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Low-Speed Wind Tunnel Investigation of an Advanced Supersonic Cruise Arrow-Wing Configuration

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SUMMARY

Tests have been conducted in the Langley V/STOL tunnel to provide a preliminary assessment of possible means for improving the low-speed aerodynamic characteristics of advanced supersonic cruise arrow-wing configurations and to extend the existing data base of such configurations. Principle configuration variables included; wind leading-and trailing-edge flap deflection, fuselage nose strakes, and engine exhaust nozzle deflection.

The results of the investigation showed that deflecting the wing leading-edge apex flaps downward to suppress the wing apex vortices provided improved longitudinal stability but resulted in reduced directional stability. The model exhibited relatively low values of directional stability over the operational angle of attack range and experienced large asymmetric yawing moments at high angles of attack. The use of nose strakes was found to be effective in increasing the directional stability and eliminating the asymmetric yawing moment.

The results of the investigation also showed that deflecting the plain trailing edge flaps for increased lift resulted in some desirable reductions in effective dihedral. However, the level of effective dihedral was still

relatively high, and when coupled with inadequate lateral control, resulted in a crosswind landing constraint which limited the approach lift coefficient of the configuration. The use of symmetric and differential thrust vectoring increased the lateral control capability, which resulted in relaxed crosswind landing constraints and increased approach lift coefficients.

INTRODUCTION

The National Aeronautics and Space Administration is currently investigating the aerodynamic characteristics of advanced supersonic cruise aircraft concepts. These conceptual designs typically incorporate a low aspect ratio highly swept arrow-wing. Although wind tunnel tests of such configurations indicate that high levels of aerodynamic efficiency may be obtained at transonic and supersonic speeds (see references 1 and 2), recent low-speed wind tunnel studies (see, for example, reference 3) have identified several deficiencies in the areas of low-speed performance, stability and control.

The present investigation is part of a broad research program which is intended to provide detailed information on the static and dynamic stability and control characteristics of advanced supersonic cruise arrow-wing configurations at low speeds. The model used in the present static force tests was a light-weight, dynamically-scaled model which will be subsequently free flight tested in the Langley full-scale tunnel to provide a qualitative evaluation of low-speed handling qualities. The model will also be used in forced oscillation tests to determine the dynamic stability derivatives for use in analytical stability and control studies.

Previous low-speed studies conducted with a geometrically similar large-scale model of the present configuration have been reported in reference 3. The present investigation was specifically intended to provide a preliminary assessment of: (1) revised leading-edge devices for improved longitudinal stability; (2) trailing-edge flap effectiveness and the effect of trailing-edge flap deflection on effective dihedral; (3) thrust vectoring of conventional underslung engines for improved low-speed performance; (4) the effect of various airframe components on lateral-directional stability and (5) differential thrust vectoring concepts used in conjunction with differential trailing-edge flap deflection for increased lateral control.

The tests were conducted in the Langley V/STOL tunnel over an angle of attack range from about -5° to 25° for sideslip angles of 0° and $\pm 5°$. The tests were conducted at a Reynolds number (based on the mean aerodynamic chord) of about 2.5×10^6.

SYMBOLS

The longitudinal data are referred to the wind system of axes, and the lateral-directional data are referred to the body system of axes as illustrated in figure 1. The moment reference center for the tests was located at 53.8 percent of the wing mean aerodynamic chord.

The dimensional quantities herein are given in both the International System of Units (SI) and the U.S. Customary Units.

b wing span, m (ft)

C_D drag coefficient, $\frac{\text{Drag}}{qS}$

C_L lift coefficient, $\frac{\text{Lift}}{qS}$

$C_{L,\Gamma}$ additional circulation lift, $\frac{\text{lift due to additional flow circulation}}{qS}$

C_l rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$

C_m pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS\bar{c}}$

C_n yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$

C_T thrust coefficient, $\frac{\text{Thrust}}{qS}$

C_Y side-force coefficient, $\frac{\text{Side force}}{qS}$

$\bar{c}$ mean aerodynamic chord, m (ft)

i_t horizontal-tail incidence, positive when leading-edge is up, deg

q free-stream dynamic pressure, Pa (lbf/ft^2)

S wing area, m^2(ft^2)

X,Y,Z body-axis coordinates

α angle of attack, deg

β angle of sideslip, deg

δ_f trailing-edge flap deflection, positive when trailing is edge down, deg

δ_N exhaust nozzle deflection (positive downward), deg

$C_{l\beta} = \frac{\partial C_l}{\partial \beta}$

$Cn_\beta = \frac{\partial Cn}{\partial \beta}$

$C_{Y\beta} = \frac{\partial C_Y}{\partial \beta}$

Model Component Designations

H horizontal tail

L_1 wing leading-edge apex flap (see figure 2(a))

L_2 leading-edge flap on outboard wing panel (see figure 2(a))

t_1, t_3, t_5, t_6 wing trailing-edge flap segments (see figure 2(a))

$V_{1,2}$ outboard vertical fins

V_3 centerline vertical tail

V_4 centerline ventral fin

WB wing-body combination

MODEL

The model used in the present investigation was a lightweight dynamically scaled model which will be used in subsequent wind tunnel free-flight tests and in forced oscillation tests. The dimensional characteristics of the 0.045 scale model are listed in table I and shown in figure 2. A photograph of the model mounted for tests in the Langley V/STOL tunnel is presented in figure 3.

Previous studies with a geometrically similar, large-scale model are reported in reference 3. The model of the present investigation differed slightly from the large-scale model. In particular, the present model incorporated revised leading-edge flaps (see figure 2(c) and 2(d) for comparison) intended to provide improved longitudinal stability characteristics. The present model also incorporated a forward shift in lower surface engine location (see figure 2(b) for comparison). The forward shift in engine location resulted in approximate alignment of the nozzle exhaust with the trailing-edge flap system, and was intended to determine if such an arrangement would be effective for developing additional circulation lift.

The model wing consisted of an arrow planform with an inboard leading-edge sweep angle of 74°, a midspan sweep angle of 70.5°, and an outboard sweep of 60°. The leading-edge apex flaps could be deflected from 0° to 30° and the leading-edge of the outboard wing panel could be deflected from 0° to 45°, or replaced with a Krueger flap arrangement (see figures 2(c) and 2(d)).

The model was equipped with four engine simulators which consisted of tip driven fans powered by externally supplied compressed air. The nozzle exhaust could be deflected using 20° elbow segments (see figure 2(b)), and the trailing-edge flap system shown in figure 2(a) permitted deflection of the individual segments.

TESTS

Static force tests were conducted over an angle of attack range of -5° to 25° for an angle of sideslip range -5° to +5°. The configuration variables associated with the wing-body-outboard vertical fin combination included; wing-apex leading-edge flaps, outboard wing-panel leading-edge flaps, and wing trailing-edge flaps. Tests were also conducted to include the effects of; various airframe component combinations, control surface deflections, engine thrust coefficient, and engine exhaust nozzle deflection.

Engine thrust coefficient was obtained from static calibration of engine thrust versus engine rotational speed. Power-on tests were performed for the model with a nominal value of thrust coefficient of 0.13, obtained by maintaining constant values of RPM. Power-off tests ($C_T = 0$) were performed with the engine simulators allowed to windmill. The unpowered tests were conducted at a Reynolds number (based on the mean aerodynamic chord) of approximately 2.5×10^6. Due to engine-simulator thrust restrictions, power on tests ($C_T = 0.13$) were conducted at a Reynolds number of about 2.0×10^6.

In addition to the forgoing tests, a limited number of smoke flow visualization tests were conducted to aid in the interpretaton of the results.

PRESENTATION OF RESULTS

A run schedule and a tabular listing of data are presented in the appendix. The results and discussion are presented in accordance with the following outline.

RESULTS AND DISCUSSION

Longitudinal Aerodynamic Characteristics

Effect of wing leading-edge devices.- The longitudinal aerodynamic characteristics of the basic wing-body-outboard vertical fin combination (L_1=L_2 = 0) and the wing-body-outboard vertical fin combination with wing-leading edge devices deflected are presented in figure 4. The data show that for $\alpha < 5°$ the leading-edge devices tested had no effect on the longitudinal aerodynamic characteristics; and that for the moment reference center tested, the wing-body-outboard vertical fin combination was about 4-percent unstable (i.e., $\partial C_m/\partial C_L = 0.04$). However, for $\alpha > 5°$ the instability of the basic wing-body-outboard vertical fin combination ($L_1 = L_2 = 0$) increased markedly with increasing angle of attack. Past investigations (see, for example, references 3 and 4) have shown that such marked increases in the level of longitudinal instability are attributable to the formation of wing apex vortices and also to the stall of the outboard wing panels. References 3 and 4 have also shown that deflection of the wing apex, and deflection of the leading-edge of the outboard wing panels, is effective in both reducing the magnitude of the instability and in delaying the angle of attack at which the instability occurs. The data of figure 4 show that deflecting the single segment apex flap 30° substantially reduces the marked non-linear variation of C_m with C_l and thus provides a stabilizing effect for angles of attack above 5°. During this phase of the investigation a limited number of smoke flow visualization tests were conducted. The smoke flow studies indicated that deflection of the apex flap was effective in reducing the intensity of the apex vortices; however, some vortex formation could still be observed. This result correlates well with measured data presented in figure 4, in that some increase in the level of instability is still present for the model with the apex flaps deflected.

Figure 4 also shows the effect of deflecting the plain leading-edge flap of the outboard wing panel, and replacing this outboard leading-edge flap segment with a Krueger flap. (see figure 2(d) for details). The data of figure 4 indicate that both the plain leading-edge flap and the leading-edge Krueger flap provided a small favorable contribution to longitudinal stability at high angles of attack, and that the contribution of the leading-edge

Krueger flap was slightly greater than that of the plain leading edge flap. This result is attributable to the improvement in the flow conditions over the outboard wing panels.

Figure 5 presents a comparison of longitudinal data obtained for the present model, with data obtained for the larger model reported in reference 3. The model of reference 3 had a deflectable leading-edge apex flap system and a plain, permanently deflected, leading-edge flap on the outboard wing panel. As can be seen from figure 5, the data for the models are in relatively good agreement. The small differences shown are probably due to the slight differences in model geometry, and also to the difference in test conditions (i.e., $R_N = 2.5 \times 10^6$ versus $R_N \doteq 5.17 \times 10^6$).

Effect of trailing-edge flap deflection.- The segmented trailing-edge flap system is sketched in figure 2(a). The angular deflection of the individual segments is described normal to the respective flap hinge lines. A trailing-edge flap setting indicated as $\delta_f = 40°/30°/20°$ corresponds to a condition wherein the inboard trailing edge flap segments (t_1) are deflected 40°, the mid-span segments (t_3) are deflected to 30°, and the outer flap segments (t_5) are deflected to 20°.

Figure 6 presents the longitudinal aerodynamic characteristics of the wing-body-outboard vertical fin combination for various trailing-edge flap deflections. The data of figure 6 indicate that for $\alpha < 10°$, deflecting the plain trailing-edge flap from 0° to 30° results in essentially a linear increase in C_L with increasing δ_f. However, at higher angles of attack, or higher flap deflections, the effectiveness of the trailing-edge flap system is reduced. The reduction in trailing-edge flap effectivness, which occurs at high flap deflections and high angles of attack, is attributed to the separation of flow over the trailing-edge flap system.

In order to provide some insight into the effectiveness of the individual trailing-edge flap segments, tests were conducted in which the segments were deflected individually. Figure 7 summarizes the resulting increment in lift coefficient as a function of flap deflection for individual segments t_1, t_3, and t_5. From figure 7 it can be seen that the inboard trailing-edge flap segment (t_1) is most effective in producing lift, and that the outboard trailing-edge flap segment (t_5) is relatively ineffective. At present, the high sweep of the hinge line of segment t_5 is thought to be responsible for its relatively poor lifting characteristics. It is of course recognized that the incremental values of lift coefficient presented in figure 7, will not necessarily sum to the total obtained by deflection of the entire trailing-edge flap system. However, the data of figure 7 are in qualitative agreement with the data of figure 6 and therefore are thought to be indicative of the relative effectiveness of the individual trailing-edge flap segments.

Effect of thrust vectoring.- The discussion of reference 5 has indicated that the overall efficiency of the present configuration may be significantly improved by the application of propulsive-lift concepts which provide improved low-speed performance. Previous low-speed investigations (see reference 3) have included the use of a simple thrust vectoring arrangement wherein the exhaust flow of the conventional lower surface engines was deflected downward. The results of reference 3 indicate that due to the relatively far aft location of the exhaust nozzles, the increment in lift due to the thrust vectoring concept was limited to the vector component of the thrust force, and that no additional circulation lift was developed. Therefore, to more nearly align the nozzle exits with the trailing-edge flap system, and thereby determine if such an arrangement would develop additional circulation lift, the underslung engines were moved forward of the location tested in reference 3 (see figure 2(b) for comparison of engine locations).

The longitudinal aerodynamic characteristics of the present configuration with the exhaust nozzles undeflected ($\delta_N = 0°$) and with the exhaust nozzles deflected ($\delta_N = 20°$) are presented in figure 8. Analysis of the data of figure 8(a) indicates that for the undeflected exhaust nozzles, the increment in lift coefficient due to thrust effects is simply the vector component of the thrust force given by the expression

$$\Delta C_L = C_T \sin \alpha \qquad (1)$$

With the deflected exhaust nozzles, static calibration tests showed that the jet exhaust was deflected through the geometric nozzle angle. Analysis of the data of figure 8(b) indicates that very small values of additional circulation lift ($C_{L,\Gamma}$) are obtained.

$$C_{L,\Gamma} = C_L\Big|_{\substack{\text{power}\\ \text{on}}} - C_L\Big|_{\substack{\text{power}\\ \text{off}}} - C_T \sin (\alpha + \delta_N) \qquad (2)$$

For example, at $\alpha = 10°$ $C_{L,\Gamma}$ is computed to be about only 2-percent of the total lift.

<u>Horizontal tail effectiveness.</u>- Figure 9 presents a comparison of the data obtained for the model with the horizontal tail off and on. From these data it can be seen that for angles of attack less than 10°, the horizontal tail provides only a small contribution to longitudinal stability. However, at higher angles of attack the horizontal tail does provide a somewhat greater stabilizing contribution. Figure 9 also shows that, as expected, thrust

affected the level of the tail-off pitching moment; however, it did not alter the horizontal tail effectiveness.

The longitudinal control effectiveness, provided by deflecting the all movable horizontal tail through a range of tail incidences corresponding to $\pm$ 15°, is shown in figure 10. Although the horizontal tail tested was ineffective for providing longitudinal stability at low angles of attack, the data of figure 10 show that the horizontal tail does provide longitudinal control. Furthermore, the data indicated that the longitudinal control effectiveness remains fairly constant over the angle of attack range tested, and that the control effectiveness was not altered by thrust effects. It should be noted that the horizontal tail apparently did not stall over the range of conditions investigated, and therefore, even higher levels of longitudinal control may be obtained by increasing the horizontal tail incidence above the values considered herein.

Lateral-Directional Characteristics

Effect of wing leading-edge devices.- As mentioned in a previous section, deflection of the wing leading-edge apex flap, L_1, and deflection of the leading-edge flap of the outboard wing panel, L_2, resulted in a beneficial contribution to longitudinal stability.

Figure 11 shows the effect on the lateral-directional stability characteristics of deflecting the leading-edge apex flap, L_1, and the outboard panel leading-edge flap, L_2. The data of figure 11 show that the basic wing-body-outboard vertical fin combination ($L_1 = L_2 = 0$) exhibits stable values of the directional stability derivative, Cn_β, and that Cn_β increased with increasing angle of attack. Consideration of the side force derivative, CY_β indicates that the increase in directional stability (i.e., increased values of C_{n_β}) with increasing angle of attack, originates from a body station forward of the moment reference center. This result has been observed for other highly swept arrow-wing configurations (see, for example, reference 4) and has been associated with the interaction of the wing apex vortices on the forward portion of the configuration. As can be seen from the data of figure 11, deflecting the wing apex flaps downward in order to suppress the wing apex vortices, and hence provide improved longitudinal stability, results in a reduction in directional statility. The data of figure 11 also show that deflecting the outboard panel leading-edge flap had no significant effect on directional stability, and that deflection of either the leading-edge apex flap or the outboard panel leading-edge flap had only slight effects on the effective dihedral derivative, C_{l_β}, for $\alpha < 15°$. It should be noted that although the leading edge devices tested had only a slight effect on C_{l_β}, the level of C_{l_β} at the higher angles of attack is relatively high. Previous simulation studies of similar arrow-wing concepts have indicated that such high levels of $-C_{l_\beta}$ result in poor handling qualities and lateral control characteristics.

Effect of trailing-edge flap deflection.- As pointed out in a previous section, the relatively high levels of $-C_{l_\beta}$ exhibited by the model may lead to handling qualities and lateral control problems. However, the results of reference 6 have indicated that reductions in $-C_{l_\beta}$ may accompany increased trailing-edge flap deflections.

Figure 12 presents the variation of the effective dihedral derivative, with lift coefficient, for various trailing-edge flap deflections. As can be seen from figure 12(a), increasing the trailing-edge flap deflection results in reduced levels of $-C_{\ell_\beta}$ at a given lift coefficient. In order to determine if the above result could be attributed to an increased loading on the inboard portion of the wing, tests were conducted for nonuniform trailing edge flap deflections of 30°/0°/0° and 0°/40°/20°. These conditions were selected in an attempt to achieve as much variation of spanwise load distribution as possible. Figure 12(b) presents a comparison of the results obtained for the nonuniform trailing-edge flap deflections, with those obtained for δ_f = 20°/20°/20°. The data show that these three trailing edge flap settings resulted in about the same variation of C_L with α, and also about the same variation of C_{ℓ_β} with C_L. For the trailing-edge flap conditions investigated, no effect on C_{n_β} was observed and hence the data are not presented.

Based on the results presented in figure 12, it appears that the reduction in the effective dihedral (obtained at a constant C_L) provided by increasing trailing-edge flap deflection, is associated with the reduction in angle of attack at which a given lift coefficient is obtained. Therefore, one possible means for further reducing the level of $-C_{l_\beta}$ is through the development of an effective high lift system which will permit the desired lift coefficient to be achieved at reduced angles of attack.

Airframe component build-up studies.- Figures 13 and 14 present the variation of the lateral-directional stability derivatives, with angle of attack, for various airframe component combinations. From the data of figure 13 it can be seen that the outboard vertical fins and the centerline vertical tail provide a stabilizing increment to the directional stability derivative, C_{n_β}, over the normal operational angle of attack range. However, the contribution of the outboard vertical fins to C_{n_β} is reduced for angles of attack greater than 20°, and the contribution of the centerline vertical tail to C_{n_β}

is reduced for angles of attack greater than 10°. The data of figure 13 also show that the centerline ventral fin has no effect on the lateral-directional stability derivatives.

Figure 14 shows the effect of the horizontal tail on the lateral-directional stability characteristics of the model. As can be seen from figure 14, at low angles of attack the addition of the horizontal tail (i_t = 0°) provided the model with a stabilizing increment to C_{n_β} which is comparable to the increments provided by addition of either the outboard vertical fins or the centerline vertical tail. The increase in directional stability provided by the horizontal tail, for the model at low angles of attack, is probably due to the horizontal tail acting as an endplate for the vertical tail. It should be noted, however, that for angles of attack greater than about 14° the horizontal tail (i_t = 0°) is directionally destabilizing and resulted in the complete model exhibiting unstable values of C_{n_β} for angles of attack from 16° to 22°. However, as also shown by figure 14, deflecting the horizontal tail to i_t = -15° resulted in an increase in C_{n_β} (relative to the horizontal tail-off condition) over the angle of attack range tested.

The data of figures 13 and 14 also show that the relatively high levels of $-C_{l_\beta}$, exhibited by the wing-body combination, are only slightly influenced by other configuration components.

Effect of fuselage forebody strakes.- As shown by the data of a previous section, the maximum value of the directional stability derivative, C_{n_β}, of the complete configuration was found to be only about 0.001. Previous studies of similar configurations (see, for example, reference 7) have indicated that increased values of C_{n_β} may be required. Of course, increases in C_{n_β} could be provided by increasing the size of the vertical tail; however, this may be detrimental to the supersonic cruise performance. Therefore, to provide necessary information for future trade studies, the use of nose strakes (see figure 2(e) for geometric details) has been investigated. Figure 15 presents a comparison of the lateral-directional data obtained for the complete model with the nose strakes on and off. As can be seen, the particular nose strakes tested provided a substantial increase in the directional stability derivative, C_{n_β}. Furthermore, the increase in C_{n_β} is seen to be accompanied by increased values of C_{Y_β}, indicating that the stabilizing influence originates from the forward portion of the configuration. However, as indicated in reference 8, increased values of C_{n_β} originating from the nose may be accompanied by undesirable reductions in the damping in yaw. Therefore, additional tests are required to assess the total effect of nose strakes on the dynamic stability characteristics of the configuration.

In addition to the relatively low level of directional stability, the model was also found to exhibit large out-of-trim yawing moments. Figure 16 presents the lateral-directional characteristics obtained for the complete model at $\beta = 0°$, for conditions with and without the previously discussed nose strakes. The data show that without nose strakes, extremely large asymmetric yawing moments occur for angles of attack greater than 15°. The data of figure 16 also show that when the strakes were added to the fuselage forebody, the asymmetry in yawing moment was virtually eliminated. Previous studies (see, for example, reference 9) have identified asymmetric displacement of vortex cores originating from long slender fuselage forebodies as one phenomena responsible for yawing moment asymmetries. A sketch of the flow field over the fuselage forebody, observed during smoke flow visualization tests of the present model, is presented in figure 17. For the model without the nose strakes, the vortex cores eminating from the fuselage forebody were found to be asymmetrically disposed as sketched in figure 17(a). Addition of the nose strakes apparently provides a well defined point of separation which, in turn, resulted in the symmetric vortex formation sketched in figure 17(b). Although this phenomenon is probably Reynolds number dependent, the investigation reported in reference 10 has indicated that it may persist at full-scale Reynolds numbers.

The effect of the nose strakes on the longitudinal aerodynamic characteristics of the configuration is presented in figure 18. As can be seen, the particular strakes tested introduced an increased level of longitudinal instability for angles of attack above 5°. However, it should be noted that the strakes were solely intended to investigate potential improvements in directional characteristics. Therefore, additional study is required to define the appropriate strake geometry which will provide the beneficial increase in C_{n_β} and eliminate the yawing moment asymmetry, without the attendant increase in longitudinal instability.

LATERAL CONTROL CHARACTERISTICS

Previous analytical studies of highly swept arrow-wing concepts have indicated that the lack of adequate roll control, for providing lateral trim under steady-state crosswind landing condition, may impose added low-speed operational constraints. Therefore, during the present investigation tests were conducted to determine the lateral control effectiveness provided by the ailerons and differential deflection of the trailing-edge flap segments, and to assess the potential advantages of thrust vectoring concepts for providing increased roll control. It should be pointed out that the model used in the investigation was relatively rigid, and that the effects of elasticity have not been considered.

Aerodynamic lateral control effectiveness.- The data of figure 7 have shown that the trailing-edge flap segment t_5 is relatively ineffective for providing lift; however, because of its geometric moment arm, segment t_5 has been found to be relatively effective for producing roll control. For example, figure 19 shows the variation of the lateral-directional aerodynamic characteristics with angle of attack for the model using the outboard aileron (t_6) and the combination of outboard aileron and trailing-edge flap segment t_5. As can be seen, segment t_5 provides approximately one-half the rolling moment produced by deflecting the outboard aileron (t_6) alone. Figure 20 presents the corresponding longitudinal data for the configuration with the above lateral control conditions. Also presented in figure 20 are the data obtained for the symmetric, δ_f = 40°/40°/20° flap condition. As can be seen from comparison of the data of figure 20, the use of segment t_5 for lateral control results in only minor lift losses, indicating that segment t_5 may be used more effectively as an aileron than as a trailing-edge flap.

In order to further establish the relative lateral control effectiveness of the individual trailing-edge segments, tests were conducted wherein the segments were deflected individually. The results are summarized in figure 21 for an assumed approach angle of attack of 8°. It is of course recognized that the incremental values of rolling moment coefficient, provided by the individual segments, will not necessarily sum to the total obtained by deflection of various segments in combination. However, comparison of the data of figure 19 with results obtained by summation of corresponding data of figure 21 shows that good agreement does exist. Hence, the data of figure 21 may be considered to be representative of the lateral control capabilities of the present trailing-edge system.

From the data of figure 21 it can be seen that the variation of C_l with deflection angle for segment t_6 is non-linear, thereby indicating that upwardly deflecting segment t_6 can produce a lift loss which is greater than the lift gain produced by a corresponding downward deflection of this segment. Since previous studies have shown that such segments are ineffective at deflections greater than 40°, and since it is desired that no lift losses accompany the lateral control provided, the data of figure 21 indicate that the maximum lateral control produced by segment t_6 would be about $C_l = 0.01$. The data of figure 21 also show that the maximum lateral control provided by segment t_5 for $\pm 40°$ deflection would be $C_l = 0.006$. Hence, for the assumed approach angle of attack of 8°, the lateral control provided by segments t_5 and t_6 would be limited to about $C_l = 0.016$. However, as shown by figure 21, segments t_1 and t_3 produce significantly higher levels of rolling moment than segments t_5 and t_6, which suggests that utilizing surfaces t_1 and t_3 as flaperons may substantially increase the lateral control available.

Assuming that segment deflections greater than 40° will result in flow separation (as indicated by figures 6 and 7), then the total roll control available with minimum lift loss, using segments t_5 and t_6 as ailerons and segment t_1 and t_3 as flaperons, is as follows:

δ_f t_1,t_3 deg	δ_a t_1,t_3 deg	C_l t_1+t_3	C_l t_5+t_6	C_l Total
0	± 40	0.028	0.016	0.044
10	30	0.021	↓	0.037
20	20	0.014	↓	0.030
30	10	0.007	↓	0.023
40	0	0	↓	0.016

If it is assumed that the lateral control available remains constant over the angle of attack range considered, then lines of constant lateral control available may be superimposed on the plot of C_L versus δ_f as illustrated in figure 22. It should be noted that the longitudinal data presented in figure 22 are obtained from figure 6, assuming that the lift contribution of segment t_5 is negligible.

The roll control required for lateral trim under crosswind conditions may be obtained from the expression

$$C_l = C_{l_\beta}\beta \qquad (3)$$

where the values of C_{l_β} are a function of lift coefficient and flap deflection (see figure 12). The sideslip angle, β, is by definition

$$\beta = \sin^{-1}\frac{v}{V} \qquad (4)$$

where v = crosswind velocity, and V is the approach speed which is assumed to be a function of C_L only.

$$V = \sqrt{W/S\ .\ 2/\rho C_L} \qquad (5)$$

Therefore, for a given approach lift coefficient, flap deflection and crosswind velocity, equation 3 defines the lateral control required. Superimposing the lateral control required on the plot of lateral control available, and plotting the locus of points for which the lateral control available equals the lateral control required, results in the lateral control constraint illustrated in figure 23. From figure 23 it can be seen that for an assumed approach angle of 8°, the requirement for lateral trim in a 30 knot crosswind would limit the approach lift coefficient to values of about 0.5. Although increases in approach C_L would be provided by reducing the crosswing velocity (see figure 23), the 30 knot crosswind constraint is considered to be consistent with current design practice.

In order to more clearly demonstrate the relationship between crosswind velocity and approach lift coefficient (or approach speed) the results of figure 23 are presented as a nomogram in figure 24. From figure 24 it can be seen that desirable reductions in approach speed would be accompanied by an increasingly restrictive crosswind constraint.

It is of course recognized that the above results are for a lateral control system of outboard ailerons and differential trailing-edge flaps, and that other sources of lateral control may allow the crosswind constraint to be relaxed. One concept is to provide increased trailing-edge flap effectiveness (for example with the use of propulsive-lift concepts). Increased trailing-edge flap effectiveness would, of course, provide increased lateral control; moreover, it would permit increased lift to be obtained at a given angle of attack, which, as indicated previously, will provide reduced levels of $-C_{l_\beta}$ at a given value of C_L. The reduction in $-C_{l_\beta}$ will of course result in reduced levels of required lateral control.

Effect of thrust vectoring.- As indicated in the previous section, the development of propulsive lift concepts may allow the crosswind constraint to be relaxed. As an illustration, the 30 knot crosswind constraint calculated for the configuration employing symmetric thrust vectoring is compared with the constraint for the basic configuration in figure 25. As can be seen from comparison of figures 25(a) and (b), the use of symmetric thrust vectoring would result in an increase in approach lift coefficient from about .5 to about 0.55. The increase in approach lift coefficient, provided by symmetric thrust vectoring is due to: (1) the previously mentioned reduction in $-C_{l_\beta}$ at a given lift coefficient, which results in a reduction in lateral control required, and (2) an increase in aileron (differential flap) deflection available, due to reduced symmetrical flap deflection required to achieve a given C_L.

