https://ntrs.nasa.gov/search.jsp?R=19850014054 2020-03-20T18:30:25+00:00Z

NASA CR-

NASA Contractor Report 172531

NASA-CR-172531
19850014054

EFFECTS OF LEADING-EDGE DEVICES ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A HIGHLY-SWEPT ARROW-WING

SAMUEL J. SCOTT, ORAN W. NICKS,
AND P. K. IMBRIE

TEKWORLD COMPANY
HAMPTON, VIRGINIA

PURCHASE ORDER L-69215B
FEBRUARY 1985

LIBRARY COPY

LANGLEY RESEARCH CENTER
LIBRARY, NASA
HAMPTON, VIRGINIA

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

CONTENTS

N85-22365 #

SYMBOLS

The longitudinal data are referred to the stability 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 59.855 percent of the reference wing mean aerodynamic chord. The reference wing area and reference mean aerodynamic chord are based on the wing planform which results from extending the inboard leading-edge sweep angle 73.02° and the outboard trailing-edge sweep angle 41.46° to the model center line. (See Fig. 2.)

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

A	-	aspect ratio, $\frac{b^2}{S_{ref}}$
b	-	wing span, m (ft)
C_D (CD)	-	drag coefficient, $\frac{\text{Drag}}{qS_{ref}}$
C_{D_i}	-	induced drag coefficient
$C_{D_{min}}$	-	minimum drag coefficient
$C_{D_{sym}}$	-	drag coefficient of the configuration without twist and camber at zero lift (see pg. 4)
C_L (CL)	-	lift coefficient, $\frac{\text{Lift}}{qS_{ref}}$
C_ℓ (CRM)	-	rolling-moment, $\frac{\text{Rolling moment}}{qS_{ref}b}$
C_m (CM)	-	pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS_{ref}\bar{c}}$
C_n (CYM)	-	yawing-moment coefficient, $\frac{\text{Yawing moment}}{qS_{ref}b}$

C_Y (CSF) - side-force coefficient, $\frac{\text{Side force}}{qS_{ref}}$

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

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

S - Leading-edge suction parameter

S_{ref} - reference wing area, m^2 (ft^2)

X,Y,Z - body axes system

α (ALPHA) - angle of attack, deg

β (BETA) - angle of sideslip, deg

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

$\delta_{L.E.}$ - leading-edge deflection, positive when leading edge is down, deg

Derivatives:

C_{L_α} - $\partial C_L/\delta\alpha$, per deg

C_{ℓ_β} - $\partial C_\ell/\delta\beta$, per deg

Summary

An investigation was conducted in the Texas A & M University 7-by 10-foot Low-Speed Wind Tunnel to provide a direct comparison of the effect of several leading-edge devices on the aerodynamic performance of a highly-swept wing configuration. The tests were conducted over an angle-of-attack range of -6° to 16°, for a Mach number of 0.21 and a Reynolds number (based on the mean aerodynamic chord) of 4.1×10^6.

Analysis of the data indicates that for the configuration with undeflected leading edges, vortex separation first occurs on the outboard wing panel for angles of attack of approximately 2°, and wing apex vorticies become apparent for $\alpha \geq 4°$. However, the occurence of the leading-edge vortex flow may be postponed with leading-edge devices. Of the devices considered, the most promising were a simple leading-edge deflection of 30°, and a leading-edge slat system. The trailing-edge flap effectiveness was found to be essentially the same for the configuration employing either of these more promising leading-edge devices.

Analysis of the lateral-directional data showed that for all of the concepts considered, deflecting the leading edges downward in an attempt to postpone leading-edge vortex flows, has the favorable effect of reducing the effective dihedral.

Introduction

The National Aeronautics and Space Administration is currently investigating the aerodynamic characteristics of advanced aircraft concepts which are capable of cruising efficently at supersonic speeds. The conceptual designs are representative of future generation commercial and military vehicles and incorporate wing sweeps on the order of 70° to 80° (e.g., Refs. 1 and 2). Unfortunately such configurations have typically exhibited deficient subsonic aerodynamic characteristics. These deficiencies have been attributed to the formation of leading-edge vorticies. Numerous leading-edge devices and concepts have been considered to eliminate or minimize this vortex formation (see, for example, Refs. 3 through 5). The present wing geometry differs slightly from the geometry considered in References 3 through 5. The leading-edge being modified to obtain a constant inboard leading-edge sweep of 73.05°.

The present study was specifically intended to provide a direct comparison of several leading-edge devices. The tests were conducted in the Texas A & M University 7-by-10 ft Wind Tunnel over an angle of attack range from about -6° to 16° for sideslip angles of 0°,- 5° and -10° and at Reynolds numbers (based on the wing mean aerodynamic chord) from 4.1×10^6 to 5.3×10^6.

Model

The principal dimensional characteristics of the model used in the present investigation are listed in Table I and shown in Figures 2 and 3. A sketch of the model and mounting arrangement in the Texas A & M University 7-by 10-foot wind tunnel is shown in Figure 4.

The model incorporated three different leading-edge systems and a trailing-edge flap system as shown in Figure 3. The model did not incorporate either nacelles or an aft fuselage.

Tests and Correction

The tests were conducted in the Texas A & M University 7-by 10-foot low speed wind tunnel. The model was mounted in a wings vertical attitude so that the wind tunnel turntable could be used to obtain a -6° to 16° angle of attack range (see Fig. 4). A variable knuckle was used to provide side slip angles of 0°, -5° and -10°. Forces and moments were measured with a standard six-component strain-gage balance mounted internal to the model. Flow visualization was accomplished using 0.048cm (0.019 in.) diameter nylon tufts. Test were conducted at dynamic pressures of 3064.3, 4069.8, and 5123.16 Pa (64, 85, and 107 lbf/ft^2) these values of dynamic pressure resulted in Reynolds numbers (based on the wing mean aerodynamic chord) of 4.1×10^6, 4.8×10^6, and 5.4×10^6. The majority of the tests were run at the lower dynamic pressure which resulted in a Mach number of 0.21.

Jet boundary corrections to the angle of attack and drag were applied in accordance with Reference 6. Blockage corrections were applied to the data by the method of Reference 7. Balance chamber pressure and model base pressure were measured and the drag measurements were adjusted to correspond to conditions of free-stream static pressure acting over the base of the model. An angle-of-attack correction of 0.8° was applied based on comparisons of previous tests of similar configurations (Refs. 3 through 5).

Presentation of Results

A data supplement containing a run schedule and tabular listing of data is provided in Appendix A. The results and discussion are presented in accordance with the following outline:

Longitudinal Aerodynamic Characteristics

- Effect of Reynolds number
- Effect of leading-edge vorticies
- Effect of simple leading-edge deflection
- Effect of leading-edge slat
- Effect of variable chord leading-edge
- Comparison of leading-edge devices
- Effect of trailing-edge flap deflection

Lateral-Directional Aerodynamic Characteristics

- Effective dihedral derivative

In addition to the standard longitudinal aerodynamic coefficients C_m, C_L, and C_D and the lift-drag ratio (L/D); the leading-edge suction parameter (S) is also presented as a figure of merit. The leading-edge suction parameter is fully discussed in References 4 and 5 and is defined as :

$$S = \frac{C_D - [C_{D_{sym}} + C_L \tan (C_L/C_{L_\alpha})]}{C_L{}^2/\pi - C_L \tan (C_L/C_{L_\alpha})}$$

Where $C_{D_{sym}}$ is the drag coefficient of the configuration without twist and camber, at zero lift. (See ref. 4 for a discussion of $C_{D_{sym}}$). The value of

$C_{D_{sym}}$ has been estimated for the present model tests using the relationship

$$C_{D_{sym}} = C_{D_{min}} - \frac{C_L^2 \Big|_{C_{D_{min}}}}{\pi A}$$

Evaluation of this relationship yields $C_{D_{sym}} = 0.0107$. The value of C_{L_α} has been determined experimentally (from the linear region of C_L versus α) to be 0.039.

Results and Discussion

The present study was specifically intended to provide a direct comparison for the effect of several leading-edge devices on the aerodynamic performance of highly swept wings. The model did not incorporate either nacelles or an aft fuselage.

Longitudenal Aerodynamic Characteristics

Effect of Reynolds Number.- Figure 5 presents the longitudinal aerodynamic characteristics for the configuration with undeflected leading-edges over a range of Reynolds numbers of 4.1×10^6 to 5.3×10^6. As can be seen, for the configuration with undeflected leading-edges, increasing the Reynolds number from 4.1×10^6 to 4.8×10^6 results in only slight changes in C_m, C_L, and C_D. However, the nature of the changes in C_L and C_D are such that significant increases in leading-edge suction and lift-drag ratio occur with increasing Reynolds number. Further increasing the Reynolds number to 5.3×10^6 yields no further changes in the aerodynamic characteristics. Reynolds number sensitivity studies were also conducted for a number of deflected leading-edge configurations. These data are not presented, but are contained in the tabulated data of this report. Results of these studies all showed that with deflected leading edges, no Reynolds number effects existed.

Effect of leading-edge vorticies.- References 3 through 5 have shown that this class of highly swept-wing configuration exhibits vortex separation on the outboard wing panel for angles of attack of approximately 2° and that wing apex vorticies become evident for $\alpha > 4°$. Flow visualization, using mini-tufts, verified this phenomenon for the present configuration with undeflected leading edges. Unfortunately, the photographic quality of this particular sequence was quite poor and tuft photographs are not available.

The data of Figure 5 illustrates the effect that such vorticies have on the longitudinal aerodynamic characteristics of the configuration. As can be seen for $\alpha = 4°$, a pronounced non-linearity in C_L and C_m versus α exists. These results are consistent with previous studies, the non-linearity in C_L being termed vortex-lift and the non-linearity in C_m being termed pitch-up.

Effect of simple leading-edge deflection.- Reference 3 has shown that a simple leading-edge deflection of 30° is an effective means to forestall leading edge vortex separation for a similar, highly-swept arrow-wing configuration. For the present configuration figure 6(a-d) shows the effect of simply deflecting the leading-edge about the hinge-line shown in Figure 3(a), for conditions with the outboard vertical fins on and off, and $\delta_f = 0°$ and 20°. In as much as the higher R_N data was obtained for the configuration with $\delta_{LE} = 0°$, only for conditons with the outboard vertical fins on, plots of S and L/D are presented for the configuration with $\delta_{LE} = 0°$, only for conditions with the vertical fins on. However, noting that C_m, C_L, and C_D are only slightly influenced by R_N , these data are presented for the configuration with $\delta_{LE} = 0°$ for conditions with vertical fins on and off. Comparison of the data of figure 6a with that of figure 6b, and comparision of the data of figure 6c with that of figure 6d indicates that the outboard vertical fins may provide a slight reduction in the pitch-up tendancy at higher angles of attack.

Most importantly, the data of Figure 6 shows that deflecting the leading edge through either 30° or 40° is effective in delaying the angle-of-attack at which pitch-up occurs to $\alpha \geq 8°$, and that the vortex lift increment is virtually eliminated. The data further show that for the range of lift coefficients of interest (i.e., $0.3 \leq C_L \leq 0.6$), $\delta_{LE} = 30°$ provides better performance than $\delta_{LE} = 40°$.

Tuft photographs for the configuration with $\delta_{LE} = 30°$ are presented in Figure 7. As can be seen for $\alpha \geq 8°$ some vortex separation is apparent for the inboard wing panel, while the outboard wing panel experiences plain separation. This condition, as expected, worsens with increasing angles-of-attack.

Effect of leading-edge-slat.- The leading-edge slat tested, was designed using simple sweep theory in conjunction with two-dimensional methods. The slat design was intended to limit the normally high leading-edge suction peaks, to values for which it was considered that attached flow could be maintained. This resulted in an average value of slat gap of approximately 0.170 cm (0.067 inches) and an average value of slat overlap of approximately 0.079 cm (0.031 inches). Results for the configuration with the leading edge slat (see Fig. 3(b) for geometric details of the slat) are presented in Figure 8(a-c). The data show that for $\delta_f = 0°$ the leading-edge slat is effective in postponing the occurence of pitch-up to $\alpha \approx 12°$ (corresponding to $C_L \approx 0.55$), and that with $\delta_f = 20°$ pitch-up could also be delayed to $C_L \approx 0.55$. Tuft photographs for the configuration with the leading-edge slat are presented in Figure 9. Comparison with the tuft photographs for the configuration with the simple $\delta_{LE} = 30°$, shows that the slat tends to suppress the inboard vortex separation to higher α's, but the flow over the outboard panel is essentially the same and is experiencing separation for $\alpha \geq 8°$.

The data of Figure 8 further show that reducing the deflection of the innermost leading-edge element (slat configuration II) results in a very slight degradation in performance. This result is apparently due to a drag increment associated with the surface discontinuity inherent in non-uniformly deflecting the leading edge.

During the course of the investigation, concern arose regarding possible effects of air leakage between the intersegment joints of the multi-segmented leading edge (see Fig. 3(b)). Consequently, the intersegment joints were sealed with tape. The results presented in Figure 10 show that no intersegment leakage effects are discernible for $\alpha \leq 14°$ (i.e., $C_L \leq 0.6$); however for higher angles-of-attack (or higher C_L's) sealing the intersegment joints had a slightly unfavorable effect on drag.

Figure 11 shows the effect of slat gap by comparing data for the configuration with the leading-edge-slat gap in the nominal condition with: (1) data for the configuration with the leading-edge slat gap increased (see Fig. 3(b)) and (2) data for the configuration with the outboard wing panel leading-edge slat gaps sealed. As can be seen, the data for the three conditions are virtually identical.

<u>Effect of variable chord leading-edge</u>.- The variable chord leading-edge was designed using a modified version of the analysis and design methodology presented in reference 8. Figure 12 presents the longitudinal aerodynamic characteristics of the configuration with the variable chord leading edge (see Fig. 3(c) for geometric details of the variable chord leading edge). As can be seen, deflecting the variable chord leading-edge through either 20° or 40° is only somewhat effective in forestalling pitch-up. Although, the 40° deflection is seen to result in a better pitching moment characteristic (relative to the 20°

deflection) it also results in a significant performance degradation relative to the 20° deflection, at lower lift coefficients.

Tuft photographs for the configuration with the variable chord leading-edge are presented in Figure 13. As can be seen for either the 20° or the 40° deflection, vortex separation is apparent for $\alpha \geq 4°$. These results are consistent with the force and moment data shown in Figure 12.

Comparison of leading-edge devices.- Figure 14 presents a comparison of the longitudinal aerodynamic characteristics for the leading-edge configurations considered. As can be seen, the simply deflected leading-edge with δ_{LE} = 30°, and the leading-edge slat provide improvements in longitudinal stability and performance which are similar, however, the leading-edge slat generally exhibits slightly better aerodynamic characteristics. Both of these geometries exhibit substantial improvements relative to the undeflected leading edge and the variable chord leading-edge concept.

Effect of trailing-edge flap deflection.- Figure 15 shows the effect of trailing-edge flap deflection for the configurations with the simply deflected leading edge and the leading-edge slat. As can be been, the trailing-edge flap effectiveness is essentially the same for both configurations and remains relatively constant for the range of conditions investigated.

Lateral-Directional Aerodynamic Characterictics.

As noted previously, the present model was comprised of a wing-fuselage and was intended to address generic problems associated with highly swept wings. Reference 5 indicates that one of the major deficiences of this class of highly swept wings is the excessively high levels of effective dihedral.

Effective dihedral derivative.- Figure 16 presents the variation of C_{ℓ_β} with α and with C_L for several of the leading-edge configurations investigated. As can be seen, deflecting the leading edge has the positive effect of reducing C_{ℓ_β}. This result is thought to be due to the deflected leadingedge effectively representing some geometric anhedral.

Summary of Results

An investigation was conducted to provide a direct comparison of the effect of several leading-edge devices on the aerodynamic performance of a highly swept wing configuration. The results may be summarized as follows:

1. For the configuration with undeflected leading-edges, vortex separation first occurs on the outboard wing panel for angles of attack of approximately 2°, and wing apex vortices become apparent for $\alpha \geq 4°$.
2. Occurrence of leading-edge vortex flows may be postponed with leading-edge devices. Of the devices considered, the most promising were the simple leading edge deflection of 30°, and the leading-edge slat system.
3. The trailing-edge flap effectiveness is essentially the same for the configuration with either the simple leading-edge deflection of 30° or the leading-edge slat system.
4. Deflecting the leading-edges downward in an attempt to postpone leading-edge vortex flows, has the positive of effect of reducing the effective dihedral.

APPENDIX A

WIND-TUNNEL TEST SCHEDULE AND DATA TABULATION

As an aid to the reader, the appendix provides the wind-tunnel test schedule and tabulated longitudinal aerodynamic data.

TABLE AI. - TEST PROGRAM

RUN	q,PSF	β,Deg	Vertical Fin	δ_f, Deg	Leading Edge
2	64	0	On	0	Undeflected
3	85	0	On	0	Undeflected
4	107	0	On	0	Undeflected
5	64	0	Off	0	Undeflected
6	107	0	On	20	Undeflected
7	64	0	On	20	Undeflected
8	64	0	Off	20	Undeflected
9	64	-5	Off	20	Undeflected
10	64	-10	Off	20	Undeflected
11	64	0	Off	20	Slat, IA
12	107	0	Off	20	Slat, IA
13	64	0	On	20	Slat, IA
14	107	0	On	20	Slat, IA
15	64	0	On	0	Slat, IA
16	64	0	Off	0	Slat, IA
17	64	-5	Off	0	Slat, IA
18	64	-10	Off	0	Slat, IA
19	64	0	Off	0	Slat, IIA
20	64	0	On	0	Slat, IIA
21	64	0	On	0	Slat, IIA
22	64	0	Off	0	Slat, IIA
23	64	0	Off	0	Slat, IA Taped Intersegment
24	64	0	On	0	Slat, IA Taped Intersegment
25	64	0	Off	0	Simple, 30°
26	64	0	On	0	Simple, 30°
27	64	0	On	20	Simple, 30°
28	64	0	Off	20	Simple, 30°
29	64	-5	Off	0	Simple, 30°
30	64	-10	Off	0	Simple, 30°
31	64	0	Off	0	Simple, 40°
32	64	0	On	0	Simple, 40°
33	64	0	On	20	Simple, 40°
34	64	0	Off	20	Simple, 40°
35	64	-5	Off	0	Simple, 40°
36	64	-10	Off	0	Simple, 40°

TABLE AI. - TEST PROGRAM (Concluded)

RUN	q,PSF	β,Deg	Vertical Fin	δ_f, Deg	Leading Edge
37	64	0	Off	0	Variable Chord, 20°
38	64	0	On	0	Variable Chord, 20°
39	64	0	On	20	Variable Chord, 20°
40	64	0	Off	20	Variable Chord, 20°
41	64	-5	Off	20	Variable Chord, 20°
42	64	-10	Off	20	Variable Chord, 20°
43	64	0	Off	20	Variable Chord, 40°
44	64	0	On	20	Varialbe Chord, 40°
45	64	0	On	20	Variable Chord, 40°
46	64	0	Off	20	Variable Chord, 40°
47	64	-5	Off	0	Variable Chord, 40°
48	64	-10	Off	0	Variable Chord, 40°
49	64	0	Off	0	Slat, IB
50	64	0	Off	0	Slat, IB
51	64	0	On	0	Slat, IB
52	64	0	On	0	Slat, IB Out 'BD Gap Sealed
53	107	0	On	0	Slat, IB
54	64	0	On	10	Slat, IB
55	64	0	On	20	Slat, IB
56	64	0	On	10	Simple, 30°
57	64	0	On	0	Simple, 30°
58	64	0	On	0	Simple, 30°
59	64	0	On	0	Simple, 30°

TABLE AII. - TABULATED DATA

RUN 2

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	.00	.1258	.0146	.0175	.0005	-.0002	.0003
-5.58	.00	-.1374	.0208	-.0028	.0007	-.0002	.0005
-3.33	.00	-.0411	.0125	.0051	.0007	-.0002	.0006
-1.13	.00	.0432	.0110	.0122	.0005	-.0002	.0004
1.12	.00	.1258	.0147	.0175	.0004	-.0003	.0003
3.40	.00	.2184	.0250	.0239	.0006	-.0002	.0001
5.69	.00	.3284	.0454	.0346	.0001	-.0004	.0001
7.97	.00	.4422	.0756	.0499	-.0001	-.0005	.0003
10.31	.00	.5582	.1165	.0689	.0000	-.0010	.0003
12.56	.00	.6757	.1686	.0949	.0009	-.0032	-.0020
14.96	-.01	.7531	.2319	.1281	.0011	-.0059	-.0063
1.15	.00	.1365	.0145	.0185	.0005	-.0003	.0008

RUN 3

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.19	.00	.1248	.0143	.0176	.0005	-.0004	-.0001
-5.62	.00	-.1361	.0208	-.0029	.0005	-.0003	.0005
-3.32	.00	-.0382	.0122	.0050	.0007	-.0003	.0002
-1.09	.00	.0479	.0107	.0122	.0005	-.0003	.0000
1.18	.00	.1324	.0143	.0172	.0003	-.0004	.0000
3.48	.00	.2284	.0247	.0237	.0002	-.0003	.0000
5.84	.00	.3422	.0461	.0348	-.0002	-.0006	-.0005
8.18	.00	.4617	.0784	.0525	-.0003	-.0007	-.0004
10.58	.00	.5847	.1225	.0739	.0000	-.0015	-.0009
12.96	-.02	.7059	.1778	.1026	.0010	-.0042	-.0051
15.46	-.04	.8655	.2593	.1268	.0020	-.0082	-.0135
18.01	-.06	1.0269	.3604	.1571	.0006	-.0113	-.0176
1.22	.00	.1444	.0145	.0179	.0003	-.0004	.0005

RUN 4

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.25	.00	.1415	.0149	.0176	.0004	-.0005	.0003
-5.67	.00	-.1355	.0204	-.0033	.0004	-.0004	.0007
-3.34	.00	-.0355	.0121	.0052	.0005	-.0003	.0004
-1.08	.00	.0513	.0109	.0127	.0005	-.0004	.0004
1.22	.00	.1288	.0148	.0173	.0003	-.0004	.0004
3.62	.00	.2400	.0263	.0235	.0004	-.0004	.0009
6.00	.00	.3550	.0490	.0362	-.0004	-.0007	.0006
8.42	.00	.4836	.0854	.0556	-.0003	-.0009	.0007
10.86	.00	.6105	.1335	.0803	.0002	-.0022	-.0003
1.28	.00	.1454	.0149	.0178	.0003	-.0005	.0005

RUN 5

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.17	.00	.1413	.0144	.0181	.0005	-.0001	-.0005
-5.53	.00	-.1212	.0191	-.0011	.0008	.0000	-.0002
-3.28	.00	-.0269	.0115	.0067	.0007	-.0001	-.0004
-1.16	.00	.0560	.0103	.0135	.0006	.0000	-.0004
1.15	.00	.1393	.0143	.0181	.0006	-.0001	-.0005
3.44	.00	.2372	.0262	.0256	.0007	-.0003	-.0001
5.72	.00	.3422	.0482	.0394	.0002	-.0002	-.0008
7.95	.00	.4462	.0796	.0616	.0002	-.0003	-.0006
10.31	.00	.5562	.1211	.0851	.0004	-.0008	-.0014
12.64	-.01	.6706	.1736	.1128	.0016	-.0035	-.0046
14.97	-.02	.7953	.2399	.1463	.0031	-.0070	-.0088
1.16	.00	.1431	.0144	.0186	.0006	-.0001	-.0008

TABLE AII. - CONTINUED

RUN 6

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.81	.00	.3001	.0369	-.0156	.0002	-.0005	.0007
-5.09	.00	.0325	.0214	-.0343	.0005	-.0003	-.0002
-2.76	.00	.1204	.0204	-.0242	.0004	-.0003	-.0002
-.51	.00	.2057	.0255	-.0185	.0005	-.0004	-.0003
1.81	.00	.2997	.0366	-.0154	.0002	-.0005	-.0003
4.18	.00	.4069	.0565	-.0081	.0000	-.0003	-.0002
6.55	.00	.5289	.0804	.0069	-.0004	-.0007	-.0007
9.06	.00	.6646	.1352	.0264	-.0005	-.0007	.0003
11.51	.00	.7929	.1931	.0506	-.0001	-.0024	-.0005
13.99	-.03	.9288	.2679	.0867	.0007	-.0058	-.0079
1.84	.00	.3092	.0373	-.0151	.0001	-.0005	.0001

RUN 7

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.58	.00	.2978	.0356	-.0147	.0003	-.0004	.0000
-5.11	.00	.0425	.0206	-.0323	.0007	-.0002	.0001
-2.88	.00	.1253	.0200	-.0227	.0005	-.0002	-.0001
-.69	.00	.2060	.0246	-.0176	.0005	-.0002	-.0002
1.56	.00	.2978	.0354	-.0149	.0002	-.0004	-.0001
3.87	.00	.4009	.0549	-.0060	.0000	-.0004	-.0003
6.18	.00	.5119	.0834	.0073	-.0002	-.0004	-.0003
8.48	.00	.6296	.1229	.0223	-.0003	-.0006	.0001
10.84	.00	.7512	.1744	.0415	-.0003	-.0014	-.0002
13.19	-.01	.8679	.2365	.0694	.0002	-.0044	-.0034
15.48	-.01	.9729	.3070	.1082	-.0006	-.0063	-.0062
17.75	-.02	1.0687	.3855	.1532	-.0032	-.0086	-.0091
1.59	.00	.3015	.0357	-.0145	.0002	-.0003	-.0002

RUN 8

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.58	.00	.2988	.0354	-.0146	.0004	-.0002	-.0004
-5.10	.00	.0430	.0206	-.0323	.0007	-.0001	-.0003
-2.88	.00	.1253	.0198	-.0227	.0006	-.0001	-.0002
-.68	.00	.2070	.0242	-.0177	.0007	.0000	-.0007
1.59	.00	.2987	.0355	-.0148	.0003	-.0002	-.0004
3.91	.00	.4078	.0562	-.0059	.0001	-.0002	-.0004
6.19	.00	.5140	.0860	.0102	.0000	-.0002	-.0005
8.48	.00	.6248	.1264	.0295	.0000	-.0003	-.0003
10.83	.00	.7482	.1799	.0504	.0001	-.0009	-.0014
13.21	-.01	.8747	.2455	.0757	.0013	-.0038	-.0043
15.55	-.02	1.0066	.3251	.1095	.0030	-.0067	-.0079
17.90	-.03	1.1277	.4145	.1499	.0007	-.0076	-.0120
1.61	.00	.3027	.0357	-.0146	.0003	-.0002	-.0007

