1.76 at $R = 9 \times 10^6$ |

Neutral Point (Flaps and undercarriage up)

| C.A.T. | Flight |
|---|---|
| $0.42\bar{c}$ from $R = 0.2 \times 10^6$ to $5 \times 10^6$ (No Propellers) | |
| Less $0.025\bar{c}$ roughly (Windmilling Propellers) | |
| i.e. $0.395\bar{c}$ | $0.396\bar{c}$ up to $R = 25 \times 10^6$ (Windmilling Propellers) |

In the course of tunnel tests, with propellers fitted, the blades were damaged and the results were not considered to be reliable. It is interesting, however, that the estimate of the effect of propellers on $h_n$ (made by Messrs. Armstrong Whitworth from the C.A.T. measurements and not by ourselves) brings the value into close agreement with the flight test result.

## Appendix II

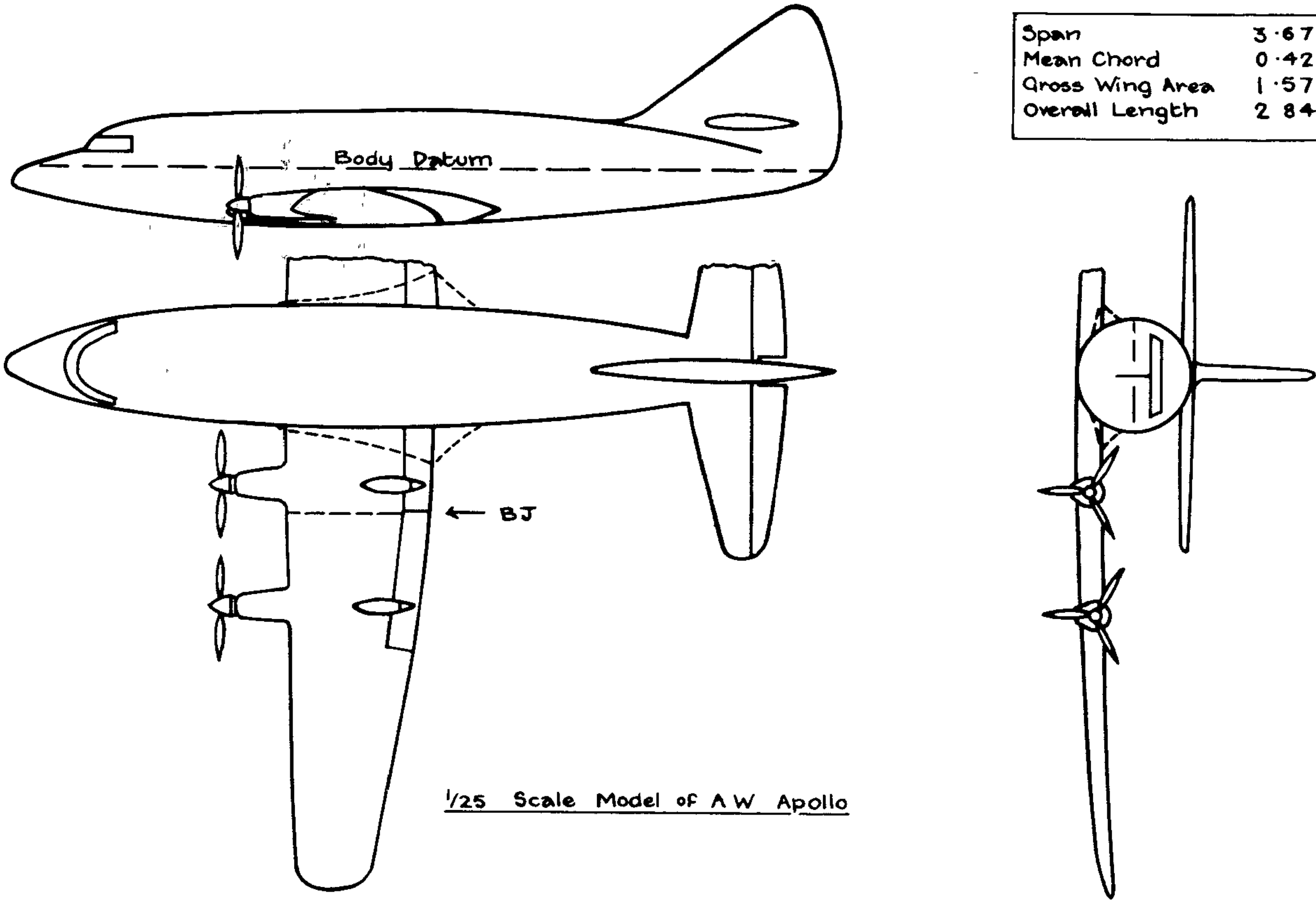
Section ordinates at B J. (Fig.1)