In order to investigate the use of differential thrust vectoring as a possible means for providing further increased lateral control, tests were conducted wherein the outboard exhaust nozzles were deflected 20° differentially from the undeflected condition. Figure 26 presents the rolling moment coefficient produced by the differential thrust vectoring and also presents the values of rolling moment coefficient which would be directly attributable to differential inclination of the thrust produced by the outboard engines. The calculated value of rolling moment coefficient is computed from the expression

$$C_l = -\sum_i \frac{Y_i}{b} C_T \sin \delta_{N_i} \qquad (6)$$

As would be expected (based on the longitudinal results obtained from symmetric thrust vectoring tests) the experimental and calculated results are in relatively good agreement. However, it is interesting to note that the calculated rolling moment coefficient somewhat underestimates the experimentally determined values. This result is probably due to the upwardly deflected engine exhaust acting as a spoiler, and hence providing a slight increase in lateral control.

If it is assumed that $\pm 20°$ differential thrust vectoring of all four engines may be superimposed on 20° of symmetric thrust vectoring, then for $C_T = 0.13$ an incremental rolling moment coefficient of 0.009 is computed from equation 6. The increase in lateral control, provided by differential thrust vectoring, further relaxes the lateral control constraint as illustrated in figure 27. Hence for the conditions considered (i.e., $\alpha = 8°$ and a 30 knot crosswind) the approach lift coefficient could be increased to 0.6.

It should be noted that the particular thrust vectoring concept investigated produced only limited additional circulation lift and therefore, is seen to require substantial deflection angles to achieve the lateral control shown in figure 27. However, it may be possible to reduce these required deflections and further relax the lateral control constraint through the use of alternate propulsive-lift concepts which do produce substantial levels of additional circulation lift.

SUMMARY OF RESULTS

The results of low-speed wind tunnel tests of an advanced supersonic cruise arrow-wing configuration may be summarized as follows:

1. Deflection of the wing leading-edge apex flaps downward to suppress the wing apex vortices, and hence provide improved longitudinal stability, results in a reduction in directional stability.
2. For $\alpha < 10°$, deflecting the entire plain trailing-edge flap system from 0° to 30° resulted in essentially a linear increase in C_L with δ_f. However for $\alpha > 10°$, or $\delta_f > 30°$, the effectiveness of the plain trailing-edge flap system was reduced.

3. For the particular configuration tested, the increment in lift provided by thrust vectoring was essentially limited to the vector component of the thrust forces.

4. The horizontal tail tested was effective in providing longitudinal control over the angle of attack range tested. However, the horizontal tail provided only a small contribution to longitudinal stability for $\alpha < 10°$.

5. Increasing the trailing-edge flap deflection resulted in a reduction in $-C_{l_\beta}$ at a given lift coefficient. This result is apparently due to a reduction in angle of attack at which the given lift coefficient is obtained.

6. The outboard vertical fins and the centerline vertical tail provided a stabilizing increase in C_{n_β} over the normal operational angle of attack range. The addition of the horizontal tail provided a substantial increase in C_{n_β} at low angles of attack.

7. The use of nose strakes was found to provide a significant increase in C_{n_β} and to eliminate large asymmetric yawing moments at high angles of attack; however, the particular strakes tested were longitudinally destabilizing.

8. The high levels of effective dihedral, and inadequate lateral control exhibited by the model, resulted in a 30 knot crosswind landing constraint which would limit the approach lift coefficient of the configuration to about 0.5.

9. The use of symmetric and differential thrust vectoring resulted in increased lateral control which provided relaxed crosswind landing constraints and permitted increased approach lift coefficients.

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Configuration. NASA TN D-7716, 1974.

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TABLE I.- DIMENSIONAL CHARACTERISTICS OF MODEL

Wing (aspect ratio of 1.72):		
Area, m^2 (ft^2)	2.067	(22.25)
Span, m (ft)	1.89	(6.20)
Root chord, m (ft)	2.515	(8.252)
Tip chord, m (ft)	9.242	(0.794)
Mean aerodynamic chord, m (ft)	1.557	(5.109)
Leading-edge sweep, deg -		
At body station 1.275 m (4.184 ft)		74
At body station 4.758 m (15.609 ft)		70.5
At body station 6.238 m (20.615 ft)		60
Vertical tail:		
Area, m^2 (ft^2)	.0327	(.352)
Span, m (ft)	.171	(.562)
Root chord, m (ft)	.0732	(.240)
Leading-edge sweep, deg		59
Vertical fin (two):		
Area, m^2 (ft^2)	.084	(.90558)
Span, m (ft)	0.147	(0.484)
Root chord, m (ft)	0.499	(1.637)
Tip chord, m (ft)	0.071	(0.2331)
Leading-edge sweep, deg		73.4
Horizontal tail (aspect ratio of 1.39):		
Area, m^2 (ft^2)	.140	(1.613)
Span, m (ft)	.457	(1.499)
Root chord, m (ft)	.540	(1.772)
Tip chord, m (ft)	.116	(0.380)
Leading-edge sweep, deg		43
Dihedral, deg		-15

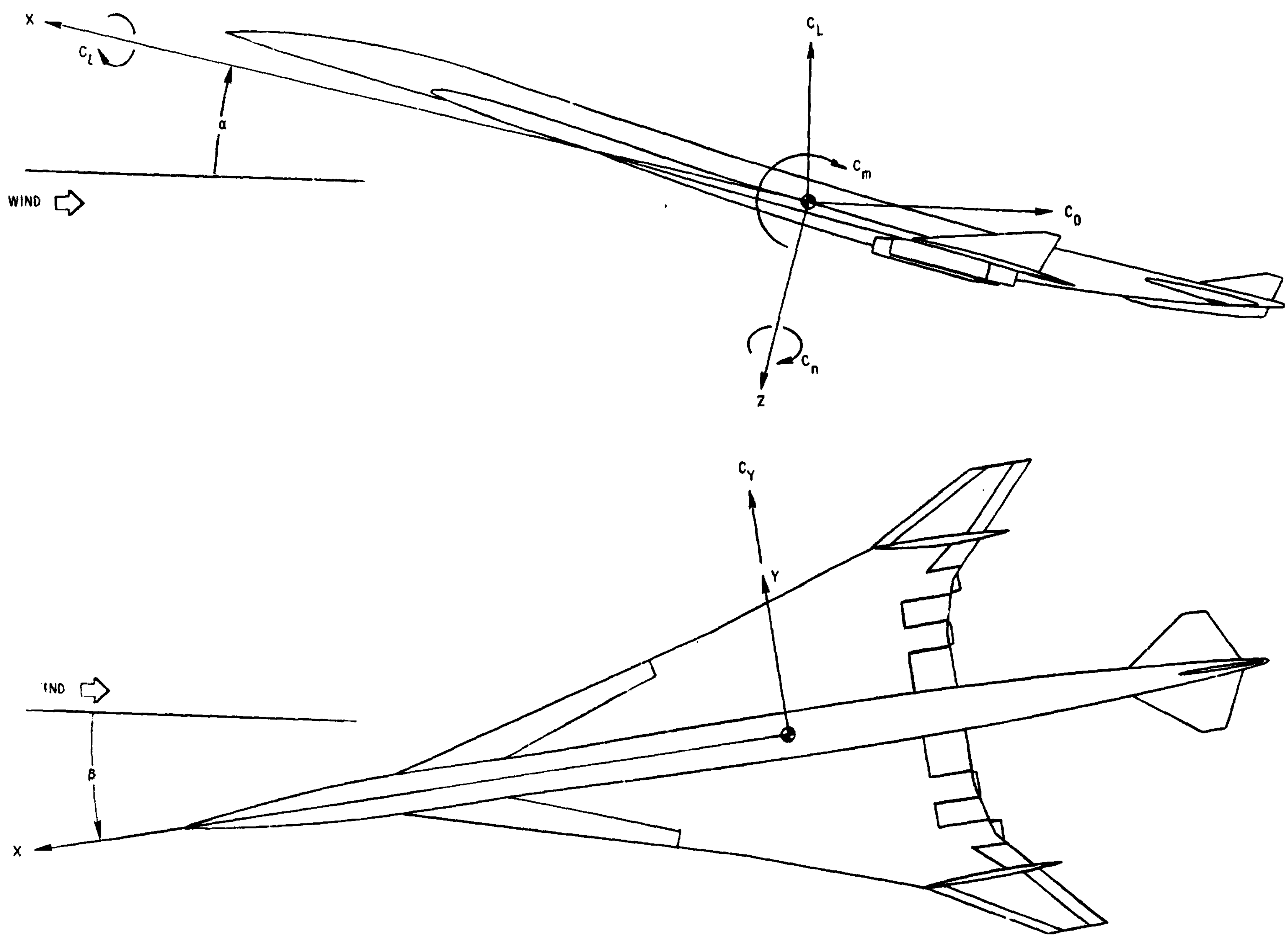
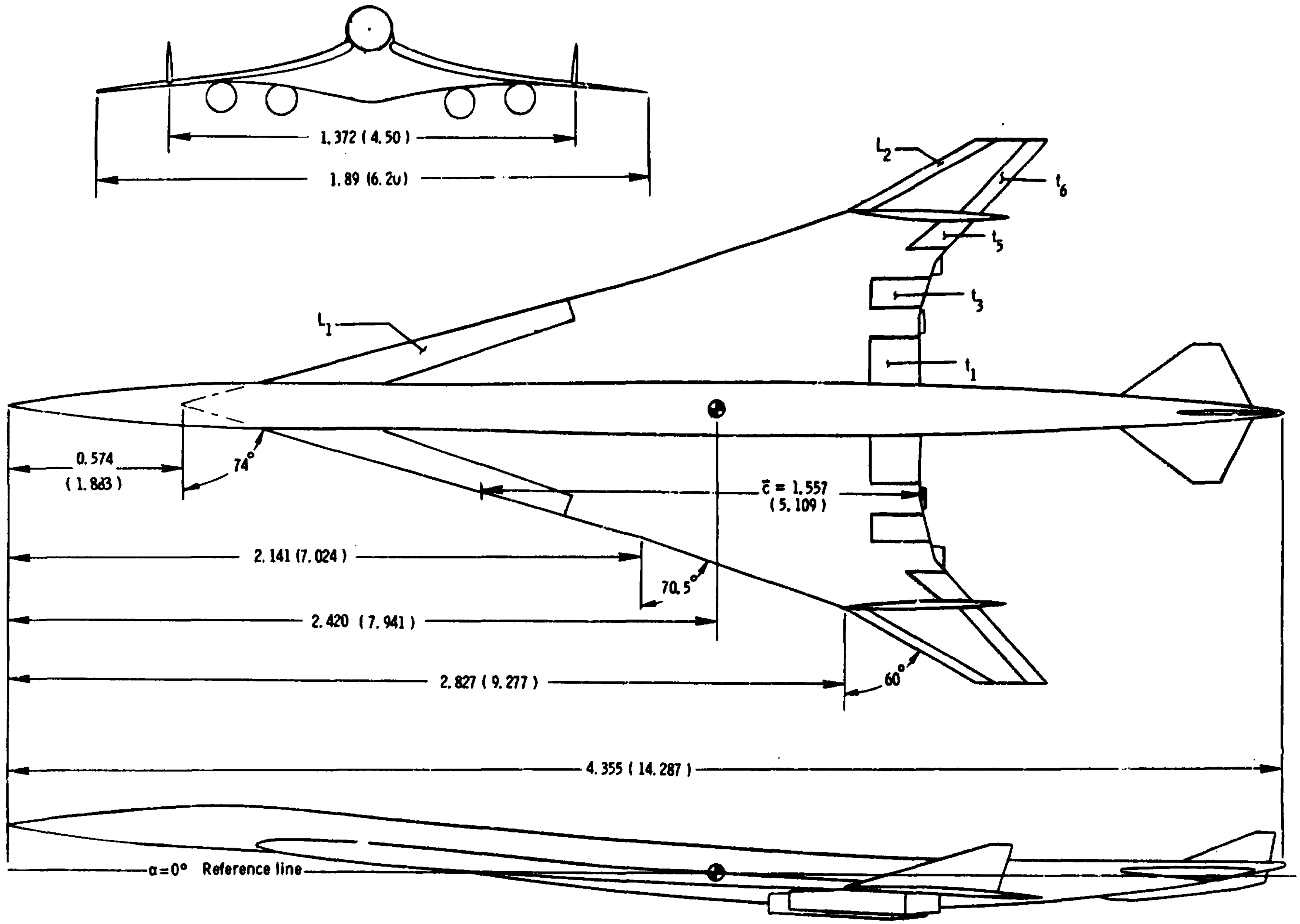
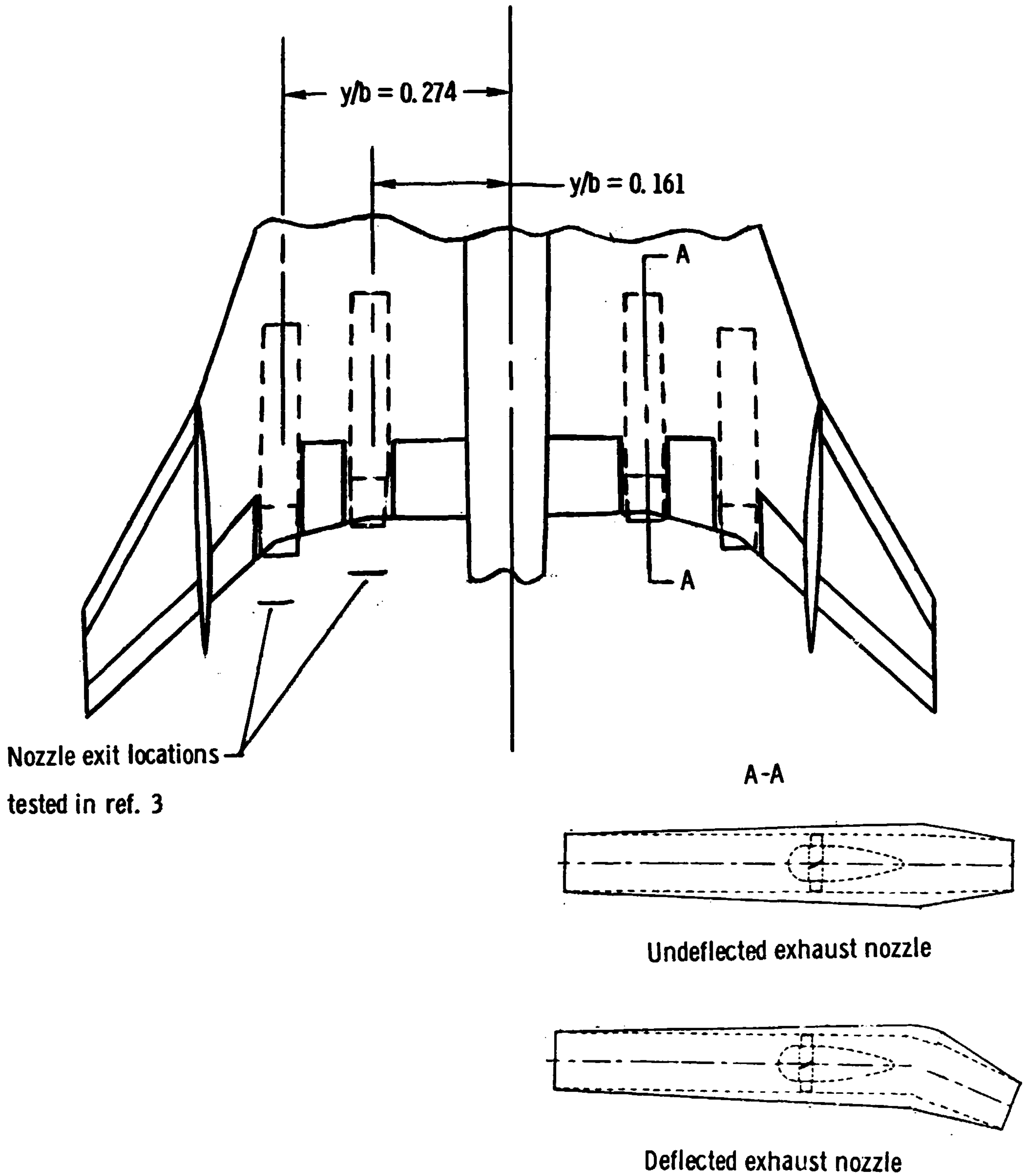


Figure 1. - The body system of axes.



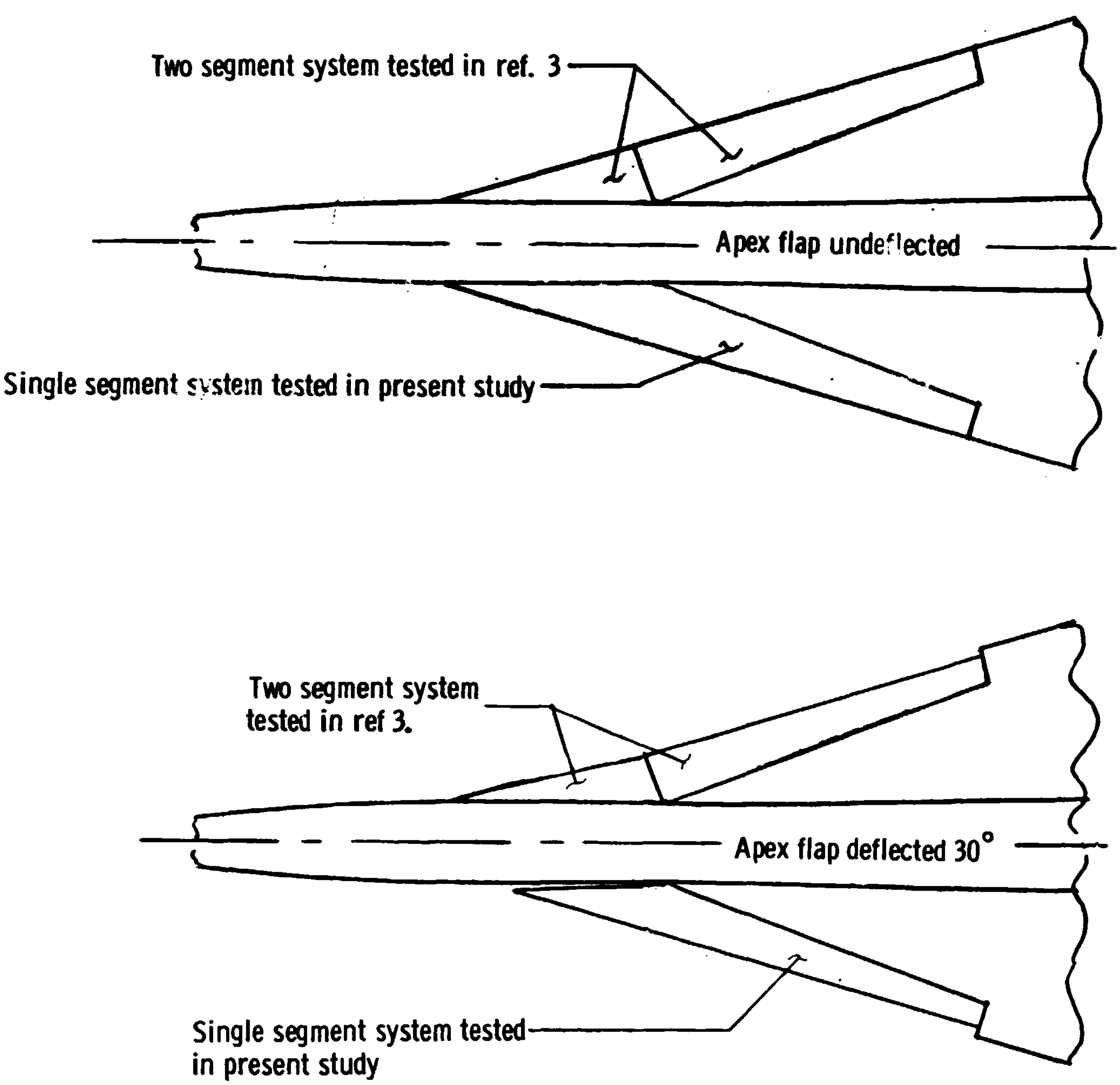
(a) Three-view sketch of model. Dimensions are given in meters and parenthetically in feet.

Figure 2. - Geometric characteristics of model.



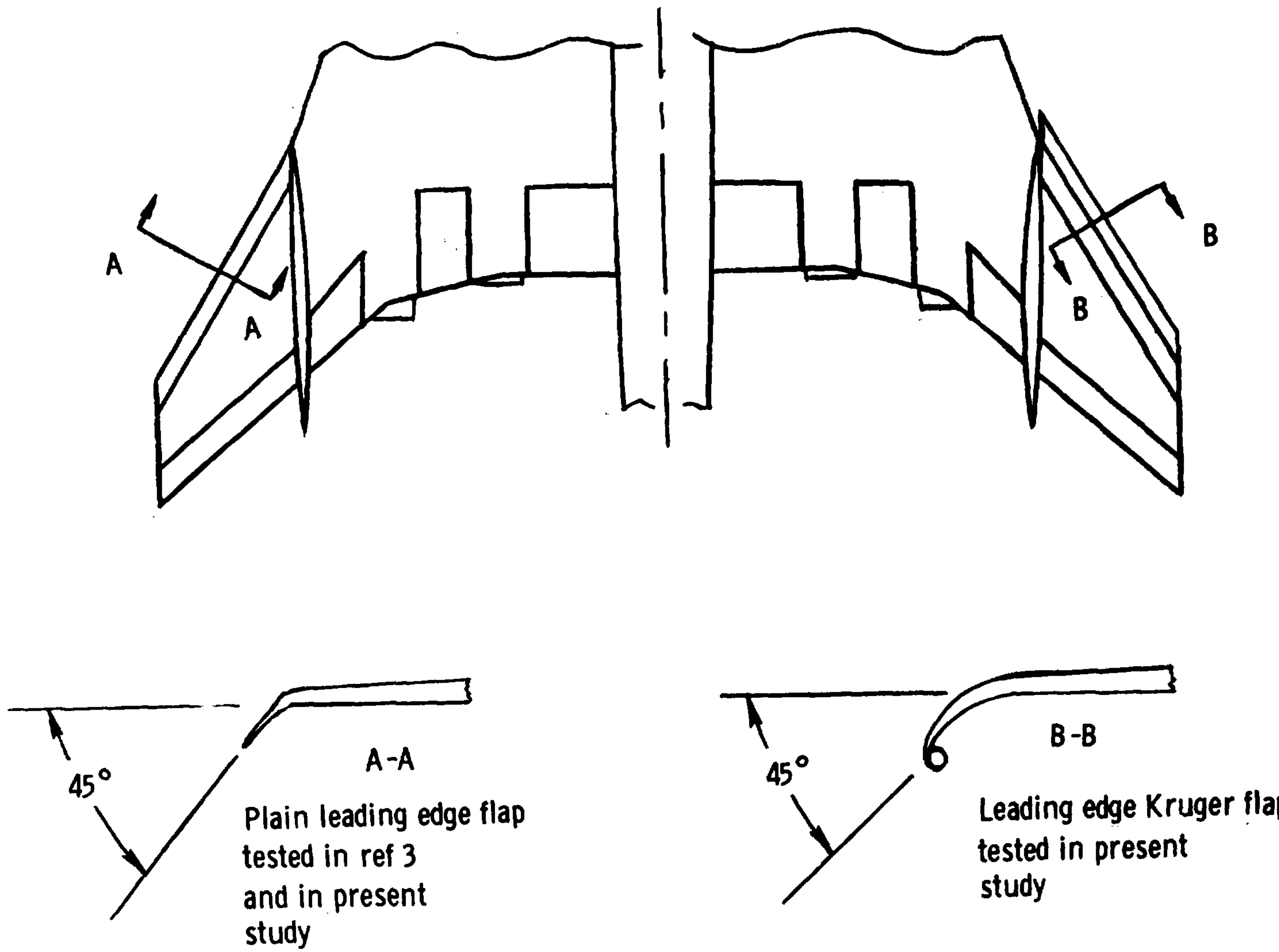
(b) Sketch of nacelles and engine simulator

Figure 2. - Continued



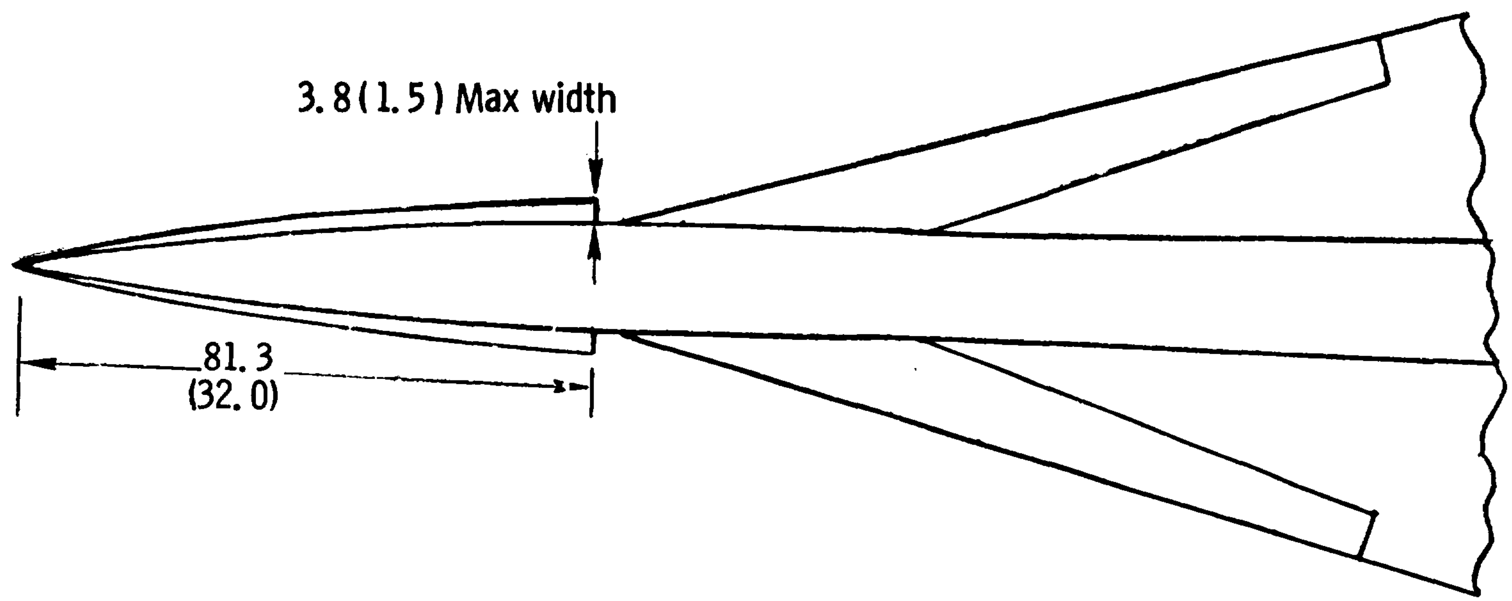
(c) Sketch of leading edge apex flap system

Figure 2 - Continued



(d) Sketch of outboard wing-panel leading edge flaps.

Figure 2. - Continued.



(e) Sketch of fuselage forebody strakes. Dimensions are in centimeters and parenthetically in inches.

Figure 2. - Concluded.