RUN 9

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.61	5.01	.3025	.0368	-.0122	.0064	.0042	-.0227
-5.09	5.01	.0478	.0216	-.0338	.0005	.0047	.0023
-2.86	5.01	.1267	.0208	-.0232	.0023	.0040	-.0062
-.67	5.01	.2085	.0252	-.0183	.0045	.0039	-.0126
1.59	5.01	.3010	.0368	-.0126	.0065	.0041	-.0226
3.90	5.00	.4025	.0562	-.0028	.0091	.0043	-.0347
6.19	5.00	.5128	.0867	.0131	.0110	.0034	-.0442
8.48	5.00	.6794	.1270	.0336	.0128	.0017	-.0556
10.86	4.99	.7543	.1813	.0582	.0149	-.0009	-.0702
13.25	4.98	.8754	.2470	.0859	.0174	-.0045	-.0866
15.57	4.97	1.0102	.3255	.1171	.0187	-.0075	-.1032
15.94	4.97	1.1401	.3958	.1559	.0162	-.0093	-.1180

TABLE AII. - CONTINUED

RUN 10

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.62	10.02	.3141	.0395	-.0023	.0130	.0100	-.0446
-5.09	10.04	.0486	.0246	-.0330	-.0011	.0111	.0083
-2.86	10.03	.1319	.0236	-.0210	.0037	.0099	-.0088
-.66	10.03	.2192	.0279	-.0114	.0086	.0096	-.0250
1.62	10.02	.3128	.0394	-.0026	.0130	.0099	-.0445
3.92	10.01	.4110	.0588	.0098	.0175	.0094	-.0660
6.19	10.01	.5149	.0876	.0274	.0198	.0083	-.0877
8.51	10.00	.6369	.1294	.0507	.0231	.0053	-.1107
10.85	9.99	.7592	.1823	.0806	.0261	-.0001	-.1386
13.11	9.98	.8373	.2353	.1187	.0202	-.0029	-.1571
15.38	9.98	.9394	.3038	.1541	.0168	-.0053	-.1799
1.64	10.02	.3184	.0395	-.0021	.0135	.0099	-.0458

RUN 11

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.50	.00	.2695	.0334	-.0215	.0003	-.0001	.0008
-5.18	.00	.0148	.0369	-.0571	.0007	-.0003	.0003
-2.94	.00	.1045	.0307	-.0439	.0006	-.0002	.0005
-.77	.00	.1862	.0296	-.0324	.0004	-.0002	.0009
1.51	.00	.2671	.0335	-.0219	.0003	-.0001	.0010
3.75	.00	.3470	.0412	-.0142	.0001	-.0003	.0008
5.95	.00	.4274	.0536	-.0081	.0000	-.0004	.0007
8.16	.00	.5127	.0725	-.0023	-.0007	-.0004	.0003
10.43	.00	.5992	.0994	.0058	-.0005	-.0013	-.0016
12.64	-.01	.6712	.1320	.0211	-.0013	-.0039	-.0045
14.86	-.02	.7574	.1757	.0345	-.0003	-.0055	-.0107
17.12	-.02	.8466	.2301	.0514	-.0041	-.0090	-.0079
19.40	-.01	.9423	.2964	.0705	-.0068	-.0097	-.0040
1.50	.00	.2655	.0334	-.0214	.0003	-.0001	.0019

RUN 12

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.68	.00	.2678	.0335	-.0223	.0002	-.0004	-.0009
-5.24	.00	-.0005	.0385	-.0603	.0003	-.0002	-.0005
-2.91	.00	.0940	.0315	-.0460	.0004	-.0002	-.0008
-.64	.00	.1827	.0302	-.0336	.0002	-.0004	-.0008
1.67	.00	.2672	.0339	-.0223	.0002	-.0005	-.0005
3.99	.00	.3509	.0422	-.0142	-.0001	-.0005	-.0010
6.27	.00	.4355	.0554	-.0079	-.0002	-.0005	-.0011
8.55	-.01	.5269	.0762	-.0013	-.0009	-.0005	-.0015
10.89	-.02	.6183	.1057	.0077	-.0011	-.0018	-.0043
13.20	-.04	.6966	.1425	.0263	-.0010	-.0044	-.0098
15.50	-.07	.7946	.1934	.0414	-.0012	-.0070	-.0181
17.86	-.09	.8980	.2577	.0612	-.0025	-.0051	-.0216
20.37	-.07	1.0260	.3459	.0816	-.0072	-.0018	-.0182
1.73	.00	.2805	.0337	-.0208	.0003	-.0004	-.0007

RUN 13

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.52	.00	.2722	.0341	-.0206	.0000	-.0002	.0002
-5.18	.00	.0187	.0370	-.0566	.0006	-.0004	-.0001
-2.93	.00	.1089	.0306	-.0430	.0005	-.0003	-.0001
-.74	.00	.1906	.0301	-.0317	.0002	-.0003	.0001
1.48	.00	.2709	.0337	-.0208	.0000	-.0003	.0003
3.72	.00	.3489	.0418	-.0134	-.0001	-.0004	-.0001
5.93	.00	.4291	.0543	-.0074	-.0003	-.0006	-.0003
8.15	.00	.5155	.0735	-.0015	-.0009	-.0007	-.0013
10.38	-.01	.6031	.0995	.0234	-.0009	-.0013	-.0033
12.59	-.01	.6606	.1291	.0045	.0051	.0047	-.0064
14.70	-.03	.7185	.1667	.0458	-.0011	-.0072	-.0133
16.92	-.03	.7561	.2157	.0627	-.0034	-.0100	-.0131
19.20	-.02	.8957	.2802	.0818	-.0052	-.0075	-.0077
1.49	.00	.2667	.0337	-.0208	.0002	-.0002	.0005

TABLE AII. - CONTINUED

RUN 14

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.68	.00	.2722	.0345	-.0208	.0003	-.0005	-.0007
-5.19	.00	.0069	.0385	-.0586	.0004	-.0003	.0002
-2.89	.00	.1000	.0316	-.0450	.0004	-.0003	-.0001
-.62	.00	.1871	.0306	-.0326	.0003	-.0005	-.0004
1.65	.00	.2709	.0347	-.0211	.0001	-.0005	-.0002
3.97	.00	.3538	.0433	-.0133	-.0002	-.0005	-.0005
6.25	.00	.4393	.0567	-.0065	-.0003	-.0006	-.0001
8.55	-.01	.5318	.0779	-.0003	-.0008	-.0007	-.0016
10.87	-.02	.6254	.1064	.0068	-.0014	-.0013	-.0044
13.04	-.04	.6653	.1373	.0335	-.0022	-.0037	-.0096
15.30	-.08	.7459	.1822	.0541	-.0022	-.0083	-.0190
17.65	-.09	.8493	.2628	.0739	-.0029	-.0092	-.0228
20.10	-.10	.9731	.2247	.0898	-.0060	-.0033	-.0245
1.70	.00	.2763	.0346	-.0203	.0001	-.0006	-.0002

RUN 15

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	.00	.1317	.0177	.0081	.0006	-.0002	-.0002
-5.62	.00	-.1480	.0381	-.0265	.0006	-.0005	-.0007
-3.39	.00	-.0541	.0252	-.0131	.0010	-.0004	-.0011
-1.15	.00	.0403	.0188	-.0020	.0008	-.0003	-.0008
1.14	.00	.1297	.0180	.0080	.0006	-.0003	-.0002
3.37	.00	.2125	.0212	.0159	.0004	-.0003	-.0006
5.56	.00	.2915	.0291	.0222	.0001	-.0004	-.0011
7.75	.00	.3741	.0413	.0287	.0000	-.0007	-.0016
10.00	-.01	.4600	.0609	.0348	-.0003	-.0014	-.0039
12.25	-.02	.5467	.0878	.0419	-.0008	-.0029	-.0085
14.42	-.03	.6063	.1177	.0643	-.0041	-.0059	-.0118
16.53	-.02	.6585	.1567	.0909	-.0035	-.0081	-.0107
19.82	-.02	.7580	.2140	.1094	-.0059	-.0084	-.0072
1.10	.00	.1313	.0175	.0082	.0005	-.0002	-.0005

RUN 16

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.10	.00	.1304	.0170	.0079	.0005	.0000	-.0002
-5.61	.00	-.1479	.0377	-.0262	.0008	-.0004	-.0008
-5.61	.00	-.1481	.0376	-.0263	.0008	-.0004	-.0006
-3.37	.00	-.0532	.0247	-.0130	.0010	-.0003	-.0010
-1.13	.00	.0424	.0185	-.0017	.0008	-.0002	-.0009
1.09	.00	.1278	.0174	.0077	.0006	-.0001	-.0004
3.36	.00	.2120	.0202	.0152	.0004	-.0001	-.0008
5.57	.00	.2920	.0280	.0216	.0001	-.0003	-.0010
7.74	.00	.3739	.0399	.0281	.0000	-.0005	-.0014
10.01	-.01	.4600	.0600	.0357	-.0003	-.0015	-.0039
12.25	-.02	.5427	.0877	.0449	-.0016	-.0030	-.0067
14.43	-.03	.6190	.1229	.0629	-.0005	-.0044	-.0116
16.67	-.02	.7002	.1686	.0820	-.0044	-.0082	-.0092
18.93	-.01	.7573	.2276	.1017	-.0060	-.0090	-.0056
1.14	.00	.1336	.0173	.0082	.0006	.0000	-.0005

RUN 17

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.14	5.03	.1334	.0194	.0069	.0023	.0082	.0014
-5.60	5.05	-.1436	.0407	-.0263	-.0035	.0108	.0332
-3.36	5.04	-.0474	.0271	-.0135	-.0007	.0101	.0209
-1.13	5.03	.0464	.0205	-.0028	.0007	.0094	.0107
1.10	5.03	.1319	.0194	.0066	.0022	.0082	.0016
3.37	5.03	.2143	.0229	.0146	.0041	.0070	-.0053
5.60	5.04	.2954	.0302	.0224	.0055	.0065	-.0104
7.78	5.04	.3795	.0428	.0300	.0069	.0073	-.0177
10.03	5.03	.4673	.0639	.0389	.0095	.0083	-.0297
12.26	5.00	.5455	.0913	.0540	.0139	.0078	-.0467
14.44	4.98	.6236	.1279	.0729	.0146	.0047	-.0632
16.73	4.98	.7188	.1762	.0895	.0116	.0049	-.0726
19.00	4.99	.8190	.2368	.1072	.0071	.0063	-.0789

TABLE AII. - CONTINUED

RUN 18

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	10.07	.1384	.0248	.0073	.0036	.0186	.0057
-5.57	10.10	-.1319	.0471	-.0274	-.0072	.0236	.0665
-3.32	10.08	-.0331	.0335	-.0146	-.0029	.0214	.0431
-1.11	10.07	.0565	.0262	-.0032	-.0001	.0198	.0219
1.10	10.07	.1362	.0248	.0072	.0035	.0184	.0059
3.39	10.07	.2220	.0287	.0180	.0075	.0178	-.0082
5.65	10.07	.3063	.0377	.0283	.0116	.0182	-.0240
7.83	10.05	.3974	.0533	.0397	.0161	.0206	-.0464
10.08	10.02	.4856	.0735	.0547	.0221	.0201	-.0769
12.35	10.01	.5776	.1055	.0720	.0234	.0189	-.0990
14.57	10.00	.6648	.1448	.0889	.0205	.0174	-.1193
16.84	10.00	.7613	.1950	.1101	.0186	.0186	-.1376
19.11	9.98	.8593	.2554	.1351	.0137	.0153	-.1627
1.12	10.06	.1378	.0245	.0075	.0036	.0184	.0039

RUN 19

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.11	.00	.1302	.0164	.0094	.0007	-.0002	-.0007
-5.62	.00	-.1480	.0377	-.0250	.0008	-.0002	-.0004
-3.37	.00	-.0545	.0247	-.0108	.0008	-.0002	-.0004
-1.14	.00	.0405	.0182	.0008	.0009	-.0001	-.0006
1.11	.00	.1293	.0167	.0094	.0007	-.0001	-.0006
3.37	.00	.2106	.0202	.0167	.0003	-.0002	-.0006
5.56	.00	.2892	.0279	.0235	.0002	-.0003	-.0007
7.79	.00	.3742	.0405	.0304	.0002	-.0008	-.0015
10.02	-.01	.4585	.0606	.0386	-.0003	-.0015	-.0032
12.27	-.02	.5463	.0898	.0493	-.0010	-.0037	-.0083
14.46	-.03	.6217	.1250	.0680	-.0004	-.0049	-.0109
16.66	-.01	.7000	.1710	.0894	-.0045	-.0055	-.0062
19.95	.01	.7964	.2321	.1134	-.0086	-.0053	.0060
1.12	.00	.1331	.0160	.0099	.0006	-.0002	.0005

RUN 20

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	.00	.1320	.0172	.0097	.0007	-.0003	-.0001
-5.61	.00	-.1460	.0378	-.0243	.0008	-.0002	.0001
-3.36	.00	-.0540	.0253	-.0103	.0010	-.0002	-.0002
-1.13	.00	.0411	.0187	.0010	.0008	-.0002	-.0001
1.14	.00	.1300	.0174	.0096	.0007	-.0002	.0000
3.36	.00	.2097	.0211	.0171	.0004	-.0003	-.0001
5.59	.00	.2900	.0292	.0242	.0001	-.0005	-.0004
7.77	.00	.3725	.0416	.0309	.0002	-.0008	-.0011
10.01	-.01	.4592	.0616	.0380	-.0002	-.0017	-.0035
12.29	-.02	.5491	.0898	.0466	-.0004	-.0031	-.0093
14.43	-.02	.6072	.1201	.0697	-.0040	-.0037	-.0096
16.58	-.02	.6612	.1607	.0987	-.0038	-.0043	-.0078
19.84	.01	.7554	.2187	.1206	-.0078	-.0043	.0037
1.10	.00	.1313	.0170	.0099	.0006	-.0003	.0005

RUN 21

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	.00	.1309	.0170	.0097	.0007	-.0003	-.0003
-5.62	.00	-.1493	.0378	-.0247	.0010	-.0002	-.0003
-3.38	.00	-.0552	.0247	-.0110	.0011	-.0003	-.0003
-1.14	.00	.0404	.0182	.0004	.0010	-.0003	-.0004
1.11	.00	.1258	.0170	.0096	.0007	-.0003	-.0002
3.37	.00	.2107	.0207	.0173	.0004	-.0004	-.0004
5.57	.00	.2900	.0284	.0243	.0003	-.0005	-.0008
7.77	.00	.3756	.0410	.0307	.0002	-.0008	-.0016
10.04	-.01	.4664	.0621	.0361	.0000	-.0015	-.0041
12.29	-.02	.5486	.0892	.0480	-.0012	-.0029	-.0093
14.45	-.02	.6172	.1237	.0723	-.0027	-.0037	-.0101
16.68	-.02	.6956	.1725	.0994	-.0034	-.0058	-.0073
19.02	-.01	.8186	.2426	.1229	-.0059	-.0032	-.0027
1.13	.00	.1328	.0166	.0099	.0006	-.0003	.0001

RUN 22

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.12	.00	.1320	.0162	.0097	.0007	-.0001	-.0004
-5.63	.00	-.1480	.0372	-.0245	.0010	-.0001	-.0006
-3.39	.00	-.0537	.0242	-.0108	.0012	-.0002	-.0007
-1.15	.00	.0416	.0176	.0008	.0009	-.0002	-.0004
1.10	.00	.1296	.0163	.0095	.0007	-.0001	-.0004
3.38	.00	.2116	.0199	.0170	.0003	-.0002	-.0002
5.57	.00	.2898	.0274	.0235	.0002	-.0004	-.0009
7.79	.00	.3748	.0398	.0301	.0000	-.0009	-.0016
10.01	-.01	.4621	.0605	.0374	-.0002	-.0014	-.0031
12.27	-.02	.5414	.0892	.0526	-.0005	-.0048	-.0093
14.51	-.03	.6435	.1338	.0668	-.0002	-.0034	-.0114
16.81	-.02	.7453	.1890	.0869	-.0044	-.0050	-.0066
19.16	.00	.8666	.2626	.1121	-.0076	-.0021	-.0006
1.12	.00	.1328	.0162	.0099	.0007	-.0002	-.0006

RUN 23

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.15	.00	.1265	.0170	.0077	.0006	-.0002	-.0004
-5.60	.00	-.1489	.0373	-.0266	.0008	-.0003	-.0006
-3.33	.00	-.0448	.0245	-.0131	.0011	-.0002	-.0001
-1.12	.00	.0461	.0185	-.0021	.0010	-.0002	.0000
1.13	.00	.1265	.0168	.0076	.0006	-.0003	-.0004
3.38	.00	.2112	.0201	.0153	.0004	-.0002	-.0004
5.59	.00	.2895	.0275	.0217	.0002	-.0003	-.0010
7.82	.00	.3799	.0413	.0281	.0000	-.0005	-.0006
10.01	-.01	.4580	.0595	.0344	-.0002	-.0013	-.0029
12.28	-.01	.5386	.0872	.0478	-.0015	-.0040	-.0058
14.53	-.02	.6394	.1298	.0598	-.0006	-.0058	-.0059
16.78	-.02	.7388	.1829	.0754	-.0035	-.0069	-.0107
19.10	-.02	.8453	.2457	.0934	-.0067	-.0058	-.0068
1.15	.00	.1304	.0167	.0083	.0006	-.0001	.0004

RUN 24

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.15	.00	.1299	.0177	.0081	.0005	-.0003	-.0004
-5.59	.00	-.1490	.0379	-.0270	.0008	-.0004	-.0005
-3.32	.00	-.0557	.0249	-.0137	.0008	-.0005	-.0007
-1.14	.00	.0381	.0187	-.0024	.0007	-.0004	-.0004
1.15	.00	.1274	.0179	.0076	.0005	-.0003	-.0002
3.39	.00	.2106	.0213	.0156	.0002	-.0003	-.0004
5.60	.00	.2901	.0290	.0220	.0001	-.0004	-.0012
7.78	.00	.3733	.0411	.0284	-.0001	-.0007	-.0017
10.04	-.01	.4632	.0613	.0334	-.0006	-.0012	-.0036
12.28	-.02	.5467	.0874	.0432	-.0019	-.0033	-.0080
14.45	-.02	.6130	.1206	.0657	-.0032	-.0061	-.0088
16.66	-.02	.6901	.1673	.0896	-.0034	-.0075	-.0105
18.95	-.02	.7928	.2243	.1083	-.0055	-.0070	-.0072
1.13	.00	.1269	.0177	.0080	.0004	-.0003	-.0002

RUN 25

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.10	.00	.1180	.0141	.0139	.0009	-.0001	-.0007
-5.66	.00	-.1750	.0377	-.0094	.0011	.0001	-.0007
-3.36	.00	-.0600	.0244	.0022	.0014	.0001	.0007
-1.16	.00	.0277	.0176	.0097	.0010	-.0002	-.0003
1.11	.00	.1213	.0145	.0138	.0008	-.0001	-.0003
3.37	.00	.2013	.0171	.0176	.0005	-.0003	-.0005
5.56	.00	.2736	.0246	.0256	.0004	-.0003	-.0010
7.74	.00	.3542	.0378	.0347	.0005	-.0003	-.0016
10.02	-.01	.4466	.0586	.0421	.0007	-.0013	-.0031
12.29	-.02	.5455	.0917	.0553	.0009	-.0031	-.0085
14.52	-.03	.6333	.1310	.0782	.0004	-.0053	-.0128
16.75	-.03	.7164	.1786	.0996	-.0021	-.0077	-.0139
19.08	.00	.8283	.2474	.1225	-.0068	-.0052	.0006
1.11	.00	.1194	.0138	.0139	.0008	-.0001	-.0003

TABLE AII. - CONTINUED

RUN 26

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.11	.00	.1205	.0148	.0140	.0007	-.0002	.0000
-5.66	.00	-.1739	.0381	-.0100	.0011	-.0001	-.0001
-3.42	.00	-.0806	.0248	.0021	.0013	-.0002	-.0004
-1.18	.00	.0200	.0172	.0100	.0008	-.0004	-.0001
1.13	.00	.1188	.0149	.0139	.0007	-.0004	-.0001
3.36	.00	.2032	.0182	.0176	.0005	-.0004	.0000
5.57	.00	.2786	.0260	.0245	.0002	-.0004	-.0008
7.76	.00	.3613	.0389	.0323	.0003	-.0006	-.0010
10.04	-.01	.4539	.0592	.0402	.0003	-.0013	-.0022
12.32	-.02	.5565	.0903	.0497	.0006	-.0033	-.0075
14.57	-.03	.6489	.1288	.0677	.0002	-.0071	-.0115
16.84	-.03	.7460	.1780	.0848	-.0023	-.0085	-.0128
19.15	-.01	.8535	.2439	.1061	-.0060	-.0046	-.0027

RUN 27

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.55	.00	.2734	.0321	-.0188	.0004	-.0004	.0003
-5.20	.00	-.0021	.0356	-.0416	.0009	-.0002	.0003
-2.97	.00	.0862	.0290	-.0304	.0006	-.0002	.0003
-.74	.00	.1799	.0278	-.0229	.0007	-.0004	.0002
1.55	.00	.2701	.0319	-.0186	.0005	-.0005	.0005
3.79	.00	.3503	.0413	-.0134	.0001	-.0004	.0004
5.99	.00	.4317	.0541	-.0083	-.0001	-.0005	.0002
8.18	.00	.5178	.0729	-.0012	.0001	-.0007	-.0010
10.46	.00	.6075	.0995	.0076	-.0007	-.0015	-.0015
12.77	-.02	.7135	.1389	.0195	-.0001	-.0043	-.0071
14.95	-.02	.7892	.1820	.0400	-.0015	-.0051	-.0096
17.22	-.02	.8827	.2377	.0606	-.0029	-.0071	-.0137
19.51	-.01	.9841	.3097	.0835	-.0040	-.0037	-.0036
1.54	.00	.2748	.0320	-.0185	.0005	-.0004	.0005

RUN 28

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.53	.00	.2712	.0305	-.0190	.0004	-.0003	-.0004
-5.20	.00	-.0026	.0346	-.0415	.0009	.0000	-.0007
-2.97	.00	.0870	.0279	-.0305	.0007	-.0001	-.0004
-.75	.00	.1796	.0264	-.0235	.0006	-.0002	-.0004
1.54	.00	.2701	.0305	-.0191	.0004	-.0003	-.0003
3.78	.00	.3469	.0394	-.0140	.0002	-.0003	-.0007
5.98	.00	.4297	.0518	-.0080	.0000	-.0004	-.0009
8.18	.00	.5135	.0713	.0000	-.0001	-.0006	-.0009
10.45	.00	.6045	.0995	.0101	-.0007	-.0014	-.0020
12.76	-.02	.7106	.1426	.0250	-.0003	-.0040	-.0078
14.95	-.03	.7846	.1868	.0505	-.0002	-.0053	-.0115
17.20	-.03	.8782	.2455	.0702	-.0032	-.0078	-.0129
19.52	.00	.9876	.3220	.0930	-.0072	-.0041	.0012
1.55	.00	.2722	.0304	-.0188	.0005	-.0003	.0000

RUN 29

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.14	5.02	.1225	.0161	.0131	.0013	.0051	-.0012
-5.65	5.03	-.1671	.0398	-.0107	-.0035	.0085	.0302
-3.40	5.03	-.0731	.0256	.0012	-.0015	.0076	.0185
-1.19	5.02	.0258	.0191	.0087	-.0006	.0064	.0081
1.11	5.02	.1203	.0160	.0130	.0012	.0051	-.0010
3.39	5.02	.2047	.0194	.0193	.0054	.0048	-.0087
5.58	5.02	.2835	.0273	.0274	.0070	.0055	-.0149
7.79	5.02	.3673	.0405	.0369	.0070	.0065	-.0233
10.03	5.01	.4593	.0626	.0477	.0083	.0069	-.0362
12.31	4.99	.5529	.0931	.0628	.0122	.0071	-.0534
14.54	4.97	.6429	.1342	.0841	.0117	.0052	-.0717
16.82	4.96	.7471	.1915	.1057	.0072	.0018	-.0746
19.14	5.01	.8499	.2560	.1299	.0034	.0063	-.0741
1.17	5.02	.1718	.0158	.0132	.0015	.0051	-.0022

TABLE AII. - CONTINUED

RUN 30

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.13	10.05	.1253	.0202	.0151	.0023	.0129	.0005
-5.60	10.08	-.1488	.0442	-.0138	-.0073	.0179	.0611
-3.35	10.06	-.0528	.0296	-.0024	-.0046	.0161	.0382
-1.12	10.06	.0364	.0223	.0057	-.0027	.0141	.0183
1.15	10.05	.1257	.0204	.0150	.0023	.0130	.0005
3.42	10.05	.2172	.0241	.0246	.0085	.0129	-.0174
5.65	10.04	.3048	.0334	.0354	.0124	.0138	-.0353
7.85	10.03	.3940	.0485	.0482	.0150	.0164	-.0554
10.11	10.00	.4847	.0701	.0650	.0188	.0172	-.0856
12.41	9.98	.5812	.1036	.0813	.0214	.0165	-.1117
14.66	9.97	.6827	.1476	.1010	.0201	.0160	-.1328
16.92	9.99	.7812	.2038	.1251	.0145	.0175	-.1428
19.25	10.00	.8697	.2768	.1544	.0093	.0155	-.1593
1.14	10.05	.1266	.0201	.0154	.0025	.0130	-.0005

RUN 31

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.09	.00	.1009	.0171	.0146	.0008	-.0002	-.0003
-5.70	.00	-.1864	.0438	-.0103	.0009	.0001	-.0004
-3.47	.00	-.0975	.0296	.0025	.0010	.0000	-.0005
-1.23	.00	-.0011	.0210	.0106	.0009	-.0001	-.0003
1.05	.00	.0980	.0171	.0146	.0008	-.0002	-.0003
3.35	.00	.1929	.0188	.0166	.0006	-.0001	-.0002
5.57	.00	.2740	.0264	.0211	.0002	-.0005	.0008
7.74	.00	.3500	.0420	.0307	.0002	-.0001	-.0005
9.93	.00	.4210	.0585	.0441	-.0001	-.0008	-.0020
12.23	-.03	.5148	.0832	.0542	.0024	-.0027	-.0111
14.44	-.04	.6037	.1207	.0716	.0029	-.0057	-.0175
16.74	-.04	.7002	.1673	.0868	-.0028	-.0075	-.0179
18.96	.01	.7844	.2194	.1069	-.0070	-.0066	.0043
1.09	.00	.1008	.0167	.0151	.0009	-.0003	.0005