True chord 6.04"
L.E. radius 0.099"
T.E. radius 0.008"

| Ordinate No. | Distance from L.E. | | Ordinates (inches) | |
|---|---|---|---|---|
| | Inches | Fraction of chord | Top Surface | Bottom Surface |
| 1 | 0.030 | 0.005 | 0.082 | 0.069 |
| 2 | 0.045 | 0.0075 | 0.101 | 0.084 |
| 3 | 0.075 | 0.0125 | 0.133 | 0.106 |
| 4 | 0.151 | 0.025 | 0.191 | 0.145 |
| 5 | 0.302 | 0.050 | 0.276 | 0.196 |
| 6 | 0.453 | 0.075 | 0.341 | 0.234 |
| 7 | 0.604 | 0.100 | 0.395 | 0.263 |
| 8 | 0.906 | 0.50 | 0.481 | 0.310 |
| 9 | 1.208 | 0.20 | 0.548 | 0.345 |
| 10 | 1.510 | 0.25 | 0.600 | 0.371 |
| 11 | 1.812 | 0.30 | 0.639 | 0.391 |
| 12 | 2.114 | 0.35 | 0.666 | 0.404 |
| 13 | 2.416 | 0.40 | 0.679 | 0.410 |
| 14 | 2.718 | 0.45 | 0.680 | 0.409 |
| 15 | 3.020 | 0.50 | 0.660 | 0.397 |
| 16 | 3.322 | 0.55 | 0.621 | 0.370 |
| 17 | 3.624 | 0.60 | 0.564 | 0.333 |
| 18 | 3.926 | 0.65 | 0.438 | 0.291 |
| 19 | 4.228 | 0.70 | 0.425 | 0.246 |
| 20 | 4.530 | 0.75 | 0.348 | 0.199 |
| 21 | 4.832 | 0.80 | 0.270 | 0.152 |
| 22 | 5.134 | 0.85 | 0.194 | 0.107 |
| 23 | 5.436 | 0.90 | 0.122 | 0.066 |
| 24 | 5.738 | 0.95 | 0.057 | 0.030 |