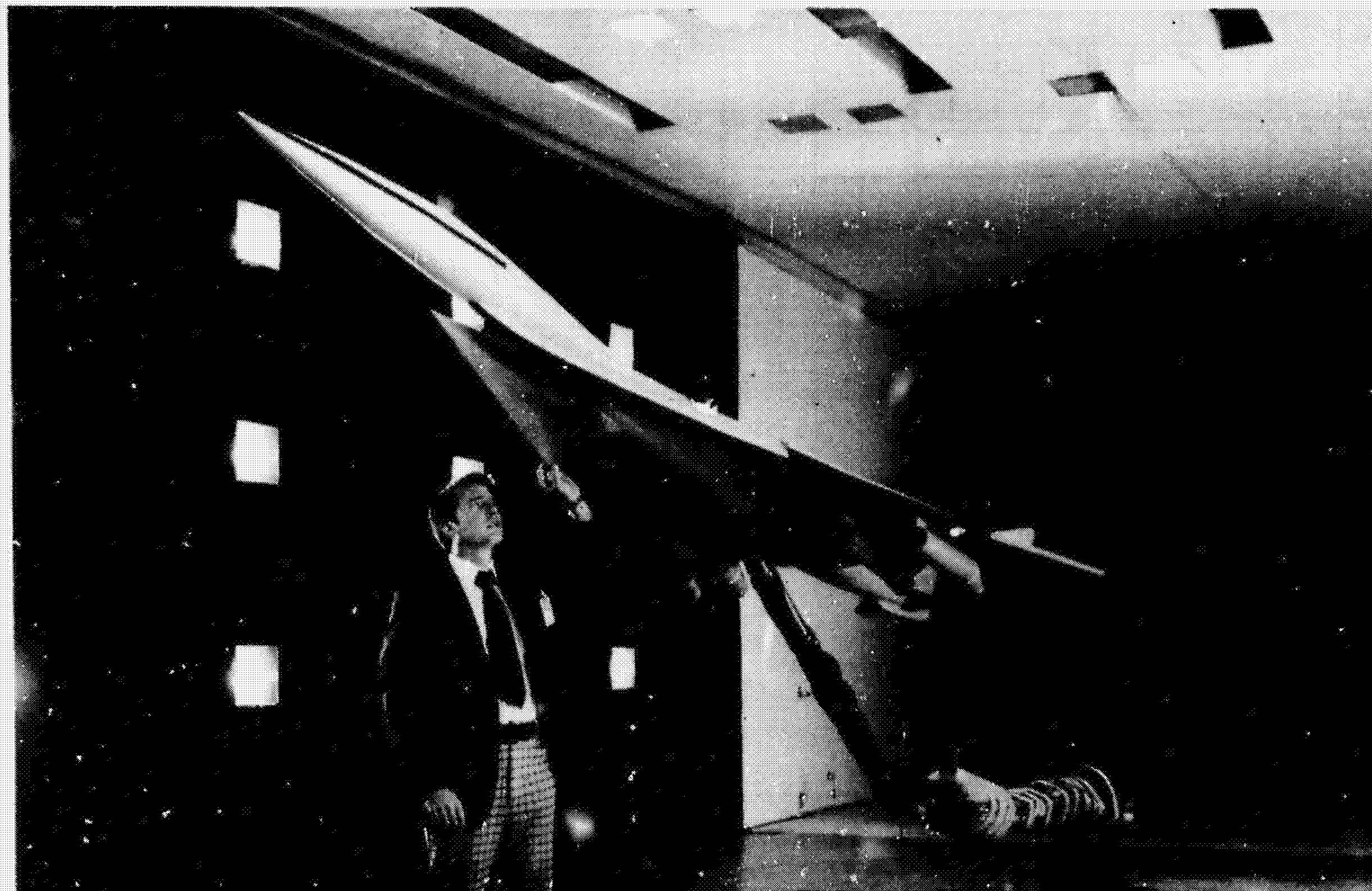


Figure 3. - Photograph of model mounted for tests in Langley V/ STOL tunnel.

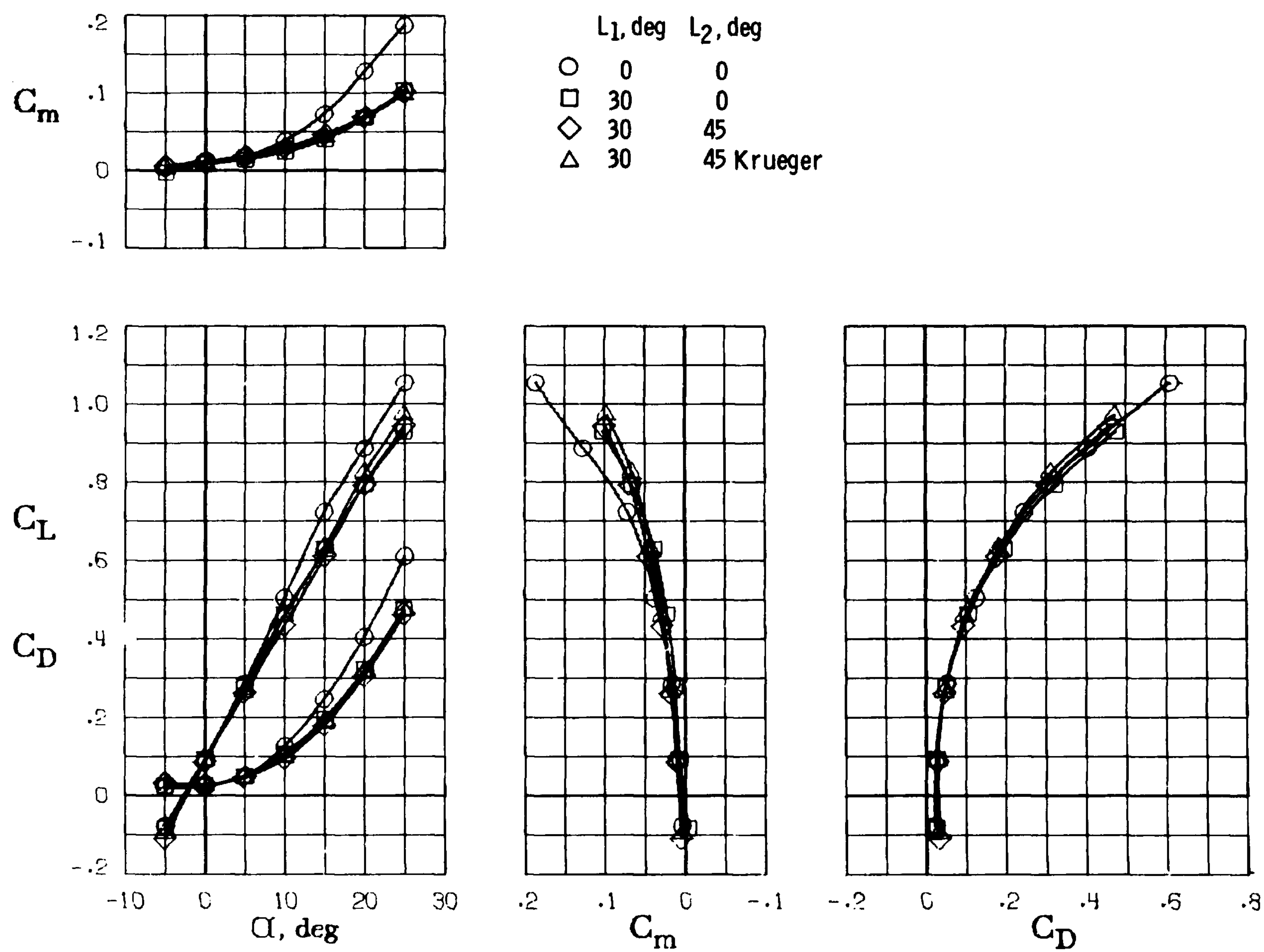


Figure 4. - Effect of wing leading edge devices on the longitudinal aerodynamic characteristics of the wing - body - outboard vertical fin combination. $\delta_f = 0$, $C_T = 0$.

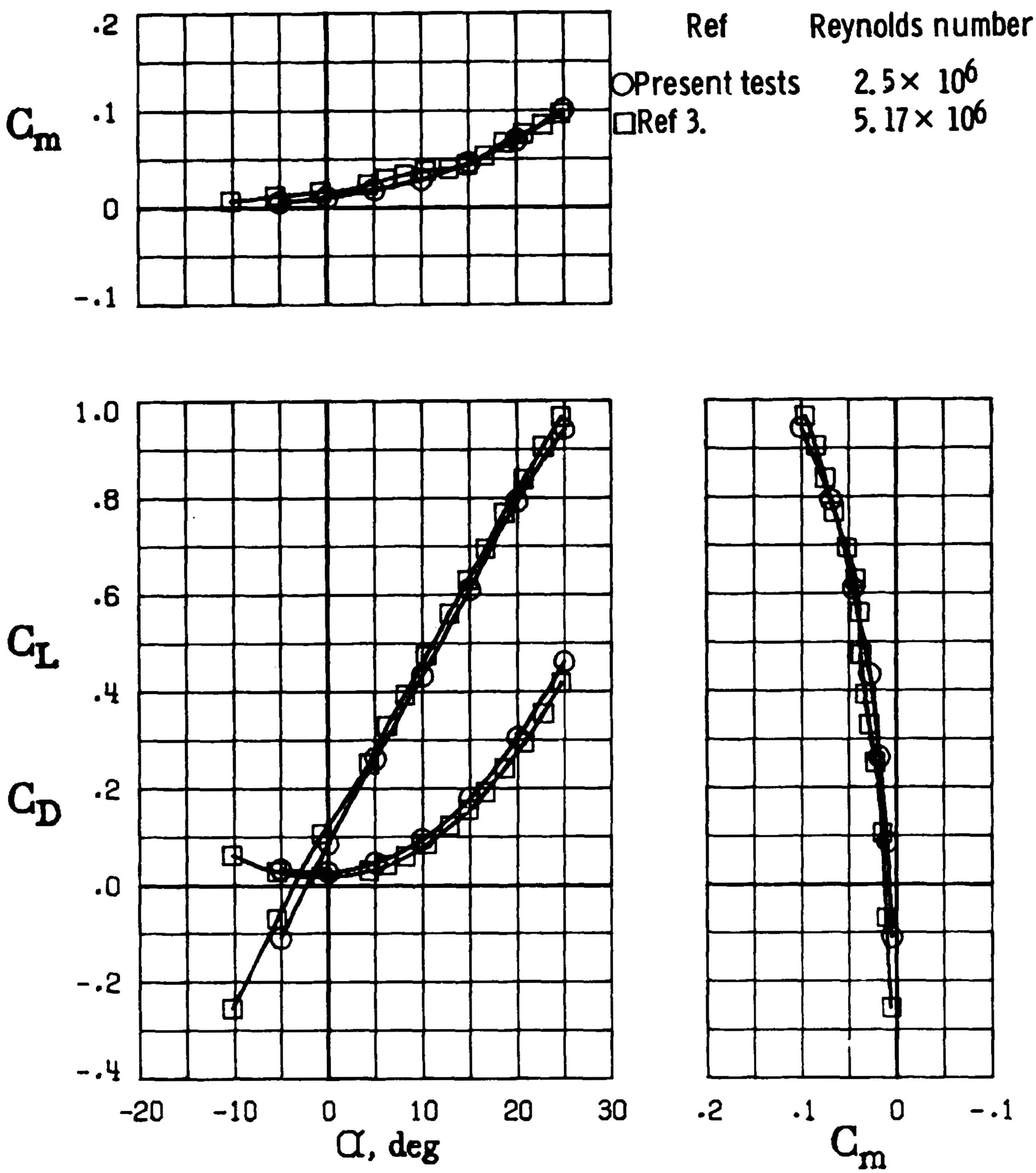


Figure 5. - Comparison of data obtained from present tests with data of ref. 3. $L_1 = 30^\circ$, $L_2 = 45^\circ$.

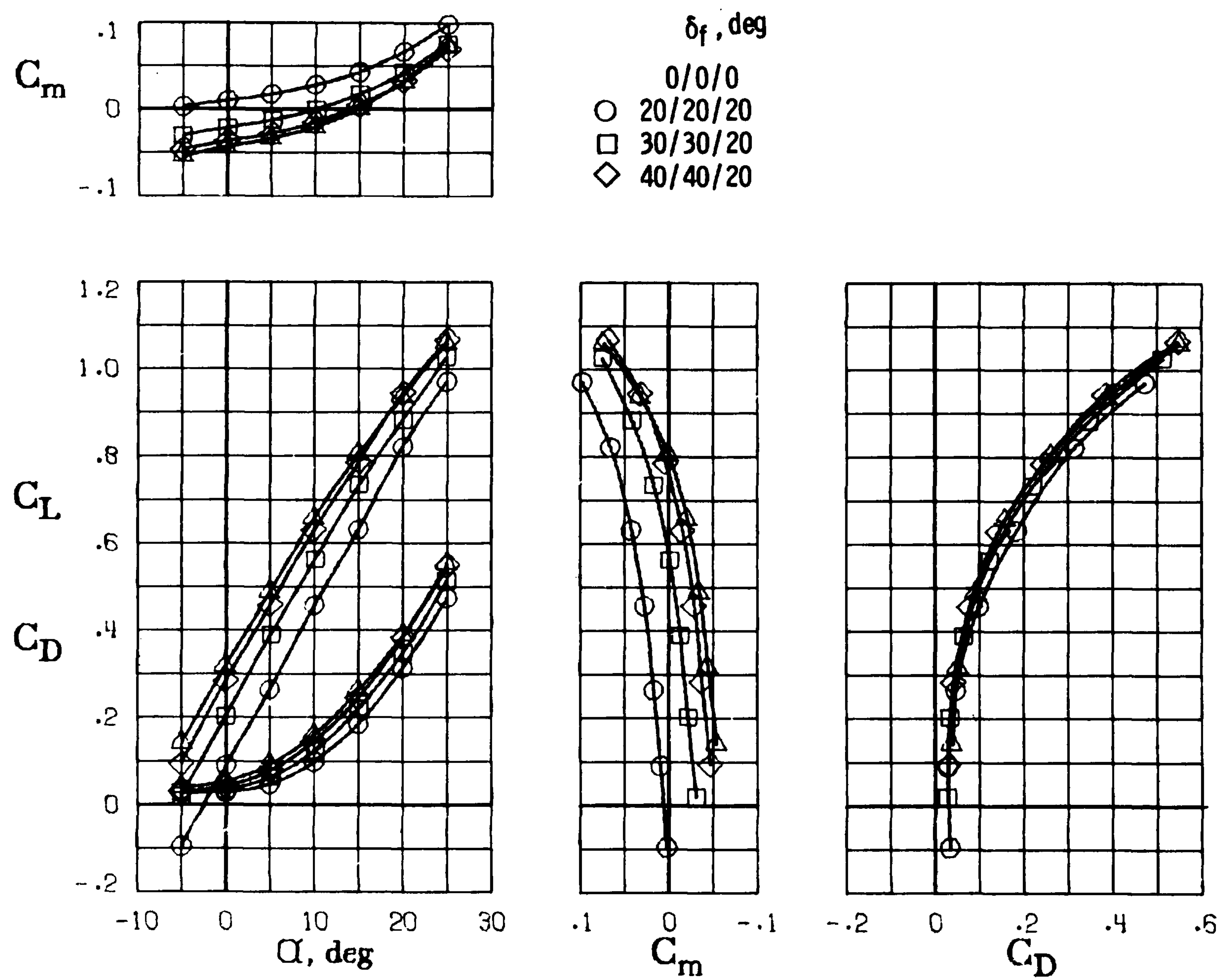


Figure 6. - Effect of trailing-edge deflection on longitudinal aerodynamic characteristics of the wing-body-outboard vertical fin combination. $L_1 = 30°$, $L_2 = 45°$ Krueger, $C_T = 0$.

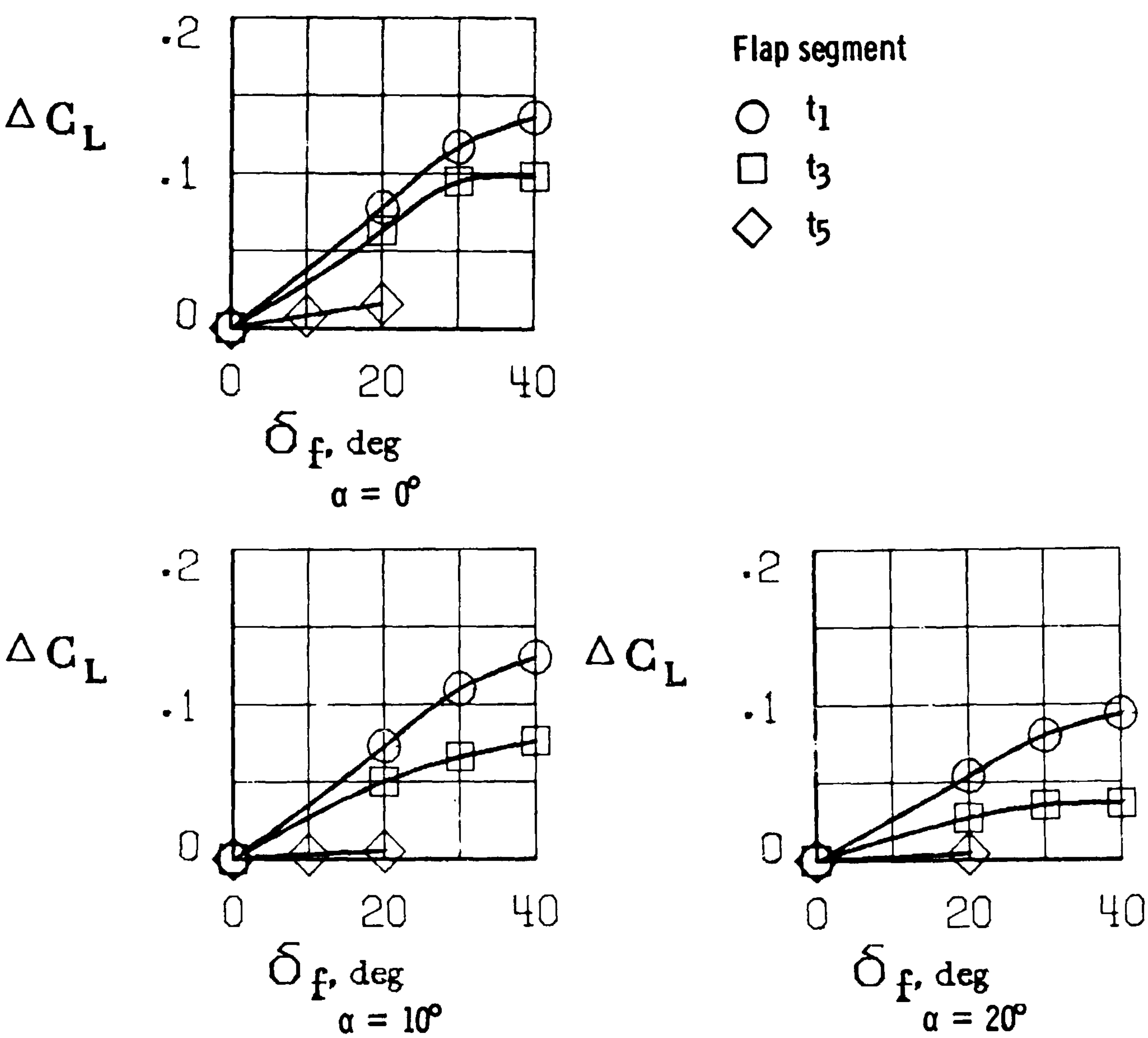


Figure 7. - Individual trailing edge flap effectiveness.

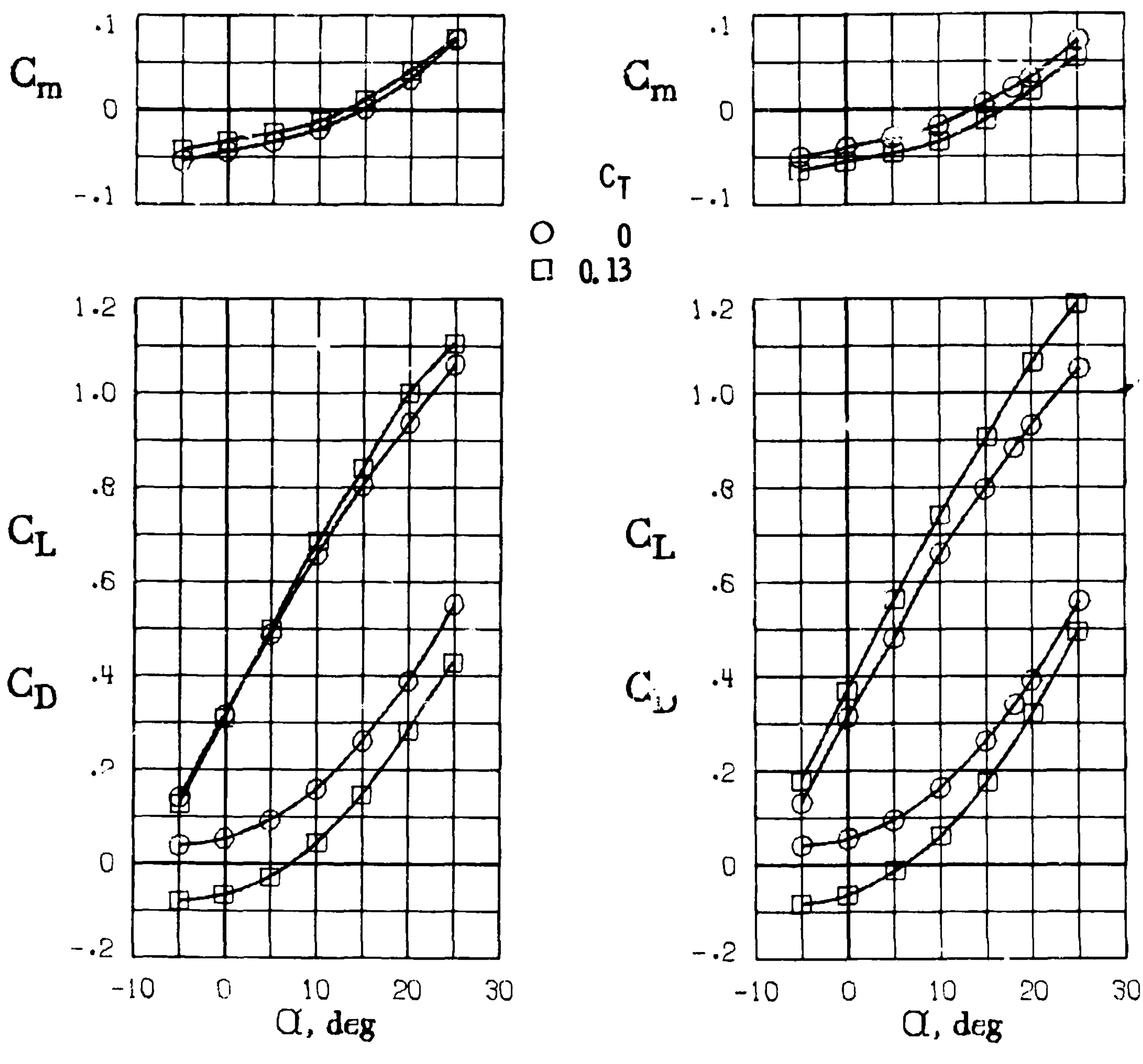


Figure 8. - Effect of thrust and thrust vectoring on longitudinal aerodynamic characteristics of the wing - body - outboard vertical fin combination. L_1 = 30, L_2 = 45° Krueger, δ_f = 40°/40°/20°.

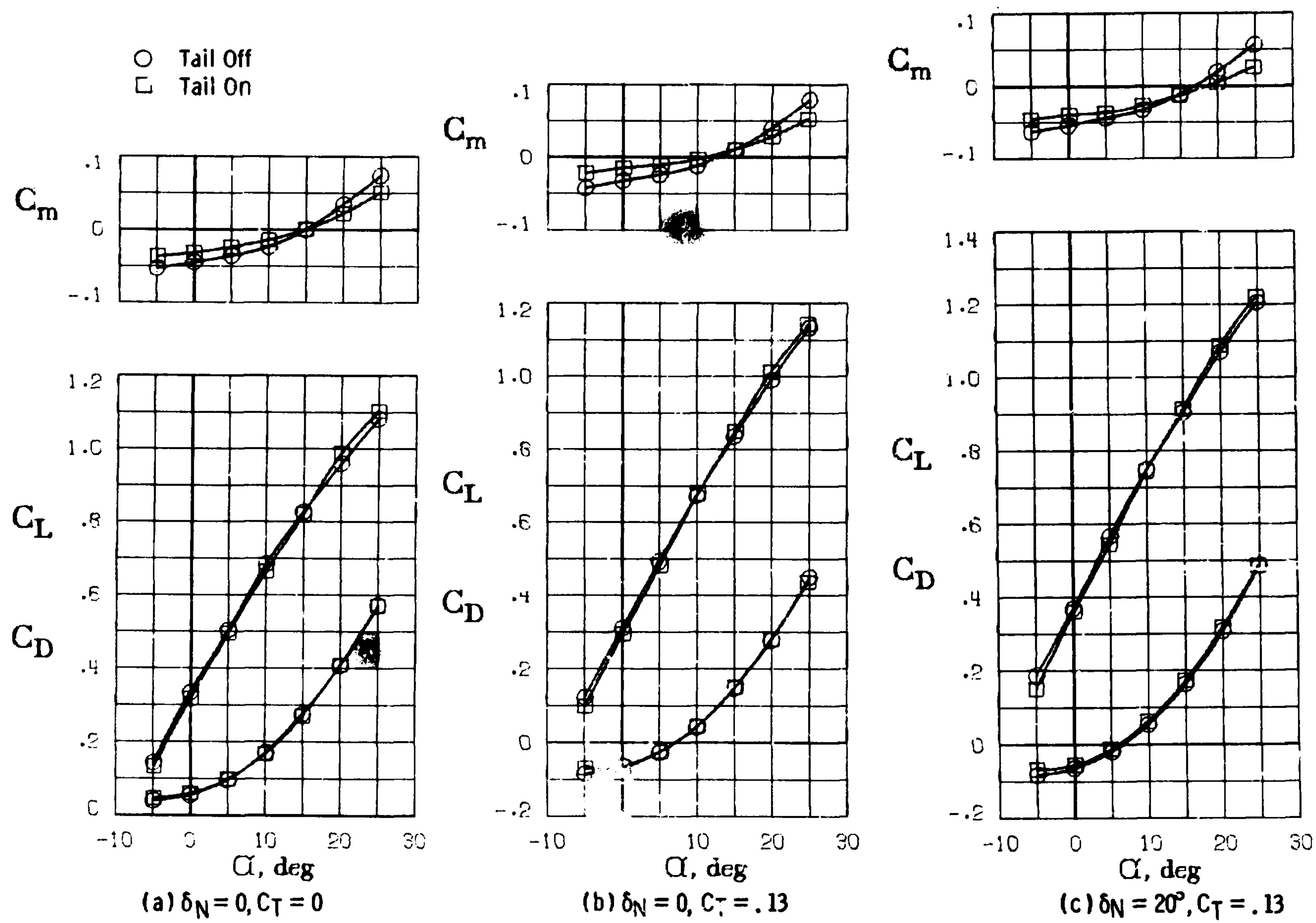
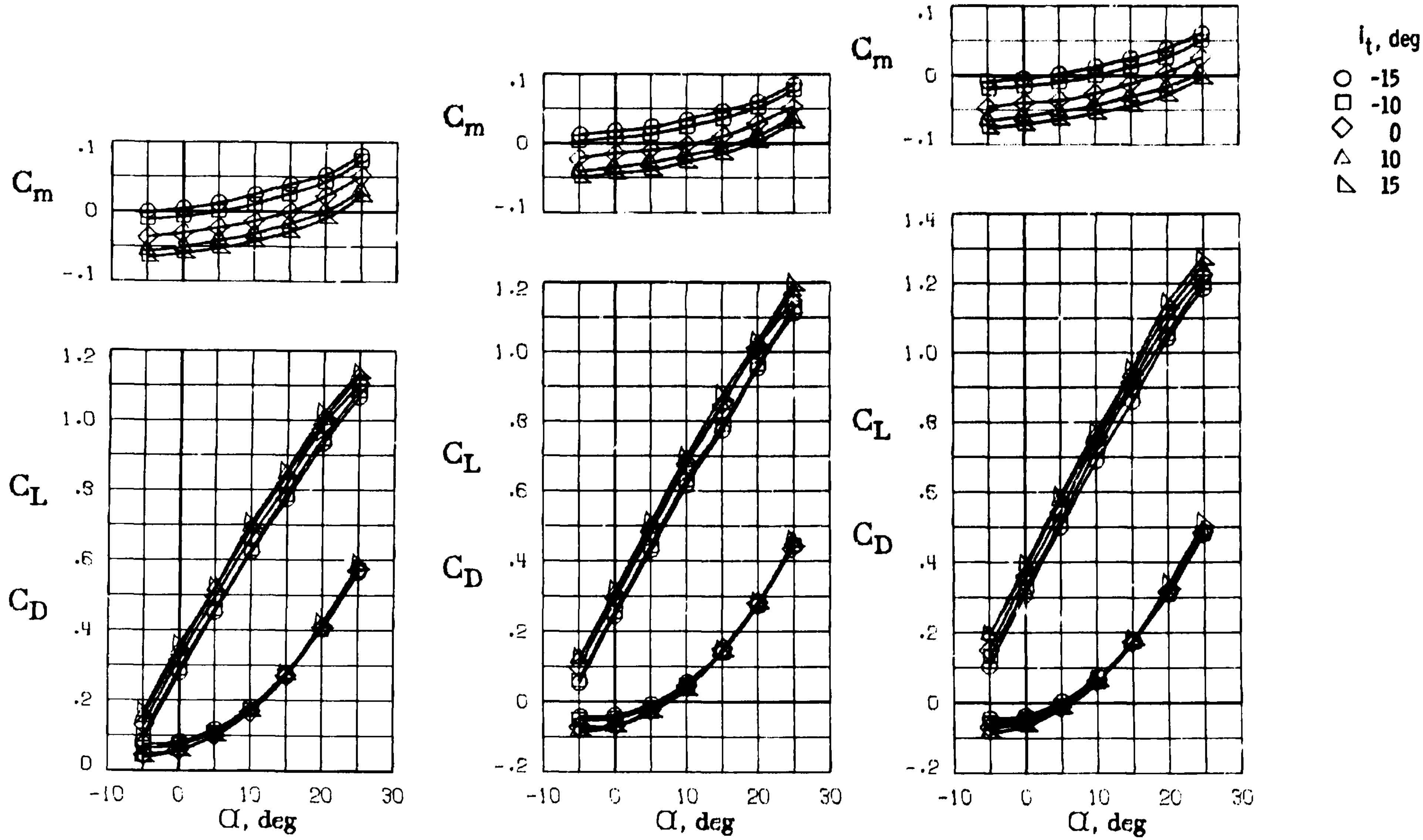


Figure 9. - Horizontal tail effectiveness and effects of thrust. $L_1 = 30°, L_2 = 45°$ Krueger, $\delta_f = 40°/40°/20°$.