RUN 32

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.08	.00	.0997	.0181	.0147	.0008	-.0003	.0000
-5.69	.00	-.1874	.0445	-.0108	.0010	.0000	.0000
-3.44	.00	-.0974	.0302	.0021	.0011	-.0002	-.0004
-1.22	.00	-.0015	.0216	.0103	.0009	-.0002	.0000
1.07	.00	.0974	.0183	.0145	.0008	-.0003	.0000
3.33	.00	.1910	.0201	.0166	.0006	-.0003	.0001
5.57	.00	.2758	.0278	.0203	.0000	-.0002	.0001
7.75	.00	.3552	.0424	.0282	-.0001	-.0003	-.0005
10.01	.00	.4345	.0593	.0384	.0001	-.0010	-.0022
12.25	-.02	.5226	.0822	.0495	.0019	-.0035	-.0105
14.50	-.04	.6225	.1195	.0613	.0027	-.0071	-.0164
16.77	-.04	.7232	.1651	.0741	-.0023	-.0076	-.0169
19.04	.00	.8119	.2175	.0914	-.0057	-.0056	.0003
1.09	.00	.1010	.0181	.0148	.0008	-.0004	-.0003

RUN 33

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.52	.00	.2618	.0347	-.0204	.0008	-.0004	-.0004
-5.24	.00	-.0152	.0410	-.0436	.0010	-.0002	-.0001
-3.00	.00	.0723	.0334	-.0318	.0008	-.0002	.0001
-.78	.00	.1642	.0313	-.0241	.0008	-.0004	.0000
1.53	.00	.2602	.0347	-.0207	.0007	-.0005	-.0003
3.77	.00	.3471	.0428	-.0171	.0002	-.0004	.0003
5.97	.00	.4256	.0561	-.0125	-.0001	-.0003	.0001
8.20	.00	.5158	.0763	-.0063	-.0004	-.0005	-.0002
10.43	.00	.5857	.0965	.0065	-.0002	-.0011	-.0018
12.69	-.02	.6745	.1275	.0175	.0015	-.0038	-.0103
14.94	-.04	.7713	.1710	.0304	.0016	-.0075	-.0156
17.20	-.03	.8652	.2230	.0470	-.0047	-.0075	-.0133
19.40	.00	.9412	.2796	.0675	-.0044	-.0042	-.0020
1.52	.00	.2636	.0346	-.0205	.0007	-.0005	-.0001

RUN 34

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.51	.00	.2615	.0329	-.0208	.0007	-.0003	-.0008
-5.24	.00	-.0167	.0402	-.0430	.0011	.0001	-.0008
-3.00	.00	.0716	.0323	-.0317	.0009	-.0001	-.0008
-.79	.00	.1638	.0297	-.0246	.0009	-.0002	-.0006
1.51	.00	.2587	.0329	-.0209	.0007	-.0003	-.0008
3.76	.00	.3457	.0408	-.0177	.0004	-.0005	.0001
5.96	.00	.4225	.0536	-.0119	-.0001	-.0006	.0004
8.18	.00	.5091	.0743	-.0046	-.0003	-.0004	-.0006
10.39	-.01	.5789	.0958	.0090	.0003	-.0011	-.0026
12.65	-.03	.6676	.1280	.0213	.0019	-.0036	-.0117
14.90	-.04	.7589	.1735	.0392	.0017	-.0052	-.0189
17.13	-.04	.8535	.2278	.0559	-.0056	-.0073	-.0151
19.37	.01	.9287	.2860	.0772	-.0076	-.0057	.0042
1.51	.00	.2614	.0328	-.0209	.0007	-.0003	-.0007

RUN 35

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.09	5.03	.1052	.0191	.0128	.0003	.0059	.0026
-5.67	5.04	-.1797	.0464	-.0119	-.0035	.0093	.0340
-3.46	5.03	-.0881	.0315	-.0004	-.0019	.0083	.0222
-1.22	5.03	.0052	.0226	.0088	-.0013	.0073	.0121
1.07	5.03	.1043	.0190	.0129	.0003	.0059	.0028
3.34	5.02	.1919	.0217	.0178	.0036	.0055	-.0066
5.58	5.02	.2770	.0302	.0244	.0069	.0055	-.0144
7.75	5.03	.3572	.0446	.0343	.0069	.0045	-.0178
9.99	5.03	.4353	.0641	.0481	.0069	.0039	-.0261
12.25	5.02	.5181	.0893	.0630	.0057	.0051	-.0381
14.44	5.00	.6084	.1200	.0768	.0096	.0038	-.0556
16.73	5.00	.6970	.1637	.0942	.0085	.0059	-.0616
19.01	5.04	.8042	.2301	.1125	.0044	.0097	-.0537
1.08	5.03	.1051	.0189	.0131	.0004	.0059	.0023

RUN 36

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.11	10.06	.1139	.0246	.0127	.0011	.0140	.0070
-5.61	10.09	-.1580	.0520	-.0162	-.0077	.0194	.0690
-3.40	10.08	-.0658	.0365	-.0049	-.0042	.0180	.0461
-1.16	10.07	.0280	.0272	.0034	-.0021	.0159	.0248
1.11	10.06	.1133	.0247	.0126	.0010	.0139	.0071
3.37	10.06	.1999	.0271	.0219	.0059	.0132	-.0105
5.62	10.05	.2913	.0357	.0309	.0110	.0131	-.0273
7.83	10.06	.3772	.0504	.0430	.0134	.0132	-.0416
10.05	10.05	.4597	.0726	.0593	.0133	.0116	-.0594
12.30	10.03	.5446	.1013	.0782	.0136	.0137	-.0822
14.53	10.03	.6358	.1383	.0945	.0115	.0181	-.0984
16.81	10.04	.7455	.1874	.1070	.0140	.0243	-.1169
19.13	10.04	.8484	.2489	.1323	.0099	.0266	-.1351
1.11	10.06	.1154	.0247	.0129	.0011	.0141	.0066

RUN 37

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.13	.00	.1237	.0162	.0204	.0011	-.0002	-.0004
-5.68	.00	-.1819	.0386	-.0022	.0009	.0001	-.0002
-3.42	.00	-.0830	.0248	.0094	.0012	.0000	-.0002
-1.15	.00	.0204	.0176	.0171	.0011	.0000	-.0004
1.13	.00	.1230	.0164	.0205	.0010	-.0002	-.0002
3.42	.00	.2134	.0209	.0259	.0010	-.0003	-.0002
5.61	.00	.2956	.0316	.0357	.0007	-.0003	-.0006
7.82	.00	.3742	.0452	.0504	.0001	-.0004	-.0011
10.14	.00	.4840	.0798	.0751	.0005	-.0014	-.0012
12.49	-.01	.6022	.1269	.1028	.0012	-.0037	-.0064
14.77	-.03	.7190	.1836	.1367	.0018	-.0068	-.0120
17.17	-.02	.8659	.2632	.1650	-.0012	-.0068	-.0143
19.70	-.07	1.0474	.3740	.1909	-.0058	-.0065	-.0078
1.14	.00	.1244	.0158	.0206	.0011	-.0002	.0005

TABLE AII. - CONTINUED

RUN 38

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.14	.00	.1256	.0167	.0207	.0009	-.0003	-.0001
-5.67	.00	-.1797	.0388	-.0033	.0010	-.0002	.0002
-3.42	.00	-.0625	.0255	.0089	.0012	-.0002	.0000
-1.19	.00	.0197	.0183	.0166	.0010	-.0002	.0000
1.14	.00	.1241	.0170	.0206	.0009	-.0003	.0000
3.40	.00	.2151	.0214	.0254	.0009	-.0003	-.0002
5.62	.00	.2962	.0317	.0345	.0005	-.0004	-.0006
7.81	.00	.3817	.0451	.0467	.0002	-.0004	-.0011
10.17	.00	.4941	.0777	.0696	.0002	-.0014	-.0010
12.51	-.01	.6190	.1230	.0940	.0013	-.0040	-.0065
14.83	-.02	.7467	.1801	.1227	.0013	-.0067	-.0118
17.26	-.03	.8935	.2581	.1521	-.0020	-.0088	-.0145
19.67	-.03	1.0406	.3519	.1809	-.0046	-.0063	-.0111
1.14	.00	.1263	.0168	.0207	.0008	-.0003	.0000

RUN 39

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.56	.00	.2812	.0342	-.0126	.0007	-.0005	.0004
-5.24	.00	-.0123	.0359	-.0351	.0008	-.0002	.0003
-2.98	.00	.0828	.0294	-.0229	.0007	-.0003	.0004
-.73	.00	.1833	.0288	-.0167	.0008	-.0003	.0003
1.55	.00	.2798	.0341	-.0127	.0007	-.0005	.0005
3.87	.00	.3667	.0458	-.0060	.0004	-.0004	-.0001
6.04	.00	.4531	.0603	.0034	.0000	-.0003	-.0004
8.29	.00	.5470	.0799	.0119	.0000	-.0005	-.0006
10.63	.00	.6715	.1250	.0361	.0002	-.0017	-.0011
13.00	-.02	.7973	.1803	.0627	.0008	-.0042	-.0069
15.32	-.02	.9182	.2454	.0944	-.0002	-.0070	-.0107
17.67	-.03	1.0390	.3232	.1314	-.0040	-.0088	-.0119
20.01	-.03	1.1580	.4157	.1666	-.0050	-.0062	-.0114
1.56	.00	.2828	.0342	-.0122	.0007	-.0004	.0003

RUN 40

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.55	.00	.2781	.0329	-.0126	.0010	-.0003	-.0002
-5.21	.00	-.0124	.0350	-.0348	.0008	.0000	-.0002
-2.97	.00	.0816	.0284	-.0229	.0009	-.0001	-.0003
-.72	.00	.1846	.0279	-.0168	.0010	-.0002	.0002
1.54	.00	.2783	.0331	-.0125	.0010	-.0004	-.0001
3.80	.00	.3633	.0448	-.0057	.0007	-.0005	-.0001
6.02	.00	.4459	.0591	.0055	.0002	-.0003	-.0008
8.26	.00	.5375	.0784	.0144	.0001	-.0004	-.0016
10.62	.00	.6636	.1286	.0411	.0001	-.0016	-.0011
13.00	-.02	.7875	.1867	.0700	.0010	-.0042	-.0076
15.30	-.03	.9118	.2553	.1038	.0015	-.0070	-.0131
17.69	-.03	1.0461	.3414	.1407	-.0026	-.0088	-.0121
20.17	-.02	1.2151	.4577	.1718	-.0055	-.0059	-.0056
1.57	.00	.2817	.0330	-.0121	.0010	-.0003	-.0001

RUN 41

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.15	5.02	.1270	.0175	.0200	.0009	.0041	.0000
-5.65	5.03	-.1679	.0392	-.0066	-.0040	.0064	.0297
-3.40	5.03	-.0761	.0258	.0068	-.0037	.0054	.0187
-1.16	5.02	.0244	.0185	.0148	-.0017	.0047	.0088
1.14	5.02	.1250	.0174	.0198	.0009	.0041	.0000
3.38	5.02	.2135	.0228	.0277	.0048	.0042	-.0077
5.61	5.02	.2960	.0335	.0419	.0076	.0040	-.0154
7.84	5.00	.3918	.0529	.0596	.0087	.0054	-.0327
10.10	4.97	.4887	.0783	.0795	.0100	.0059	-.0565
12.50	4.94	.6121	.1259	.1098	.0134	.0052	-.0796
14.82	4.94	.7440	.1897	.1418	.0128	-.0029	-.0906
17.20	4.94	.8777	.2670	.1730	.0083	-.0059	-.1061
19.72	4.96	1.0618	.3772	.1961	.0050	-.0054	-.1123
1.13	5.02	.1257	.0175	.0201	.0012	.0040	-.0005

TABLE AII. - CONTINUED

RUN 42

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.15	10.05	.1320	.0217	.0262	.0018	.0109	-.0005
-5.60	10.07	-.1457	.0424	-.0114	-.0083	.0145	.0570
-3.35	10.06	-.0558	.0290	.0027	-.0068	.0130	.0362
-1.12	10.05	.0405	.0222	.0129	-.0038	.0114	.0171
1.15	10.05	.1322	.0217	.0262	.0016	.0112	-.0005
3.44	10.04	.2302	.0286	.0415	.0082	.0112	-.0218
5.70	10.03	.3308	.0426	.0603	.0128	.0115	-.0461
7.94	10.00	.4271	.0632	.0793	.0154	.0112	-.0734
10.22	9.96	.5277	.0900	.1054	.0177	.0095	-.1112
12.56	9.91	.6431	.1280	.1292	.0230	.0078	-.1527
14.90	9.92	.7676	.1918	.1583	.0175	.0017	-.1708
17.29	9.95	.9127	.2764	.1868	.0112	.0029	-.1836
19.80	9.97	1.0829	.3779	.2110	.0052	-.0015	-.2114
1.17	10.05	.1341	.0216	.0270	.0019	.0110	-.0008

RUN 43

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.04	.00	.0861	.0283	.0208	.0007	.0002	-.0005
-5.79	.00	-.2183	.0599	-.0126	.0009	.0001	-.0002
-3.54	.00	-.1222	.0433	.0013	.0010	.0000	-.0007
-1.28	.00	-.0193	.0325	.0121	.0007	.0000	-.0006
1.03	.00	.0845	.0283	.0208	.0008	.0002	-.0007
3.33	.00	.1851	.0312	.0288	.0008	.0000	-.0003
5.57	.00	.2812	.0408	.0371	.0003	-.0002	-.0003
7.79	.00	.3711	.0555	.0473	.0002	-.0003	-.0007
10.06	-.01	.4580	.0752	.0635	.0002	-.0008	-.0029
12.28	-.02	.5361	.0965	.0808	.0010	-.0030	-.0094
14.44	-.04	.6065	.1202	.1023	.0010	-.0053	-.0153
16.83	-.02	.7440	.1872	.1380	-.0014	-.0086	-.0096
19.28	.00	.9039	.2745	.1653	-.0077	-.0062	.0003
1.03	.00	.0851	.0279	.0211	.0008	.0001	-.0003

RUN 44

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.03	.00	.0848	.0279	.0210	.0008	-.0001	-.0003
-5.79	.00	-.2175	.0604	-.0135	.0007	-.0001	.0001
-3.53	.00	-.1222	.0438	.0011	.0009	-.0002	-.0003
-1.29	.00	-.0231	.0330	.0132	.0009	-.0001	-.0002
1.03	.00	.0843	.0282	.0209	.0008	-.0001	-.0002
3.32	.00	.1878	.0305	.0270	.0008	-.0001	-.0003
5.60	.00	.2874	.0393	.0341	.0000	-.0002	-.0003
7.83	.00	.3823	.0540	.0428	-.0003	-.0004	-.0008
10.08	-.01	.4705	.0734	.0568	-.0002	-.0012	-.0028
12.33	-.02	.5552	.0964	.0719	.0006	-.0032	-.0081
14.54	-.03	.6362	.1221	.0915	.0002	-.0052	-.0143
16.86	-.02	.7550	.1822	.1334	-.0018	-.0079	-.0092
19.31	-.01	.9155	.2668	.1592	-.0056	-.0054	-.0030
1.04	.00	.0881	.0280	.0213	.0007	-.0002	-.0002

RUN 45

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.49	.00	.2541	.0437	-.0125	.0006	-.0002	-.0001
-5.28	.00	-.0386	.0541	-.0450	.0006	-.0002	.0001
-3.05	.00	.0541	.0452	-.0305	.0005	-.0002	.0001
-.84	.00	.1499	.0413	-.0200	.0005	-.0002	.0001
1.56	.00	.2534	.0437	-.0124	.0005	-.0002	-.0002
3.76	.00	.3529	.0532	-.0065	.0001	-.0003	.0000
6.05	.00	.4537	.0694	-.0003	-.0005	-.0003	.0000
8.27	.00	.5430	.0896	.0123	-.0006	-.0005	-.0007
10.52	-.01	.6311	.1143	.0256	-.0005	-.0011	-.0027
12.78	-.02	.7189	.1419	.0400	.0004	-.0033	-.0051
14.98	-.03	.7948	.1728	.0644	-.0009	-.0034	-.0127
17.24	-.02	.9276	.2486	.1092	-.0029	-.0063	-.0085
19.68	-.01	1.0490	.3284	.1457	-.0052	-.0040	-.0047
1.50	.00	.2572	.0437	-.0124	.0005	-.0003	-.0004

RUN 46

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.48	.00	.2490	.0436	-.0119	.0007	.0001	-.0012
-5.29	.00	-.0409	.0536	-.0450	.0009	.0000	-.0009
-3.05	.00	.0546	.0444	-.0316	.0008	.0001	-.0010
-.85	.00	.1509	.0409	-.0208	.0007	.0001	-.0011
1.47	.00	.2483	.0437	-.0121	.0007	.0001	-.0012
3.77	.00	.3487	.0537	-.0048	.0005	.0000	-.0007
6.03	.00	.4473	.0703	.0020	.0001	-.0002	-.0006
8.25	.00	.5342	.0905	.0155	.0000	-.0003	-.0013
10.47	-.01	.6182	.1148	.0304	-.0003	-.0008	-.0036
12.73	-.03	.7000	.1419	.0479	.0008	-.0031	-.0110
14.92	-.04	.7777	.1741	.0738	.0006	-.0007	-.0170
17.33	-.02	.9296	.2564	.1064	-.0033	-.0081	-.0073
19.73	.00	1.0626	.3463	.1463	-.0085	-.0056	.0017
1.50	.00	.2540	.0437	-.0117	.0007	.0001	-.0012

RUN 47

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.06	5.05	.0875	.0316	.0197	-.0025	.0044	.0131
-5.78	5.05	-.2146	.0632	-.0146	-.0067	.0074	.0433
-3.52	5.05	-.1183	.0463	-.0007	-.0050	.0065	.0323
-1.25	5.05	-.0159	.0352	.0103	-.0036	.0054	.0221
1.05	5.05	.0856	.0317	.0194	-.0024	.0043	.0133
3.34	5.05	.1862	.0340	.0275	-.0003	.0035	.0049
5.61	5.05	.2827	.0440	.0392	.0010	.0030	-.0017
7.80	5.06	.3681	.0567	.0520	.0038	.0032	-.0068
10.04	5.06	.4514	.0757	.0697	.0077	.0015	-.0123
12.34	5.03	.5510	.1069	.0961	.0091	.0008	-.0374
14.59	4.98	.6551	.1452	.1206	.0094	.0016	-.0650
16.88	4.94	.7605	.1907	.1432	.0073	.0024	-.0917
19.33	4.97	.9141	.2766	.1710	.0039	.0047	-.0963
1.04	5.05	.0873	.0316	.0199	-.0024	.0043	.0128

RUN 48

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.05	10.10	.0905	.0378	.0207	-.0065	.0109	.0286
-5.73	10.11	-.1996	.0697	-.0184	-.0142	.0159	.0864
-3.48	10.10	-.1014	.0519	-.0046	-.0104	.0145	.0641
-1.23	10.10	-.0052	.0418	.0086	-.0082	.0126	.0454
1.05	10.10	.0894	.0380	.0207	-.0066	.0110	.0292
3.33	10.10	.1857	.0404	.0333	-.0018	.0102	.0130
5.59	10.11	.2786	.0494	.0527	.0018	.0094	-.0014
7.84	10.10	.3775	.0674	.0754	.0046	.0097	-.0239
10.12	10.07	.4855	.0931	.0960	.0110	.0097	-.0567
12.48	10.04	.6017	.1291	.1227	.0138	.0093	-.0902
14.76	10.01	.7108	.1718	.1527	.0115	.0077	-.1216
17.14	9.97	.8502	.2322	.1734	.0128	.0073	-.1664
1.06	10.10	.0918	.0378	.0209	-.0065	.0108	.0286

RUN 49

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.17	.00	.1301	.0170	.0080	.0005	-.0002	-.0007
-5.59	.00	-.1491	.0376	-.0267	.0006	-.0004	-.0006
-3.34	.00	-.0540	.0241	-.0135	.0008	-.0004	-.0008
-1.10	.00	.0403	.0178	-.0020	.0006	-.0003	-.0006
1.17	.00	.1294	.0169	.0080	.0005	-.0002	-.0006
3.39	.00	.2122	.0203	.0156	.0002	-.0002	-.0006
5.61	.00	.2918	.0279	.0223	.0000	-.0003	-.0009
7.82	.00	.3758	.0401	.0284	-.0003	-.0005	-.0015
10.05	-.01	.4632	.0605	.0351	-.0001	-.0014	-.0031
12.30	-.01	.5401	.0869	.0487	-.0011	-.0034	-.0062
14.53	-.02	.6325	.1280	.0629	-.0013	-.0053	-.0100
16.80	-.01	.7360	.1805	.0769	-.0073	-.0067	-.0052
19.17	-.01	.8471	.2470	.0981	-.0073	-.0081	-.0030
1.16	.00	.1308	.0167	.0083	.0004	-.0002	-.0004

TABLE AII. - CONTINUED

RUN 50

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.17	.00	.1302	.0169	.0081	.0005	-.0002	-.0007
-5.58	.00	-.1486	.0373	-.0267	.0006	-.0004	-.0008
-3.32	.00	-.0534	.0240	-.0133	.0009	-.0004	-.0009
-1.11	.00	.0405	.0177	-.0021	.0006	-.0003	-.0007
1.18	.00	.1292	.0169	.0079	.0005	-.0002	-.0007
3.41	.00	.2124	.0204	.0156	.0003	-.0002	-.0007
5.62	.00	.2919	.0279	.0221	.0001	-.0003	-.0011
7.81	.00	.3748	.0400	.0286	-.0004	-.0005	-.0014
10.08	-.01	.4635	.0607	.0350	-.0001	-.0015	-.0031
12.30	-.02	.5384	.0868	.0487	-.0007	-.0032	-.0067
14.55	-.02	.6315	.1282	.0627	-.0016	-.0056	-.0096
16.82	-.01	.7355	.1809	.0766	-.0075	-.0078	-.0046
19.13	.00	.8402	.2436	.0976	-.0077	-.0084	-.0015
1.17	.00	.1315	.0168	.0083	.0005	-.0002	-.0004

RUN 51

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.17	.00	.1314	.0176	.0083	.0004	-.0004	-.0004
-5.58	.00	-.1489	.0380	-.0266	.0008	-.0005	-.0008
-3.33	.00	-.0535	.0245	-.0134	.0009	-.0005	-.0010
-1.10	.00	.0399	.0184	-.0019	.0007	-.0004	-.0006
1.14	.00	.1287	.0181	.0080	.0005	-.0004	-.0005
3.39	.00	.2122	.0214	.0159	.0002	-.0004	-.0005
5.61	.00	.2917	.0291	.0226	.0000	-.0005	-.0010
7.80	.00	.3760	.0415	.0293	-.0004	-.0006	-.0019
10.08	-.01	.4670	.0622	.0338	-.0002	-.0015	-.0032
12.32	-.02	.5456	.0878	.0447	-.0004	-.0033	-.0078
14.49	-.02	.6158	.1209	.0654	-.0025	-.0051	-.0106
16.69	-.02	.6866	.1652	.0904	-.0056	-.0078	-.0073
18.98	.00	.7886	.2238	.1102	-.0067	-.0085	-.0019
1.18	.00	.1315	.0177	.0083	.0004	-.0003	-.0005

RUN 52

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.18	.00	.1328	.0177	.0082	.0004	-.0004	-.0004
-5.59	.00	-.1499	.0381	-.0267	.0007	-.0005	-.0006
-3.33	.00	-.0540	.0248	-.0137	.0009	-.0005	-.0007
-1.13	.00	.0400	.0185	-.0023	.0007	-.0004	-.0004
1.16	.00	.1301	.0178	.0079	.0005	-.0003	-.0003
3.40	.00	.2141	.0215	.0157	.0003	-.0003	-.0003
5.64	.00	.2964	.0296	.0222	.0000	-.0005	-.0007
7.86	.00	.3861	.0434	.0255	-.0002	-.0007	-.0014
10.06	-.01	.4680	.0627	.0346	-.0006	-.0014	-.0026
12.32	-.02	.5495	.0889	.0448	-.0005	-.0030	-.0074
14.48	-.02	.6152	.1246	.0656	-.0023	-.0059	-.0086
16.73	-.01	.7035	.1708	.0841	-.0064	-.0078	-.0056

RUN 53

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.25	.00	.1302	.0176	.0078	.0003	-.0008	-.0006
-5.75	.00	-.1652	.0401	-.0297	.0003	-.0006	.0000
-3.40	.00	-.0638	.0256	-.0148	.0005	-.0006	-.0003
-1.10	.00	.0339	.0187	-.0029	.0005	-.0007	-.0004
1.24	.00	.1267	.0178	.0074	.0003	-.0007	-.0006
3.56	.00	.2148	.0218	.0158	.0000	-.0007	-.0003
5.83	.00	.2992	.0300	.0231	-.0004	-.0007	-.0004
8.11	.00	.3868	.0435	.0296	-.0007	-.0007	-.0011
10.44	-.01	.4832	.0661	.0361	-.0006	-.0015	-.0033
12.74	-.04	.5658	.0942	.0502	-.0005	-.0031	-.0100
14.95	-.06	.6346	.1342	.0756	-.0037	-.0084	-.0163
17.36	-.08	.7456	.1936	.0903	-.0038	-.0102	-.0207

TABLE AII. - CONCLUDED

RUN 54

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.38	.00	.2056	.0238	-.0068	.0001	-.0005	-.0004
-5.35	.00	-.0582	.0347	-.0435	.0007	-.0006	-.0005
-3.09	.00	.0358	.0249	-.0298	.0006	-.0006	-.0005
-.88	.00	.1216	.0220	-.0176	.0002	-.0004	-.0003
1.36	.00	.2042	.0239	-.0070	.0002	-.0004	-.0005
3.61	.00	.2854	.0300	.0011	-.0002	-.0005	-.0002
5.81	.00	.3647	.0400	.0080	-.0004	-.0006	-.0006
8.02	.00	.4519	.0566	.0135	-.0005	-.0007	-.0014
10.28	-.01	.5397	.0802	.0198	-.0008	-.0013	-.0025
12.51	-.02	.6171	.1087	.0320	-.0006	-.0034	-.0072
14.62	.02	.6694	.1440	.0589	-.0036	-.0070	-.0079
16.88	.02	.7603	.1941	.0766	-.0051	-.0084	-.0099