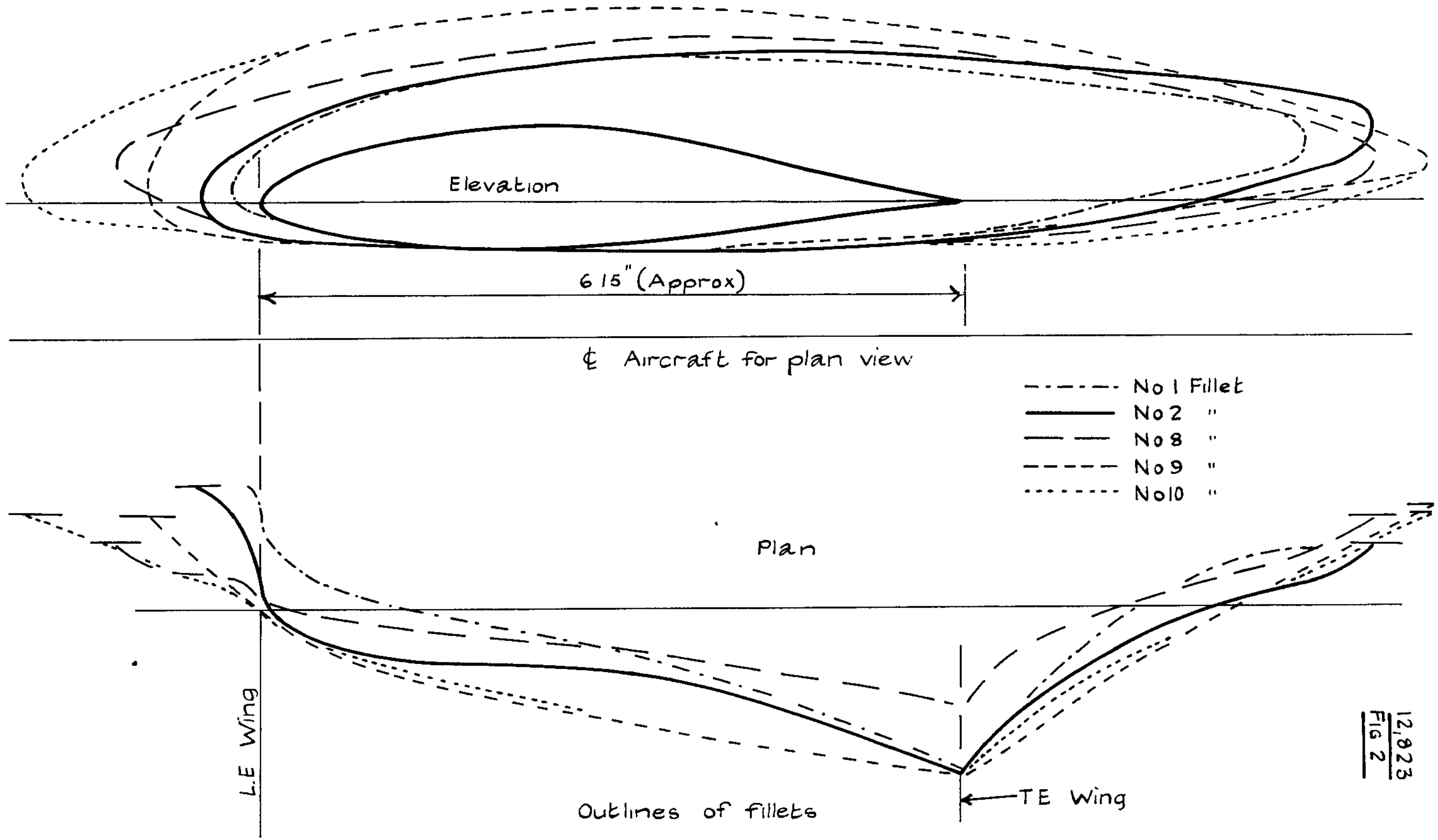
12,823
Fig 1.

| | |
|---|---|
| Span | 3·675 ft |
| Mean Chord | 0·429 ft. |
| Gross Wing Area | 1·577 sq.ft |
| Overall Length | 2 84 ft. |