(a) $\delta_N = 0^\circ, C_T = 0$

(b) $\delta_N = 0^\circ, C_T = .13$

(c) $\delta_N = 20^\circ, C_T = .13$

Figure 10. - Effect of horizontal tail incidence. $L_1 = 30^\circ, L_2 = 45^\circ$ Krueger, $\delta_f = 40^\circ/40^\circ/20^\circ$.

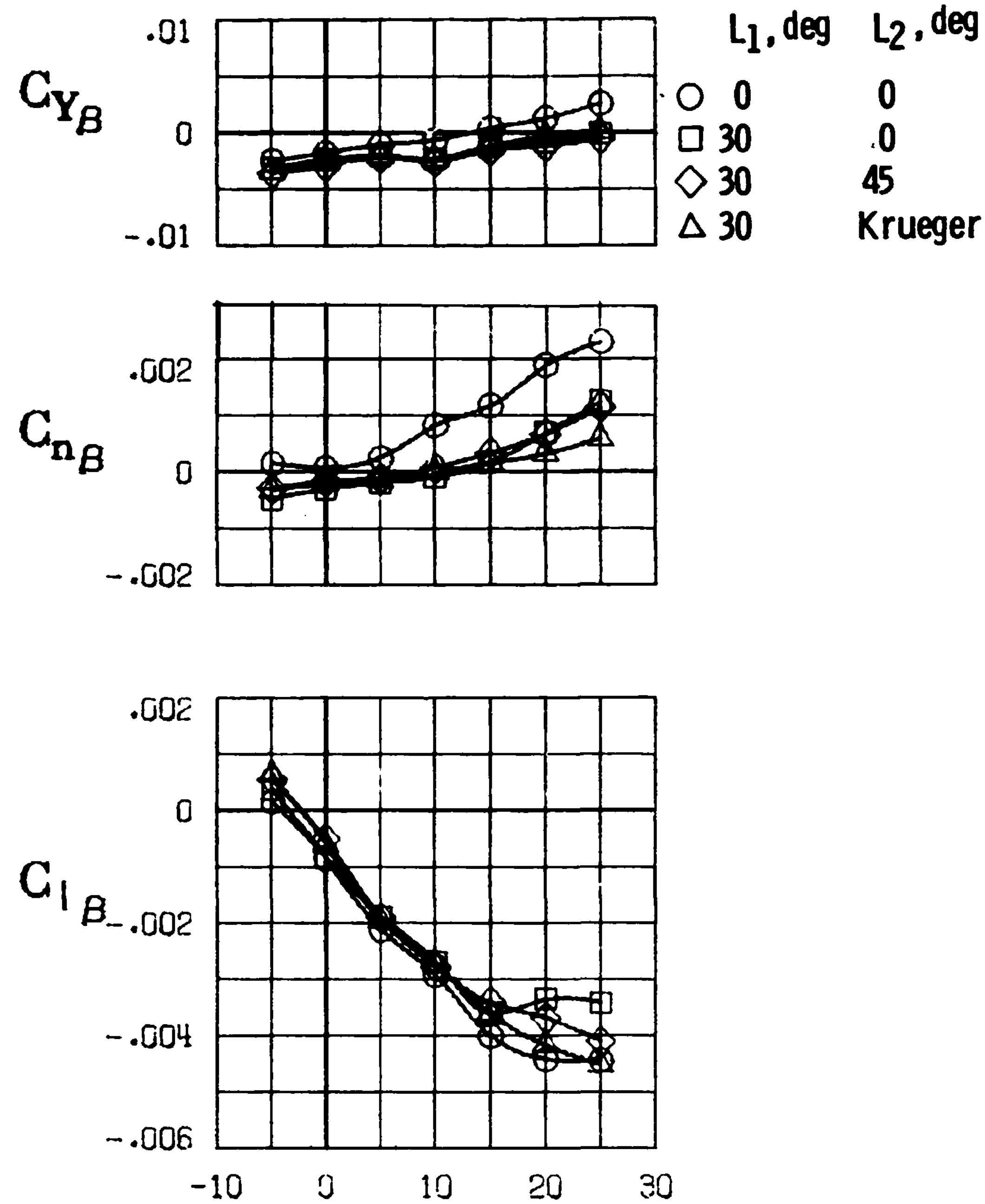
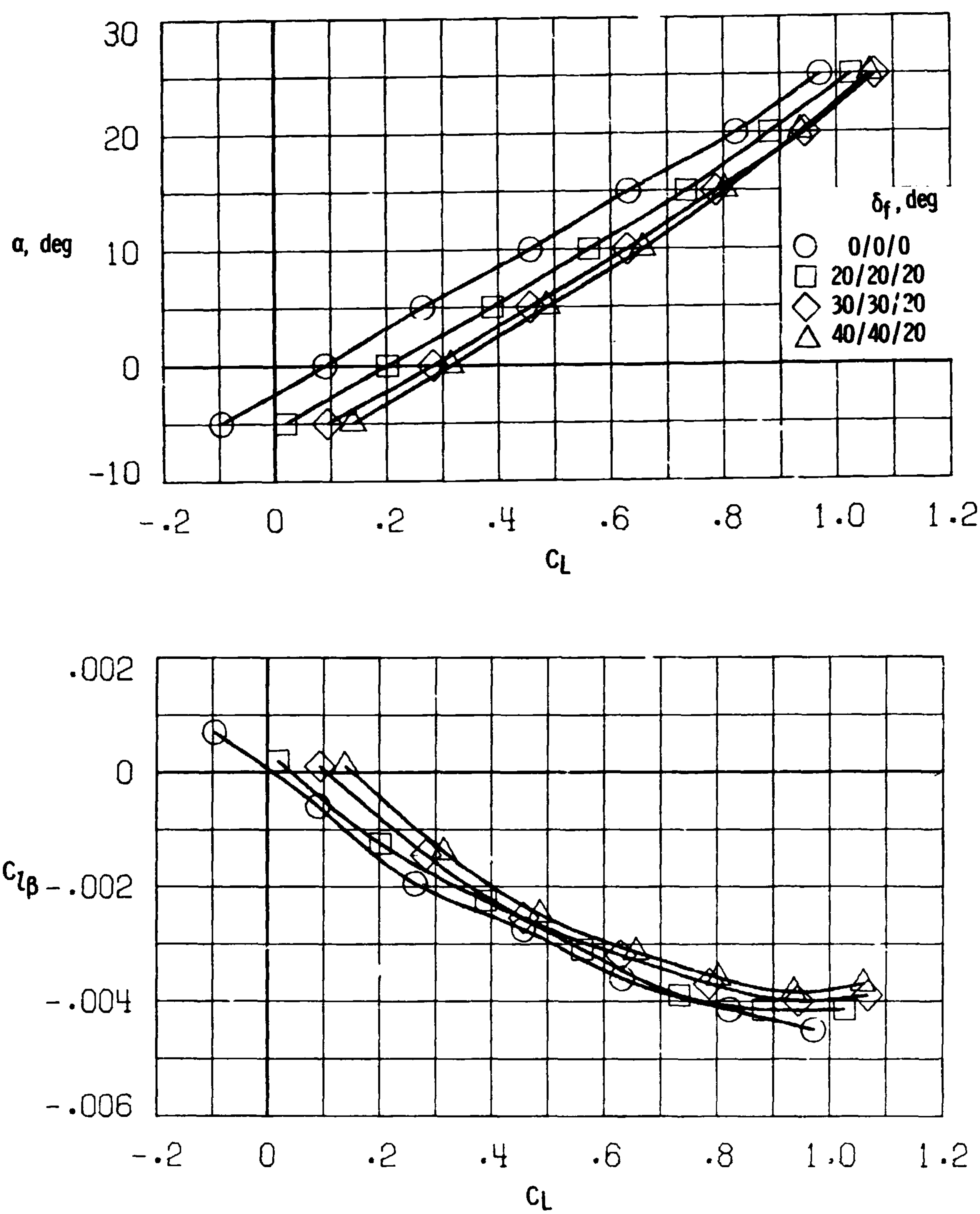
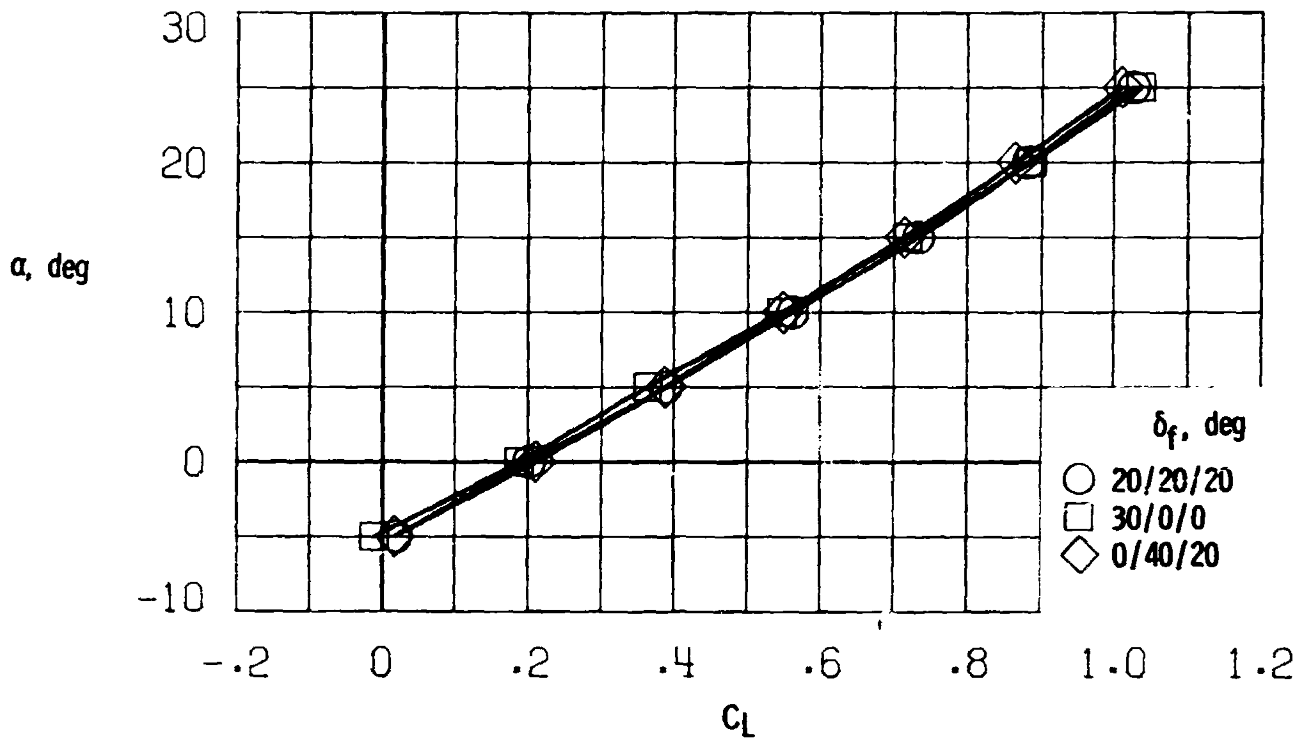


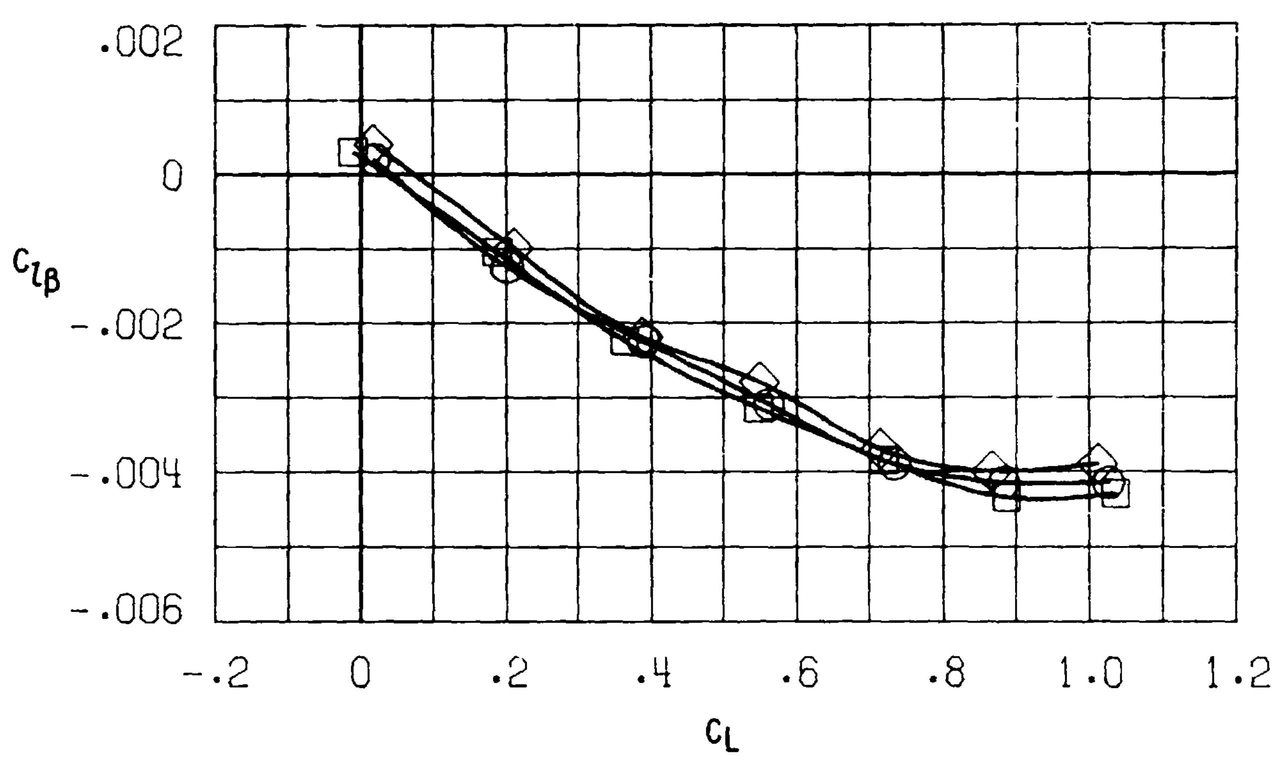
Figure 11. - Effect of wing leading edge devices on the lateral - directional aerodynamic characteristics of the wing - body outboard vertical fin combination. $\delta_f = 0°$.



(a) Uniform trailing edge deflection

Figure 12. - Effect of trailing edge flap deflection on the effective dihedral of the wing-body outboard vertical fin combination. $L_1 = 30°$, $L_2 = 45°$ Krueger, $C_T = 0$.





(b) Non-uniform trailing edge deflections.

Figure 12. - Concluded.

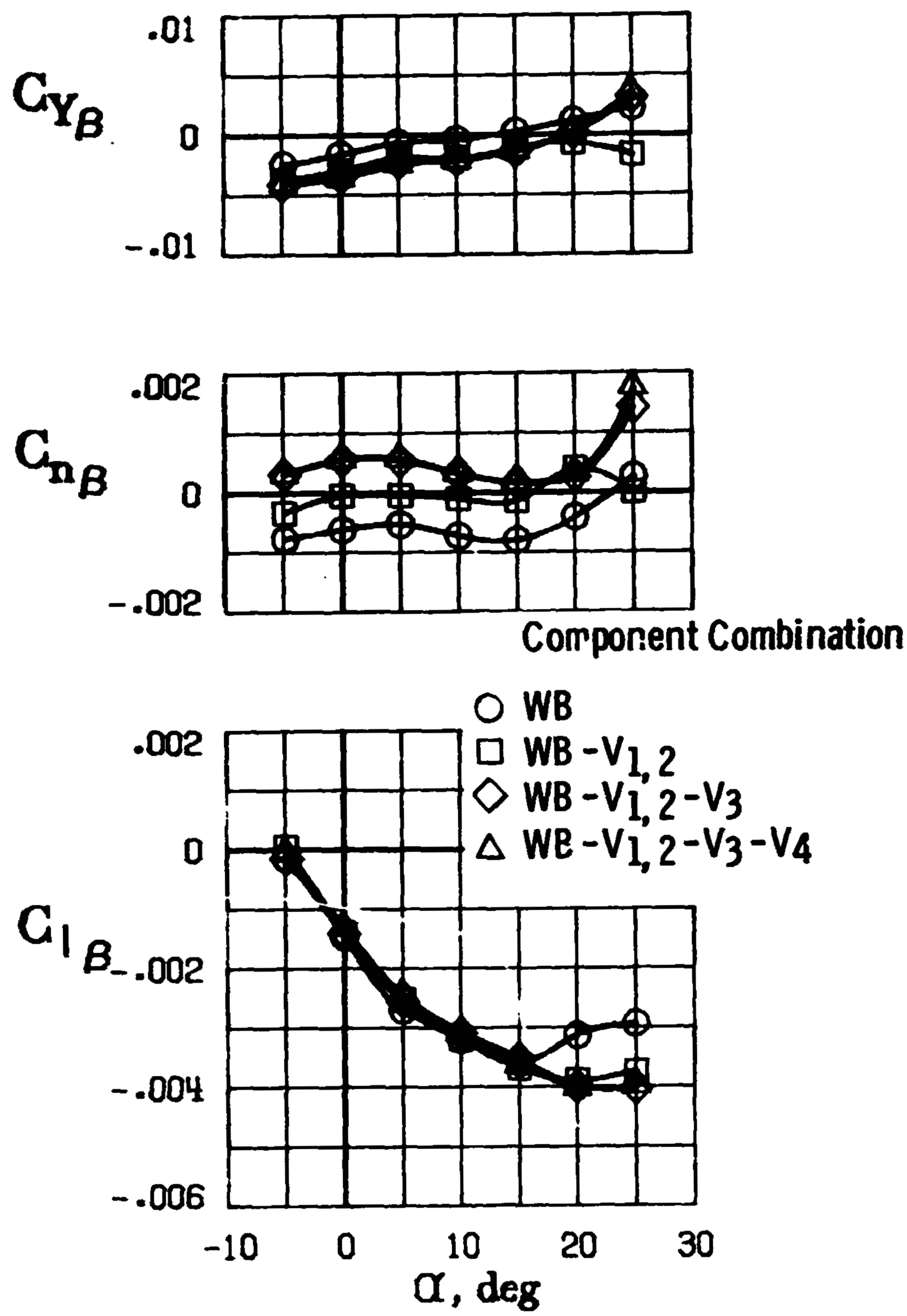


Figure 13. - Variation of lateral-directional stability derivatives with angle of attack. $L_1 = 30°$ $L_2 = 45°$ Krueger, $\delta_f = 40°/40°/20°$, $C_T = 0$.

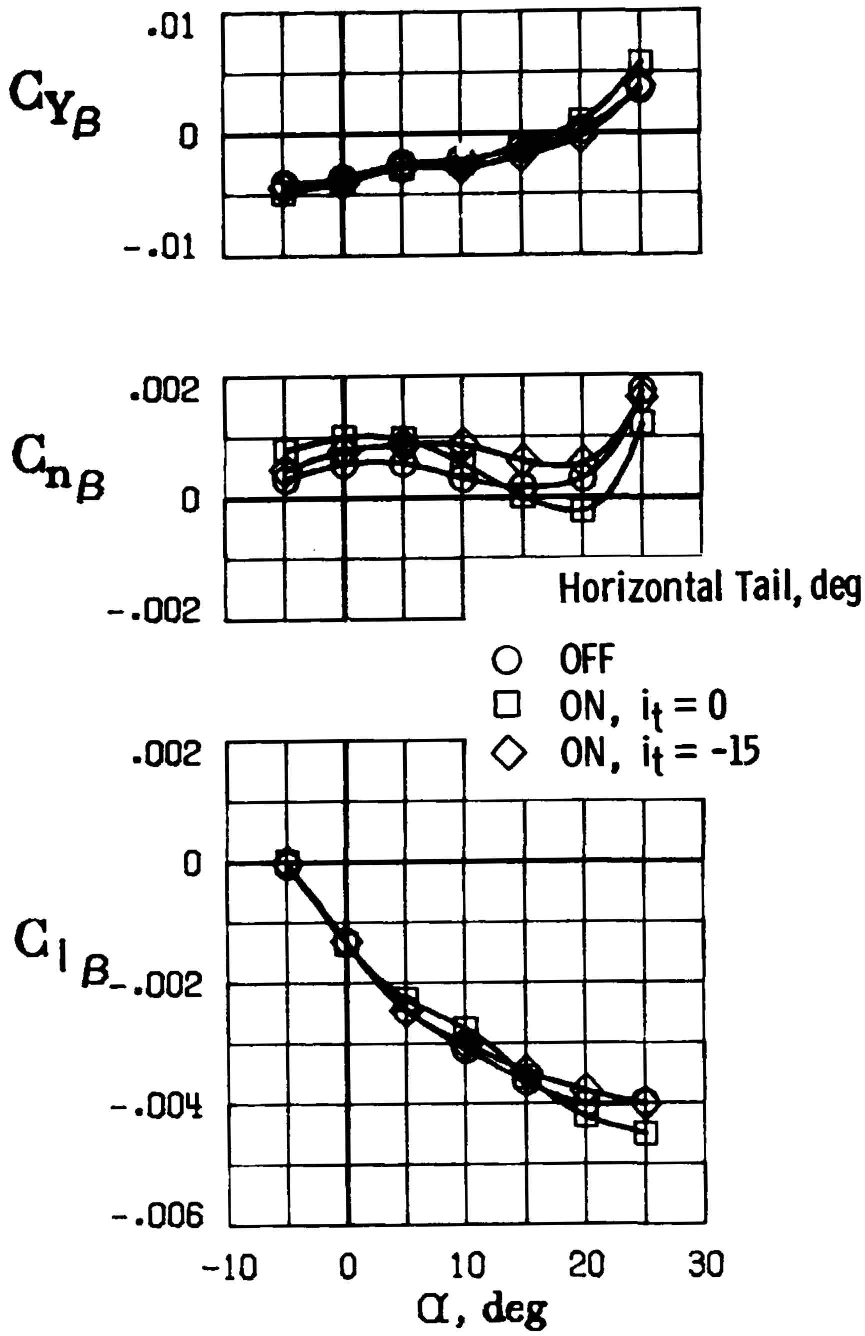


Figure 14. - Effect of horizontal tail on lateral - directional stability derivatives. $L_1 = 30°$, $L_2 = 45°$ Krueger, $\delta_f = 40°/40°/20°$, $C_T = 0$.

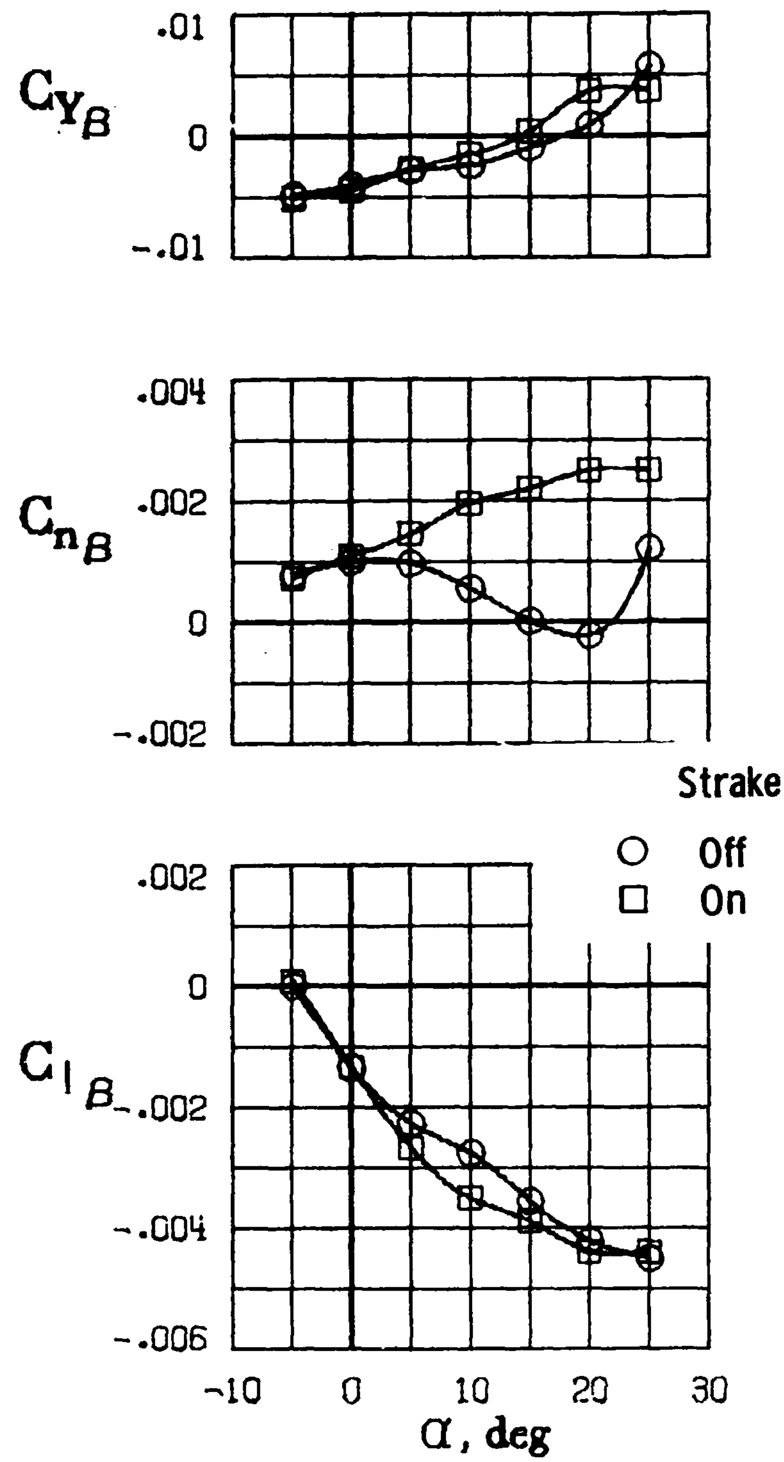


Figure 15. - Effect of nose strakes on lateral-directional stability derivatives of the complete model $L_1 = 30^\circ$, $L_2 = 45^\circ$ Krueger, $\delta_f = 40^\circ/40^\circ/20^\circ$, $C_T = 0$.