RUN 55

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.55	.00	.2740	.0346	-.0209	.0009	-.0004	-.0002
-5.15	.00	.0233	.0372	-.0580	.0008	-.0006	-.0005
-2.88	.00	.1108	.0311	-.0440	.0005	-.0005	-.0001
-.71	.00	.1529	.0305	-.0320	.0003	-.0004	-.0001
1.55	.00	.2723	.0345	-.0209	.0002	-.0004	.0000
3.77	.00	.3523	.0430	-.0135	-.0001	-.0004	-.0003
6.01	.00	.4235	.0558	-.0068	-.0003	-.0006	-.0006
8.22	.00	.5741	.0758	-.0028	-.0006	-.0008	-.0010
10.46	-.01	.6084	.1015	.0052	-.0006	-.0014	-.0032
12.67	-.02	.6771	.1320	.0210	-.0016	-.0038	-.0074
14.82	-.03	.7420	.1745	.0445	-.0016	-.0067	-.0113
17.07	-.02	.8290	.2263	.0632	-.0049	-.0089	-.0090

RUN 56

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
1.36	.00	.2007	.0212	-.0030	.0003	-.0004	.0000
-5.41	.00	-.0828	.0335	-.0269	.0008	-.0002	.0000
-3.15	.00	.0109	.0237	-.0151	.0004	-.0003	.0004
-.93	.00	.1054	.0197	-.0068	.0002	-.0004	.0002
1.33	.00	.1994	.0210	-.0030	.0002	-.0004	.0002
3.58	.00	.2789	.0273	.0022	.0000	-.0005	.0001
5.79	.00	.3576	.0380	.0087	-.0003	-.0005	-.0002
8.01	.00	.4448	.0543	.0160	-.0008	-.0004	-.0005
10.26	-.01	.5262	.0778	.0237	.0002	-.0015	-.0024
12.53	-.02	.6310	.1101	.0356	.0000	-.0039	-.0068
14.77	-.02	.7250	.1536	.0531	-.0007	-.0060	-.0097
17.04	-.03	.8205	.2071	.0721	-.0031	-.0076	-.0111

RUN 57

ALPHA	BETA	CL	CD	CM	CRM	CYM	CSF
.25	.00	.0914	.0166	.0168	.0010	.0000	-.0008
-6.53	.00	-.2019	.0417	-.0103	.0003	.0000	-.0002
-4.30	.00	-.1072	.0273	.0031	.0006	.0000	-.0004
-2.04	.00	-.0105	.0191	.0119	.0008	.0001	-.0005
.25	.00	.0513	.0166	.0167	.0011	.0000	-.0010
2.53	.00	.1801	.0192	.0189	.0009	-.0001	-.0011
4.70	.00	.2572	.0263	.0249	.0006	.0000	-.0016
6.93	.00	.3393	.0387	.0331	.0007	.0000	-.0019
9.21	-.01	.4338	.0579	.0419	.0017	-.0007	-.0037
11.48	-.02	.5438	.0888	.0524	.0020	-.0019	-.0088
13.74	-.03	.6450	.1291	.0690	.0020	-.0056	-.0120
16.10	-.03	.7680	.1877	.0786	.0002	-.0095	-.0135

REFERENCES

1. Robins, A. Warner; Morris, Odell A.; and Harris, Roy V., Jr.: Recent Research Results in the Aerodynamics of Supersonic Vehicles. J. Aircr., vol. 3, no. 6, Nov.-Dec. 1966, pp. 573-577.
2. Robins, A. Warner; Lamb, Milton; and Miller, David S.: Aerodynamic Characteristics at Mach Numbers of 1.5, 1.8, and 2.0 of a Blended Wing-Body Configuration With and Without Integral Canards. NASA TP-1427, 1979.
3. Coe, Paul L., Jr.; and Weston, Robert P.: Effects of Wing Leading-Edge Deflection on Low-Speed Aerodynamic Characteristics of a Low-Aspect-Ratio Highly Swept Arrow-Wing Configuration. NASA TP-1434, 1979.
4. Coe, Paul L., Jr.; Huffman, Jarrett K.; and Fenbert, James W.: Leading-Edge Deflection Optimization for a Highly Swept Arrow-Wing Configuration. NASA TP-1777, 1980.
5. Coe, Paul L. Jr.; Kjelgaard, Scott O.; and Gentry, Garl L., Jr.: Low-Speed Aerodynamic Characteristics of a Highly Swept, Untwisted, Uncambered Arrow Wing. NASA TP 2176, 1983.
6. Gillis, Clarence L.; Polhamus, Edward C.; and Gray, Joseph L., Jr.: Charts for Determining Jet-Boundary Corrections for Complete Models in 7- by 10-Foot Closed Rectangular Wind Tunnels. NACA WR L-123, 1945. (Formerly NACA ARR L5G31.)
7. Pope, Alan; and Harper, John J.: Low-Speed Wind Tunnel Testing. John Wiley & Sons, Inc., c.1966.
8. Carlson, Harry W.; and Walkley, Kenneth B.: An Aerodynamic Analysis Computer Program and Design Notes for Low-Speed Wing-Flap Systems. NASA CR-3675, 1983.

TABLE I. - GEOMETRIC CHARACTERISTICS OF MODEL

Wing:	
Aspect ratio	1.838
Reference area, m^2 (ft^2)	0.863 (9.293)
Gross area, m^2 (ft^2)	0.949 (10.210)
Span, m (ft)	1.260 (4.133)
Root chord, m (ft)	1.674 (5.492)
Tip chord, m (ft)	0.161 (0.529)
Reference mean aerodynamic chord, m, (ft)	0.895 (2.937)
Leading-edge sweep, deg:	
At body station 0.530 m (1.738 ft)	73.02
At body station 2.027 m (6.651 ft)	60.0
Vertical fin (each):	
Span, m (ft)	0.107 (0.350)
Root chord, m (ft)	0.326 (1.069)
Tip chord, m (ft)	0.048 (0.158)
Leading-edge sweep, deg	73.4
Taper ratio	0.148

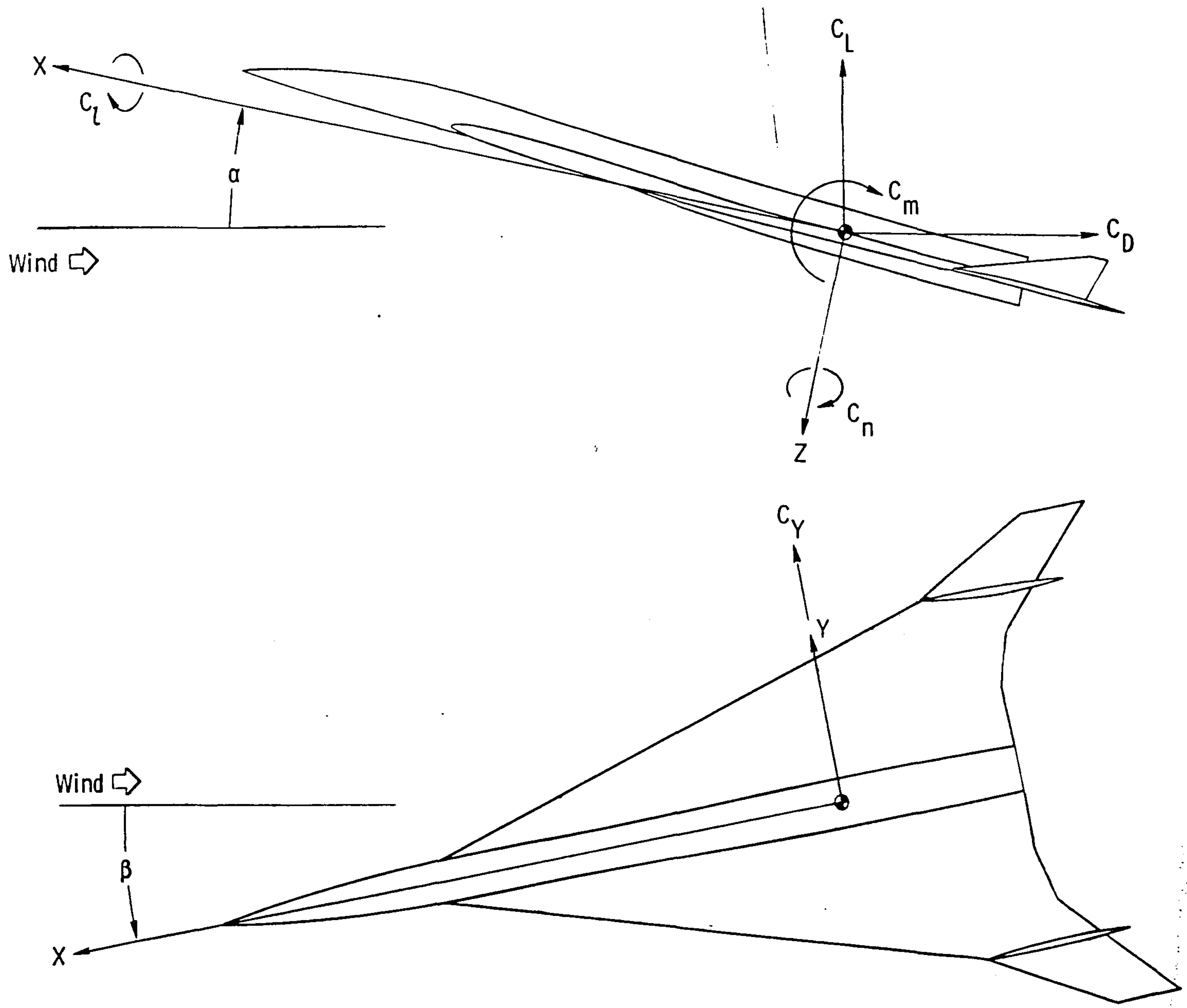


Figure 1.- System of Axes.

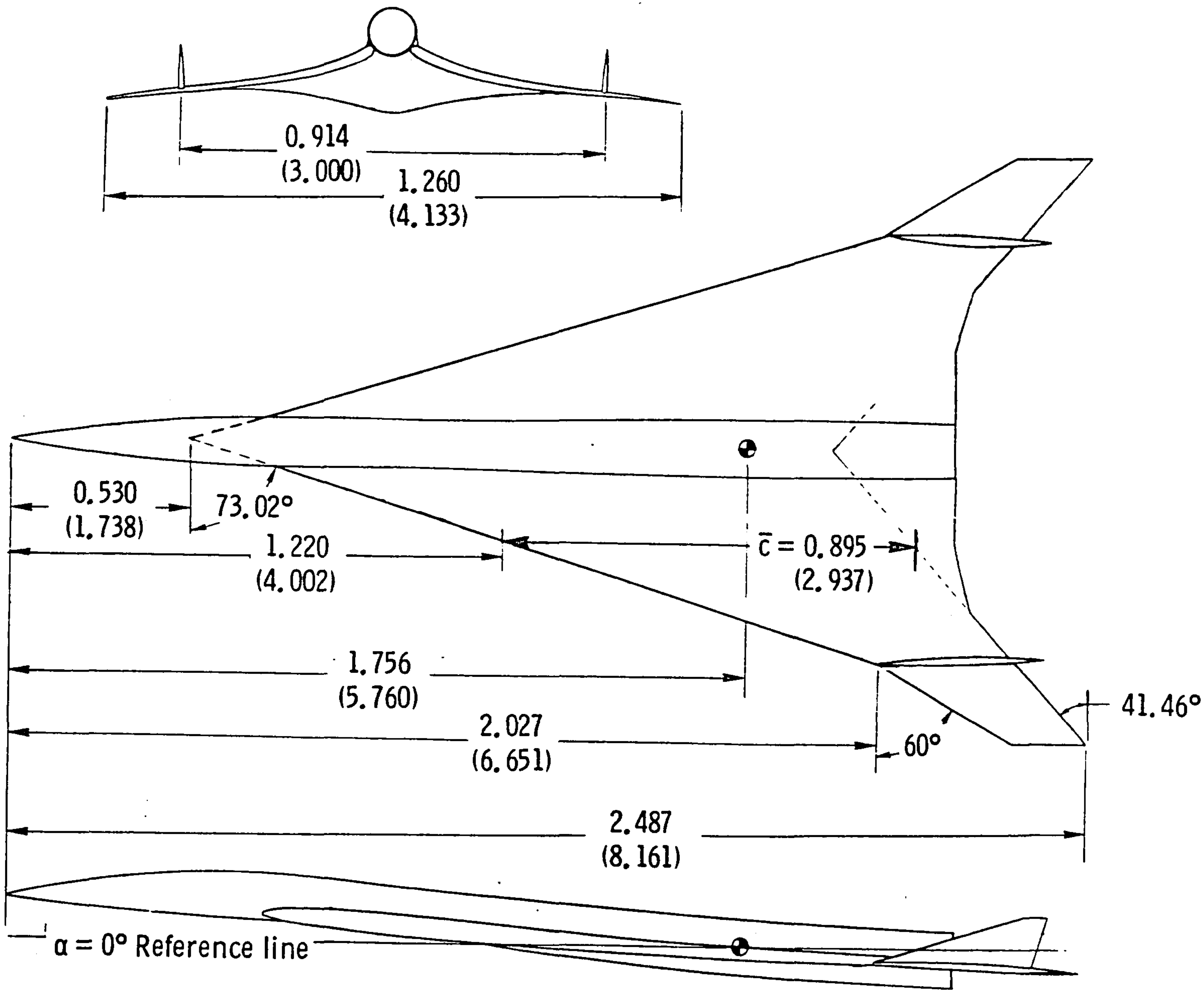


Figure 2.- Three View Sketch Of Model. Dimensions Are Given In Meters And Parenthetically In Feet.

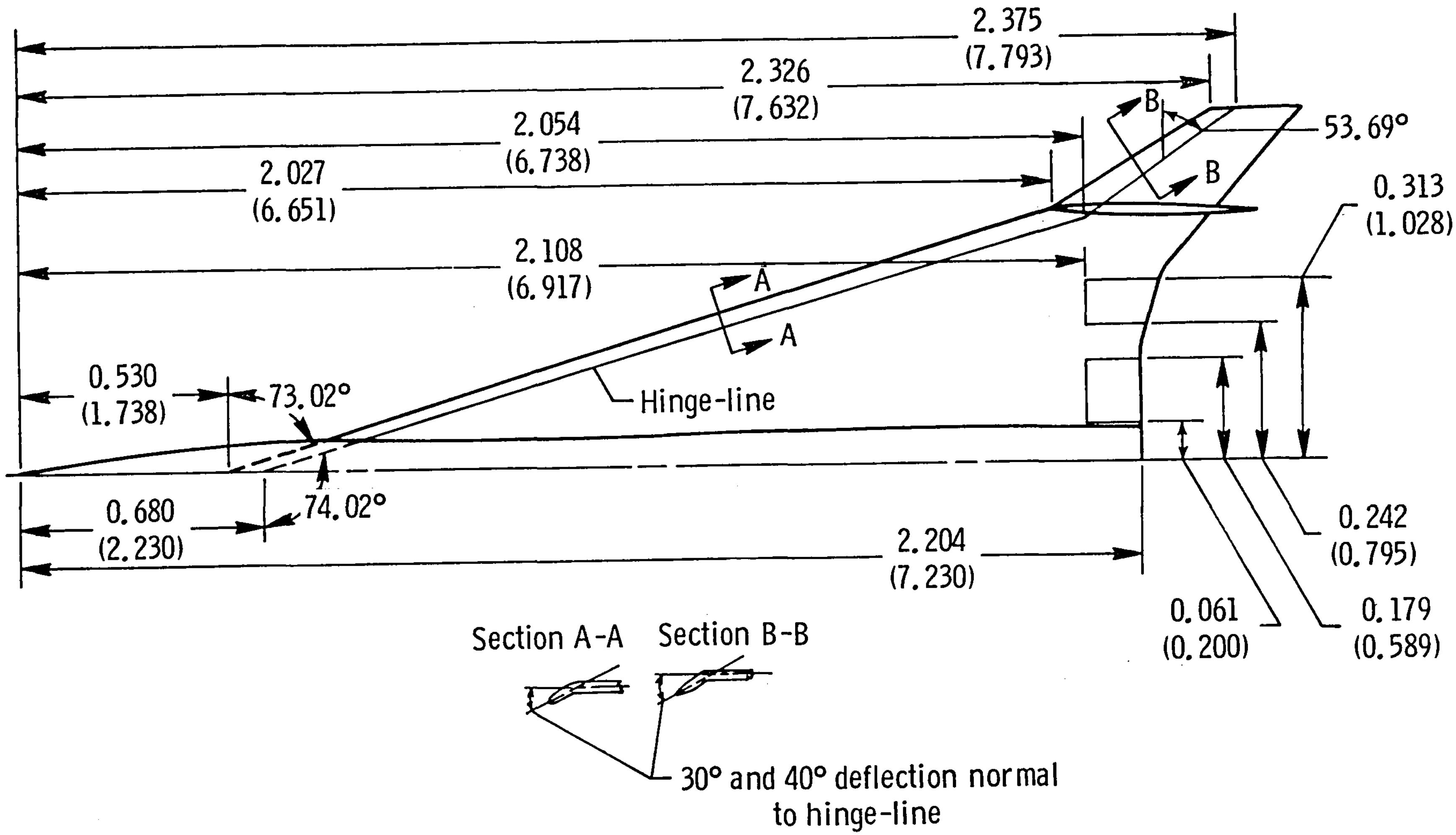
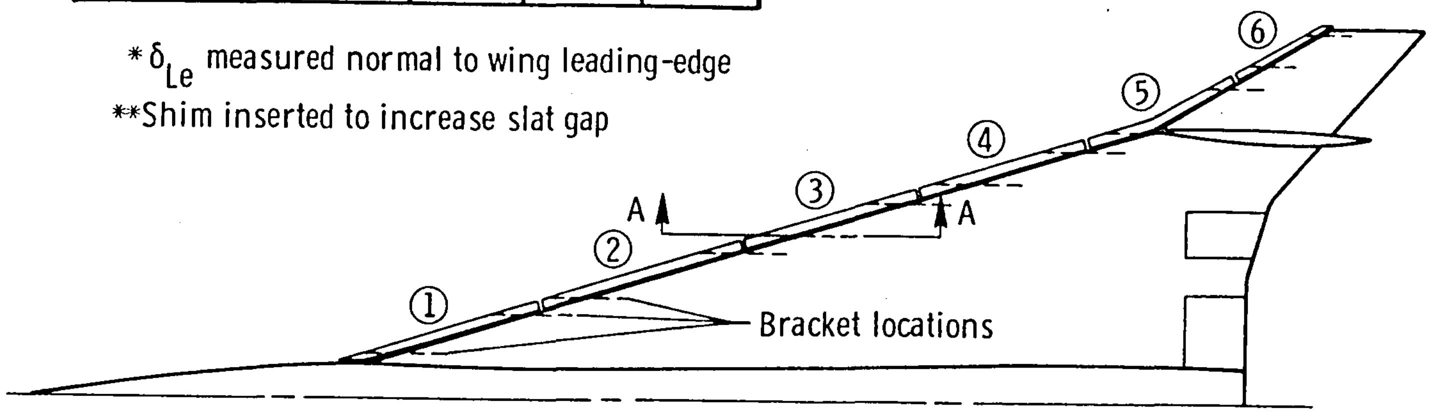


Figure 3. - Details Of Leading- and Trailing-Edge Flap Systems. Dimensions In Meters (ft) Unless Otherwise Noted.

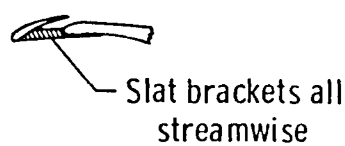
Slat element	Slat Configuration I δ_{Le}*	Slat Configuration II δ_{Le}*	Shim thickness ** cm	Shim thickness ** inches
①	35	20	.254	.100
②	35	35	.254	.100
③	35	35	.254	.100
④	35	35	.127	.050
⑤	30	30	.076	.030
⑥	30	30	.076	.030

* δ_{Le} measured normal to wing leading-edge

**Shim inserted to increase slat gap

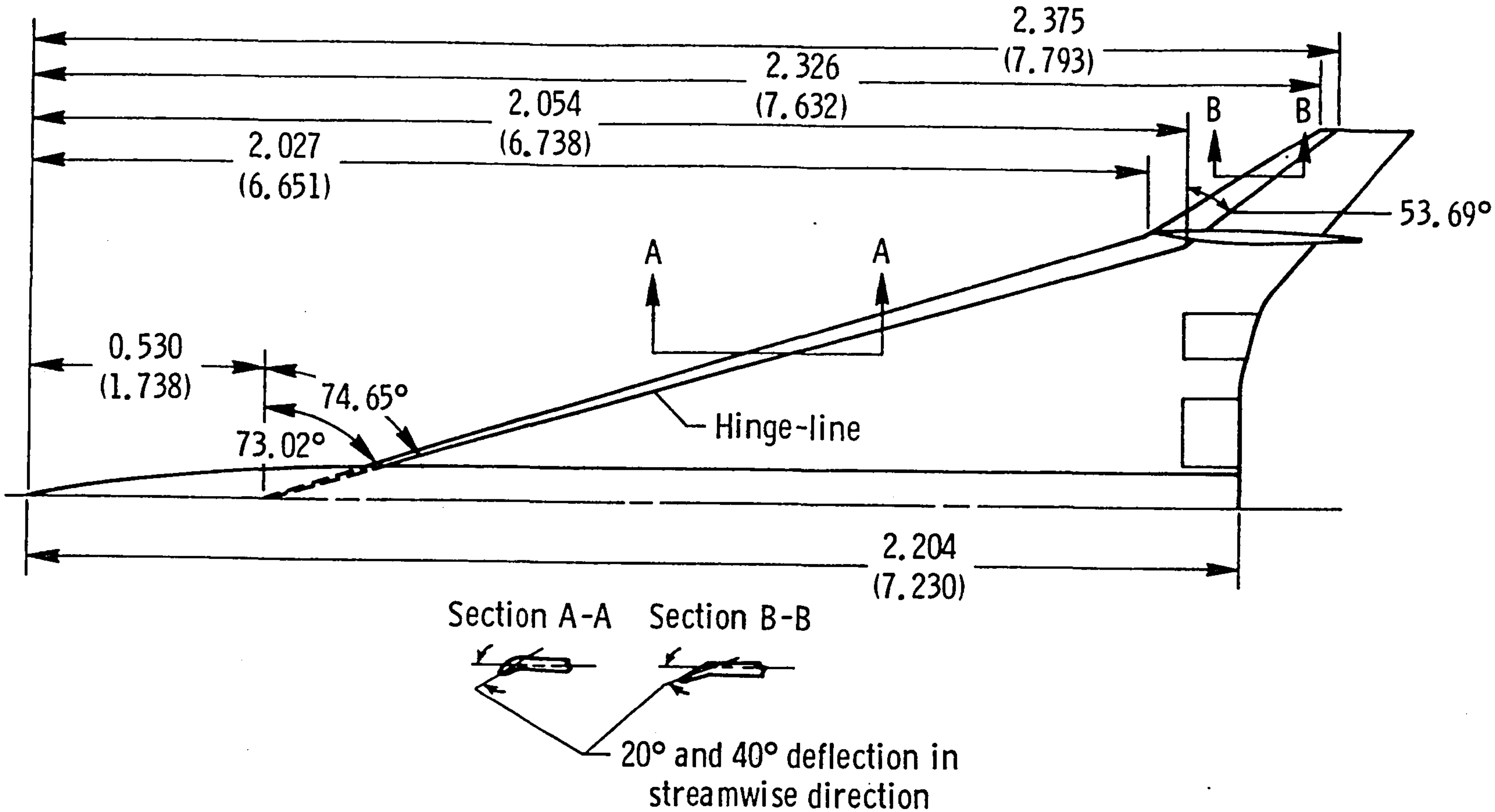


Section A-A typical



(b) Leading-Edge Slat

Figure 3. - Continued



(c) Variable Chord Leading Edge

Figure 3.- Concluded

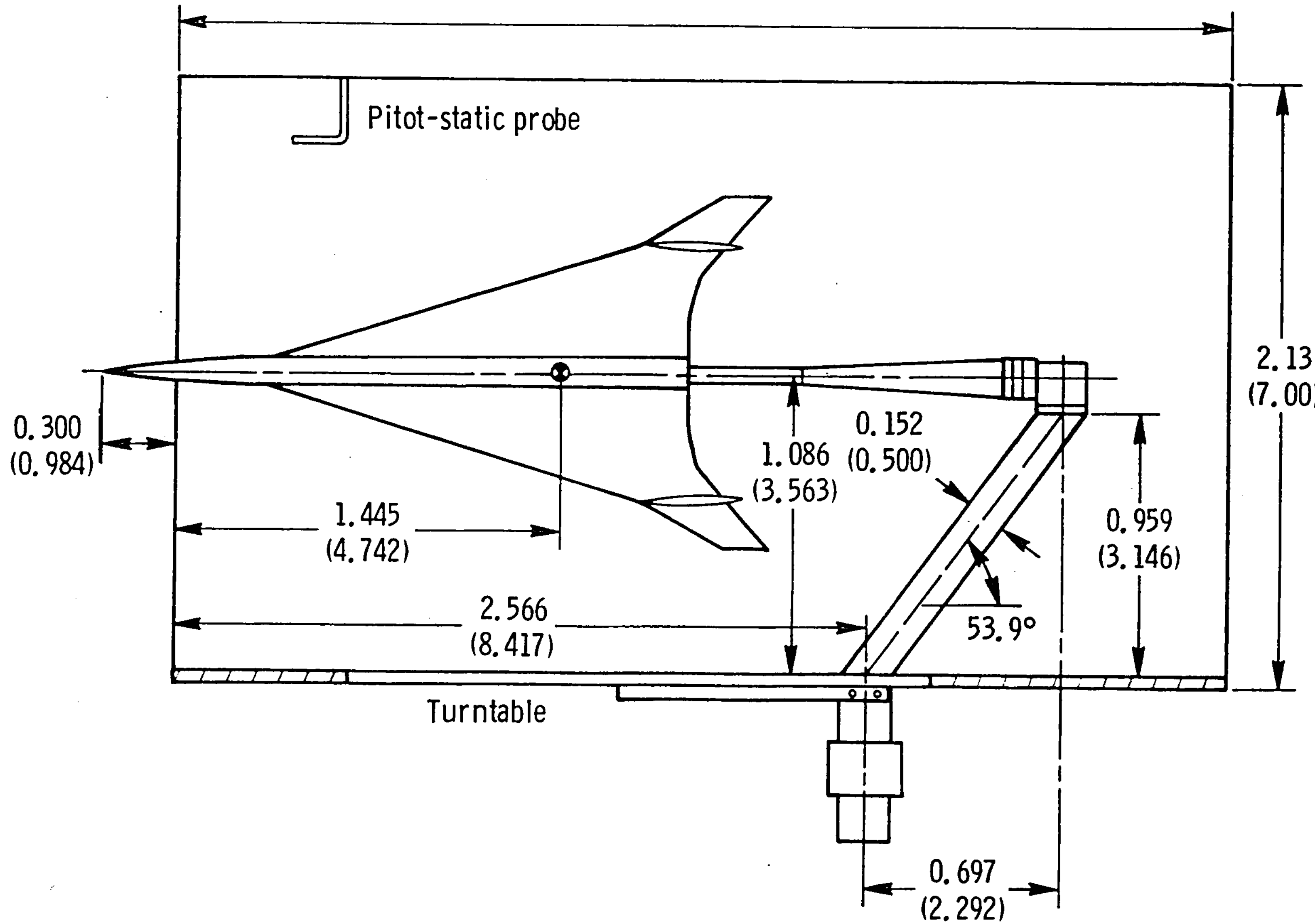


Figure 4. Model mounting arrangement in Texas A & M University 7-X 10-foot Low-Speed Wind Tunnel. Dimensions are in meters and parenthetically in feet.