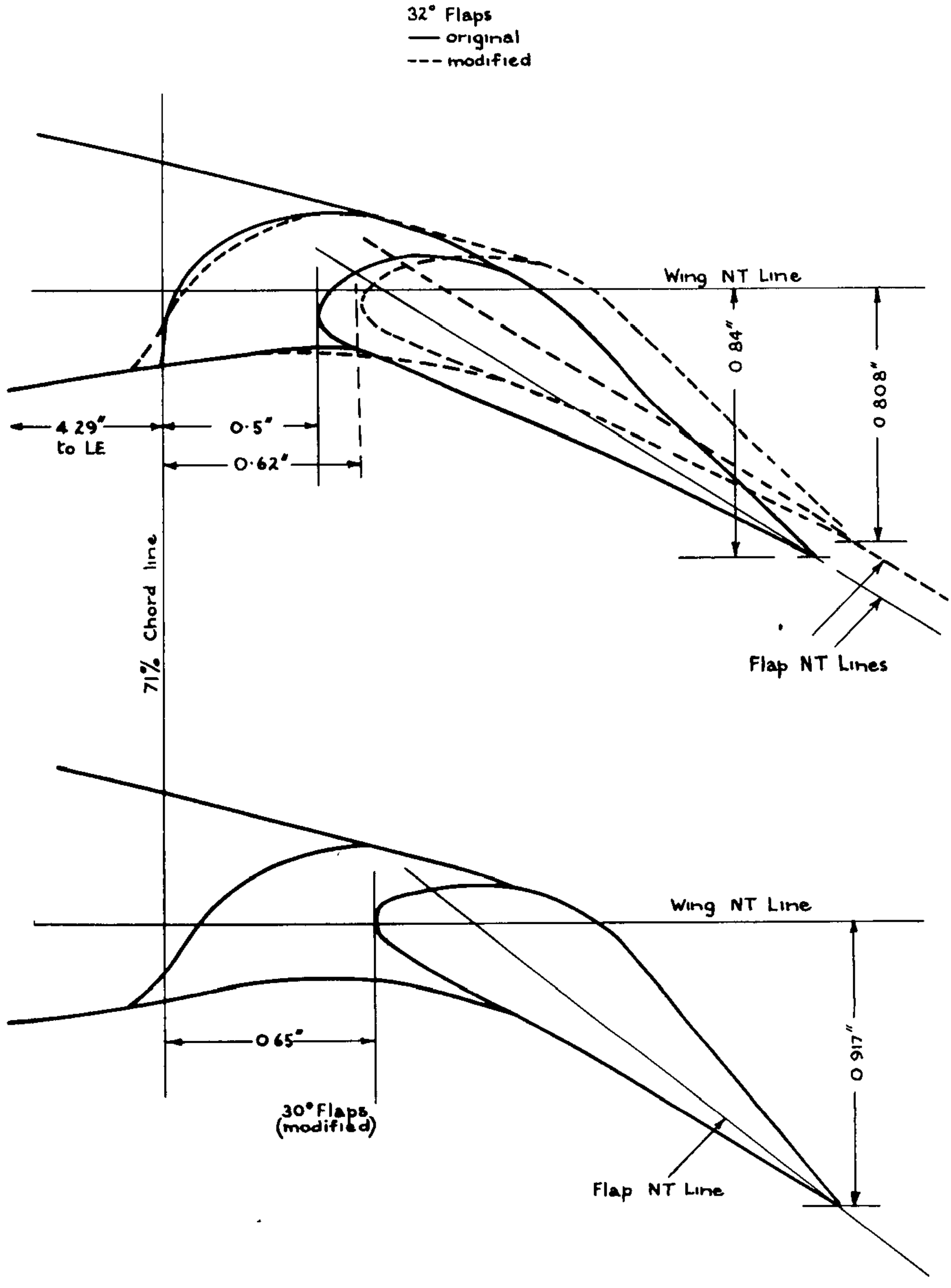



1/25 Scale Model of A W Apollo

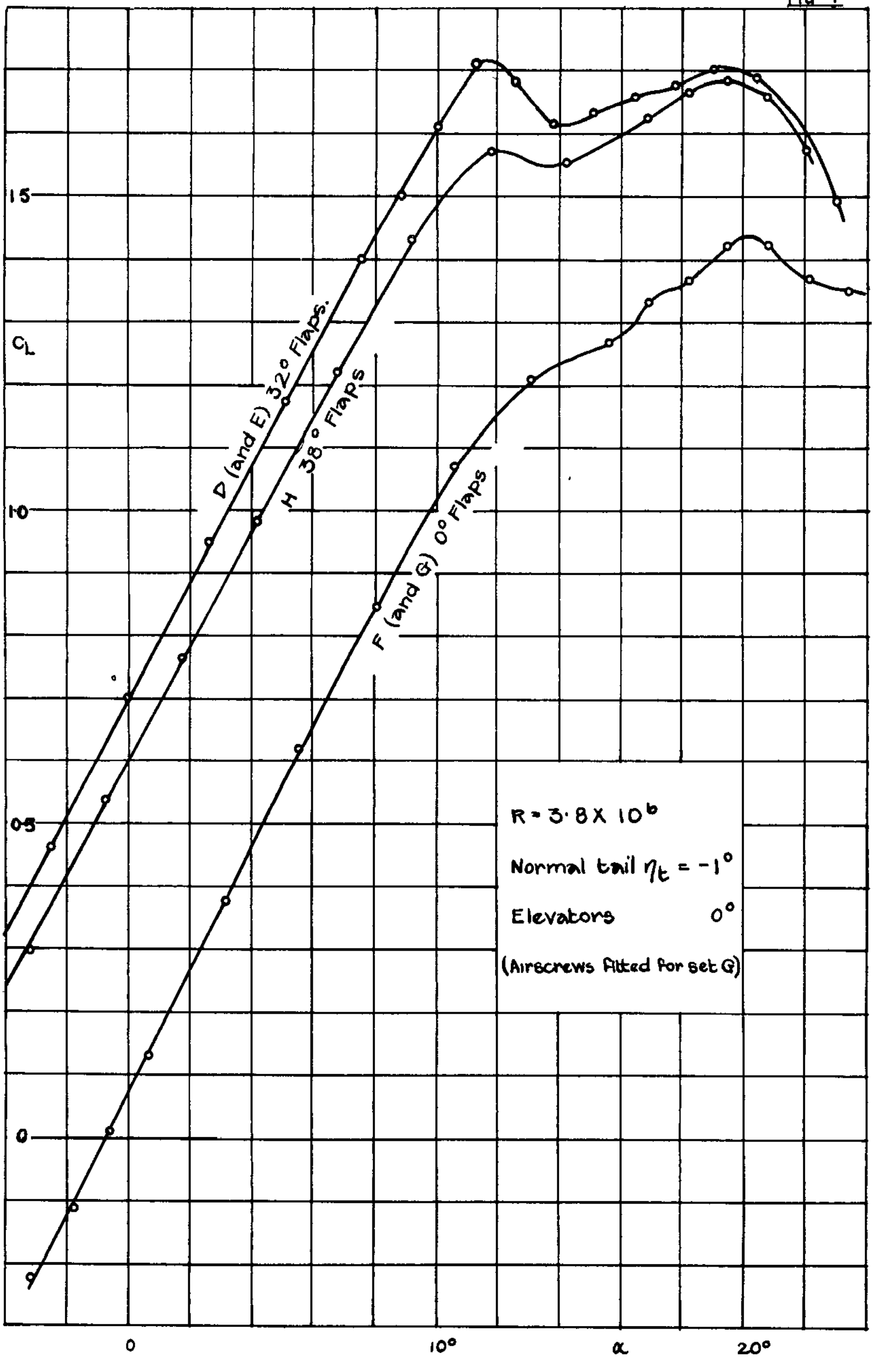
12,823
Fig 2




Outlines of fillets




Flap and Frize Sections at BJ (Fig I)




A W Apollo . Typical $C_L$ Curves.