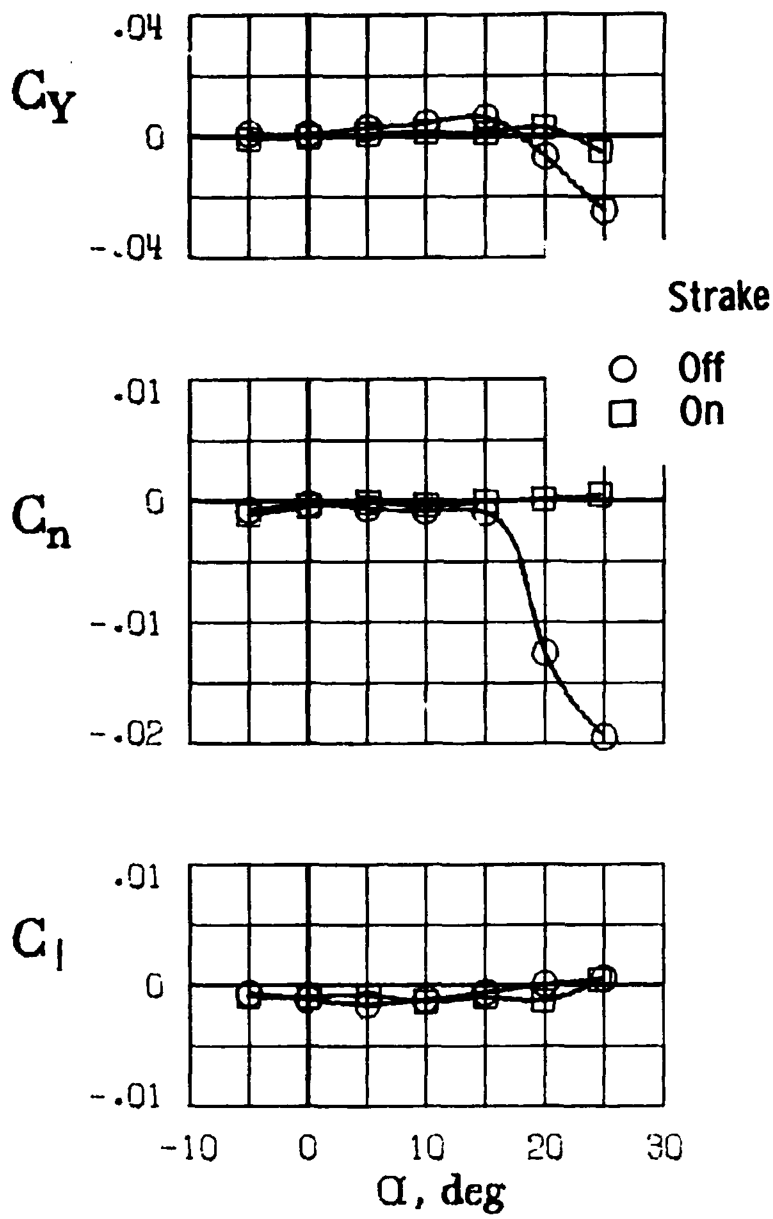


Figure 16. - Variation of the lateral-directional characteristics with angle of attack, WB-$V_{1,2}$-V_3-H, $L_1 = 30°$, $L_2 = 45°$ Krueger, $\delta_f = 40°/40°/20°$, $C_T = 0$, $\beta = 0°$.

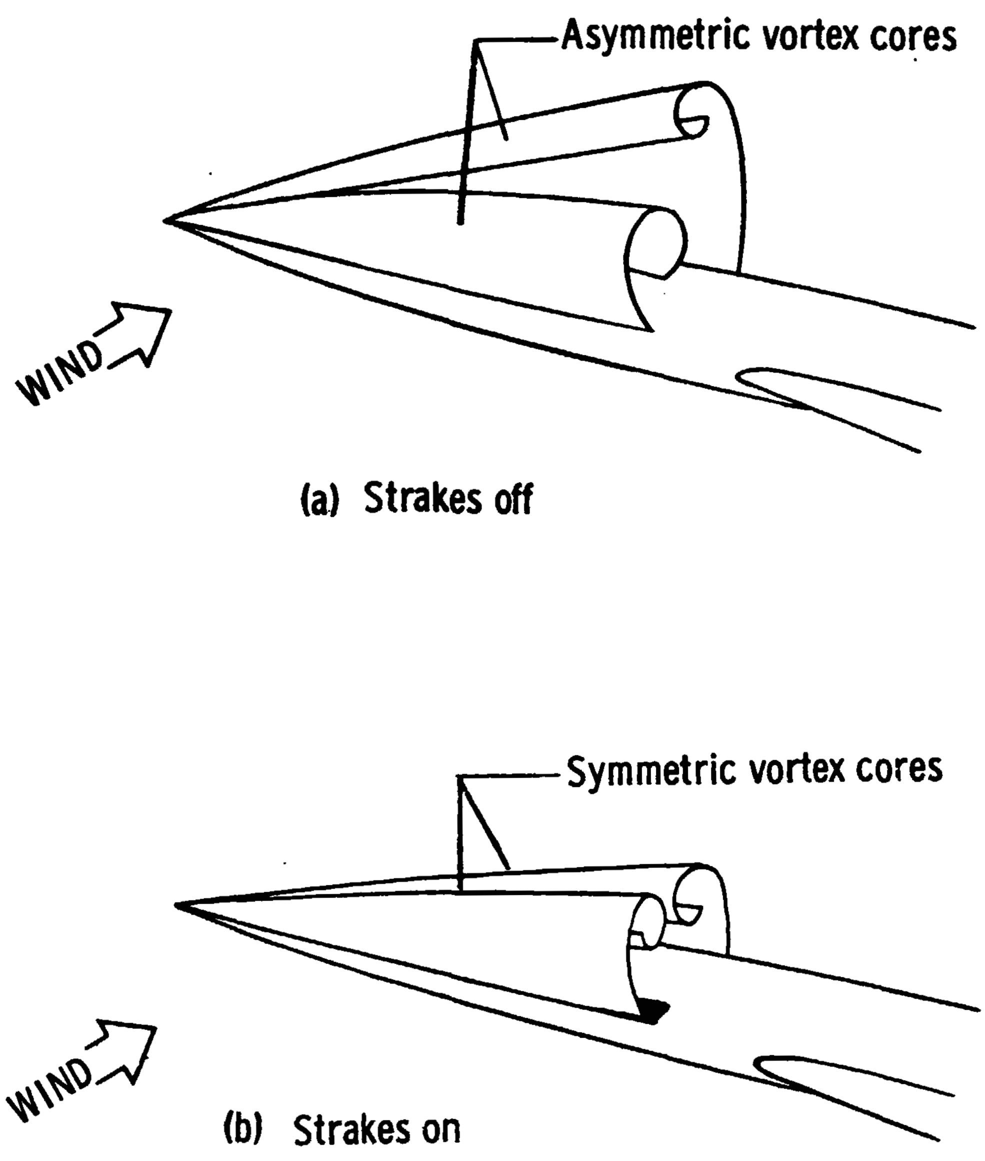


Figure 17. - Sketch of observed vortex flow.

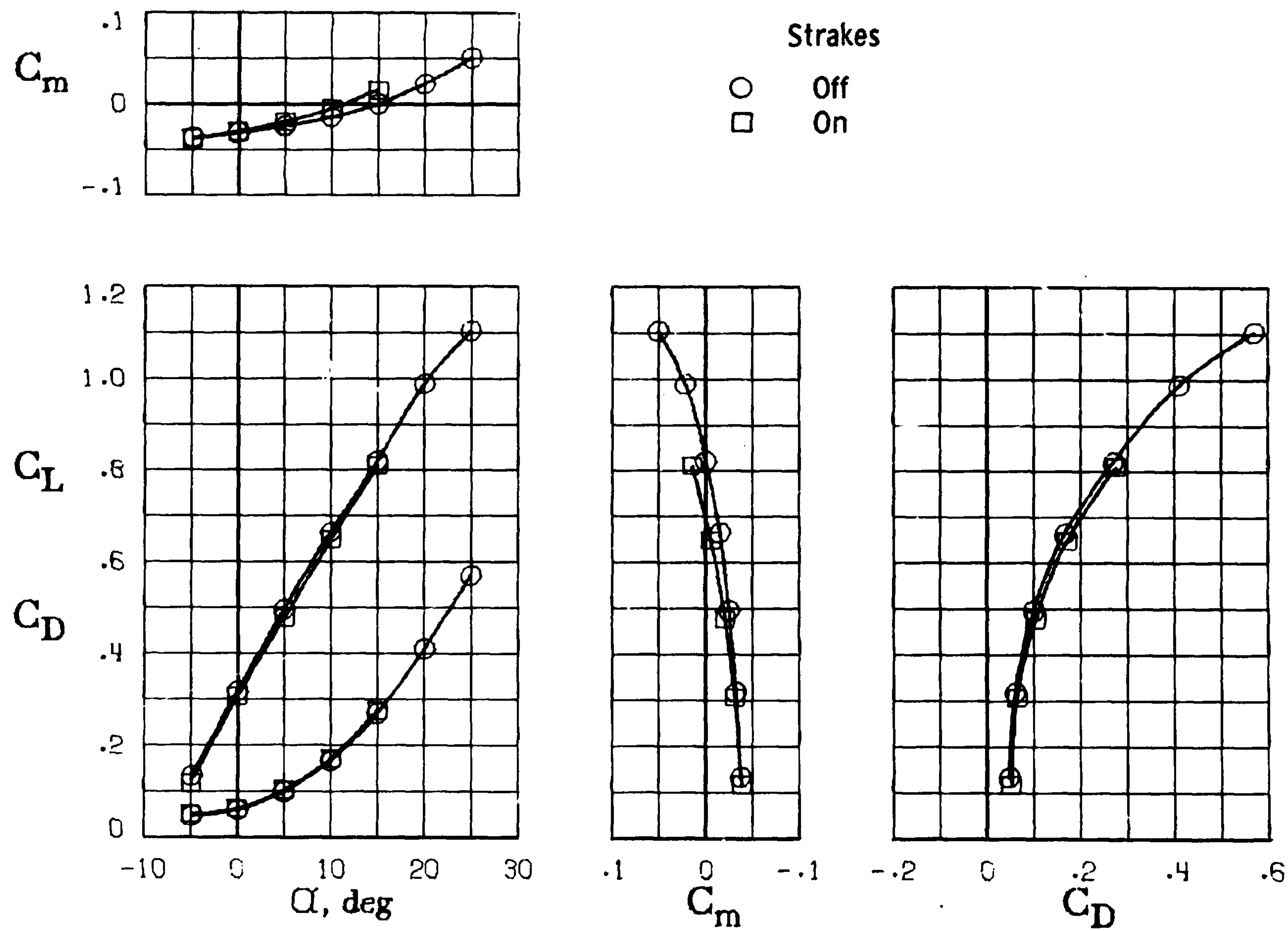


Figure 18. - Effect of strakes on longitudinal aerodynamic characteristics of the configuration.

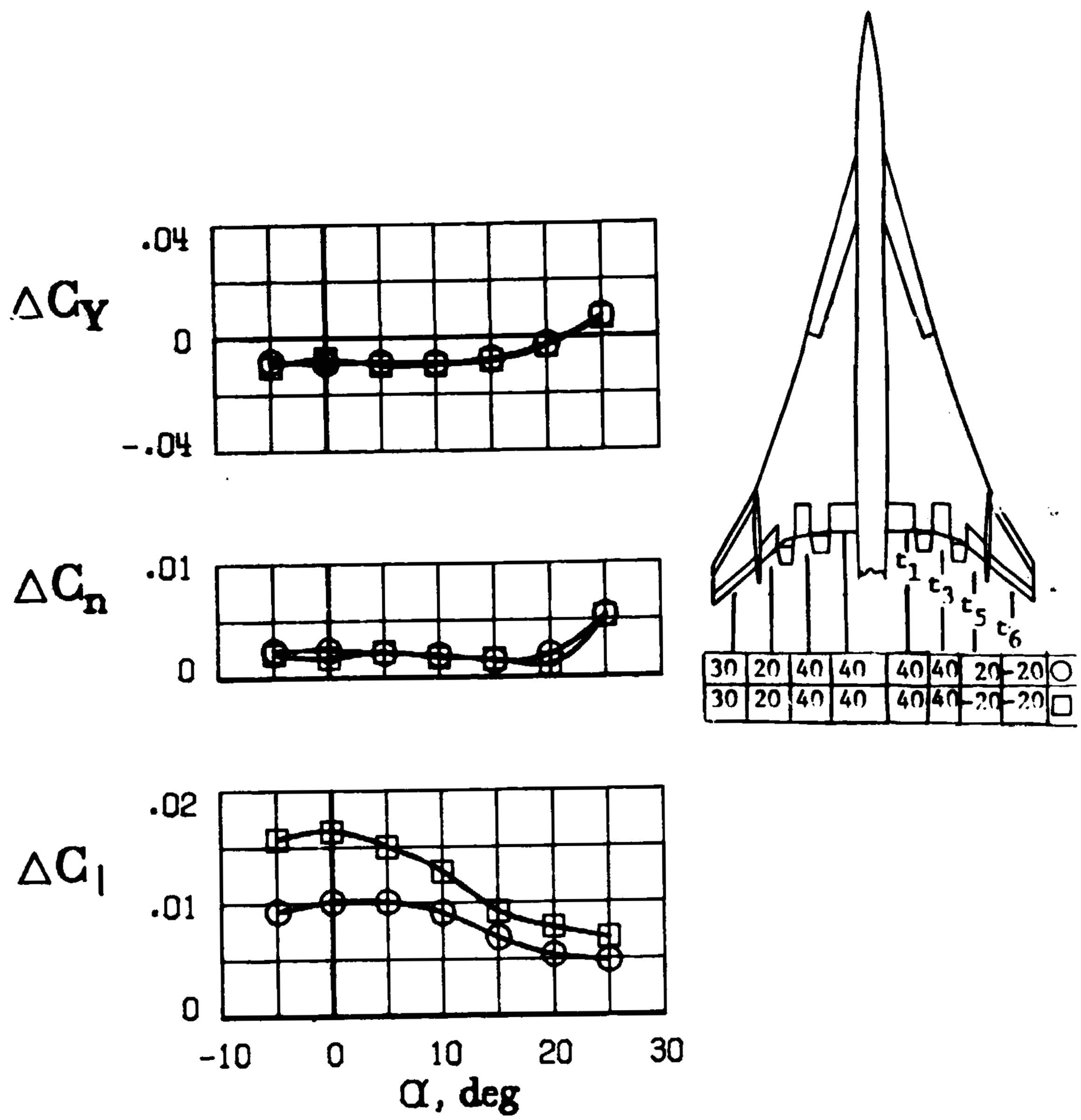


Figure 19. - Effect of lateral control surface deflection on lateral directional characteristics of complete model $L_1 = 30°$, $L_2 = 45°$ Krueger, $C_T = 0$.

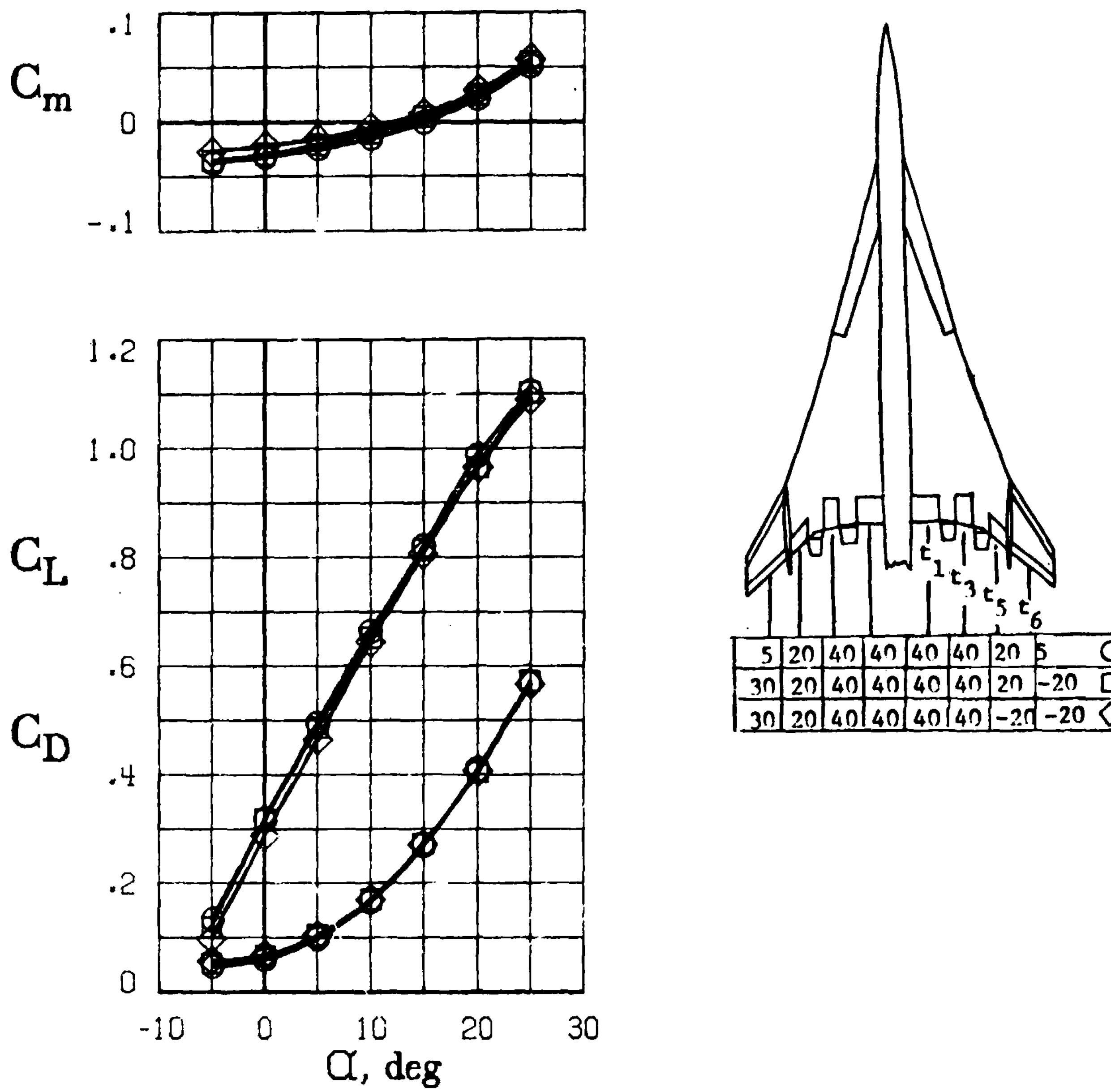


Figure 20. - Effect of lateral control surface deflection on longitudinal aerodynamic characteristics $L_1 = 30°$, $L_2 = 45°$ Krueger, $C_T = 0$.

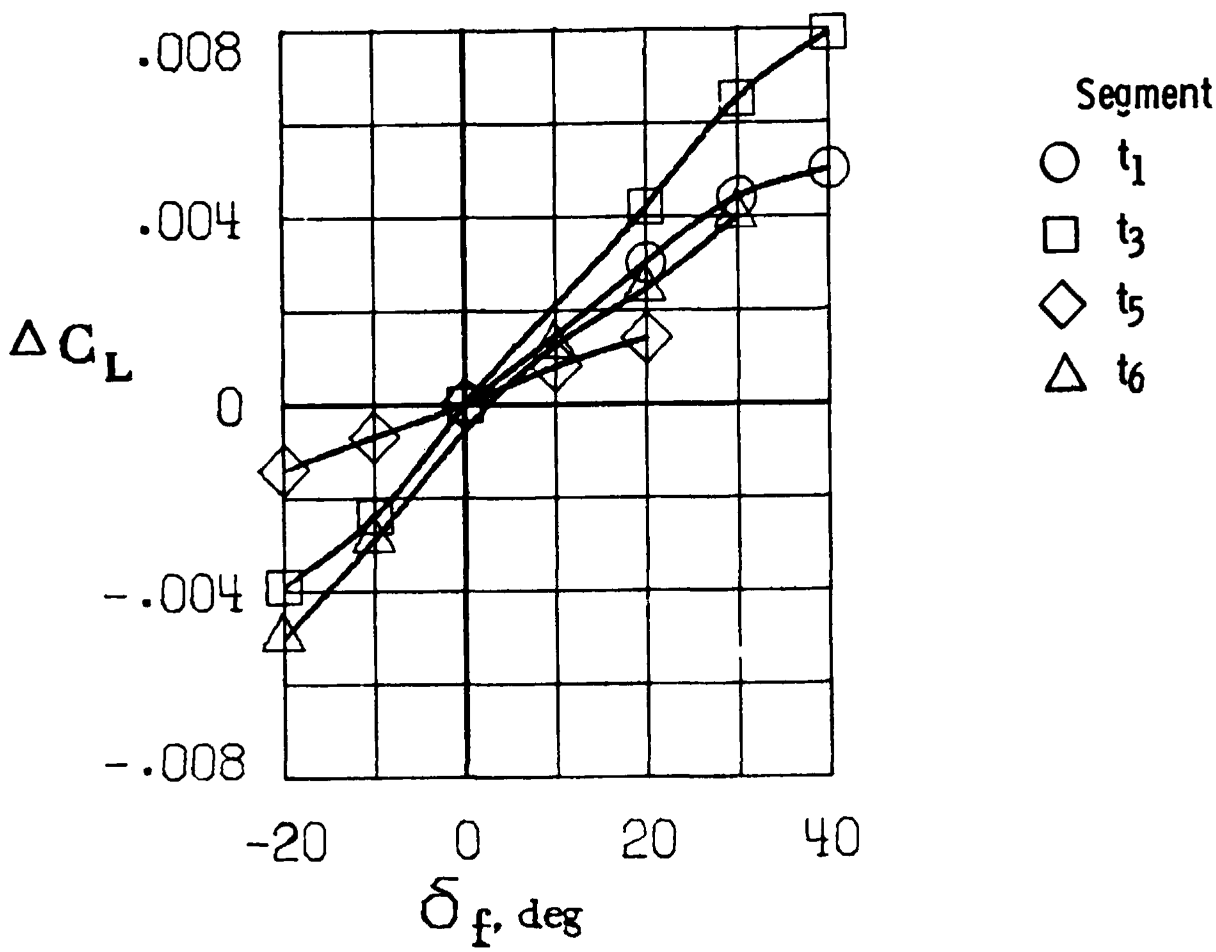


Figure 21. - Effectiveness of individual trailing - edge flap segments for roll control. $\alpha = 8^\circ$.

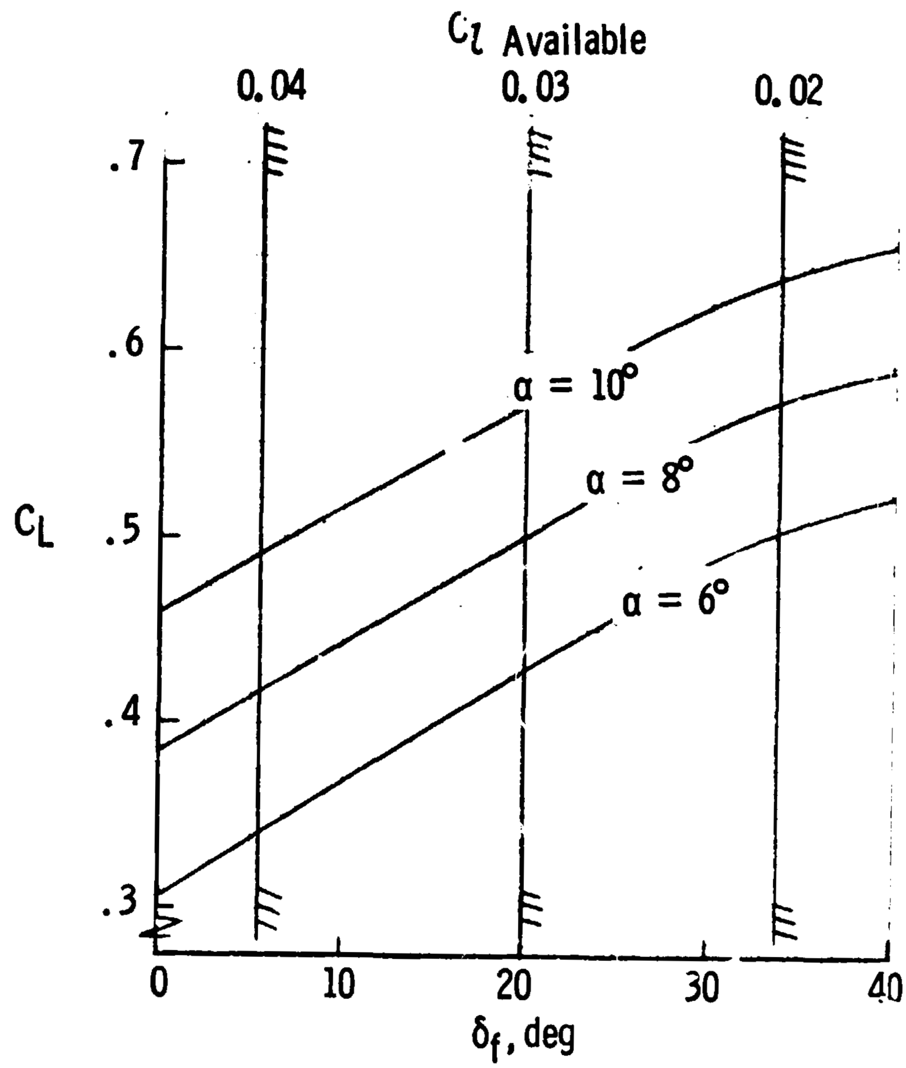


Figure 22. - Illustration of lines of constant C_l Available.

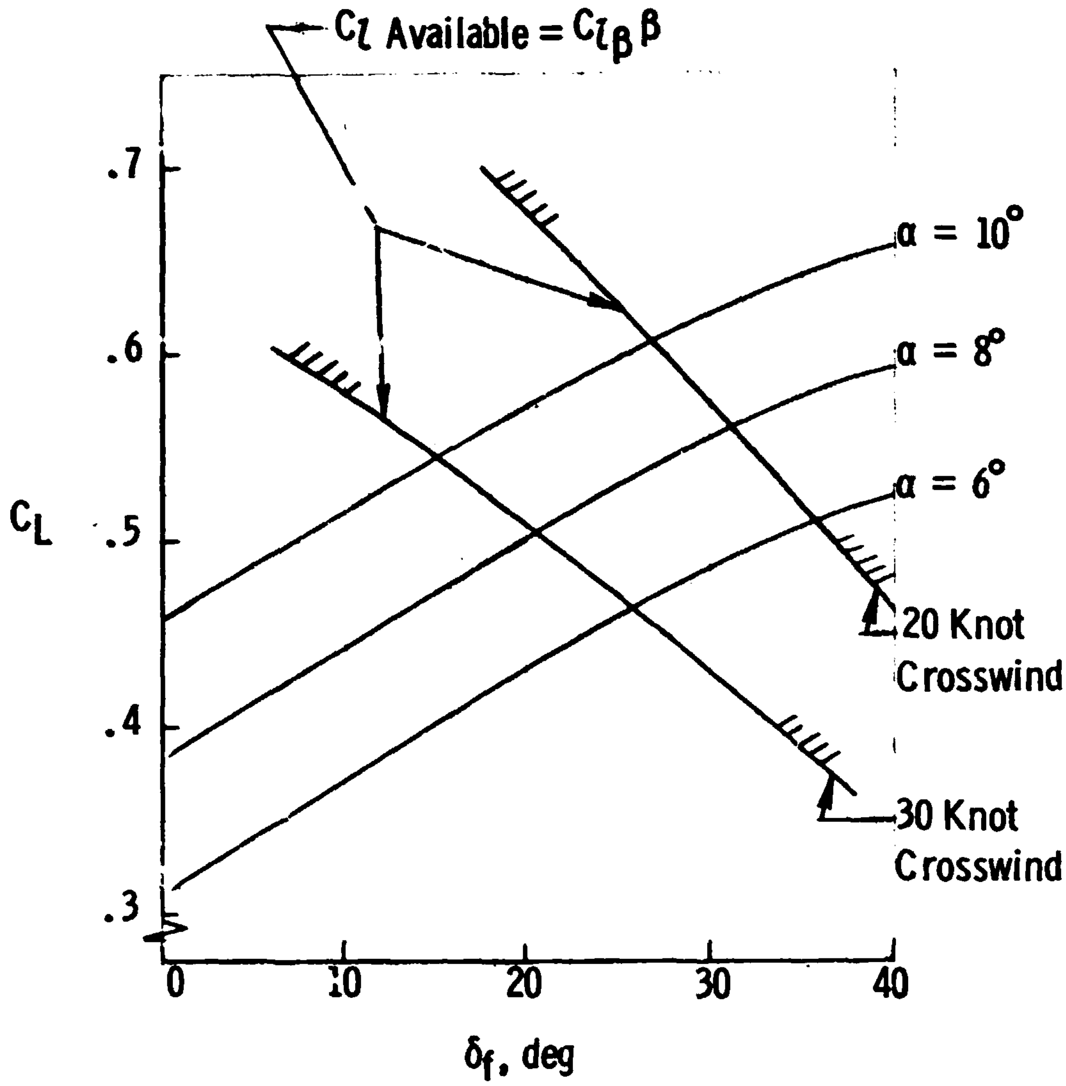


Figure 23. - Illustration of lateral control constraint.