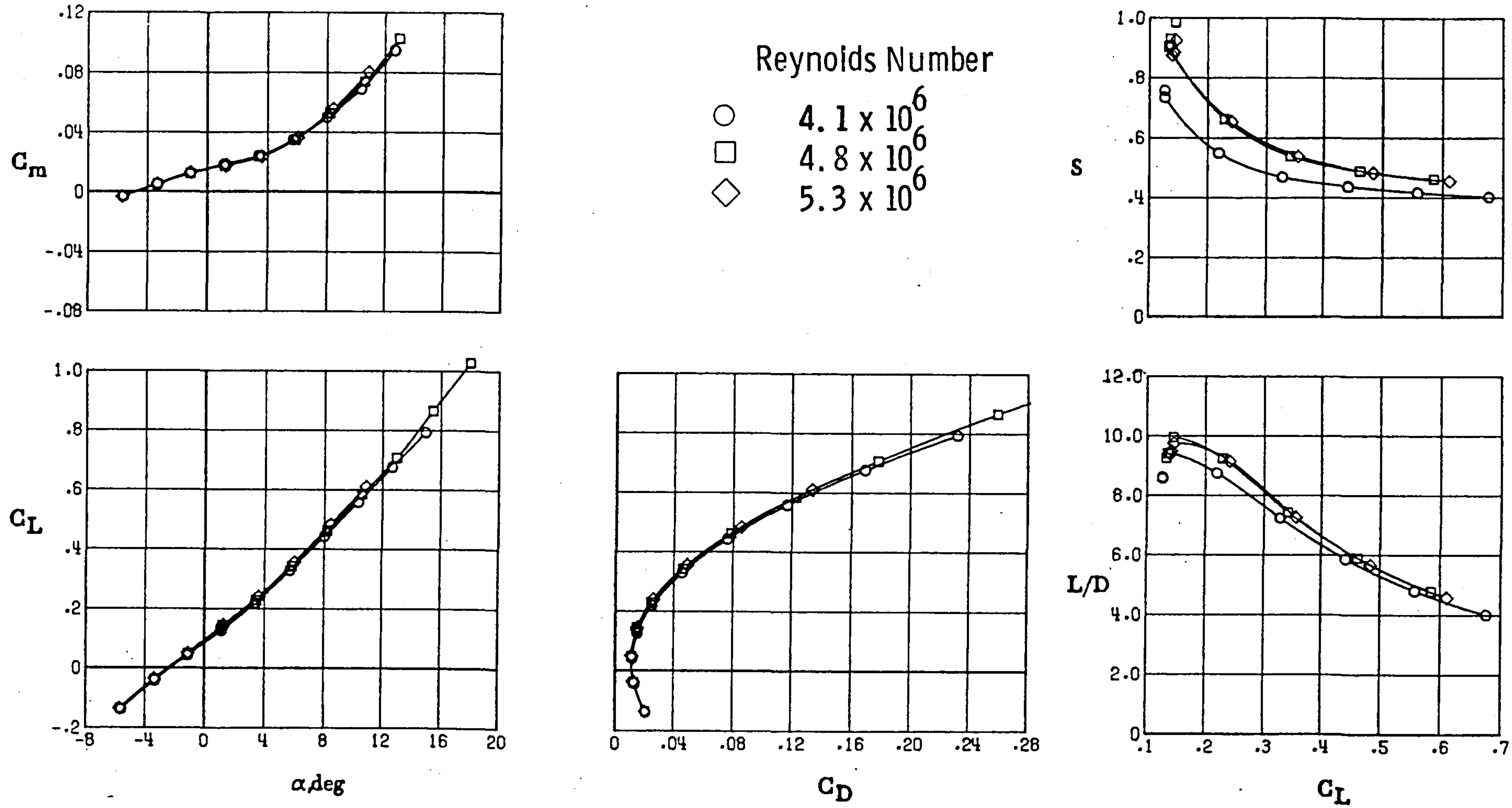
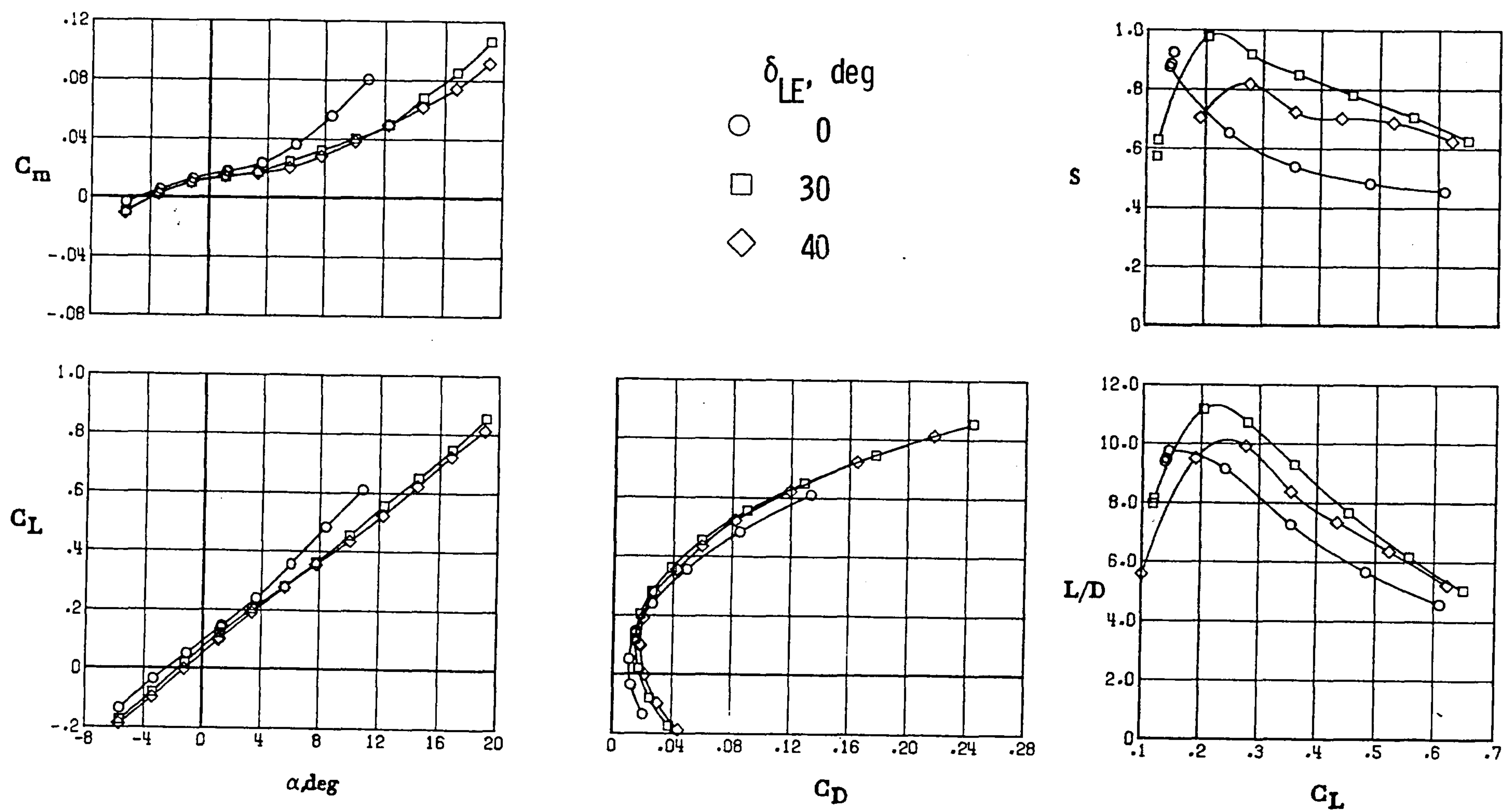
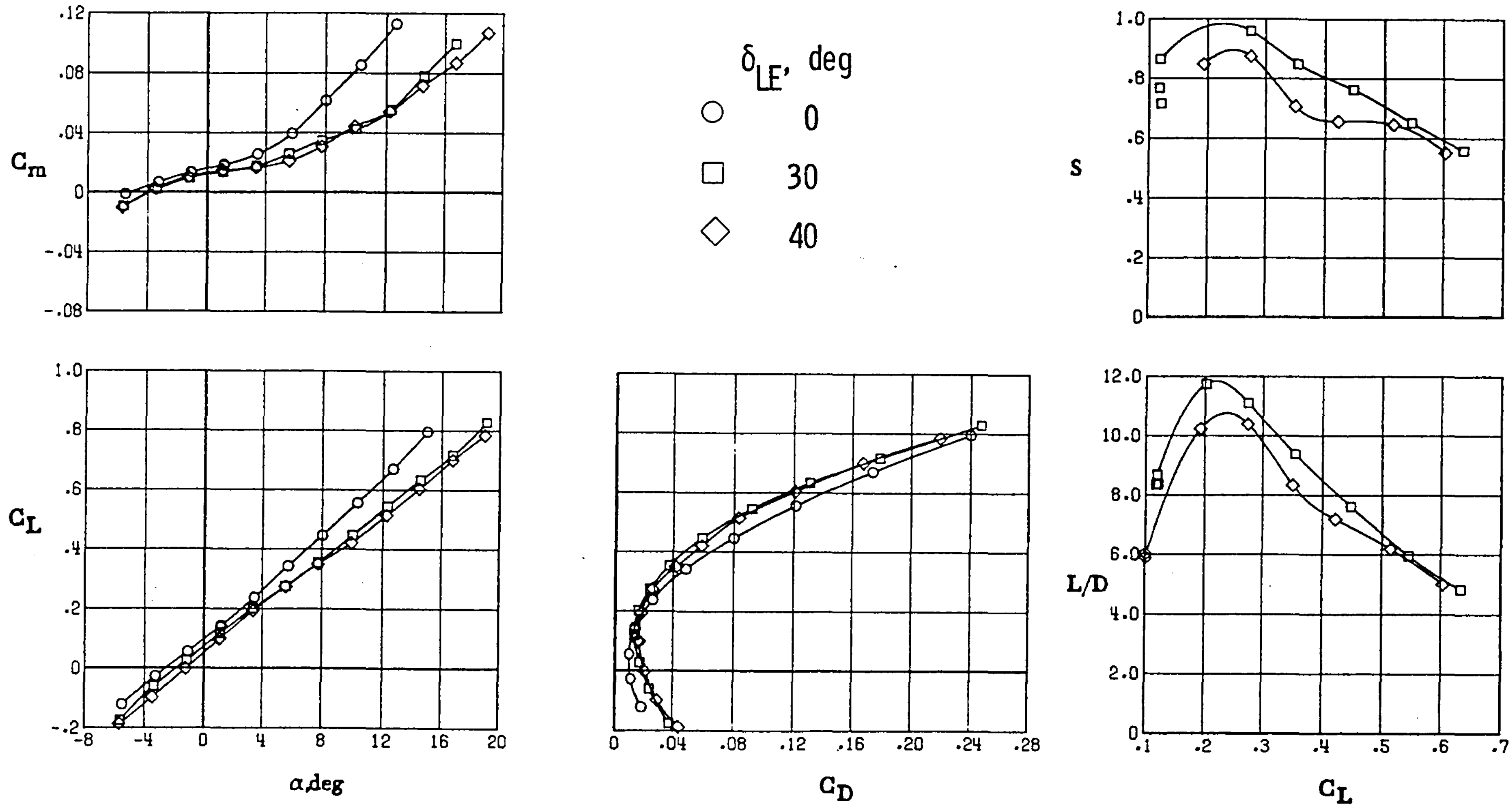


Figure 5.- Longitudinal Aerodynamic Characteristics Of Configuration With Undeflected Leading-Edge. Outboard Vertical Fins On.



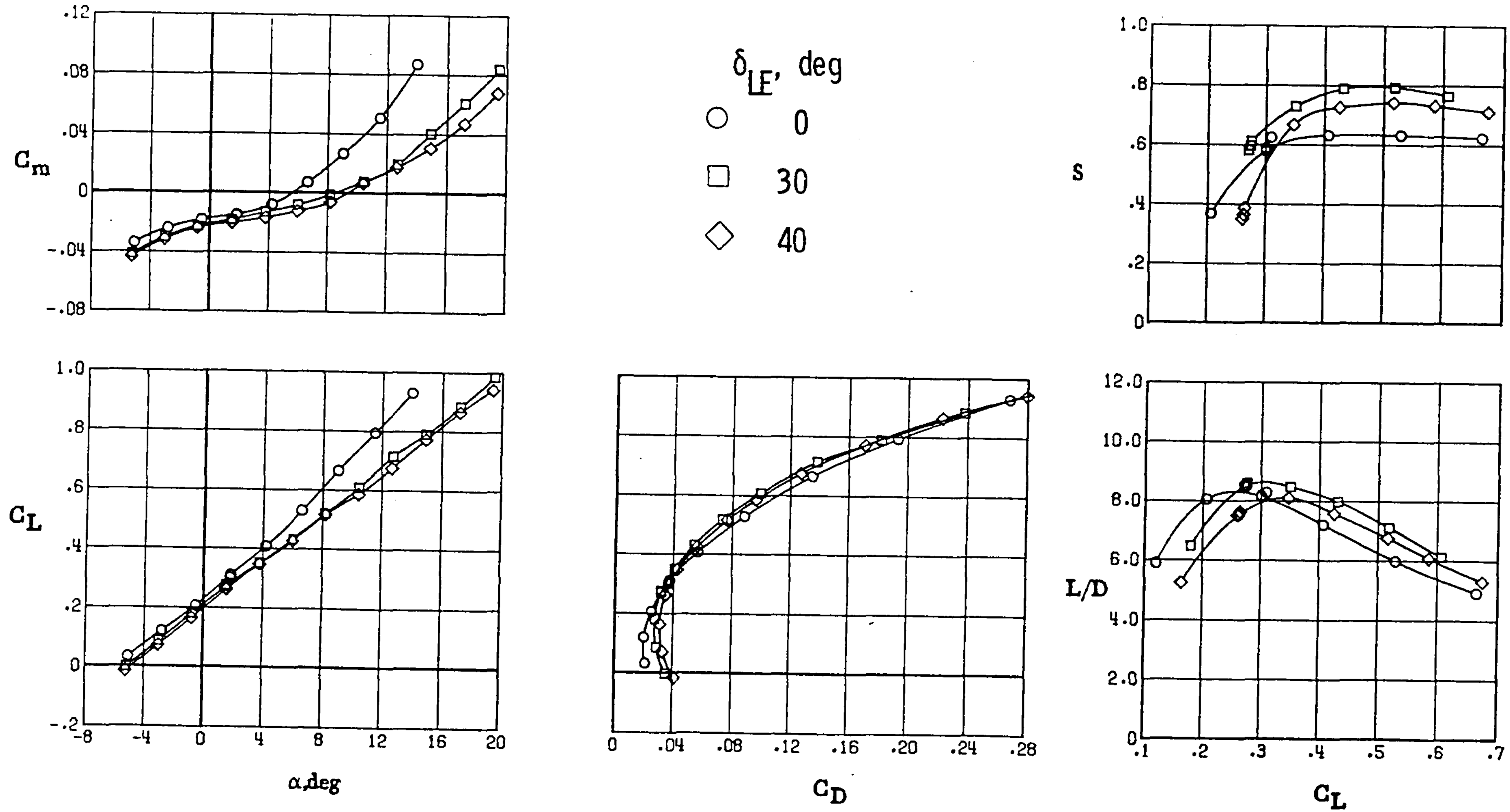
(a) Vertical fins on, $\delta_f = 0°$

Figure 6.- Effect Of Simple Leading Edge Deflection.



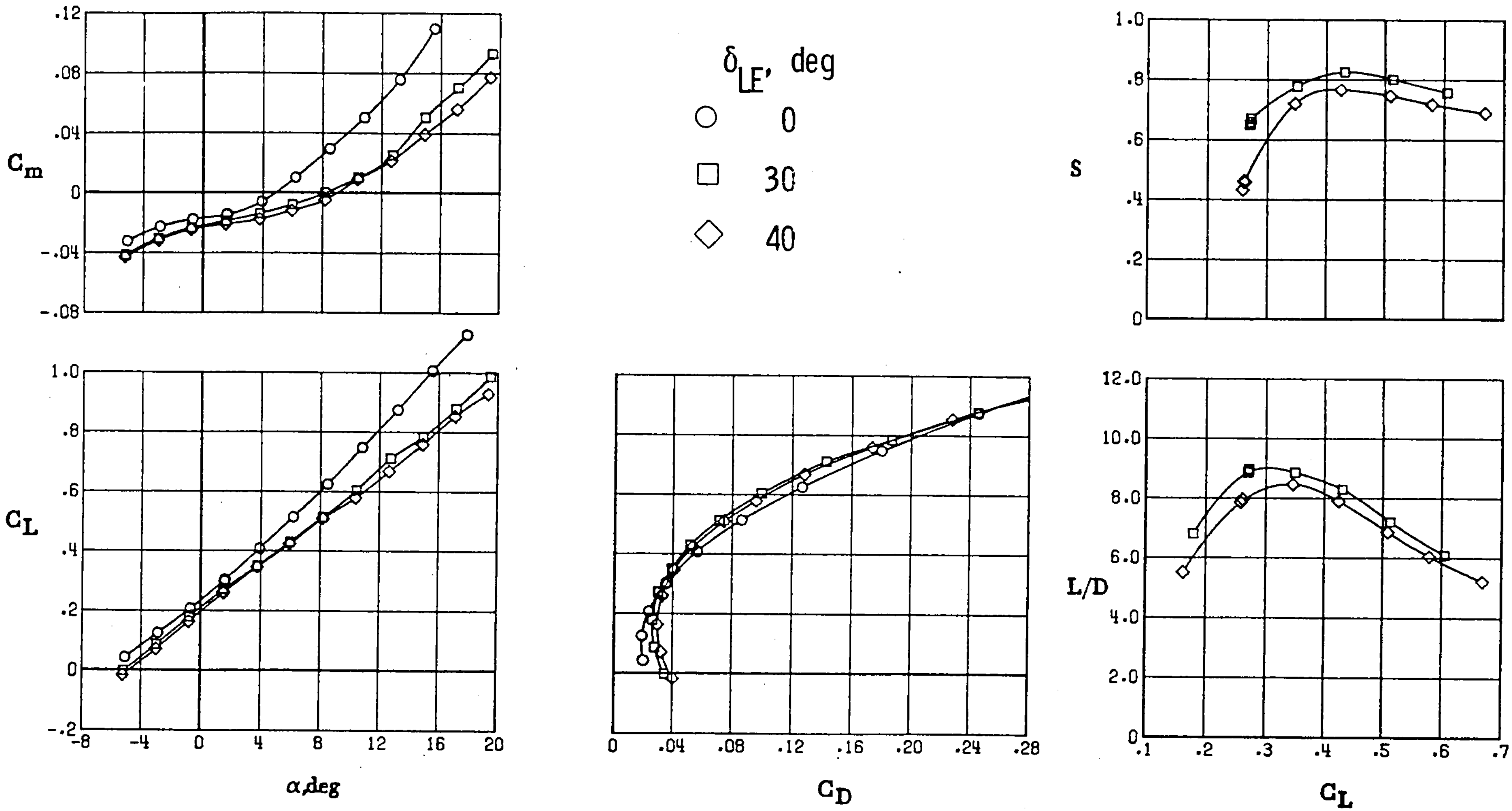
(b) Vertical fins off, $\delta_f = 0°$

Figure 6.- Continued



(c) Vertical fins on, $\delta_f = 20°$

Figure 6. - Continued



(d) Vertical fins off, $\delta_f = 20°$

Figure 6. - Concluded

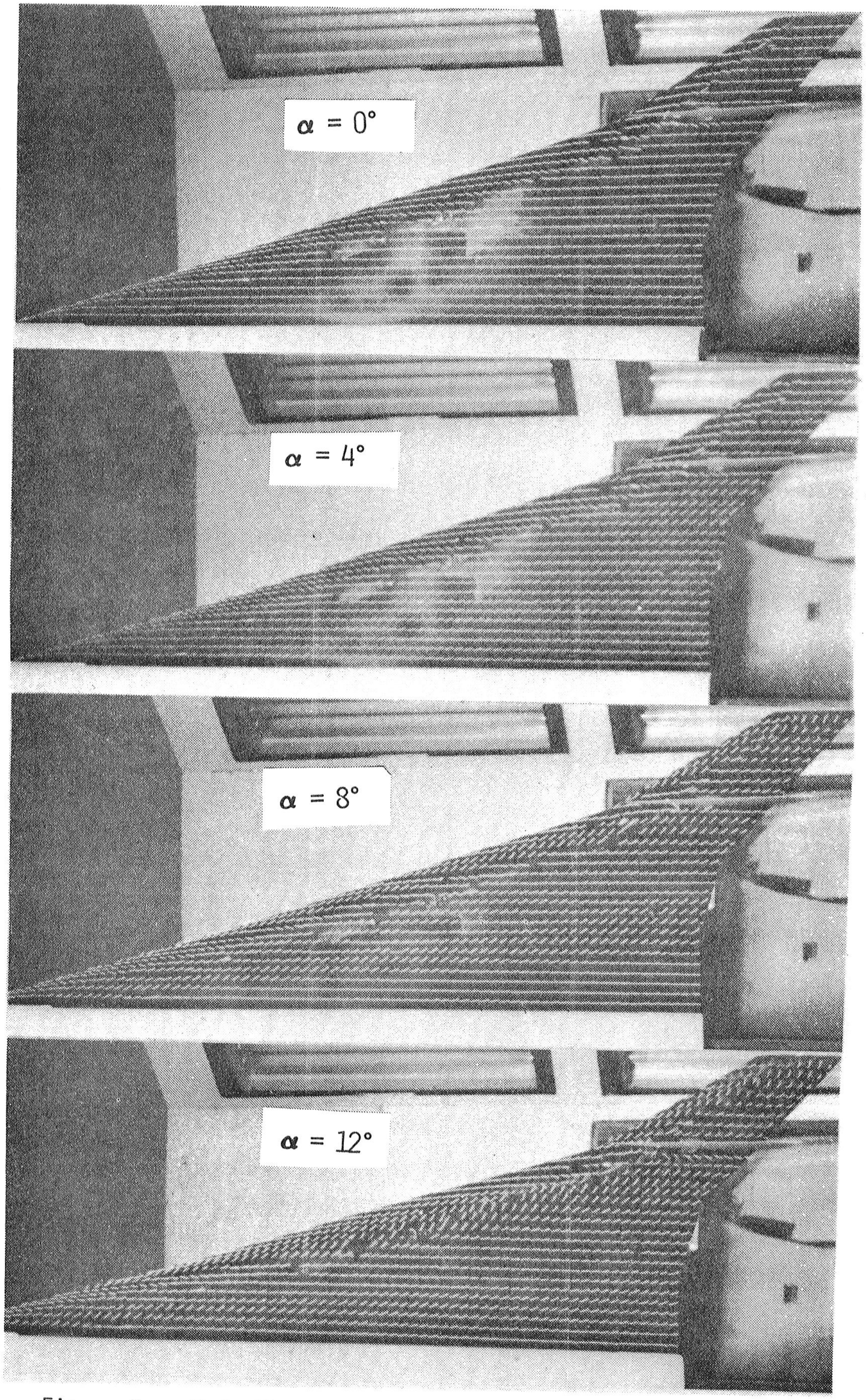
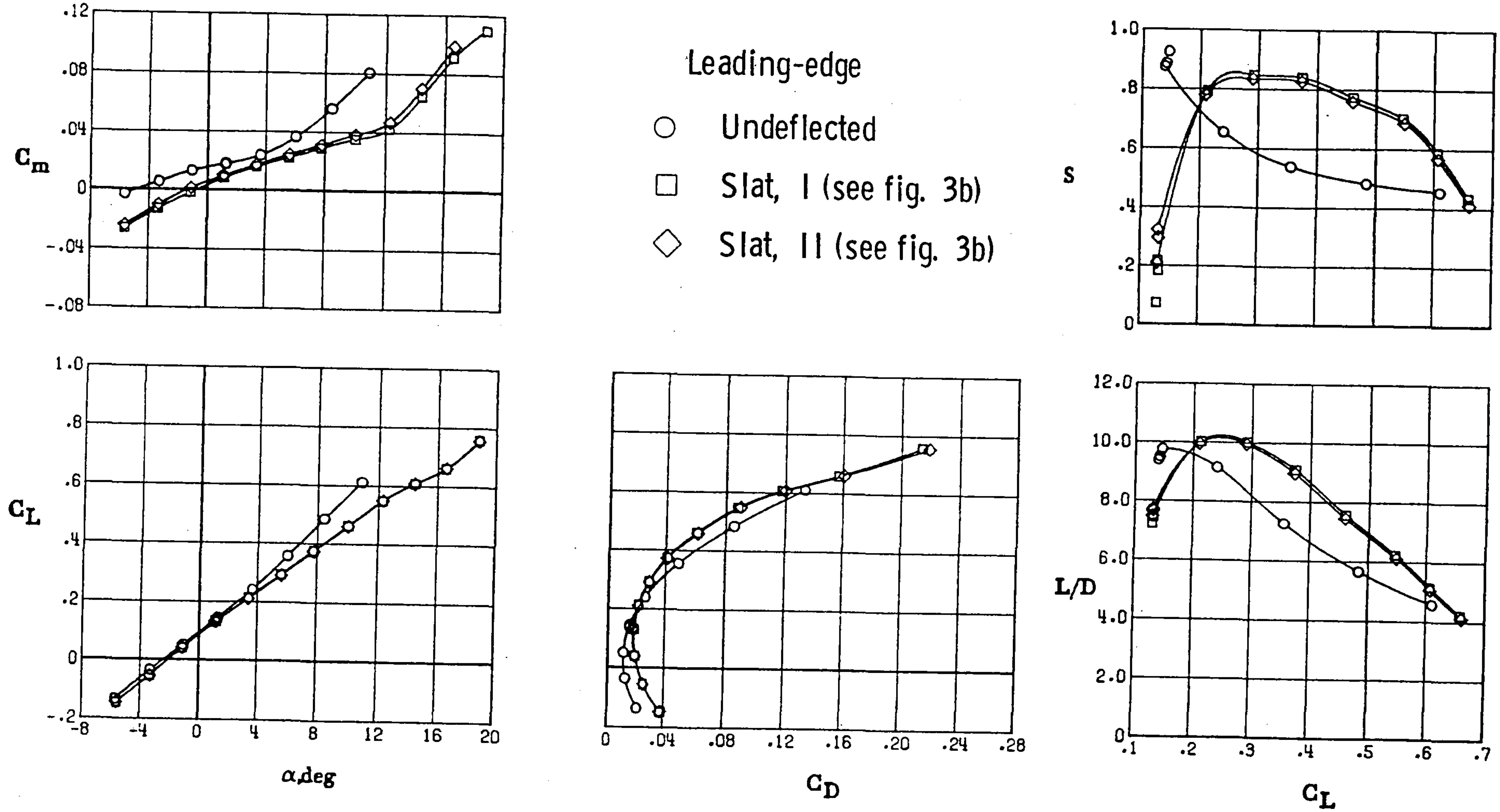
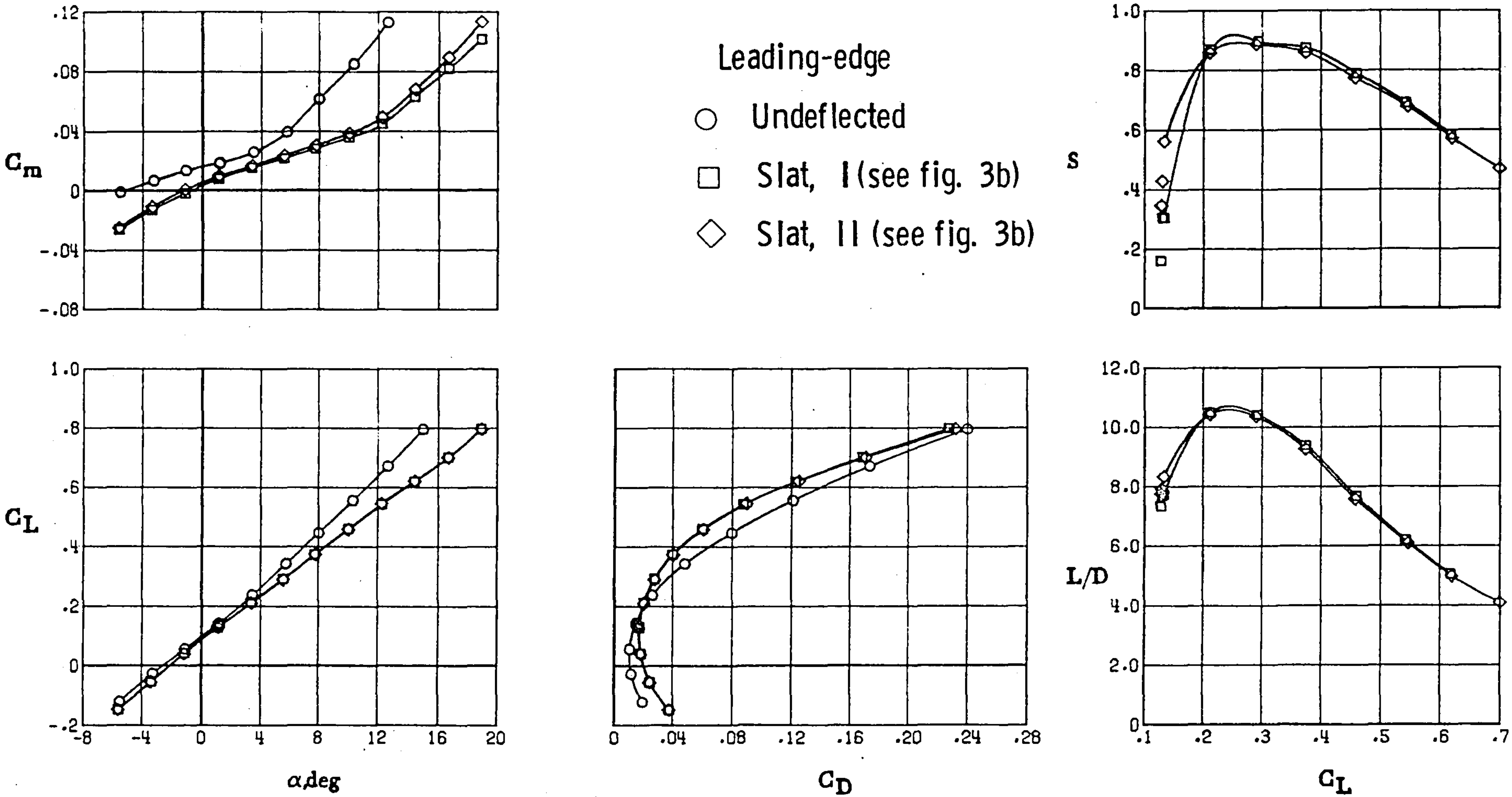