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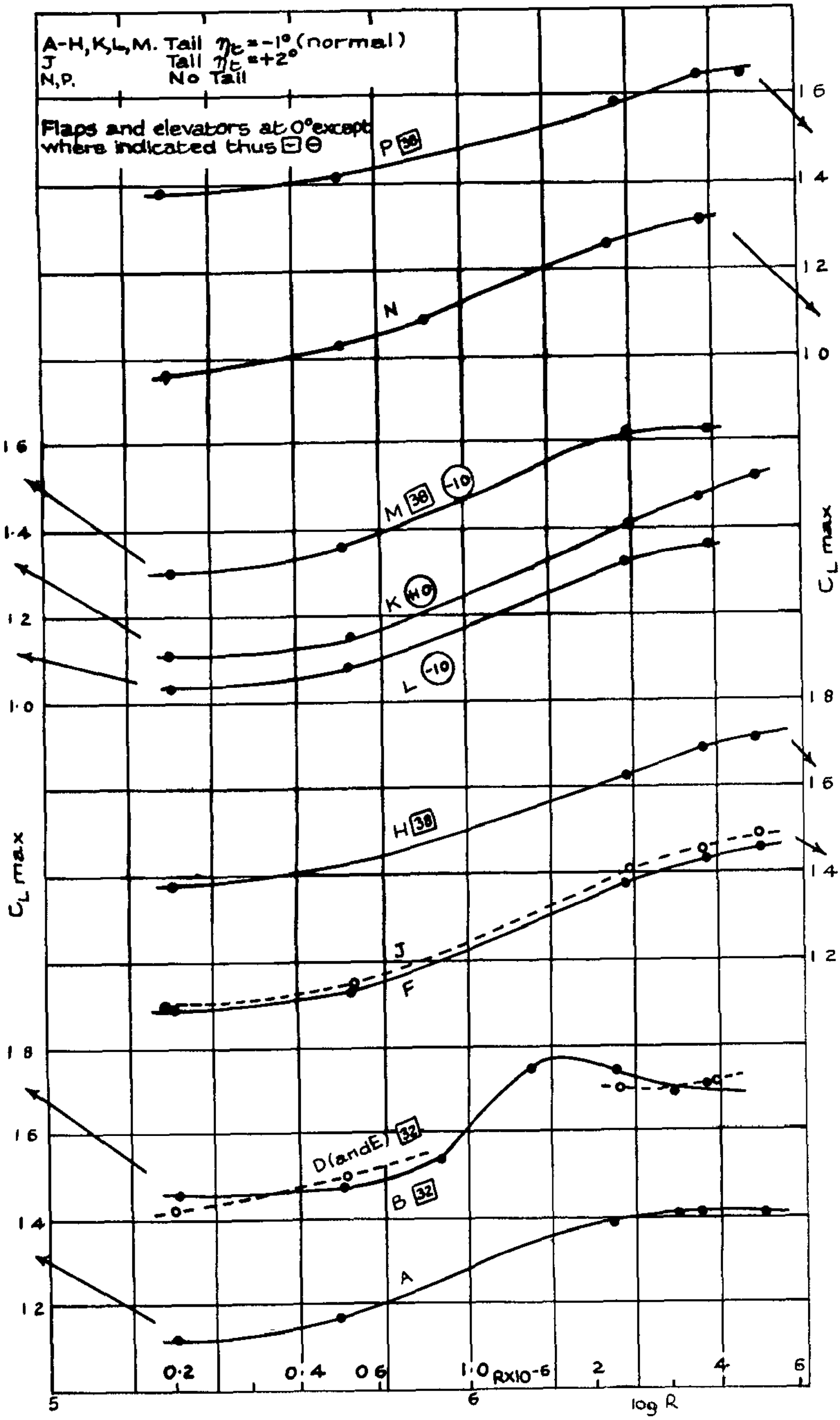
FIG 5