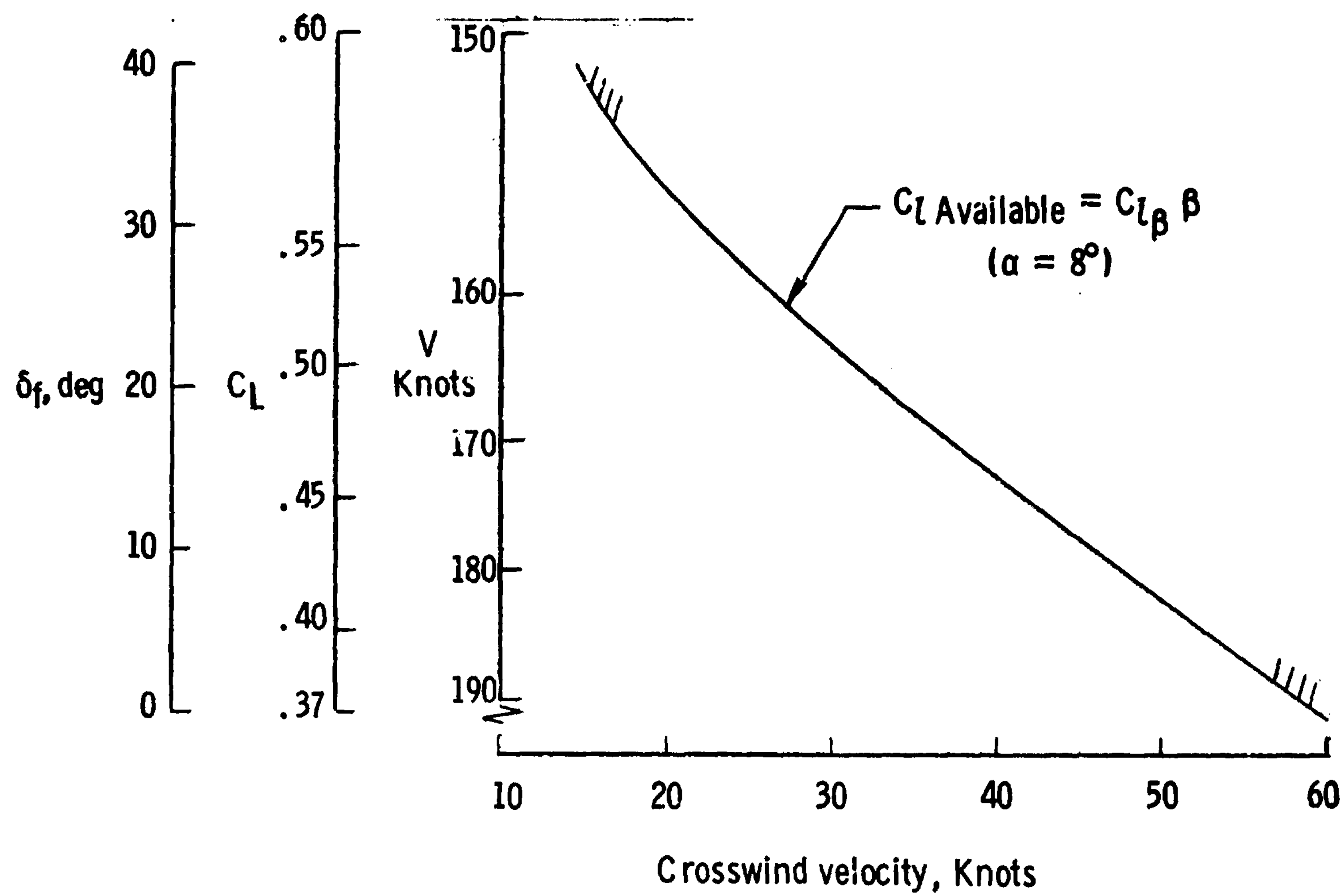
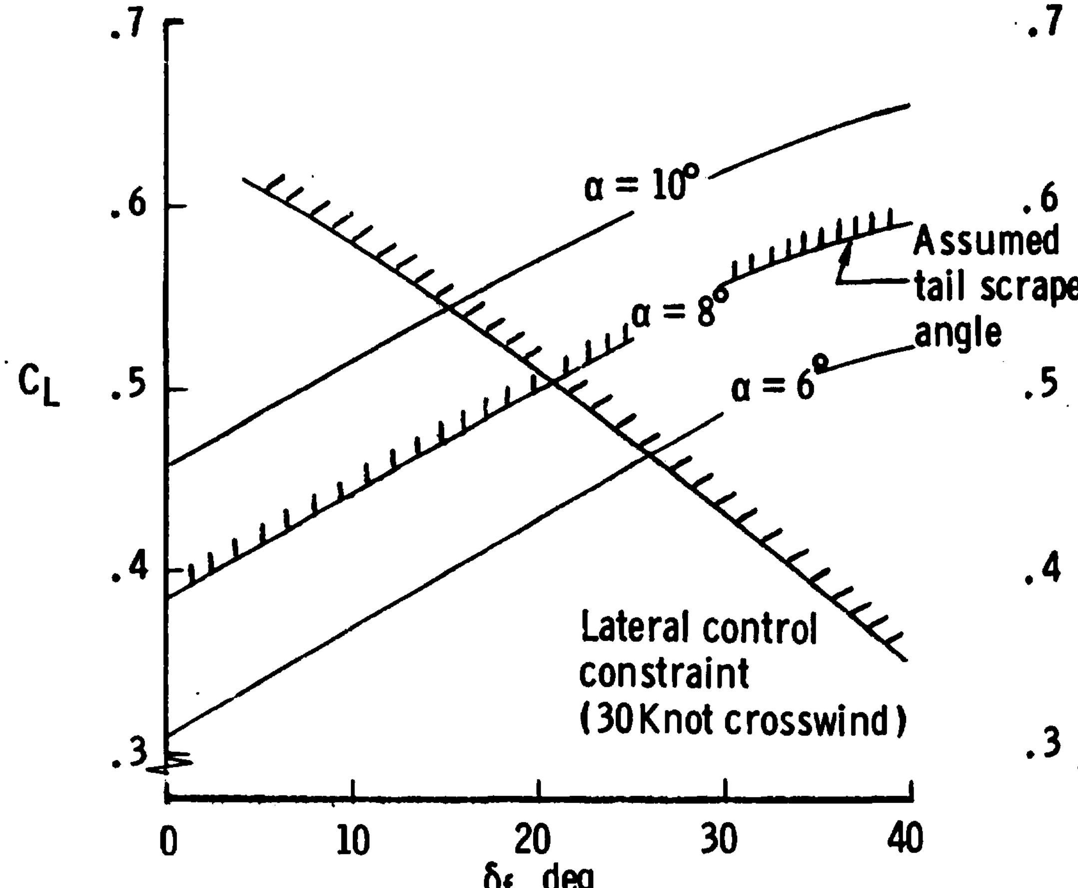
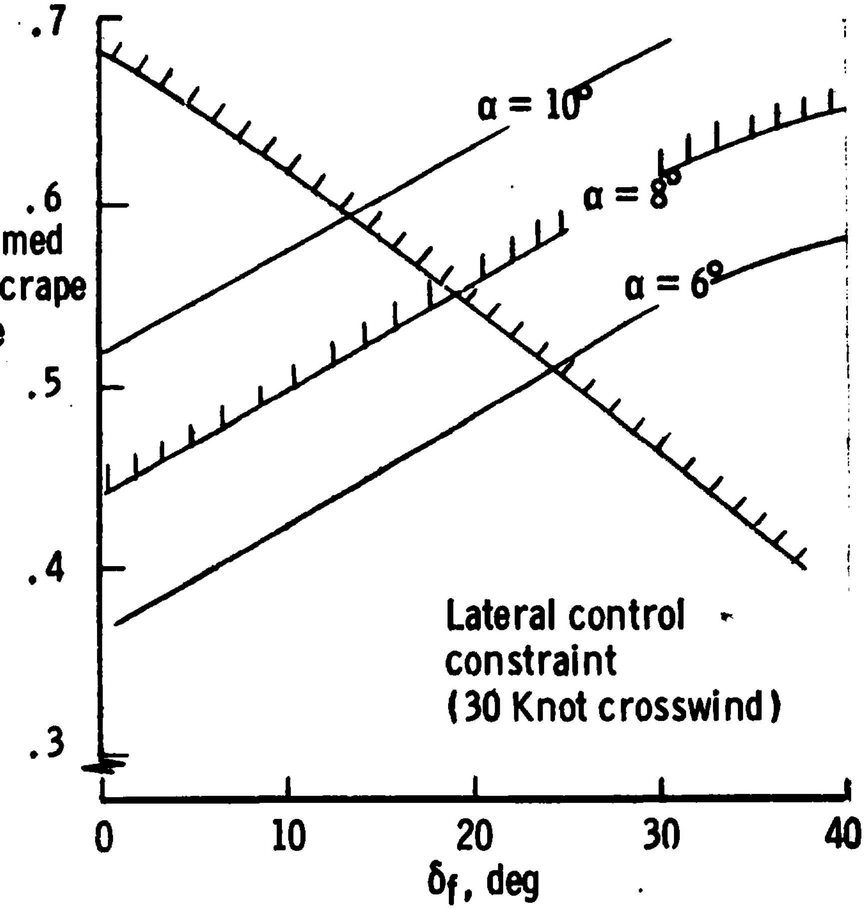


Figure 24. - Nomogram of δ_f, C_L, and approach speed versus crosswind velocity capability. $\alpha = 8°$.



(a) Basic configuration



(b) Configuration with 20° symmetric thrust vectoring.

Figure 25. - Effect of thrust vectoring on lateral control constraints. $C_T = 0.13$.

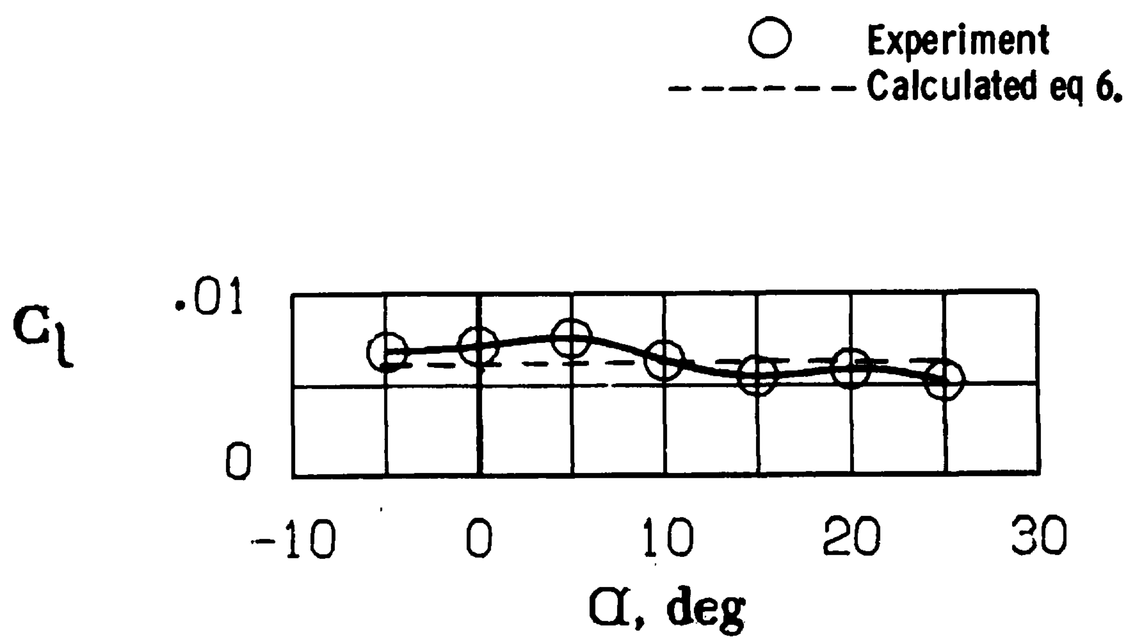


Figure 26. - Rolling moment produced by differential thrust vectoring of the outboard engines. $\delta_f = 40^\circ/40^\circ/20^\circ/$, $C_T = 0.13$, $\delta_N = 20^\circ/0^\circ/0^\circ/-20^\circ$.

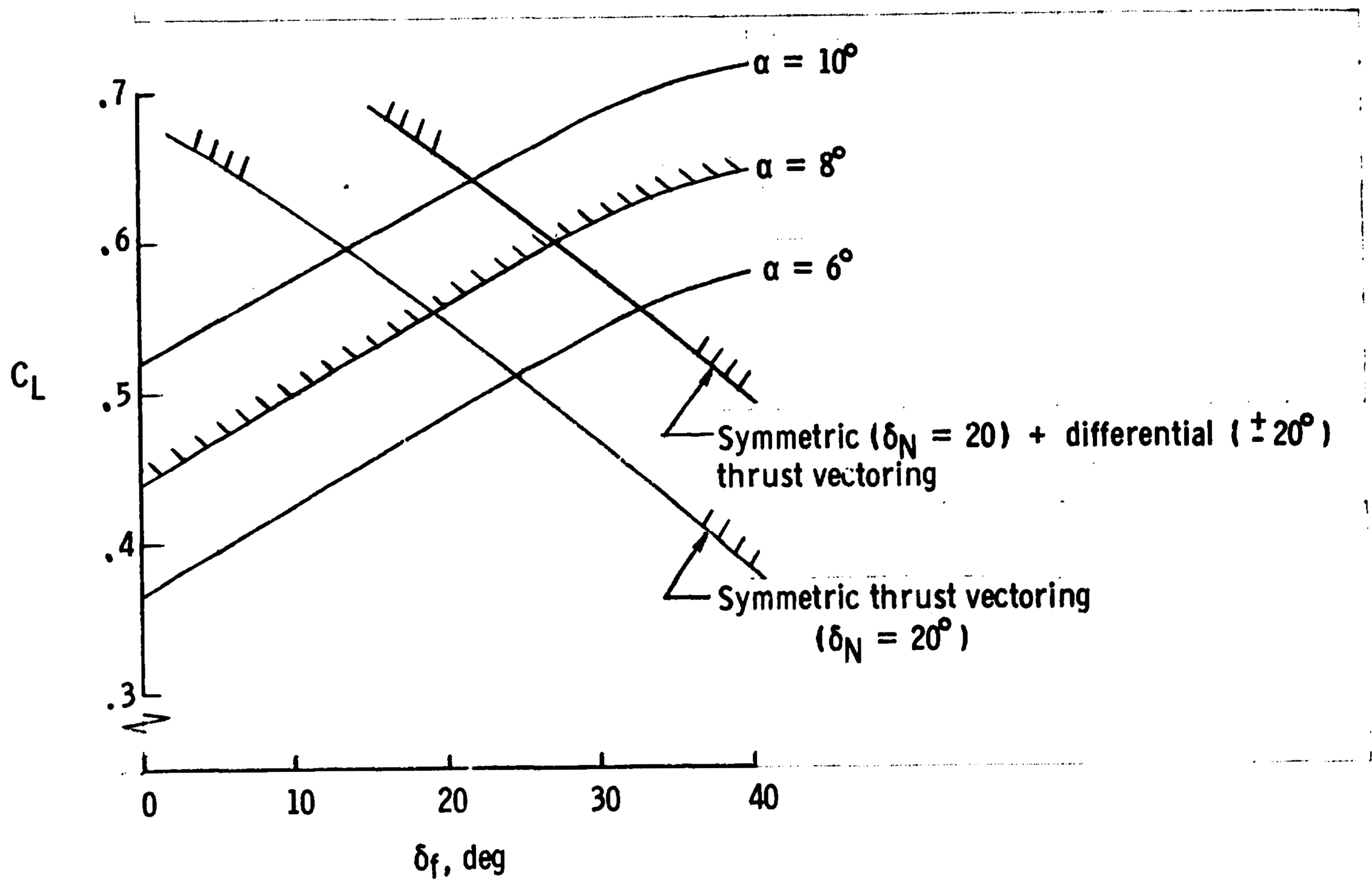


Figure 27. - Effect of differental thrust vectoring on lateral control constraint. $C_T = 0.13$.

APPENDIX - PRESENTATION OF TABULATED DATA

The symbols used in the data tabulation are defined as follows:

ALPHA	Angle of attack, deg
BETA	Angle of sideslip, deg
CD	Drag force coefficient; stability axis
CL	Lift force coefficient; stability axis
CPM	Pitching moment coefficient; stability axis
CRM	Rolling moment coefficient; body axis
CSF	Side force coefficient; body axis
CYM	Yawing moment coefficient; body axis
Q	Free stream dynamic pressure, (lbf/ft^2)

TABLE A-I. - TEST PROGRAM.

		APEX FLAP	OUT BD PANEL FLAP	TRAILING EDGE DEFLECTION deg				MODEL COMPONENTS					ENGINE THRUST COEFFICIENT / EXHAUST NOZZLE DEFLECTION (deg)			
RUN	β	L_1 deg	L_2 deg	t_1 (L) (R)	t_3 (L) (R)	t_5 (L) (R)	t_6 (L) (R)	OUT BD FINS	℄ VERT	℄ VENT	HORIZ	STRAKE	LEFT OUT'BD	LEFT IN'BD	RIGHT IN'BD	RIGHT OUT'BD
1	-5	0	0	0	0	0	5	ON	OFF	OFF	OFF	OFF	0/0	0/0	0/0	0/0
2	0															
3	+5															
4	-5	30														
5	0															
6	+5															
7	-5		45 PLAIN													
8	0															
9	+5															
10	-5		45 KRUGER													
11	0															
12	+5															
25	-5			20	20	20										
26	0															
27	5															
31	-5			30	30											
32	0															
33	5															
34	-5			40	40											
35	0															
36	5															
37	-5			30	0	0										
38	0															
39	+5															
40	-5			0	40	20										
41	0															
42	5															
43	0			(40)(0)	0	0										
44				(30)(0)												
45				(20)(0)												
46				0	(40)(0)											
47					(30)(0)											
48					(20)(0)											
49					0	(-20)(0)										
50						(-10)(0)										
51						(+10)(0)										
52						(+20)(0)										
58					(-20)(0)	0										
59					(-10)(0)											
68					0		(-20)(5)									
69							(-[illegible])(5)									
70							(+10)(5)									
71							(+20)(5)									
72							(+30)(5)									
76	-5			40	40	20	5	OFF								
77	0															
73	+5															
80	0							ON	ON			ON				
82	-5											OFF				
83	0															
84	+5															
85	-5									ON						
36	0															
87	+5															
88	-5										ON					
89	0															
90	+5															
96	-5										-15°					
97	0															
98	+5															
102	-5										ON	ON				
103	0															
104	+5															
120	0						(30)(-20)					OFF				
121						(20)(-20)										
123						20	[illegible]				+15					
124											+10					
125											-10					
126											-15					
182									OFF	OFF	OFF		0/20°	0/20°	0/20°	0/20°
219													.033/20°	.033/20°	.033/20°	.033/20
229									ON	ON						
235											ON					
237											+15					
238											+10					
239											-10					
240											-15					
266											ON		0/20°	0/0°	0/0°	0/-20°
267													.033/20°	.033/0°	.033/0°	.033/-20°
274													.033/0°	.033/0°	.033/0°	.033/0°
277											OFF					
283									OFF	OFF						
305									ON	ON	15					
308											10					
311											-10					
214											-15					

TABLE A - II. TABULATED DATA

RUN 1

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
15	.074	7.971	-5.00	-5.00	-.0776	.0233	.0053	-.0005	-.0007	.0124
16	.074	8.069	-5.00	.02	.0930	.0254	.0132	.0046	-.0003	.0088
17	.074	7.963	-5.00	4.98	.2816	.0526	.0205	.0106	-.0012	.0071
18	.074	7.955	-5.00	10.03	.4882	.1243	.0417	.0138	-.0038	.0077
19	.074	7.987	-5.00	14.93	.7015	.2418	.0719	.0186	-.0026	.0082
20	.074	8.110	-5.00	19.98	.8847	.4071	.1257	.0193	-.0037	.0093
21	.074	7.946	-5.00	25.02	1.0516	.6106	.1802	.0208	.0008	.0192

RUN 2

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
22	.074	8.020	0.00	-5.00	-.0771	.0204	.0043	.0009	-.0001	.0015
23	.074	8.020	-.01	.00	.0909	.0234	.0114	.0001	-.0002	.0026
24	.074	8.012	-.01	4.95	.2852	.0506	.0173	.0002	-.0002	.0030
25	.074	7.938	-.01	9.98	.5040	.1249	.0380	-.0014	.0005	.0105
26	.074	8.045	-.01	14.97	.7222	.2454	.0723	-.0021	.0018	.0123
27	.074	7.946	-.01	19.97	.8856	.4040	.1278	-.0021	.0035	.0182
28	.074	7.979	-.01	24.99	1.0524	.6095	.1872	-.0019	.0093	.0325

RUN 3

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
29	.074	7.946	5.01	-5.04	-.0750	.0198	.0045	.0013	.0008	-.0126
30	.074	8.028	5.01	.01	.0936	.0218	.0107	-.0041	.0004	-.0091
31	.074	8.028	5.01	5.04	.2765	.0506	.0191	-.0107	.0012	-.0036
32	.074	8.012	5.01	9.99	.4870	.1217	.0412	-.0156	.0045	.0013
33	.074	7.963	5.01	14.97	.6902	.2385	.0750	-.0214	.0092	.0118
34	.074	7.971	5.01	20.01	.8867	.4069	.1259	-.0249	.0152	.0220
35	.074	7.979	5.01	24.90	1.0394	.5987	.1798	-.0237	.0238	.0448

RUN 4

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
45	.074	7.996	-5.01	-5.02	-.0876	.0261	-.0053	-.0016	.0020	.0154
46	.074	8.020	-5.01	.01	.0960	.0265	.0070	.0044	.0013	.0116
47	.074	8.045	-5.01	4.97	.2678	.0495	.0121	.0095	.0008	.0108
48	.074	8.012	-5.01	10.02	.4529	.1058	.0228	.0128	.0003	.0139
49	.074	7.946	-5.01	14.98	.6316	.1986	.0402	.0158	.0015	.0133
50	.074	8.028	-5.01	20.01	.7854	.3236	.0717	.0164	-.0022	.0103
51	.074	8.020	-5.01	24.99	.9430	.4864	.1036	.0156	.0063	.0283

TABLE A-II. - CONTINUED

RUN 5

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
52	.074	8.004	-.01	-4.99	-.0824	.0239	-.0034	.0008	-.0007	.0003
53	.074	8.045	-.01	-.01	.0925	.0255	.0075	.0003	-.0004	.0011
54	.074	8.045	-.01	5.00	.2767	.0490	.0134	.0001	-.0002	.0011
55	.074	8.037	-.01	10.02	.4631	.1065	.0233	-.0008	-.0004	.0046
56	.074	8.020	-.01	15.00	.6272	.1949	.0395	-.0018	.0012	.0066
57	.074	7.930	-.01	19.99	.7921	.3208	.0678	-.0005	.0003	.0030
58	.074	7.94[illegible]	-.01	24.96	.9279	.4751	.1032	-.0013	.0031	.0104

RUN 6

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
59	.074	8.053	5.01	-5.01	-.0745	.0235	-.0032	.0025	-.0029	-.0163
60	.074	7.987	5.01	-.01	.0922	.0252	.0070	-.0039	-.0018	-.0124
61	.074	7.987	5.01	4.97	.2642	.0481	.0129	-.0094	-.0012	-.0102
62	.074	7.979	5.01	10.04	.4484	.1048	.0244	-.0143	-.0006	-.0094
63	.074	7.938	5.01	14.98	.6403	.2014	.0449	-.0203	.0031	.0013
64	.074	7.979	5.01	19.98	.7890	.3250	.0767	-.0173	.0047	.0021
65	.074	8.028	5.01	24.97	.9505	.4919	.1091	-.0188	.0187	.0274

RUN 7

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
68	.074	7.963	-5.00	-4.98	-.0934	.0329	.0031	-.0031	.0011	.0175
69	.074	8.020	-5.00	-.01	.0811	.0284	.0087	.0029	.0008	.0146
70	.074	8.028	-5.00	4.99	.2482	.0467	.0158	.0094	.0003	.0123
71	.074	8.028	-5.01	10.02	.4278	.0964	.0283	.0134	-.0005	.0144
72	.074	8.012	-5.01	14.98	.6164	.1837	.0459	.0162	.0004	.0137
73	.074	7.930	-5.01	19.97	.7739	.3019	.0692	.0189	-.0022	.0106
74	.074	8.069	-5.01	24.97	.9448	.4656	.0972	.0197	.0065	.0279

RUN 8

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
76	.074	7.963	.01	-5.05	-.1098	.0326	.0054	-.0002	-.0006	.0005
77	.074	7.963	.01	-.00	.0865	.0271	.0104	.0006	-.0001	-.0008
78	.074	7.963	.01	5.00	.2618	.0468	.0183	-.0011	-.0003	.000[illegible]
79	.074	7.946	.01	9.97	.4330	.0948	.0285	-.0004	-.0003	.0019
80	.074	7.996	.01	14.97	.6102	.1792	.0459	-.0010	.0013	.0055
81	.074	7.955	.01	19.98	.7930	.3047	.0692	.0008	.0000	.0016
82	.074	7.963	.01	24.97	.9410	.4610	.1005	-.0008	.0031	.0125

TABLE A-II. - CONTINUED

RUN 9

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
83	.074	8.012	5.00	-4.98	-.0911	.0310	.0044	.0025	-.0019	-.0184
84	.074	8.020	5.00	.03	.0831	.0268	.0101	-.0022	-.0009	-.0151
85	.074	8.020	5.00	4.97	.2576	.0458	.0176	-.0096	-.0008	-.0098
86	.074	8.020	5.00	9.97	.4261	.0946	.0298	-.0144	.0002	-.0108
87	.074	7.979	5.00	14.96	.6094	.1824	.0490	-.0180	.0037	-.0018
88	.074	7.930	5.00	20.00	.7890	.3081	.0748	-.0180	.0045	-.0013
89	.074	7.922	5.00	24.95	.9540	.4723	.1037	-.0214	.0180	.0223

RUN 10

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
99	.074	8.028	-5.01	-5.00	-.0980	.0347	.0010	-.0032	.0011	.0167
100	.074	8.028	-5.01	.00	.0876	.0302	.0084	.0032	.0009	.0138
101	.074	8.028	-5.01	5.01	.2606	.0485	.0162	.0099	.0007	.0121
102	.074	8.045	-5.01	9.96	.4377	.0971	.0268	.0130	-.0000	.0143
103	.074	8.045	-5.01	15.03	.6376	.1898	.0437	.0170	.0011	.0132
104	.074	7.946	-5.01	19.97	.8001	.3096	.0651	.0216	-.0003	.0073
105	.074	7.971	-5.01	24.97	.9694	.4750	.0915	.0222	.0096	.0267

RUN 11

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
106	.074	8.012	.01	-5.00	-.0966	.0325	.0024	.0007	-.0006	.0002
107	.074	7.996	0.00	.02	.0899	.0282	.0095	.0008	-.0001	.0006
108	.074	7.996	0.00	4.97	.2636	.0461	.0171	.0001	.0002	.0012
109	.074	7.987	0.00	9.98	.4568	.0982	.0282	-.0006	-.0003	.0034
110	.074	7.963	0.00	14.98	.6307	.1839	.0427	-.0006	.0014	.0076
111	.074	7.971	0.00	19.97	.8214	.3136	.0665	.0016	.0010	.0019
112	.073	7.914	0.00	24.97	.9706	.4733	.0981	.0007	.0040	.0130

RUN 12

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
113	.074	8.028	5.01	-4.98	-.1012	.0320	.0020	.0034	-.0022	-.0184
114	.074	8.028	5.01	-.02	.0810	.0267	.0095	-.0029	-.0012	-.0128
115	.074	8.028	5.01	4.98	.2539	.0463	.0172	-.0097	-.0007	-.0086
116	.074	8.028	5.01	9.97	.4386	.0958	.0278	-.0144	-.0001	-.0096
117	.074	7.996	5.01	14.98	.6220	.1840	.0444	-.0193	.0026	.0005
118	.073	7.914	5.01	19.98	.8077	.3121	.0706	-.0202	.0028	.0037
119	.074	7.971	5.01	24.93	.9701	.4774	.0985	-.0232	.0155	.0271