Figure 7. - Tuft Photographs of the Configuration With Simply Deflected Leading Edge ($\delta_{LE} = 30^o$).



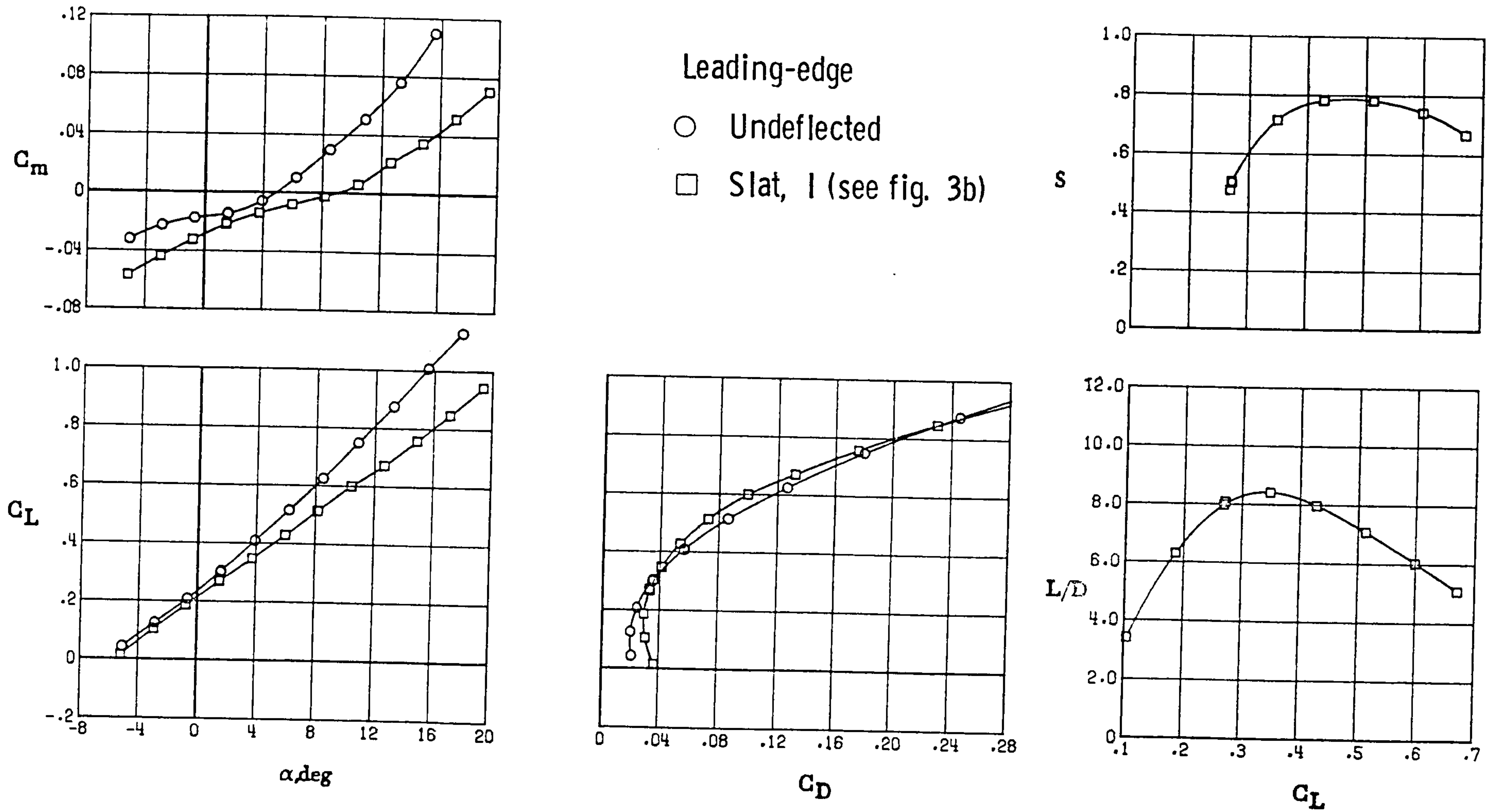
(a) Vertical fins on, $\delta_f = 0°$

Figure 8.- Effect Of Leading-Edge Slat On Longitudinal Aerodynamic Characteristics.



(b) Vertical fins off, $\delta_f = 0°$.

Figure 8. - Continued



(c) Vertical fins off, $\delta_f = 20°$.

Figure 8.- Concluded

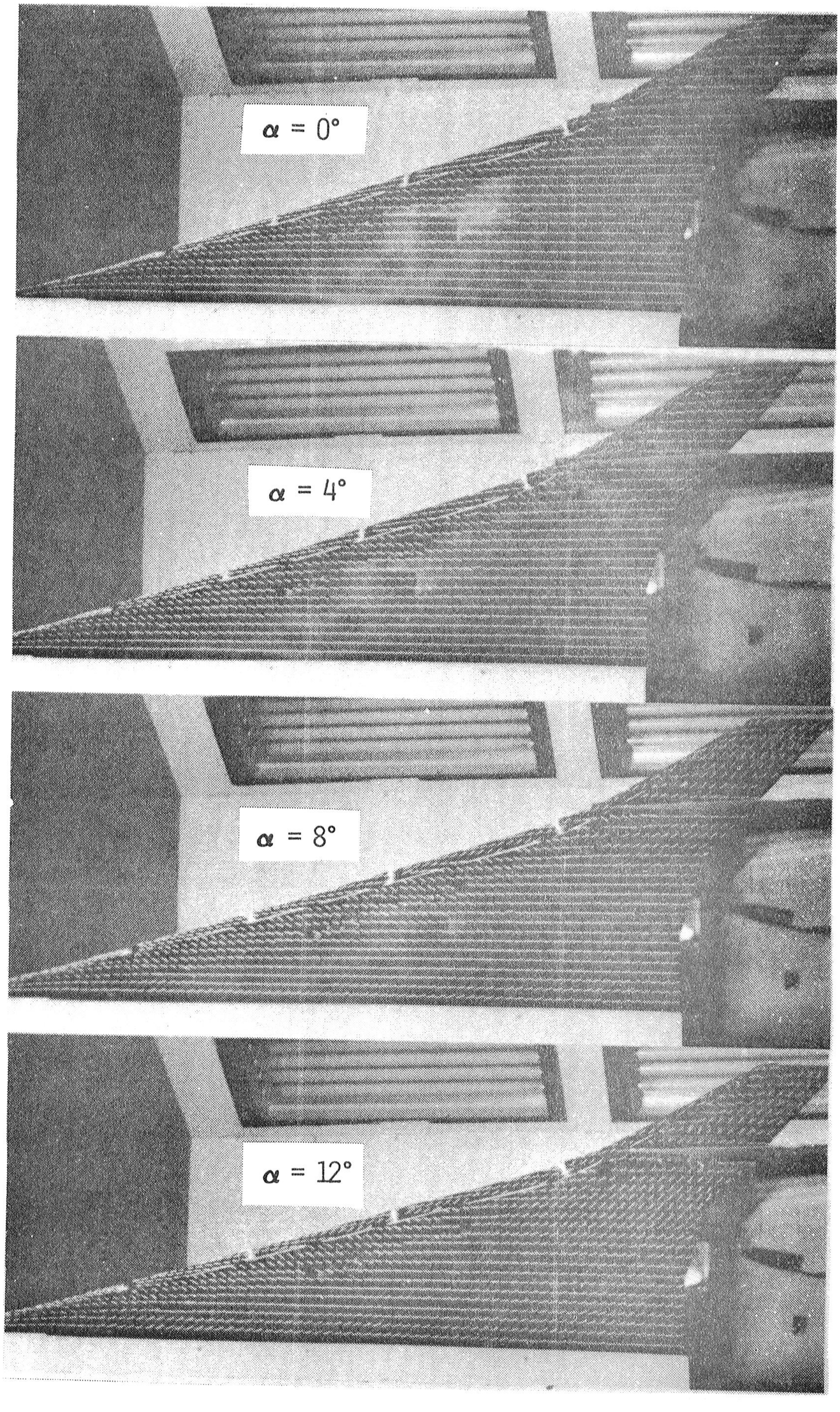
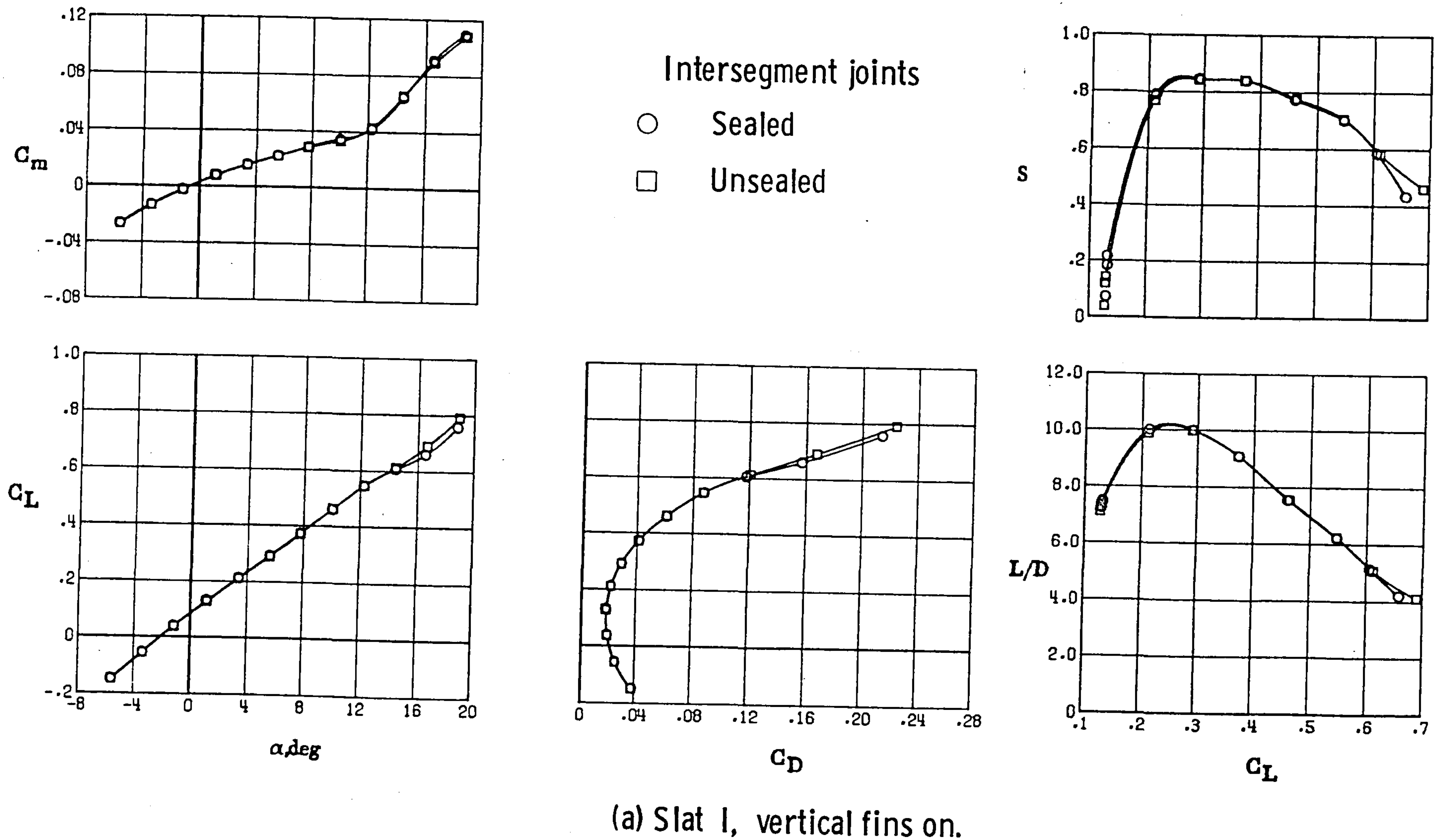
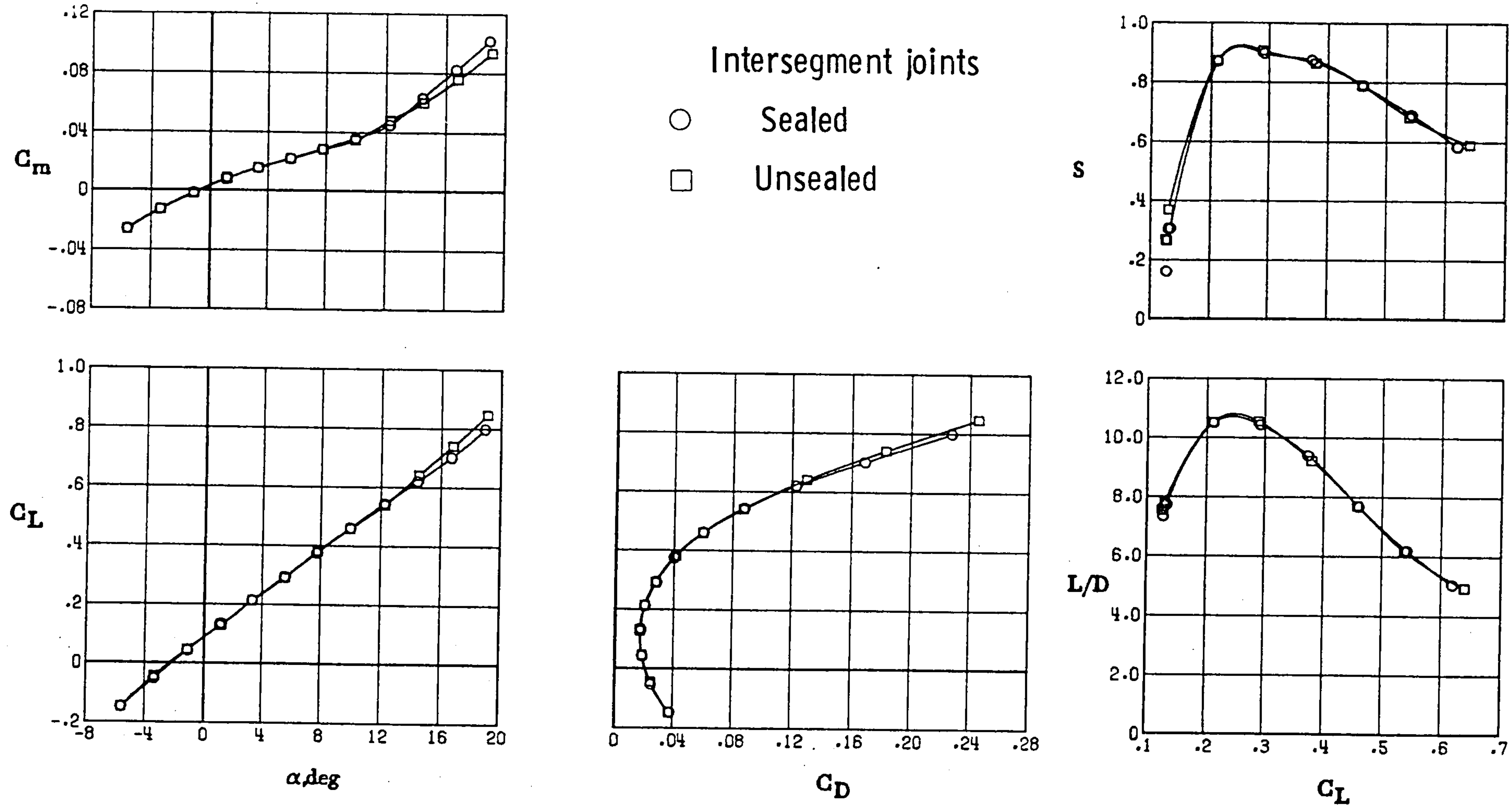


Figure 9. - Tuft Photographs of the Configuration With Leading Edge Slats.



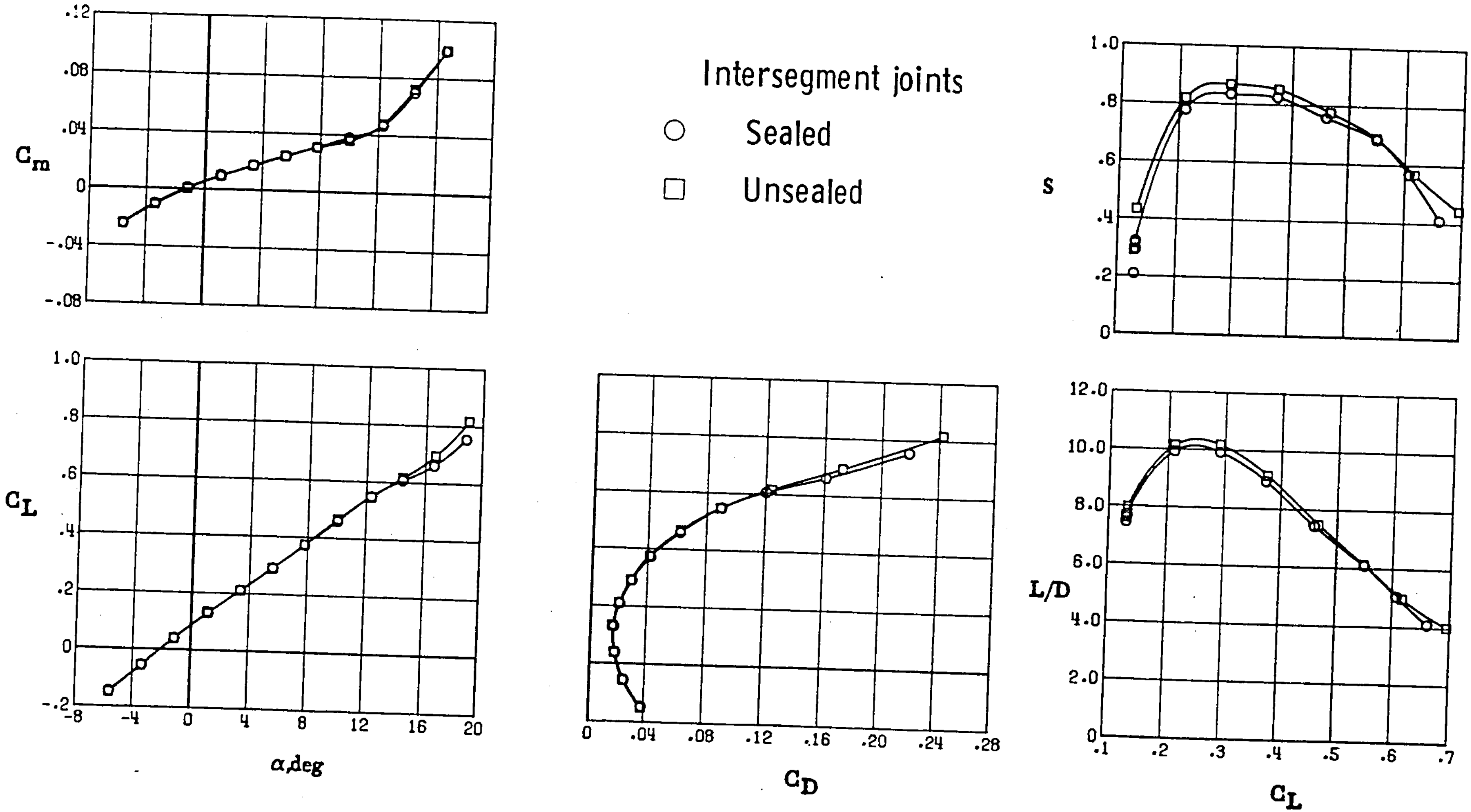
(a) Slat I, vertical fins on.