AW Apollo Maximum Lift Curves

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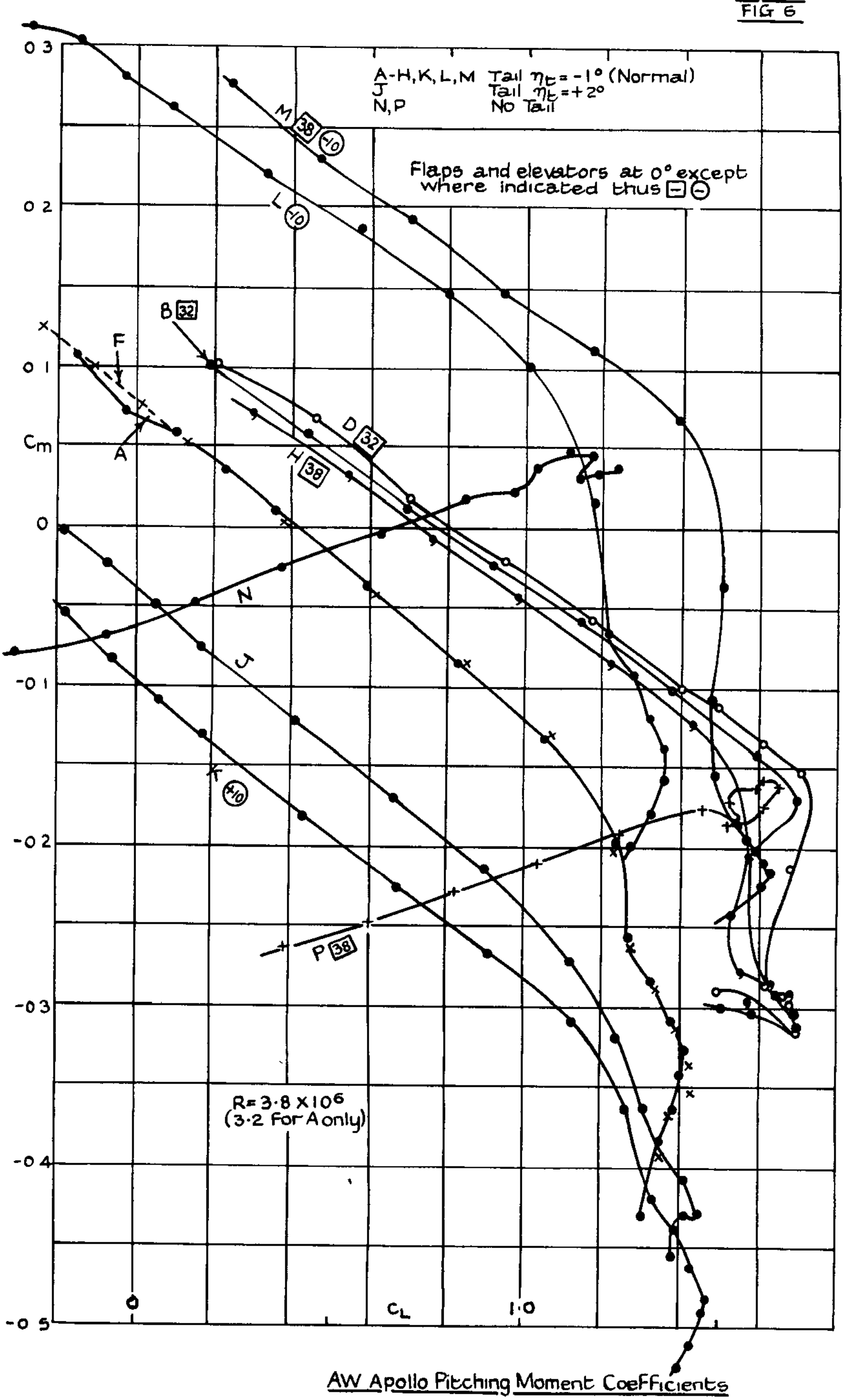