TABLE A-II. - CONTINUED

RUN 25

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
229	.074	8.078	-5.01	-5.04	.0188	.0272	-.0325	-.0021	.0012	.0173
230	.074	8.078	-5.01	.00	.2096	.0340	-.0234	.0052	.0004	.0155
231	.074	8.070	-5.01	4.96	.3826	.0625	-.0140	.0102	.0006	.0117
232	.074	8.053	-5.01	9.96	.5577	.1235	-.0023	.0135	.0006	.0120
233	.074	8.037	-5.01	14.96	.7298	.2204	.0171	.0170	.0029	.0125
234	.073	7.922	-5.01	20.05	.8855	.3553	.0456	.0212	-.0040	.0007
235	.073	7.881	-5.01	24.99	1.0161	.5112	.0715	.0204	.0031	.0137

RUN 26

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
236	.075	8.234	0.00	-5.07	.0192	.0260	-.0306	-.0013	-.0006	.0007
237	.073	7.971	0.00	.00	.2013	.0323	-.0215	-.0017	-.0002	.0016
238	.073	7.971	0.00	5.04	.3893	.0630	-.0123	-.0016	-.0000	.0017
239	.073	7.955	0.00	10.06	.5615	.1228	-.0004	-.0025	.0001	.0032
240	.073	7.889	0.00	15.03	.7336	.2204	.0173	-.0015	.0012	.0057
241	.073	7.848	0.00	19.98	.8827	.3473	.0423	.0009	-.0030	-.0047
242	.072	7.643	0.00	24.93	1.0260	.5126	.0757	-.0004	.0008	.0066

RUN 27

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
243	.075	8.266	5.02	-5.03	.0200	.0264	-.0296	-.0001	-.0019	-.0187
244	.074	8.086	5.02	-.01	.2063	.0320	-.0212	-.0072	-.0006	-.0150
245	.074	8.086	5.02	5.01	.3766	.0616	-.0122	-.0125	-.0003	-.0087
246	.074	8.070	5.02	9.93	.5482	.1208	.0010	-.0174	-.0004	-.0075
247	.074	8.012	5.02	14.99	.7273	.2191	.0197	-.0221	.0012	.0008
248	.073	7.971	5.02	19.99	.8766	.3491	.0458	-.0201	-.0015	-.0062
249	.074	8.053	4.98	24.87	1.0238	.5133	.0765	-.0209	.0054	.0059

RUN 31

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
275	.074	8.037	-5.02	-5.03	.0987	.0305	-.0474	-.0014	.0007	.0173
276	.074	8.012	-5.02	.04	.2779	.0436	-.0389	.0058	-.0003	.0170
277	.074	7.979	-5.02	5.04	.4586	.0795	-.0285	.0116	.0002	.0112
278	.074	7.979	-5.02	10.07	.6346	.1481	-.0157	.0144	.0009	.0119
279	.073	7.930	-5.02	15.03	.7632	.2455	.0048	.0169	.0030	.0127
280	.073	7.848	-5.02	20.03	.9290	.3828	.0342	.0206	-.0042	.0039
281	.073	7.807	-5.02	24.96	1.0579	.5442	.0654	.0204	.0023	.0128

TABLE A-II. - CONTINUED

RUN 32

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
282	.074	8.028	.01	-5.03	.0937	.0290	-.0466	-.0010	-.0005	-.0009
283	.074	8.028	.01	.00	.2831	.0414	-.0373	-.0013	-.0004	.0013
284	.074	7.987	.01	5.00	.4570	.0783	-.0281	-.0018	-.0002	.0016
285	.074	8.061	.01	9.94	.6287	.1428	-.0149	-.0020	.0001	.0021
286	.074	8.053	.01	14.98	.7862	.2441	.0044	-.0014	.0013	.0038
287	.074	8.020	.01	20.02	.9442	.3827	.0325	-.0009	-.0019	-.0026
288	.074	7.996	.02	25.02	1.0668	.5470	.0685	-.0007	-.0001	.0061

RUN 33

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
289	.074	8.078	5.01	-5.04	.1004	.0292	-.0446	-.0007	-.0018	-.0189
290	.074	8.078	5.01	.05	.2825	.0411	-.0365	-.0088	-.0004	-.0144
291	.074	8.078	5.01	5.06	.4549	.0782	-.0260	-.0145	-.0005	-.0085
292	.074	8.070	5.01	10.05	.6198	.1439	-.0131	-.0176	-.0005	-.0062
293	.074	8.028	5.01	14.99	.7837	.2443	.0080	-.0206	.0012	.0006
294	.073	7.946	5.01	19.95	.9198	.3757	.0361	-.0198	-.0013	-.0043
295	.074	7.996	5.01	25.01	1.0585	.5447	.0693	-.0186	.0042	.0018

RUN 34

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
298	.074	8.037	-5.00	-4.98	.1393	.0404	-.0541	-.0004	.0008	.0184
299	.074	8.012	-5.00	.04	.3196	.0546	-.0444	.0070	-.0004	.0158
300	.074	8.012	-5.00	5.04	.4895	.0939	-.0350	.0117	-.0000	.0100
301	.074	8.020	-5.00	9.96	.6605	.1631	-.0218	.0153	.0007	.0115
302	.073	7.971	-5.00	14.98	.8041	.2615	.0016	.0167	.0026	.0131
303	.074	7.996	-5.00	20.01	.9354	.3944	.0368	.0200	-.0042	.0042
304	.074	7.996	-5.00	24.97	1.0498	.5485	.0690	.0195	.0042	.0193

RUN 35

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
305	.074	8.037	0.00	-4.98	.1405	.0380	-.0541	.0003	-.0006	-.0004
306	.074	8.037	0.00	-.03	.3162	.0525	-.0442	-.0006	-.0007	.0022
307	.074	8.012	0.00	4.97	.4874	.0920	-.0341	-.0006	-.0005	.0024
308	.074	8.004	0.00	9.96	.6572	.1583	-.0205	-.0007	-.0001	.0024
309	.073	7.971	0.00	14.97	.8039	.2609	.0010	-.0009	.0009	.0054
310	.073	7.979	0.00	19.98	.9372	.3886	.0326	-.0001	-.0027	-.0014
311	.074	8.004	0.00	24.97	1.0601	.5514	.0739	.0005	-.0004	.0060

TABLE A-II. - CONTINUED

RUN 36

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
312	.074	8.061	5.01	-4.97	.1284	.0380	-.0520	.0003	-.0026	-.0185
313	.074	7.996	5.01	.05	.3064	.0514	-.0427	-.0071	-.0008	-.0145
314	.074	8.037	5.01	5.02	.4886	.0920	-.0330	-.0136	-.0005	-.0091
315	.074	7.996	5.01	10.02	.6483	.1594	-.0189	-.0168	-.0003	-.0079
316	.073	7.946	5.01	15.02	.8027	.2614	.0064	-.0202	.0012	.0014
317	.074	8.045	5.01	19.98	.9333	.3904	.0378	-.0190	-.0002	-.0024
318	.074	8.045	5.01	25.00	1.0499	.5485	.0728	-.0179	.0043	.0023

RUN 37

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
321	.074	8.111	-5.00	-4.99	.0080	.0334	-.0218	-.0011	.0015	.0187
322	.074	8.045	-5.00	.07	.1912	.0384	-.0142	.0058	.0006	.0148
323	.074	8.070	-5.00	5.05	.3609	.0659	-.0061	.0109	.0004	.0112
324	.074	8.070	-5.00	10.03	.5430	.1262	.0045	.0150	.0005	.0137
325	.073	7.946	-5.00	14.96	.7272	.2230	.0220	.0178	.0023	.0129
326	.073	7.971	-5.00	19.96	.8849	.3565	.0494	.0228	-.0037	.0031
327	.073	7.946	-5.00	24.95	1.0225	.5159	.0765	.0236	.0037	.0119

RUN 38

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
328	.073	7.979	0.00	-5.04	-.0104	.0328	-.0210	.0001	-.0006	.0010
329	.074	8.045	-.01	-.01	.1880	.0363	-.0121	.0000	-.0005	.0021
330	.074	8.028	-.01	5.02	.3634	.0642	-.0050	-.0003	-.0002	.0028
331	.074	8.020	-.01	9.95	.5474	.1234	.0059	-.0007	.0000	.0039
332	.074	7.996	-.01	14.96	.7194	.2183	.0224	-.0008	.0008	.0058
333	.073	7.897	-.01	19.94	.8866	.3504	.0470	.0021	-.0025	-.0013
334	.073	7.979	-.01	24.98	1.0357	.5198	.0809	.0011	.0004	.0066

RUN 39

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
335	.073	7.971	5.01	-4.98	-.0037	.0319	-.0213	.0018	-.00[illegible]	-.0172
336	.074	8.045	5.01	.01	.1663	.0360	-.0127	-.0050	-.00[illegible]	-.0140
337	.074	8.045	5.01	4.97	.3631	.0636	-.0045	-.0116	-.00[illegible]	-.0092
338	.073	7.979	5.01	9.94	.5408	.1235	.0069	-.0166	.0000	-.0078
339	.073	7.979	5.01	14.96	.7211	.2209	.0258	-.0208	.0020	.0008
340	.073	7.946	5.01	19.97	.8903	.3521	.0513	-.0208	.0000	-.0015
341	.073	7.930	5.01	24.99	1.0193	.5141	.0800	-.0198	.0045	.0071

TABLE A-II. - CONTINUED

RUN 40

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
344	.074	8.028	-5.00	-4.96	.0206	.0340	-.0307	-.0022	.0013	.0170
345	.074	8.028	-5.00	.02	.2002	.0400	-.0215	.0050	.0005	.01[illegible]
346	.074	8.028	-5.00	4.98	.3732	.0676	-.0124	.0105	.0004	.0108
347	.074	8.028	-5.00	9.99	.5478	.1266	.0014	.0135	.0009	.0114
348	.074	7.996	-5.00	14.98	.7081	.2182	.0231	.0172	.0032	.0109
349	.073	7.930	-5.00	19.96	.8567	.3474	.0525	.0211	-.0037	.0013
350	.073	7.922	-5.00	24.99	1.0007	.5087	.0843	.0200	.0034	.0166

RUN 41

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
352	.074	8.037	-.01	-5.00	.0175	.0320	-.0294	-.0007	-.0004	.0030
353	.074	8.037	-.01	.02	.2104	.0385	-.0209	-.0001	-.0004	.0005
354	.074	8.037	-.01	4.96	.3879	.0674	-.0113	-.0005	-.0000	-.0002
355	.074	8.028	-.01	9.96	.5490	.1228	.0021	-.0009	.0002	.0022
356	.073	7.979	-.01	14.96	.7147	.2197	.0217	-.0006	.0014	.0043
357	.073	7.963	-.01	19.96	.8658	.3448	.0491	.0016	-.0014	-.0031
358	.073	7.979	-.01	24.99	1.0109	.5104	.0871	.0002	-.0002	.0040

RUN 42

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
359	.073	7.979	5.00	-4.95	.0210	.0313	-.0289	.0020	-.0019	-.0186
360	.073	7.979	5.00	.02	.2022	.0372	-.0195	-.0052	-.0007	-.0157
361	.074	8.070	5.00	4.96	.3732	.0655	-.0103	-.0116	-.0004	-.0101
362	.073	7.946	5.00	9.98	.5441	.1240	.0034	-.0145	-.0003	-.0078
363	.074	8.070	5.00	15.00	.7118	.2180	.0249	-.0203	.0011	.0019
364	.073	7.963	5.00	19.98	.8533	.3431	.0534	-.0193	.0010	-.0016
365	.073	7.881	5.00	24.90	.9943	.5021	.0877	-.0190	.0099	.0101

R 43

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
368	.073	7.971	0.00	-5.00	-.0235	.0366	-.0125	.0062	-.0007	-.0054
369	.073	7.971	0.00	-.02	.1580	.0375	-.0045	.0059	-.0004	-.0065
370	.073	7.971	0.00	5.04	.3402	.0634	.0026	.0057	.0000	-.0080
371	.074	7.996	0.00	9.97	.5217	.1202	.0139	.0050	.0001	-.0038
372	.074	8.012	0.00	14.98	.6937	.2117	.0293	.0047	.0011	-.0017
373	.073	7.946	0.00	19.96	.8619	.3405	.0543	.0053	-.0009	-.0067
374	.073	7.979	0.00	24.97	1.0141	.5066	.0873	.0047	.0007	-.0001

TABLE A-II. - CONTINUED

RUN 44

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
377	.073	7.987	0.00	-5.01	-.0539	.0344	-.0109	.0047	-.0005	-.0051
378	.073	7.979	0.00	.04	.1484	.0343	-.0025	.0048	.0001	-.0052
379	.073	7.979	0.00	4.96	.3255	.0582	.0043	.0045	.0004	-.0043
380	.073	7.979	0.00	9.98	.5130	.1150	.0154	.0053	.0009	-.0036
381	.073	7.971	0.00	15.03	.6915	.2084	.0318	.0037	.0015	.0005
382	.073	7.938	0.00	19.98	.8672	.3395	.0568	.0052	-.0007	-.0038
383	.073	7.987	0.00	24.98	1.0154	.5045	.0890	.0037	.0008	.0031

RUN 45

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
386	.074	8.061	0.00	-4.95	-.0627	.0319	-.0065	[illegible]	.0003	-.0035
387	.073	7.963	0.00	-.04	.1227	.0307	.0009	.0029	.0005	-.0042
388	.073	7.987	0.00	4.97	.3108	.0536	.0088	.0029	.0009	-.0049
389	.073	7.971	0.00	[illegible].00	.4908	.1082	.0193	.0027	.0011	-.0025
390	.073	7.971	0.00	14.98	.6696	.1984	.0346	.0027	.0020	.0010
391	.073	7.971	0.00	19.95	.8494	.3283	.0587	.0039	.0004	-.0051
392	.074	8.053	0.00	25.01	1.0030	.4954	.0904	.0027	.0011	.0032

RUN 46

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
395	.073	7.979	0.00	-4.99	-.0545	.0362	-.0111	.0092	-.0038	.0001
396	.074	8.020	0.00	.04	.1367	.0372	-.0038	.0099	-.0026	-.0027
397	.074	8.020	0.00	5.01	.3212	.0595	.0051	.0088	-.0016	-.0050
398	.074	8.037	0.00	9.96	.49[illegible]	.1119	.0171	.0073	-.0011	-.0009
399	.074	8.012	0.00	15.00	.6791	.2061	.0344	.0058	-.0006	.0017
400	.074	8.045	0.00	20.01	.8496	.3347	.0609	.0064	-.0017	-.0012
401	.074	8.004	0.00	24.98	.9854	.4919	.0943	.0026	-.0012	.0062

RUN 47

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
404	.073	7.938	0.00	-4.99	-.0660	.0327	-.0092	.0076	-.0026	-.0012
405	.074	8.078	0.00	.04	.1344	.0322	-.0010	.0080	-.0016	-.0030
406	.074	8.053	0.00	4.97	.3101	.0546	.0071	.0069	-.0008	-.0035
407	.074	8.029	-.01	9.95	.4872	.1075	.0186	.0059	-.0004	-.0023
408	.074	8.012	-.01	14.99	.6666	.1987	.0344	.0052	.0003	.0015
409	.073	7.922	-.01	19.96	.8388	.3261	.0600	.0060	-.0015	-.0039
410	.073	7.815	-.01	24.97	.9849	.4877	.0928	.0040	-.0007	.0035

TABLE A-II. - CONTINUED

RUN 48

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
413	.074	8.029	0.00	-4.97	-.0748	.0317	-.0050	.0055	-.0018	-.0005
414	.074	8.061	0.00	-.03	.1176	.0295	.0026	.0055	-.0009	-.0016
415	.074	8.061	0.00	4.97	.2966	.0509	.0099	.0050	-.0002	-.0023
416	.074	8.061	0.00	9.99	.4799	.1041	.0214	.0032	0002	.0014
417	.074	8.029	0.00	14.96	.6603	.1941	.0373	.0029	0007	.0036
418	.073	7.946	0.00	19.99	.8261	.3195	.0608	.0041	-.0005	-.0003
419	.074	8.061	0.00	24.99	.9863	.4861	.0940	.0034	.0005	.0047

RUN 49

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
422	.074	8.045	0.00	-4.99	-.1149	.0357	.0039	-.0019	-.0010	.0006
423	.074	8.086	0.00	-.02	.0789	.0305	.0114	-.0013	-.0003	-.0010
424	.074	8.086	0.00	5.02	.2653	.0485	.0179	-.0014	-.0000	.0013
425	.074	8.086	0.00	9.98	.4510	.0992	.0275	-.0016	-.0003	.0029
426	.073	7.938	0.00	14.98	.6392	.1879	.0426	-.0013	.0010	.0054
427	.074	8.045	0.00	19.98	.8169	.3140	.0655	.0003	-.0004	.0015
428	.073	7.930	0.00	24.98	.9646	.4728	.0974	-.0000	-.0002	.0065

RUN 50

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
431	.074	8.061	0.00	-4.99	-.1075	.0340	.0029	-.0019	-.0006	.0018
432	.073	7.971	0.00	.02	.0863	.0293	.0101	-.0002	-.0002	-.0010
433	.073	7.971	0.00	4.95	.2652	.0475	.0172	-.0011	-.0002	-.0001
434	.073	7.971	0.00	10.05	.4551	.0999	.0274	-.0009	-.0001	.0022
435	.073	7.946	0.00	14.99	.6336	.1860	.0412	-.0005	.0012	.0050
436	.073	7.905	0.00	19.98	.8112	.3121	.0652	.0013	-.0006	-.0005
437	.074	8.020	0.00	24.98	.9648	.4728	.0962	-.0001	.0003	.0064

RUN 51

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
440	.074	8.070	0.00	-4.99	-.1053	.0335	-.0000	.0015	-.0015	.0009
441	.074	8.111	0.00	-.01	.0944	.0293	.0077	.0013	-.0008	.0009
442	.074	8.111	0.00	4.97	.2701	.0483	.0148	.0009	-.0004	-.0010
443	.074	8.094	0.00	9.97	.4573	.0997	.0259	.0007	-.0001	.0019
444	.074	8.078	0.00	14.99	.6378	.1876	.0405	.0001	.0013	.0055
445	.073	7.987	0.00	19.99	.8180	.3146	.0634	.0024	-.0002	-.0005
446	.073	7.979	0.00	24.95	.9706	.4752	.0957	.0013	.0004	.0061

TABLE A-II. - CONTINUED

RUN 52

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
449	.074	8.029	0.00	-4.96	-.0865	.0312	-.0009	.0030	-.0012	.0002
450	.074	8.029	0.00	-.04	.0979	.0284	.0067	.0025	-.0009	.0006
451	.074	8.029	0.00	5.02	.2766	.0481	.0143	.0017	-.0006	-.0002
452	.074	8.020	0.00	9.96	.4593	.0990	.0245	.0012	-.0002	.0023
453	.073	7.971	0.00	14.99	.6484	.1898	.0403	.0012	.0011	.0045
454	.074	8.012	0.00	20.01	.8338	.3205	.0641	.0034	-.0002	-.0003
455	.073	7.963	0.00	24.99	.9730	.4767	.0948	.0019	.0001	.0066

RUN 58

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
511	.073	7.979	0.00	-5.03	-.1418	.0386	.0058	-.0040	-.0009	.0010
512	.074	8.053	0.00	.01	.0525	.0320	.0134	-.0041	-.0009	.0027
513	.074	8.061	0.00	4.97	.2328	.0475	.0204	-.0041	-.0006	.0027
514	.074	8.061	0.00	9.97	.4152	.0958	.0302	-.0045	-.0007	.0048
515	.074	8.053	0.00	14.99	.5862	.1781	.0468	-.0078	.0001	.0107
516	.073	7.971	0.00	20.01	.7790	.3043	.0690	-.0028	-.0024	.0018
517	.072	7.766	0.00	25.00	.9390	.4621	.0987	-.0021	-.0016	.0059

RUN 59

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
520	.074	8.078	0.00	-5.01	-.1222	.0356	.0034	-.0020	-.0003	.0005
521	.074	8.135	0.00	-.02	.0616	.0302	.0108	-.0023	-.0004	.0005
522	.074	8.094	0.00	5.02	.2459	.0472	.0183	-.0028	-.0002	.0013
523	.074	8.061	0.00	9.93	.4287	.0961	.0283	-.0030	-.0004	.0035
524	.074	8.037	0.00	14.99	.6040	.1704	.0439	-.0045	.0013	.0066
525	.073	7.971	0.00	19.95	.7859	.3033	.0666	-.0011	-.0014	-.0016
526	.073	7.823	0.00	24.98	.9451	.4434	.0977	-.0009	-.0001	.0035

RUN 68

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
608	.074	8.135	0.00	-5.06	-.1094	.0265	.0019	-.0054	-.0015	.0033
609	.074	8.135	0.00	.06	.0744	.0288	.0139	-.0057	-.0019	.0052
610	.074	8.127	0.00	4.97	.2532	.0502	.0176	-.0050	-.0016	.0036
611	.074	8.102	0.00	10.04	.4402	.1065	.0276	-.0052	-.0014	.0060
612	.074	8.078	0.00	14.98	.6069	.1931	.0436	-.0057	.0003	.0083
613	.074	8.029	0.00	19.98	.7721	.3184	.0734	-.0033	-.0026	-.0016
614	.073	7.864	0.00	25.01	.9138	.4730	.1096	-.0032	-.0035	-.0021

TABLE A-II. - CONTINUED

RUN 69

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
617	.074	8.078	0.00	-5.01	-.1011	.0273	-.0006	-.0036	-.0011	.0018
618	.074	8.078	0.00	.08	.0848	.0279	.0119	-.0037	-.0010	.0035
619	.074	8.053	0.00	5.06	.2606	.0499	.0159	-.0032	-.0010	.0029
620	.074	8.053	0.00	10.04	.4407	.1052	.0246	-.0035	-.0009	.0054
621	.074	8.020	0.00	15.04	.6195	.1967	.0432	-.0034	.0005	.0070
622	.073	7.946	0.00	19.98	.7754	.3188	.0718	-.0025	-.0022	-.0009
623	.073	7.840	0.00	25.01	.9193	.4756	.1091	-.0024	-.0038	-.0023

RUN 70

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
626	.074	8.070	0.00	-5.03	-.0911	.0252	-.0050	.0008	-.0003	-.0012
627	.074	8.070	0.00	.07	.0896	.0267	.0064	.0006	-.0001	.0000
628	.074	8.070	0.00	4.98	.2713	.0497	.0112	.0011	-.0002	-.0007
629	.074	8.070	0.00	10.01	.4458	.1052	.0201	.0005	-.0003	.0020
630	.074	8.053	0.00	14.95	.6232	.1965	.0392	-.0011	.0007	.0056
631	.074	7.996	0.00	19.99	.7613	.3208	.0696	.0002	-.0023	-.0023
632	.073	7.843	0.00	24.96	.9245	.4769	.1065	-.0001	-.0041	-.0036

RUN 71

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
635	.073	7.946	0.00	-5.02	-.0760	.0241	-.0075	.0030	.0001	-.0014
636	.074	8.111	0.00	.04	.0910	.0262	.0029	.0027	-.0003	-.0016
637	.074	8.119	0.00	4.97	.2745	.0500	.0085	.0032	-.0002	-.0016
638	.074	8.045	0.00	10.04	.4617	.1079	.0183	.0026	-.0005	.0011
639	.074	8.020	0.00	15.06	.6296	.1991	.0373	.0013	.0005	.0049
640	.073	7.971	0.00	19.98	.7818	.3205	.0664	.0024	-.0023	-.0038
641	.073	7.799	0.00	24.99	.9257	.4785	.1040	.0016	-.0045	-.0033

RUN 72

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
644	.074	8.078	0.00	-5.00	-.0766	.0245	-.0093	.0044	-.0007	-.0029
645	.074	8.078	0.00	-.02	.0946	.0265	.0007	.0055	-.0004	-.0022
646	.074	8.061	0.00	4.97	.2816	.0503	.0063	.0053	-.0007	-.0021
647	.074	7.996	0.00	9.96	.4602	.1072	.0162	.0040	-.0010	.0013
648	.073	7.971	0.00	14.96	.6316	.1986	.0359	.0019	-.0001	.0047
649	.073	7.963	0.00	20.01	.7948	.3269	.0674	.0033	-.0031	-.0039
650	.073	7.971	0.00	24.98	.9308	.4810	.1041	.0018	-.0043	-.0024

TABLE A - II. - CONTINUED

RUN 76

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
685	.074	8.037	-5.00	-4.97	.1441	.0413	-.0534	-.0004	.0027	.0126
686	.074	8.029	-5.00	.05	.3207	.0562	-.0446	.0064	.0025	.0087
687	.074	8.012	-5.00	5.04	.5034	.0981	-.0350	.0126	.0026	.0045
688	.073	7.971	-4.98	10.04	.6721	.1719	-.0214	.0147	.0033	.0054
689	.073	7.971	-4.98	15.03	.8206	.2769	.0078	.0169	.0050	.0059
690	.073	7.938	-4.98	19.97	.9786	.4220	.0419	.0172	-.0011	-.0099
691	.073	7.938	-4.98	25.00	1.0902	.5843	.0813	.0174	.0056	.0003

N 77

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
692	.074	8.061	-.01	-4.97	.1472	.0388	-.0536	-.0011	-.0013	.0002
693	.074	8.037	-.01	-.00	.3277	.0541	-.0438	-.0013	-.0009	.0021
694	.073	7.979	-.01	5.06	.5049	.0972	-.0335	-.0009	-.0003	.0023
695	.073	7.963	-.01	10.04	.6707	.1697	-.0180	-.0011	-.0005	.0033
696	.074	8.045	-.01	15.02	.8163	.2748	.0049	-.0008	.0007	.0059
697	.073	7.963	-.01	19.86	.9564	.4053	.0363	.0015	-.0033	-.0033
698	.074	7.996	-.01	24.94	1.1096	.5854	.0781	.0019	-.0033	-.0040

RUN 78

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
699	.073	7.987	4.99	-4.98	.1466	.0387	-.0512	-.0017	-.0051	-.0119
700	.073	7.971	4.99	.01	.3198	.0531	-.0418	-.0083	-.0037	-.0074
701	.073	7.963	4.99	4.99	.4930	.0949	-.0330	-.0144	-.0027	-.0021
702	.073	7.971	4.99	10.05	.6746	.1708	-.0175	-.0173	-.0040	.0013
703	.074	7.996	4.99	15.03	.8229	.2779	.0118	-.0190	-.0029	.0086
704	.073	7.955	4.99	19.97	.9626	.4121	.0427	-.0141	-.0053	.0018
705	.073	7.946	4.99	24.93	1.1329	.5998	.0827	-.0119	.0082	.0231

RUN 80

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
722	.073	7.979	.01	-4.98	.1471	.0395	-.0562	-.0009	-.0012	-.0010
723	.074	7.996	.01	.04	.3383	.0554	-.0453	-.0010	-.0005	-.0003
724	.074	8.020	.01	5.06	.5079	.1004	-.0318	-.0009	-.0002	.0005
725	.073	7.987	.02	10.01	.6720	.1732	-.0115	-.0014	-.0004	.0012
726	.073	7.987	.02	14.99	.8241	.2810	.0149	-.0010	-.0001	.0010
727	.073	7.930	.02	19.87	.9703	.4163	.0528	-.0013	.0001	.0027
728	.073	7.971	.02	24.62	1.1420	.6043	.1025	.0004	.0005	-.0053

TABLE A-II. - CONTINUED

RUN 82

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
746	.073	7.955	-4.99	-4.96	.1444	.0418	-.0540	-.0004	-.0024	.0212
747	.074	8.061	-4.99	-.04	.3230	.0560	-.0437	.0056	-.0032	.0187
748	.073	7.946	-4.99	5.01	.5032	.0974	-.0349	.0112	-.0030	.0132
749	.073	7.979	-4.99	9.98	.6782	.1691	-.0235	.0142	-.0025	.0146
750	.073	7.979	-4.99	14.98	.8220	.2697	.0021	.0156	-.0010	.0149
751	.073	7.987	-4.99	20.01	.9605	.4087	.0347	.0206	-.0093	-.0045
752	.073	7.946	-4.99	24.98	1.0605	.5605	.0713	.0201	-.0155	-.0233

RUN 83

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
753	.074	8.029	0.00	-4.95	.1558	.0397	-.0534	-.0007	-.0008	.0008
754	.074	7.996	.01	.00	.3347	.0559	-.0441	-.0012	-.0003	.0006
755	.073	7.987	.01	5.01	.5065	.0968	-.0346	-.0016	-.0006	.0027
756	.073	7.971	.01	9.97	.6766	.1649	-.0228	-.0012	-.0009	.0043
757	.073	7.971	.01	14.98	.8285	.2729	.0000	-.0006	-.0010	.0061
758	.073	7.979	.01	19.97	.9614	.4027	.0312	.0000	-.0126	-.0069
759	.073	7.930	.01	24.96	1.0808	.5670	.0729	.0005	-.0195	-.0246