Figure 10. - Effect Of Sealing Intersegment Joints Of Leading Edge Slat Configurations. $\delta_f = 0°$



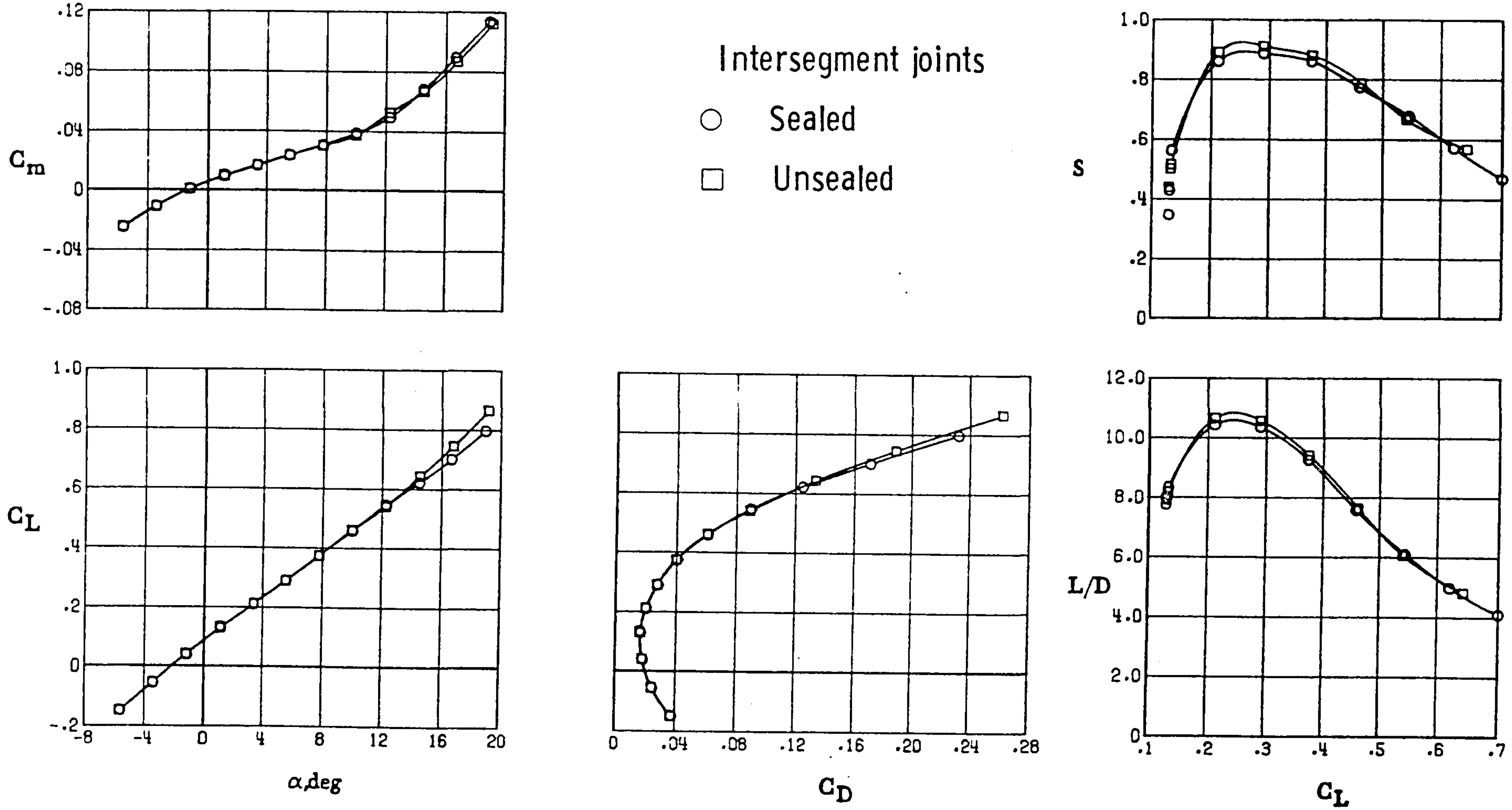
(b) Slat I, vertical fins off

Figure 10.- Continued



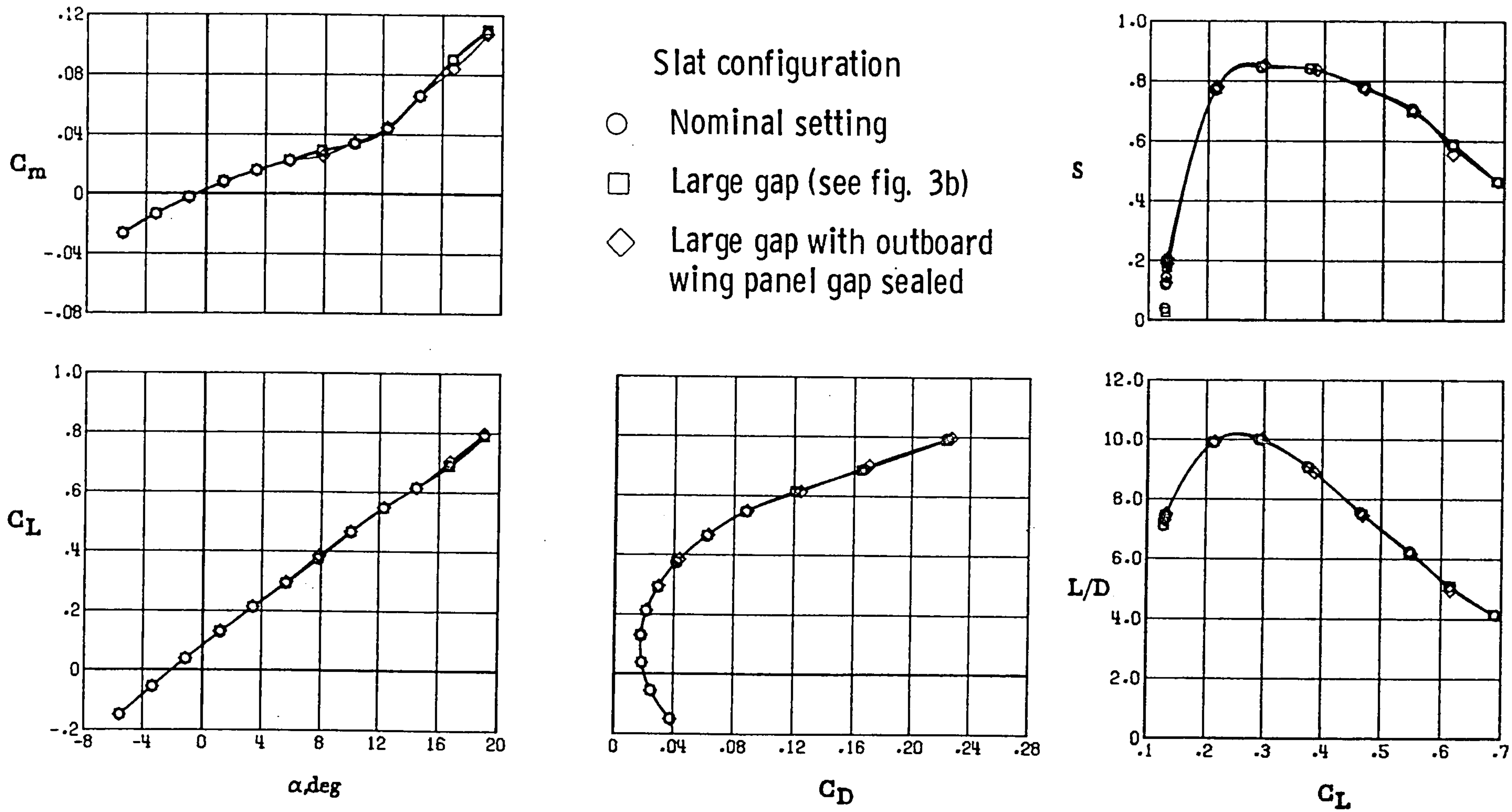
(c) Slat II, vertical fins on.

Figure 10.- Continued



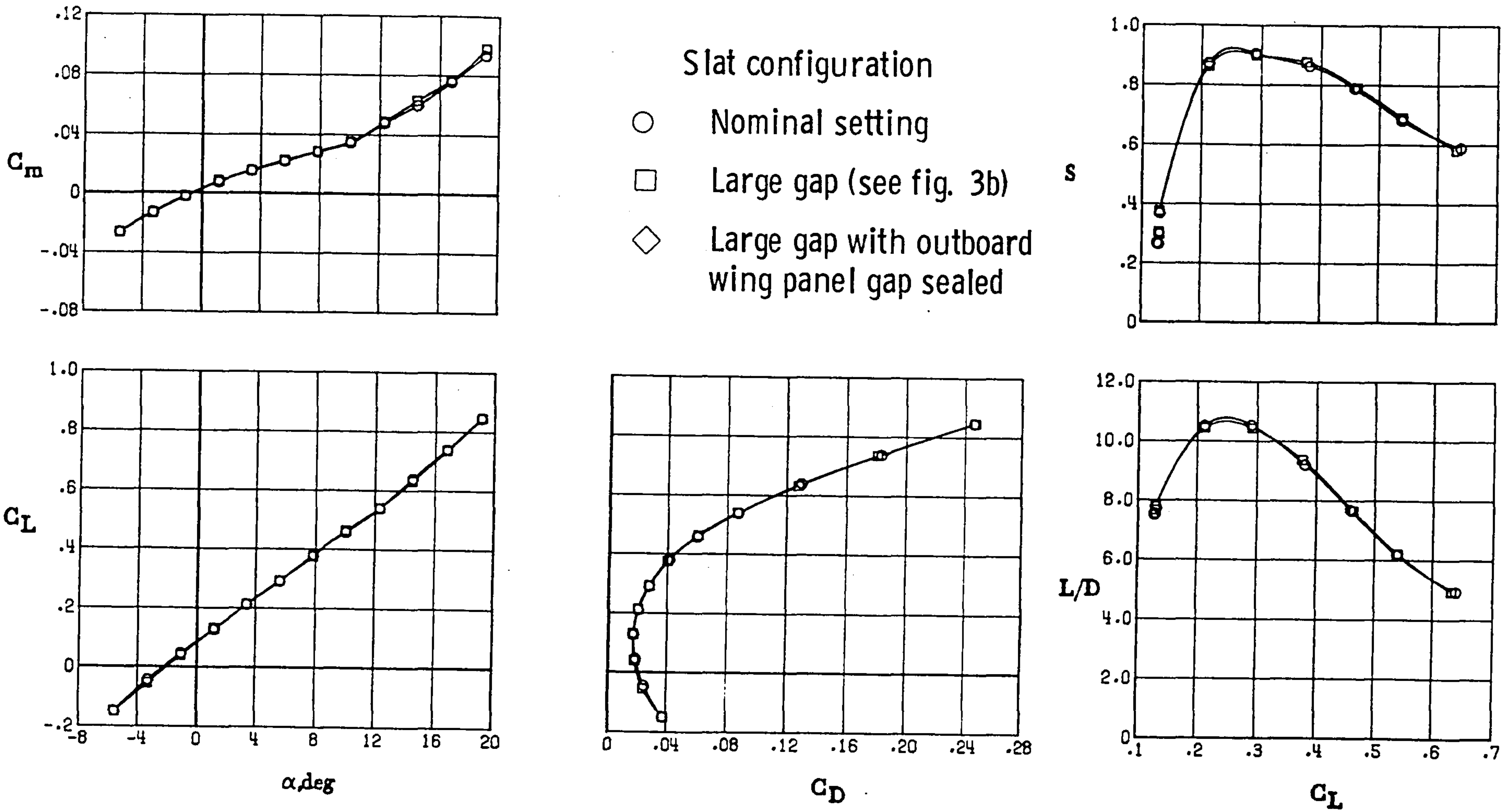
(d) Slat II, vertical fins off.

Figure 10.- Concluded



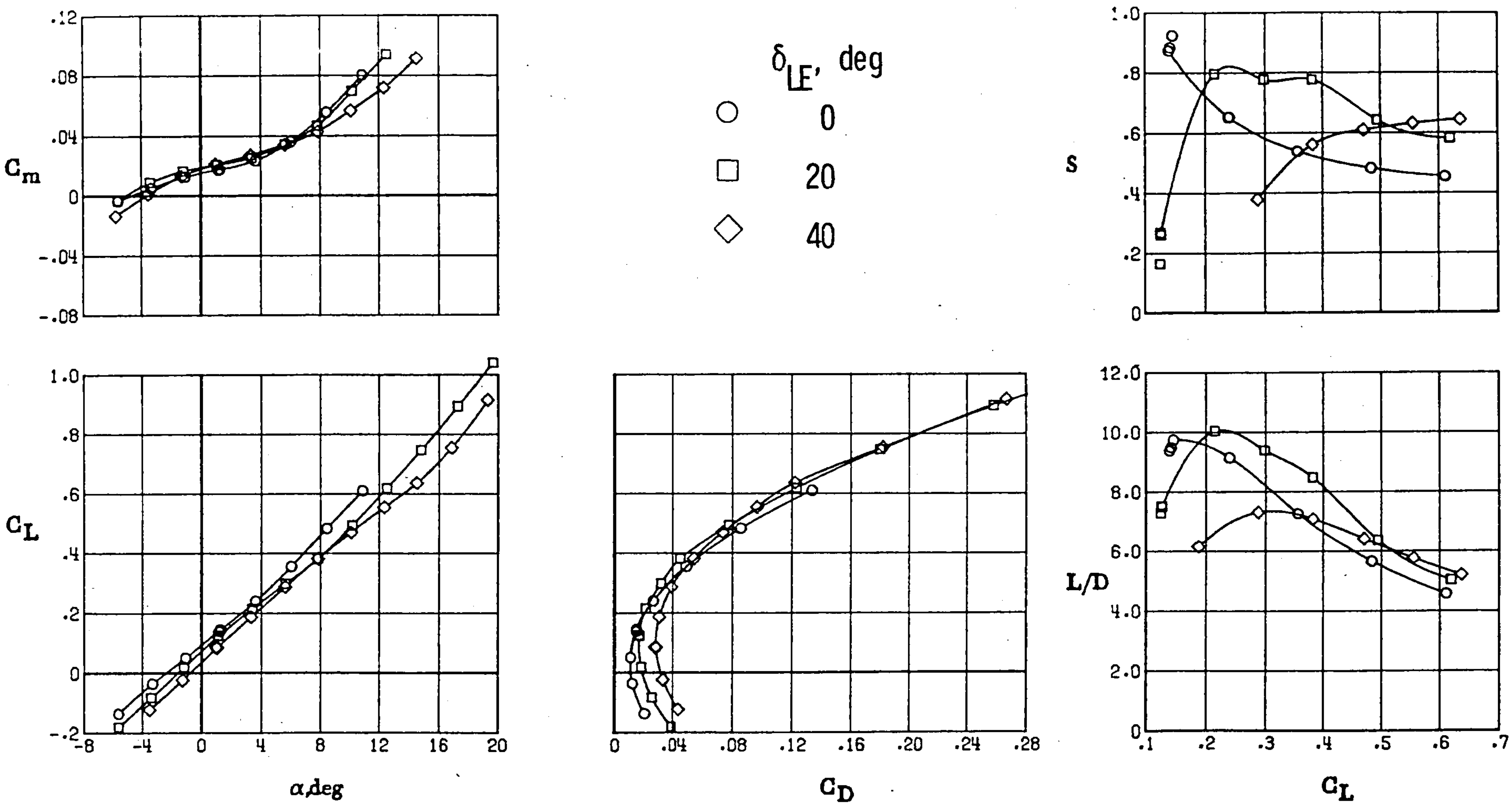
(a) Vertical fins on.

Figure 11.- Effect Of Slat Gap. Slat I.



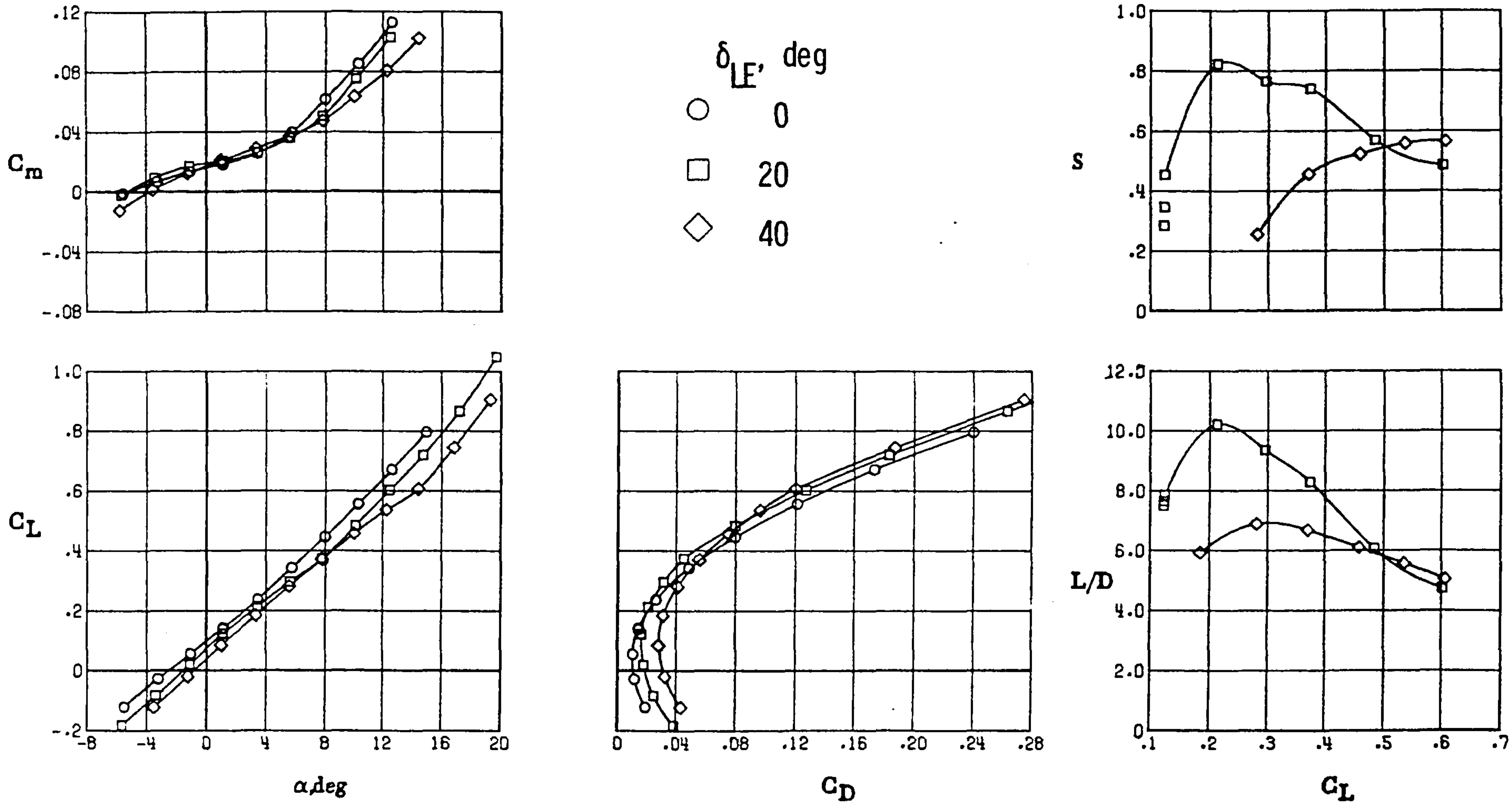
(b) Vertical fins off.

Figure 11. - Concluded



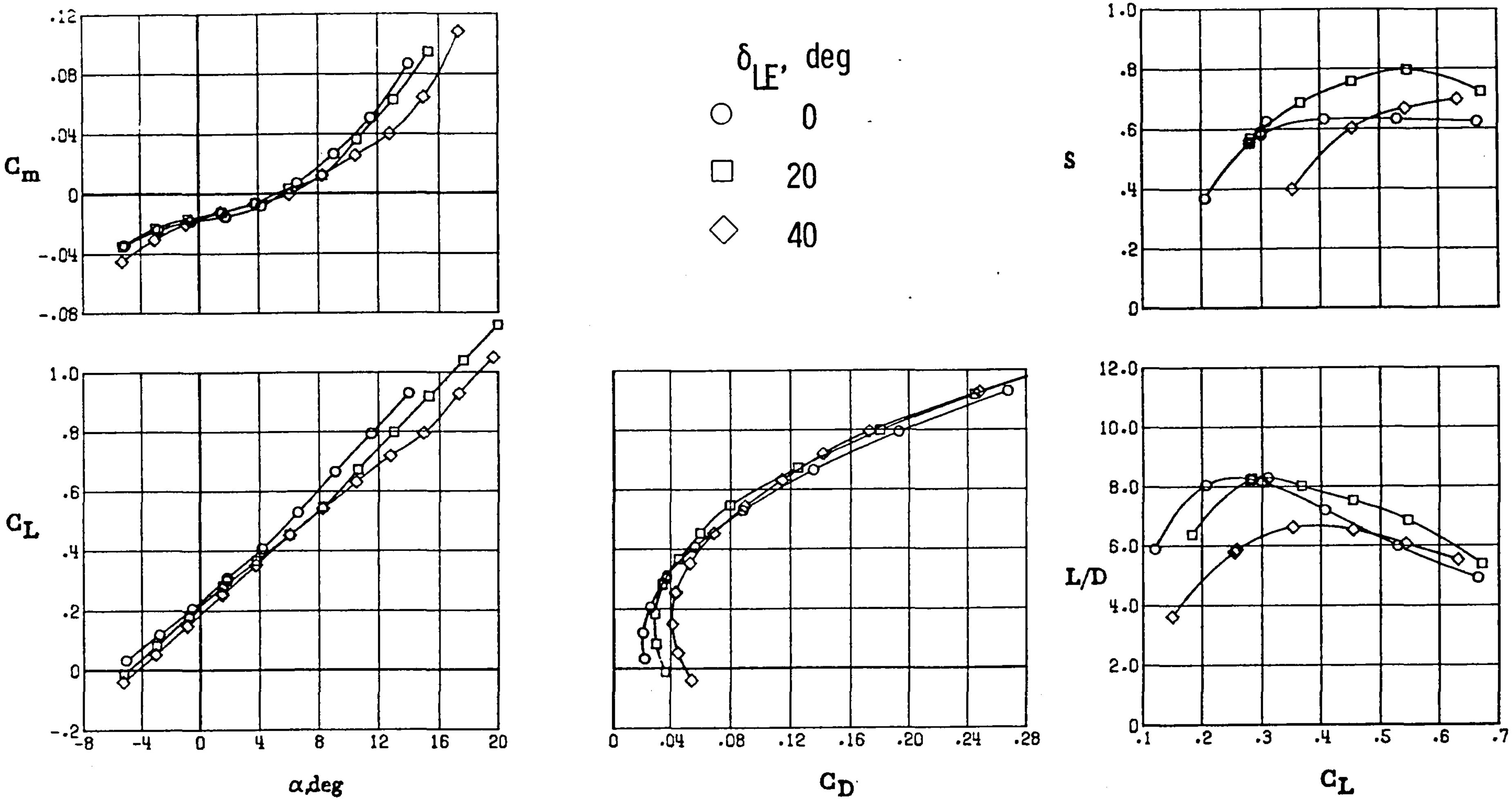
(a) Vertical fins on, $\delta_f = 0°$.

Figure 12. - Effect Of Variable Chord Leading-Edge Deflection On Longitudinal Aerodynamic Characteristics



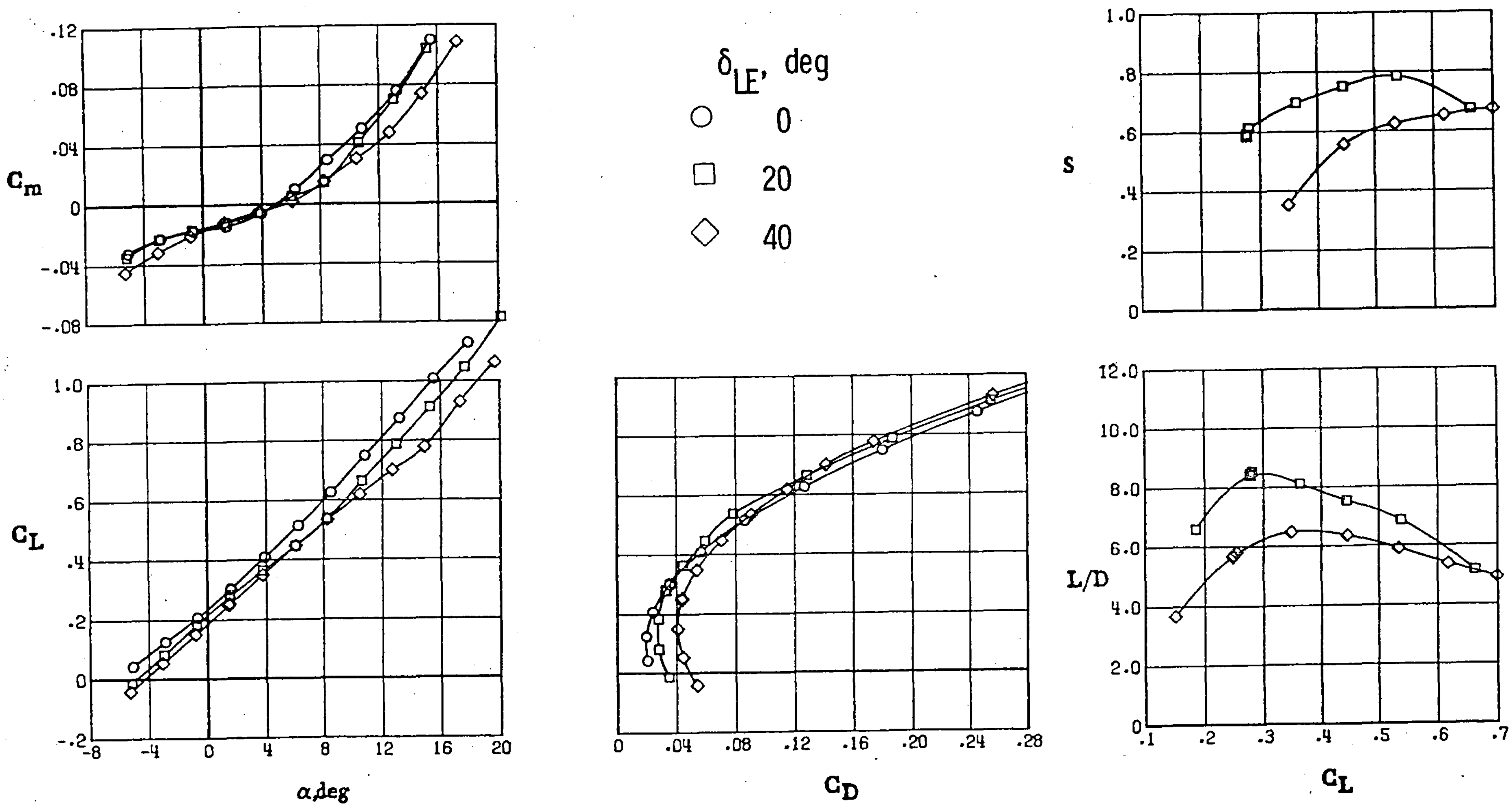
(b) Vertical fins off, $\delta_f = 0°$.

Figure 12. - Continued.