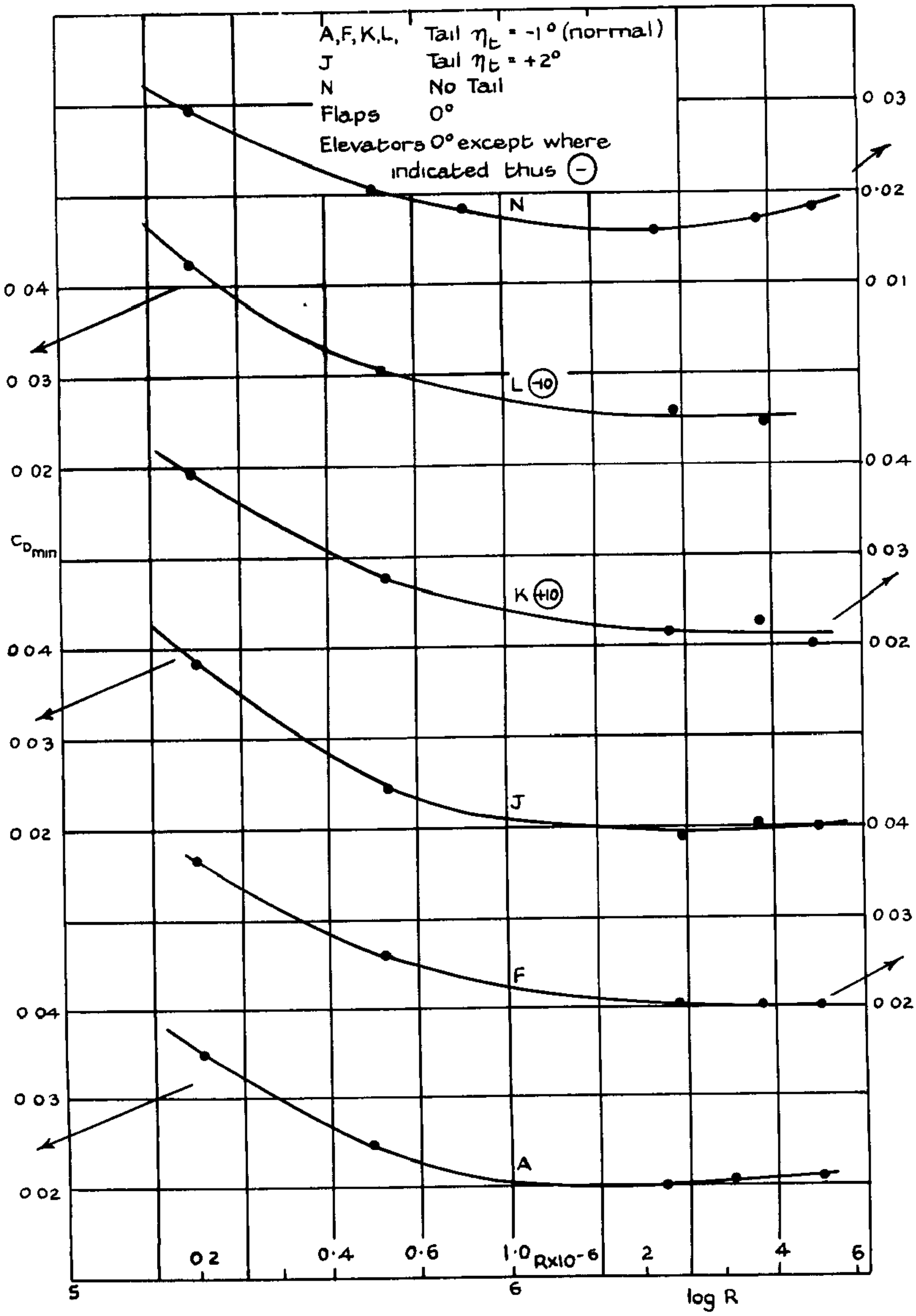
FIG 6




AW Apollo Pitching Moment Coefficients

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