RUN 84

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
760	.073	7.938	5.00	-4.98	.1470	.0405	-.0528	-.0017	.0005	-.0204
761	.074	8.020	5.00	.03	.3284	.0551	-.0433	-.0085	.0024	-.0163
762	.074	8.020	5.00	5.06	.5064	.0969	-.0338	-.0143	.0023	-.0104
763	.074	8.020	5.00	9.98	.6712	.1666	-.0208	-.0167	.0007	-.0062
764	.073	7.979	5.00	14.96	.8172	.2687	.0016	-.0196	.0006	.0008
765	.073	7.979	5.00	19.95	.9459	.4003	.0356	-.0194	-.0066	-.0032
766	.073	7.905	5.00	24.95	1.0607	.5591	.0711	-.0201	-.0013	.0081

RUN 85

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
777	.074	8.029	-5.01	-4.99	.1415	.0411	-.0524	-.0012	-.0023	.0207
778	.074	8.029	-5.01	.04	.3207	.0556	-.0440	.0061	-.0032	.0185
779	.074	8.029	-5.01	5.02	.4995	.0973	-.0366	.0125	-.0040	.0144
780	.074	8.020	-5.01	10.01	.6802	.1704	-.0248	.0159	-.0040	.0163
781	.073	7.987	-5.02	15.04	.8205	.2729	.0011	.0165	-.0035	.0181
782	.073	7.897	-5.02	19.98	.9485	.4074	.0359	.0194	-.0123	-.0003
783	.073	7.963	-5.02	24.97	1.0727	.5713	.0758	.0191	-.0200	-.0214

TABLE A-II. - CONTINUED

RUN 86

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
784	.074	8.012	.01	-4.98	.1431	.0400	-.0535	-.0017	-.0012	.0009
785	.074	7.996	.01	-.01	.3339	.0553	-.0450	-.0001	-.0008	.0011
786	.073	7.971	.01	5.00	.5043	.0970	-.0361	.0001	-.0014	.0034
787	.073	7.971	.01	10.04	.6844	.1698	-.0241	.0011	-.0032	.0067
788	.073	7.963	.01	14.97	.8256	.2754	-.0001	-.0001	-.0036	.0100
789	.073	7.987	.01	20.00	.9587	.4076	.0342	-.0014	-.0156	-.0006
790	.073	7.987	.01	24.96	1.0816	.5723	.0740	-.0008	-.0232	-.0205

RUN 87

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
791	.074	8.012	4.99	-4.95	.1458	.0399	-.0520	-.0016	.0007	-.0203
792	.074	8.020	4.99	.01	.3269	.0552	-.0440	-.0072	.0024	-.0178
793	.074	8.037	4.99	5.04	.5078	.0977	-.0360	-.0120	.0016	-.0103
794	.074	8.029	4.99	9.96	.6739	.1688	-.0226	-.0151	-.0009	-.0055
795	.073	7.971	4.99	15.01	.8214	.2749	.0030	-.0200	-.0018	.0050
796	.073	7.971	4.99	20.02	.9449	.4052	.0365	-.0208	-.0092	.0016
797	.073	7.897	4.99	24.98	1.0653	.5671	.0733	-.0208	-.0025	.0141

RUN 88

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
807	.074	7.996	-5.00	-4.97	.1179	.0474	-.0365	-.0016	-.0044	.0236
808	.074	8.029	-5.00	-.02	.2999	.0582	-.0324	.0053	-.0053	.0203
809	.073	7.987	-5.00	4.94	.4843	.0975	-.0270	.0108	-.0055	.0153
810	.073	7.979	-5.00	9.99	.6562	.1670	-.0164	.0126	-.0046	.0172
811	.073	7.930	-5.00	14.99	.8094	.2663	.0016	.0151	-.0021	.0149
812	.073	7.971	-5.00	19.98	.9670	.4067	.0247	.0206	-.0084	-.0049
813	.073	7.873	-5.00	24.95	1.1033	.5702	.0472	.0222	-.0127	-.0303

RUN 89

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
814	.074	8.029	0.00	-4.90	.1327	.0467	-.0372	-.0010	-.0006	-.0001
815	.074	8.029	0.00	-.00	.3174	.0597	-.0320	-.0015	-.0001	-.0002
816	.074	8.029	-.01	4.97	.4953	.0991	-.0245	-.0017	-.0000	.0010
817	.074	8.029	-.01	9.99	.6641	.1656	-.0147	-.0016	-.0000	.0026
818	.073	7.987	-.01	14.98	.8205	.2695	-.0000	-.0004	-.0001	.0049
819	.073	7.971	-.01	20.01	.9879	.4100	.0218	.0011	-.0133	-.0072
820	.073	7.938	-.01	24.96	1.1037	.5701	.0506	.0014	-.0190	-.0263

TABLE A-II.- CONTINUED

RUN 90

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
8[illegible]1	.073	7.971	5.00	-4.97	.1316	.0460	-.0359	-.0014	.0034	-.0249
822	.073	7.971	5.00	-.01	.3146	.0589	-.0326	-.0082	.0047	-.0199
823	.074	8.004	5.00	5.06	.4962	.1006	-.0281	-.0119	.0041	-.0129
824	.074	8.004	5.00	10.05	.6704	.1725	-.0171	-.0151	.0009	-.0069
825	.073	7.971	5.00	15.02	.8250	.2777	.0024	-.0206	-.0009	.0054
826	.073	7.955	5.00	19.99	.9632	.4087	.0256	-.0216	-.0107	.0042
827	.073	7.971	5.00	24.67	1.1119	.5742	.0476	-.0229	-.0006	.0267

RUN 96

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
880	.074	8.053	-5.00	-4.99	.0823	.0704	-.0026	-.0014	-.0029	.0231
881	.074	8.111	-5.00	.04	.2625	.0781	.0007	.0050	-.0043	.0224
882	.074	8.111	-5.00	5.01	.4413	.1115	.0056	.0103	-.0044	.0159
883	.074	8.094	-5.00	9.97	.6105	.1758	.0166	.0126	-.0039	.0174
884	.074	8.053	-5.00	15.03	.7655	.2717	.0346	.0149	-.0005	.0145
885	.073	7.955	-5.00	19.97	.9137	.3995	.0530	.0187	-.00[illegible]0	-.0037
8[illegible]6	.073	7.897	-5.00	24.93	1.0432	.5505	.0715	.0211	-.0116	-.0282

RUN 97

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
887	.074	8.086	0.00	-5.00	.0841	.0704	-.0016	-.0012	-.0007	.0001
888	.074	8.070	0.00	.03	.2630	.0789	.0015	-.0017	-.0003	.0022
889	.074	8.045	0.00	5.02	.4450	.1134	.0083	-.0019	-.0002	.0025
890	.074	8.020	0.00	9.91	.6073	.1734	.0189	-.0029	.0007	.0029
891	.074	7.996	0.00	14.97	.7626	.2706	.0322	-.0026	.0011	.0054
892	.074	8.094	0.00	19.98	.9399	.4035	.0487	.0004	-.0095	-.0092
893	.073	7.930	0.00	24.92	1.0503	.5522	.0745	.0009	-.0153	-.0303

RUN 98

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
894	.074	8.094	5.00	-5.06	.0839	.0701	-.0023	-.0011	.0015	-.0212
895	.074	8.094	5.00	.05	.2619	.0781	.0017	-.0084	.0035	-.0181
896	.074	8.086	5.00	4.99	.4393	.1119	.0073	-.0143	.0043	-.0120
897	.074	8.061	5.00	10.03	.6119	.1761	.0174	-.0175	.0047	-.0107
898	.074	8.037	4.99	14.99	.7668	.2714	.0333	-.0198	.0055	-.0039
899	.073	7.946	4.99	19.93	.9096	.3945	.0507	-.0193	-.0025	-.0072
900	.073	7.799	4.99	24.93	1.0485	.5539	.0734	-.0190	.0046	.0103

TABLE A - II. - CONTINUED

RUN 102

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
940	.074	8.053	-5.00	-4.99	.1177	.0489	-.0356	-.0016	-.0043	.0254
941	.074	8.078	-5.01	.03	.2992	.0606	-.0297	.0061	-.0057	.0223
942	.074	8.086	-5.01	5.01	.4732	.1001	-.0198	.0119	-.0076	.0151
943	.074	8.070	-5.01	9.94	.6411	.1689	-.0066	.0152	-.0099	.0102
944	.074	8.012	-5.01	15.05	.8076	.2748	.0167	.0175	-.0108	.0001
945	.073	7.914	-5.01	19.98	.9546	.4094	.0411	.0211	-.0116	-.0154

RUN 103

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
947	.074	8.152	.01	-5.02	.1169	.0507	-.0382	-.0008	-.0006	.0007
948	.074	8.143	.01	-.04	.3055	.0628	-.0309	-.0010	-.0001	.0008
949	.074	8.143	.01	4.97	.4776	.1032	-.0201	-.0016	-.0000	.0015
950	.074	8.111	.01	9.98	.6471	.1703	-.0051	-.0023	.0000	.0021
951	.074	8.079	.01	14.98	.8100	.2758	.0148	-.0018	.0008	.0028

RUN 104

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
953	.074	8.152	4.99	-5.03	.1162	.0503	-.0377	-.0005	.0029	-.0258
954	.074	8.152	4.99	.05	.2975	.0624	-.0309	-.0074	.0052	-.0218
955	.074	8.152	4.99	4.95	.4707	.1014	-.0203	-.0147	.0070	-.0123
956	.074	8.135	4.99	9.99	.6475	.1720	-.0073	-.0199	.0097	-.0047
957	.074	8.111	4.99	15.03	.8019	.2739	.0135	-.0215	.0112	.0041
958	.074	8.029	4.99	20.00	.9516	.4104	.0419	-.0229	.0134	.0217

RUN 120

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1108	.074	7.996	0.00	-5.03	.1190	.0525	-.0352	.0082	.0017	-.0085
1109	.074	7.996	0.00	.04	.3173	.0658	-.0296	.0087	.0024	-.0091
1110	.074	8.012	0.00	4.97	.4877	.1045	-.0207	.0084	.0021	-.0077
1111	.074	8.012	0.00	9.97	.6525	.1695	-.0098	.0075	.0019	-.0065
1112	.074	8.029	0.00	14.94	.8142	.2730	.0047	.0066	.0014	-.0028
1113	.073	7.971	0.00	19.97	.9652	.4047	.0244	.0065	-.0113	-.0099
1114	.073	7.955	0.00	24.96	1.1020	.5722	.0537	.0062	-.0136	-.0191

TABLE A-II. - CONTINUED

RUN 121

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1117	.074	8.029	0.00	-5.00	.0969	.0574	-.0272	.0147	.0014	-.0102
1118	.074	8.029	0.00	.01	.2874	.0682	-.0211	.0150	.0016	-.0077
1119	.073	7.971	0.00	4.98	.4647	.1046	-.0152	.0133	.0022	-.0087
1120	.073	7.979	0.00	10.00	.6444	.1694	-.0053	.0112	.0017	-.0071
1121	.073	7.979	0.00	14.90	.8060	.2708	.0080	.0089	.0016	-.0034
1122	.073	7.987	0.00	20.07	.9658	.4070	.0289	.0089	-.0124	-.0107
1123	.073	7.979	0.00	24.99	1.0891	.5669	.0571	.0082	-.0137	-.0199

RUN 123

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1135	.074	8.029	0.00	-5.01	.1664	.0398	-.0660	-.0010	.0002	-.0027
1136	.074	7.996	0.00	.05	.3570	.0570	-.0604	-.0016	.0005	-.0012
1137	.073	7.971	0.00	4.99	.5231	.0995	-.0527	-.0022	.0005	-.0010
1138	.074	8.012	0.00	9.92	.7040	.1695	-.0431	-.0021	.0005	.0002
1139	.074	8.004	0.00	14.85	.8523	.2750	-.0301	-.0021	.0011	.0022
1140	.073	7.979	0.00	20.02	1.0206	.4217	-.0098	.0011	-.0109	-.0079
1141	.074	7.996	0.00	25.01	1.1365	.5894	.0224	.0003	-.0109	-.0130

RUN 124

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CPM	CYM	CSF
1144	.074	8.012	0.00	-5.04	.1508	.0399	-.0572	-.0006	-.0002	-.0006
1145	.074	8.004	0.00	.08	.3417	.0566	-.0508	-.0019	-.0001	.0011
1146	.074	7.996	0.00	5.09	.5229	.0997	-.0420	-.0022	.0002	.0009
1147	.073	7.979	0.00	10.04	.6929	.1685	-.0329	-.0016	.0004	.0013
1148	.073	7.987	0.00	14.96	.8457	.2736	-.0183	-.0024	.0005	.0045
1149	.074	8.012	0.00	19.93	1.0013	.4110	.0005	-.0001	-.0113	-.0045
1150	.073	7.950	0.00	24.98	1.1292	.5823	.0293	.0005	-.0110	-.0125

RUN 125

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1153	.074	8.029	0.00	-5.02	.1011	.0640	-.0114	-.0011	-.0005	-.0011
1154	.074	8.045	0.00	-.02	.2878	.0731	-.0079	-.0020	-.0001	.0000
1155	.074	8.029	0.00	4.95	.4601	.1088	-.0001	-.0022	-.0000	.0007
1156	.074	8.012	0.00	9.97	.6289	.1721	.0102	-.0019	.0004	.0015
1157	.073	7.971	0.00	14.84	.7876	.2710	.0247	-.0018	.0016	.0026
1158	.073	7.971	0.00	19.92	.9468	.4019	.0418	.0005	-.0101	-.0064
1159	.073	7.971	0.00	24.99	1.0865	.5716	.0732	.0003	-.0101	-.0140

TABLE A-II.- CONTINUED

RUN 126

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1162	.074	8.029	0.00	-5.03	.0861	.0742	-.0002	-.0012	-.0007	-.0002
1163	.074	8.037	0.00	.07	.2769	.0822	.0041	-.0019	-.0002	.0007
1164	.074	8.037	0.00	4.96	.4518	.1171	.0117	-.0014	.0000	.0005
1165	.074	8.029	0.00	10.06	.6238	.1810	.0236	-.0016	.0007	.0007
1166	.073	7.963	0.00	14.98	.7754	.2783	.0386	-.0018	.0013	.0028
1167	.074	8.045	0.00	19.98	.9329	.4049	.0530	-.0002	-.0097	-.0061
1168	.073	7.987	0.00	24.96	1.0677	.5664	.0807	.0001	-.0100	-.0139

RUN 182

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1709	.074	8.094	-.02	-4.98	.1318	.0411	-.0502	.0004	.0000	-.0027
1710	.074	8.143	-.02	.02	.3138	.0554	-.0406	.0005	.0002	-.0011
1711	.074	7.996	-.02	5.00	.4810	.0951	-.0303	-.0007	.0004	-.0003
1712	.074	8.152	-.02	10.00	.6604	.1644	-.0174	-.0021	.0003	.0019
1713	.074	8.028	-.02	14.92	.7970	.2627	.0058	-.0014	.0012	.0030
1714	.073	7.997	-.02	18.07	.8840	.3399	.0221	-.0000	-.0022	-.0051
1715	.073	7.930	-.02	19.90	.9319	.3913	.0326	.0003	-.0048	-.0079
1716	.072	7.758	-.02	25.08	1.0506	.5587	.0716	-.0009	-.0066	-.0087

RUN 219

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
1984	.062	5.607	0.00	-5.05	.1792	-.0829	-.0645	.0002	.0009	-.0050
1985	.062	5.574	0.00	-.06	.3686	-.0644	-.0553	.0002	.0009	-.0040
1986	.062	5.656	0.00	5.05	.5632	-.0124	-.0465	-.0003	.0008	-.0026
1987	.062	5.664	0.00	10.02	.7421	.0618	-.0345	.0002	.0010	-.0023
1988	.062	5.664	0.00	15.06	.9054	.1759	-.0120	-.0000	.0007	-.0029
1989	.062	5.648	0.00	20.05	1.0641	.3222	.0184	.0020	-.0063	-.0136
1990	.062	5.705	0.00	24.88	1.1875	.4933	.0542	.0013	-.0068	-.0156

RUN 229

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2084	.062	5.689	.02	-4.98	.1876	-.0822	-.0625	.0064	.0149	-.0179
2085	.062	5.689	.01	-.04	.3699	-.0643	-.0543	.0064	.0155	-.0187
2086	.062	5.689	.01	5.00	.5671	-.0192	-.0439	.0047	.0155	-.0158
2087	.062	5.672	.01	9.96	.7480	.0541	-.0329	.0036	.0163	-.0178
2088	.062	5.672	.01	14.96	.9050	.1641	-.0110	.0057	.0160	-.0194
2089	.062	5.590	.01	19.97	1.0686	.3085	.0185	.0082	.0056	-.0266
2090	.062	5.623	.01	24.92	1.2059	.4874	.0563	.0074	.0069	-.0308

TABLE A-II. - CONTINUED

RUN 235

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2144	.062	5.713	0.00	-5.05	.1509	-.0677	-.0461	-.0002	.0019	-.0033
2145	.062	5.598	0.00	.10	.3610	-.0551	-.0393	.0004	.0025	-.0034
2146	.062	5.598	0.00	4.95	.5442	-.0126	-.0360	-.0017	.0026	-.0022
2147	.062	5.615	0.00	9.93	.7435	.0623	-.0264	-.0007	.0026	.0007
2148	.062	5.615	0.00	14.95	.9138	.1736	-.0122	-.0006	.0020	-.0006
2149	.062	5.615	0.00	19.93	1.0870	.3187	.0043	.0009	-.0109	-.0055
2150	.062	5.598	0.00	24.77	1.2210	.4859	.0253	-.0006	-.0089	-.0086

RUN 237

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2160	.062	5.664	.01	-4.99	.1926	-.0836	-.0756	-.0003	.0014	-.0022
2161	.062	5.615	.01	.06	.3933	-.0646	-.0710	-.0005	.0021	-.0049
2162	.062	5.639	.01	4.93	.5876	-.0151	-.0641	-.0010	.0026	-.0049
2163	.062	5.639	.01	9.95	.7722	.0614	-.0557	-.0008	.0022	-.0019
2164	.062	5.607	.01	15.05	.9539	.1802	-.0437	-.0003	.0015	-.0020
2165	.062	5.623	.01	20.04	1.1441	.3402	-.0280	.0010	-.0117	-.0068
2166	.062	5.598	.01	24.90	1.2685	.5136	-.0044	.0013	-.0085	-.0121

RUN 238

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2170	.062	5.598	0.00	-5.04	.1926	-.0864	-.0665	.0000	.0018	-.0063
2171	.062	5.623	0.00	-.07	.3773	-.0635	-.0599	.0001	.0021	-.0039
2172	.062	5.623	0.00	4.95	.5762	-.0191	-.0527	-.0008	.0022	-.0032
2173	.062	5.623	0.00	9.93	.7[illegible]07	.055[illegible]	-.0439	-.0006	.0021	-.0008
2174	.062	5.623	0.00	15.00	.9395	.1723	-.0299	-.0003	.0013	-.0013
2175	.062	5.590	0.00	20.05	1.1169	.3237	-.0168	.0007	-.0115	-.0064
2176	.062	5.582	0.00	24.73	1.2476	.4904	.0036	.0014	-.0088	-.0113

RUN 239

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2179	.062	5.664	0.00	-4.93	.1332	-.0568	-.0190	.0000	.0017	-.0059
2180	.062	5.648	0.00	.08	.3299	-.0459	-.0152	.0000	.0022	-.0056
2181	.062	5.623	0.00	4.93	.5163	-.0079	-.0102	.0003	.0020	-.0040
2182	.062	5.623	0.00	10.05	.7218	.0667	-.0008	-.0005	.0024	-.0030
2183	.062	5.631	0.00	14.97	.8954	.1749	.0123	-.0009	.0013	-.0017
2184	.062	5.6[illegible]	0.00	19.93	1.0542	.3100	.0254	.0010	-.0102	-.0096
2185	.062	5.[illegible]	0.00	24.82	1.2037	.4829	.0498	.0008	-.0075	-.0143

TABLE A-II. - CONTINUED

RUN 240

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2188	.063	5.754	0.00	-5.04	.1034	-.0450	-.0088	-.0004	.0012	-.0021
2189	.062	5.631	0.00	-.11	.3051	-.0386	-.0047	-.0001	.0019	-.0038
2190	.062	5.697	0.00	4.99	.5003	.0039	.0022	-.0002	.0018	-.0026
2191	.062	5.697	0.00	10.03	.6892	.0726	.0125	.0000	.0020	-.0018
2192	.062	5.689	0.00	15.03	.8601	.1762	.0244	-.0001	.0007	-.0013
2193	.062	5.590	0.00	19.99	1.0408	.3151	.0386	.0008	-.0112	-.0058
2194	.062	5.590	0.00	24.95	1.1846	.4844	.0608	.0012	-.0075	-.0095

RUN 266

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2443	.062	5.681	0.00	-4.96	.1236	.0532	-.0312	.0025	.0028	-.0118
2444	.062	5.689	0.00	.09	.3024	.0665	-.0246	.0014	.0029	-.0089
2445	.062	5.689	0.00	4.95	.4699	.1039	-.0174	.0006	.0032	-.0086
2446	.062	5.697	0.00	10.00	.6475	.1708	-.0079	-.0009	.0029	-.0055
2447	.062	5.664	0.00	14.88	.8019	.2692	.0054	-.0011	.0020	-.0046
2448	.062	5.631	0.00	19.98	.9545	.4009	.0278	-.0007	-.0111	-.0055
2449	.062	5.598	0.00	24.97	1.0833	.5592	.0500	.0010	-.0175	-.0353

RUN 267

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2450	.062	5.631	0.00	-4.97	.0897	-.0652	-.0180	.0093	.0035	-.0115
2451	.062	5.713	0.00	-.07	.2859	-.0495	-.0132	.0085	.0039	-.0091
2452	.062	5.722	0.00	4.98	.4706	-.0184	-.0073	.0082	.0044	-.0108
2453	.062	5.722	0.00	9.91	.6629	.0496	-.0016	.0054	.0038	-.0081
2454	.062	5.722	0.00	15.06	.8478	.1572	.0107	.0043	.0017	-.0031
2455	.062	5.672	0.00	20.03	1.0096	.2899	.0294	.0051	-.0105	-.0090
2456	.062	5.582	0.00	25.18	1.1497	.4557	.0538	.0062	-.0078	-.0136

RUN 274

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2521	.062	5.689	0.00	-4.98	.0989	-.0687	-.0223	-.0014	.0006	-.0015
2522	.062	5.607	.01	.08	.2952	-.0666	-.0152	-.0017	.0010	-.0012
2523	.062	5.639	.01	5.08	.4825	-.0245	-.0107	-.0024	.0010	.0001
2524	.062	5.639	.01	10.10	.6769	.0451	-.0027	-.0026	.0013	.0011
2525	.062	5.631	.01	15.08	.8492	.1509	.0109	-.0017	.0005	.0017
2526	.062	5.639	.01	19.90	1.0123	.2820	.0287	.0000	-.0110	-.003
2527	.061	5.566	.01	24.79	1.1429	.4369	.0521	.0001	-.0093	-.0082

TABLE A-II. - CONTINUED

RUN 277

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2551	.062	5.713	-.01	-4.95	.1242	-.0838	-.0425	-.0013	.0004	-.0030
2552	.062	5.713	-.01	.03	.3108	-.0648	-.0324	-.0017	.0006	-.0017
2553	.062	5.713	-.01	4.98	.4942	-.0260	-.0240	-.0014	.0007	-.0010
2554	.062	5.697	-.01	9.95	.6722	.0415	-.0124	-.0025	.0008	.0014
2555	.062	5.672	-.01	14.96	.8352	.1475	.0103	-.0015	.0008	.0013
2556	.062	5.590	-.01	19.93	.9890	.2782	.0399	-.0002	-.0092	-.0054
2557	.061	5.566	-.01	24.99	1.1335	.4509	.0793	-.0004	-.0080	-.0080

RUN 283

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2613	.062	5.615	.01	-4.97	.1264	-.0799	-.0427	-.0008	.0003	-.0020
2614	.062	5.615	.01	-.07	.3096	-.0661	-.0327	-.0012	.0005	-.0014
2615	.062	5.631	.01	5.00	.4978	-.0289	-.0246	-.0020	.0005	.0002
2616	.062	5.672	.01	10.05	.6861	.0442	-.0123	-.0020	.0004	.0024
2617	.062	5.672	.01	14.95	.8399	.1455	.0098	-.0030	.0007	.0017
2618	.062	5.607	.01	19.97	1.0002	.2830	.0413	-.0006	-.0057	-.0084
2619	.061	5.566	.01	24.84	1.1042	.4283	.0756	-.0003	-.0066	-.0075

RUN 305

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2891	.063	5.812	0.00	-4.92	.1250	-.0806	-.0500	-.0002	.0010	-.0035
2892	.062	5.705	0.00	.06	.3180	-.0683	-.0438	-.0008	.0016	-.0039
2893	.062	5.631	-.01	5.07	.5126	-.0294	-.0386	-.0016	.0016	-.0038
2894	.062	5.598	-.01	9.98	.6948	.0346	-.0283	-.0022	.0014	-.0025
2895	.062	5.557	-.01	15.02	.8752	.1460	-.0156	-.0018	.0017	-.0014
2896	.062	5.566	-.01	[illegible]	1.0308	.2829	.0024	-.0068	.0230	.0260
2897	.061	5.475	-.01	24.92	1.1935	.4586	.0303	-.0071	.0261	[illegible]

RUN 308

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2914	.062	5.590	-.01	[illegible]	.1234	-.0857	-.0411	-.0005	.0009	-.0015
[illegible]	.062	5.590	-.01	-.06	.3046	-.0700	-.0352	-.0016	.0013	.0001
[illegible]	.062	5.582	-.01	4.93	.4935	-.0322	-.0287	-.0024	.0011	.0009
[illegible]	.062	5.607	-.01	9.96	.6821	.0385	-.0189	-.0025	.0011	.0025
2918	.062	5.631	-.01	14.93	.8497	.1432	-.0067	-.0025	.0013	.0035
2919	.062	5.598	-.01	20.02	1.0210	.2844	.0117	[illegible]	.0229	.0315
2920	.061	5.500	-.01	24.93	1.1746	.4554	[illegible]	-.0069	.0256	[illegible]

TABLE A-II. - CONCLUDED

RUN 31[illegible]

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2937	.062	5.697	0.00	-5.08	.0595	-.0507	.0032	-.0008	.0002	.0022
2938	.062	5.681	0.00	-.01	.2568	-.0482	.0084	-.0014	.0010	.0015
2939	.062	5.681	0.00	4.98	.4427	-.0163	.0134	-.0021	.0012	.0030
2940	.062	5.681	0.00	10.01	.6312	.0469	.0236	-.0028	.0008	.0041
2941	.062	5.664	0.00	15.04	.7912	.1415	.0357	-.0031	.0012	.0068
2942	.062	5.582	0.00	19.97	.9640	.2764	.0518	-.0069	.022[illegible]	.0334
2943	.062	5.557	0.00	24.99	1.1279	.4471	.0774	-.0076	.0268	.0691

RUN 314

POINT	MACH	Q	BETA	ALPHA	CL	CD	CPM	CRM	CYM	CSF
2960	.063	5.763	0.00	-4.92	.0544	-.0430	.0126	-.0009	-.0001	.0018
2961	.062	5.697	-.19	-.01	.2444	-.0398	.0180	-.0010	.0006	.0016
2962	.062	5.681	0.00	5.10	.4306	-.0079	.0233	-.0022	.0006	.0027
2963	.062	5.631	0.00	10.06	.6156	.0541	.0337	-.0020	.0004	.0056
2964	.062	5.623	0.00	14.99	.7736	.1461	.0469	-.0022	.0012	.0079
2965	.062	5.566	0.00	19.94	.9520	.2756	.0607	-.0066	.0232	.0350
2966	.062	5.590	0.00	25.02	1.1128	.4441	.0851	-.0074	.0267	.0698

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16. Abstract
A low-speed wind tunnel investigation has been conducted in the Langley V/STOL tunnel to provide a preliminary assessment of possible means for improving the low-speed aerodynamic characteristics of advanced supersonic cruise arrow-wing configurations and to extend the existing data base of such configurations. Principle configuration variables included; wind leading-and trailing-edge flap deflection, fuselage nose strakes, and engine exhaust nozzle deflection.

The tests were conducted at a Reynolds number (based on the mean aerodynamic chord) of about 2.5×10^6 for an angle-of-attack range from -5 to 25° and an angle-of-sideslip of $\pm 5°$.

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