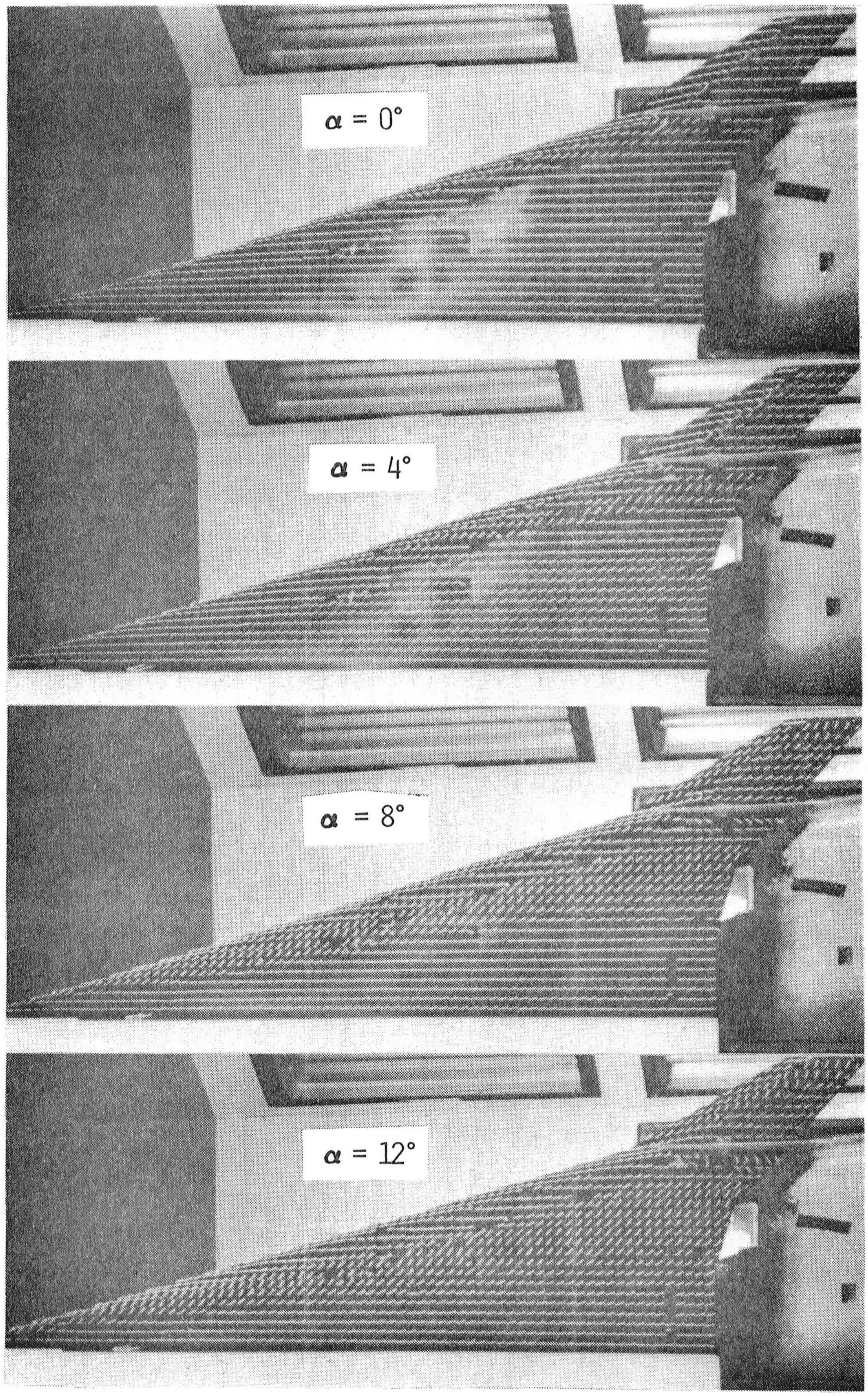
(c) Vertical fins on, $\delta_f = 20°$.

Figure 12. - Continued



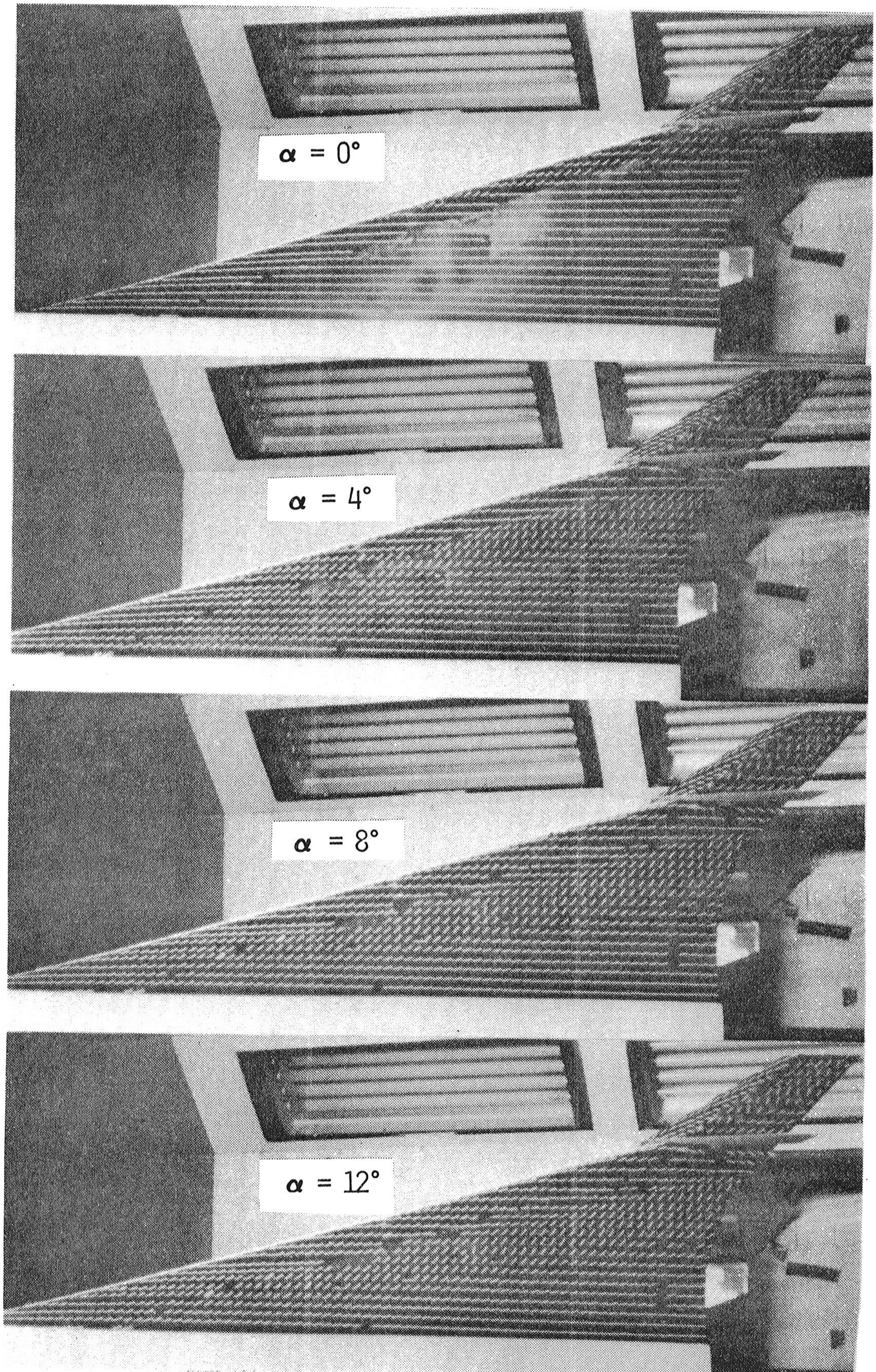
(d) Vertical fins off, $\delta_f = 20°$.

Figure 12. - Concluded



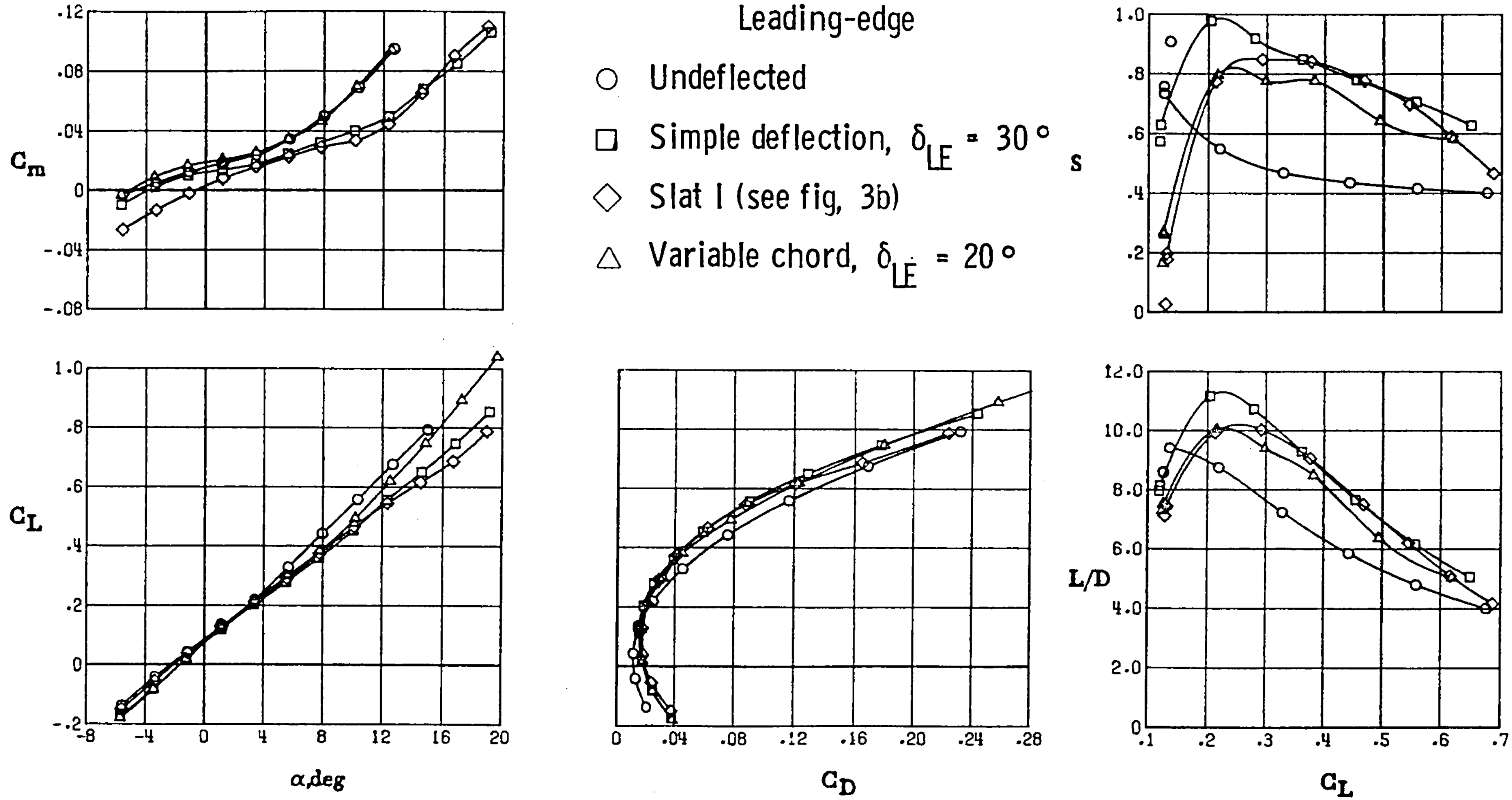
(a) $\delta_{LE} = 20^{o}$.

Figure 13. - Tuft Photographs of the Configuration With Variable Chord Leading Edge.



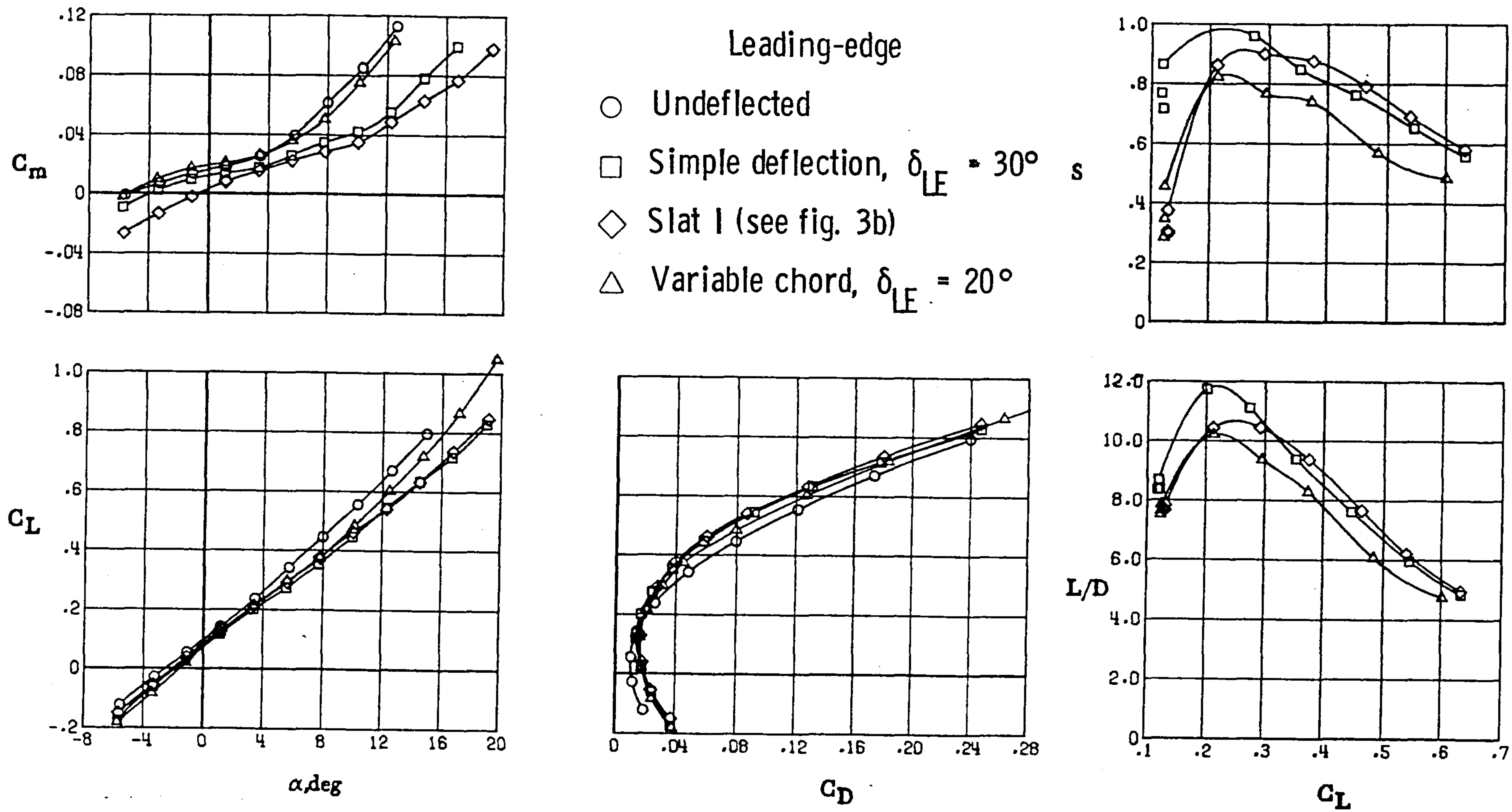
(b) $\delta_{LE} = 40^{\circ}$.

Figure 13. - Concluded.



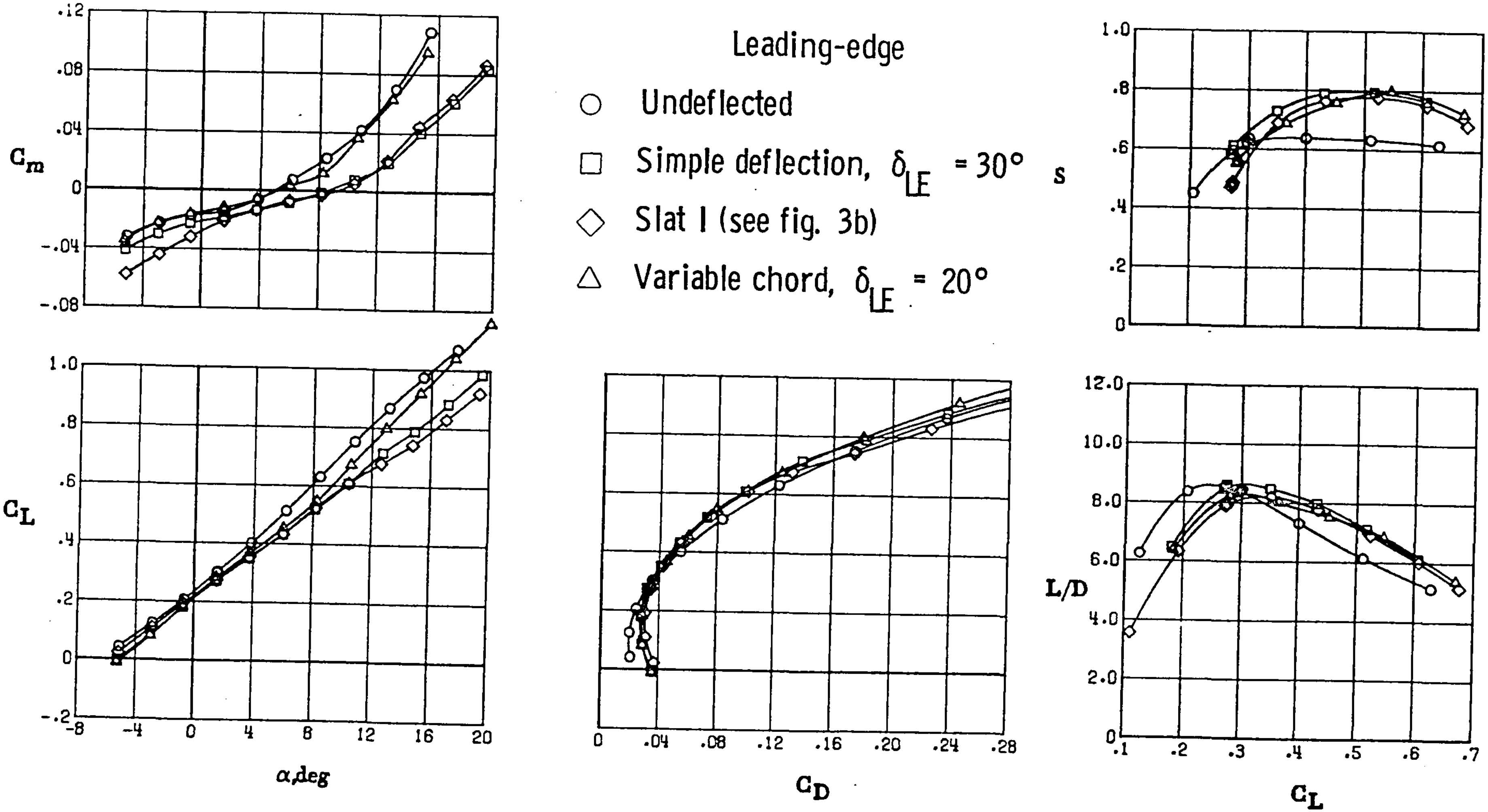
(a) Vertical fins on, $\delta_f = 0°$.

Figure 14. - Comparison Of Longitudinal Aerodynamic Characteristics Of Configuration With Various Leading-Edge Devices.



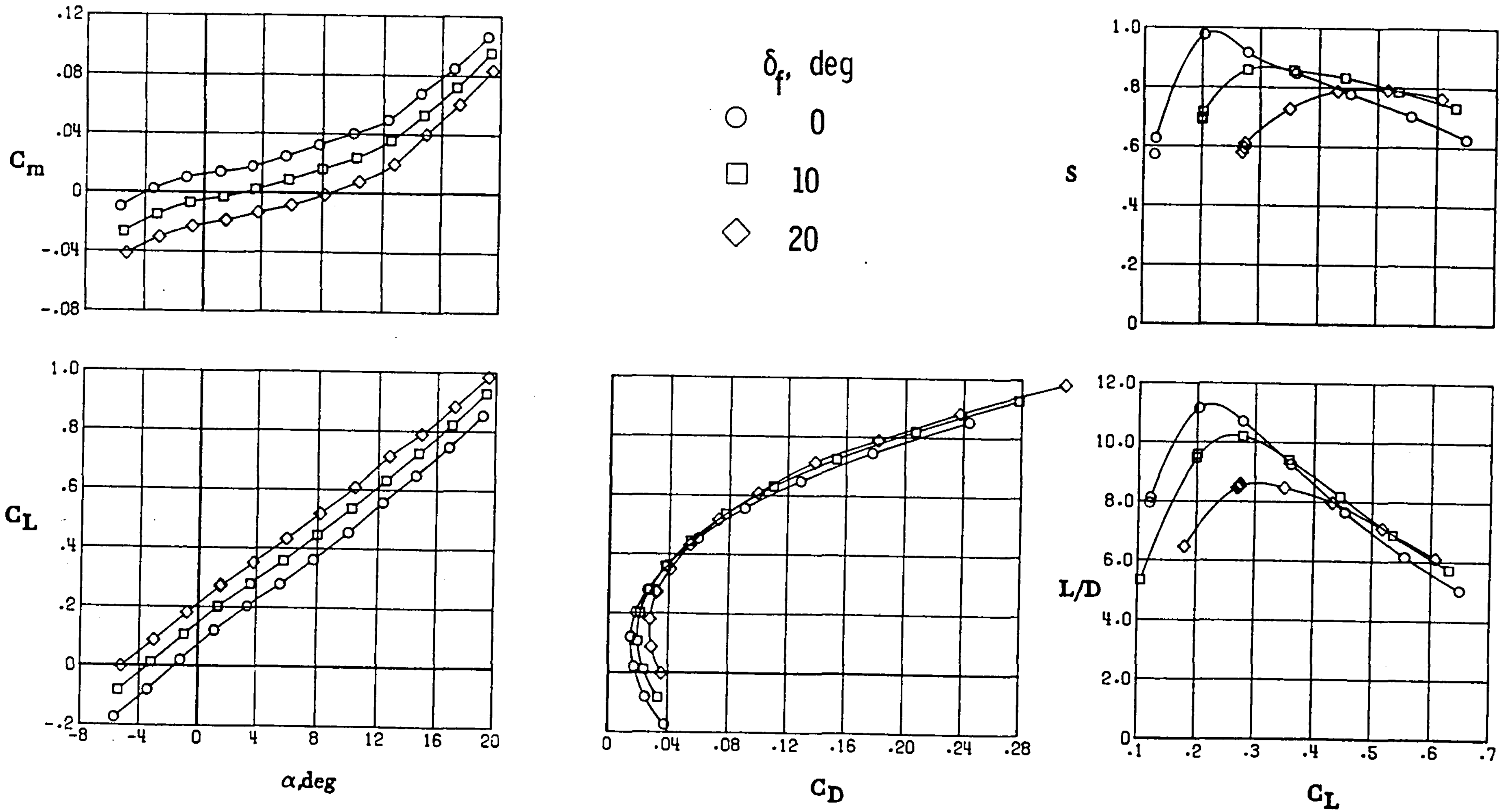
(b) Vertical fins off, $\delta_f = 0°$

Figure 14. - Continued



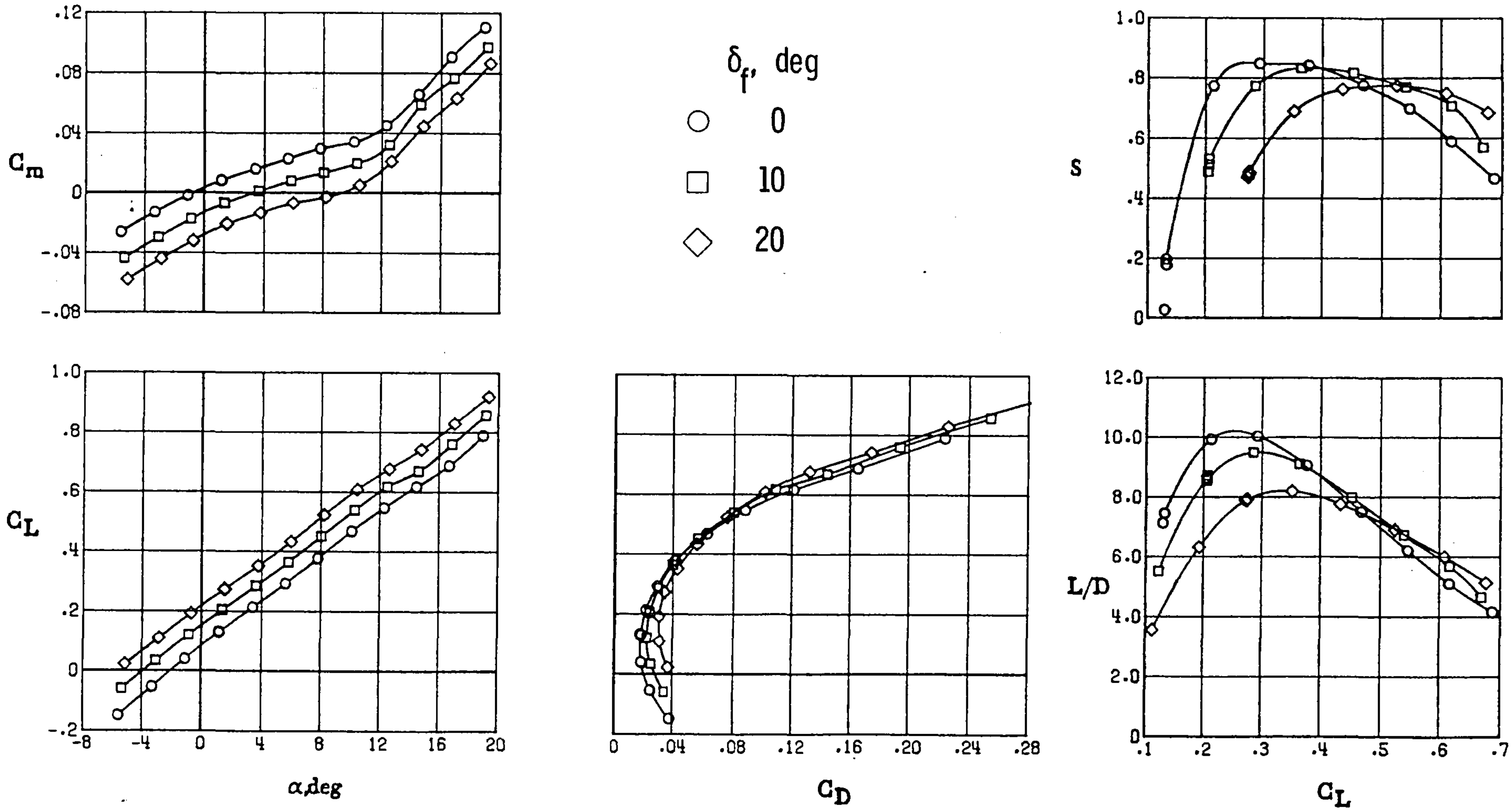
(c) Vertical fins on, $\delta_f = 20°$.

Figure 14. - Concluded



(a) Simple leading edge, $\delta_{L.E.} = 30^{\circ}$

Figure 15.- Effect Of Trailing Edge Flap Deflection On Longitudinal Aerodynamic Characteristics



(b) Slat I.

Figure 15. - Concluded

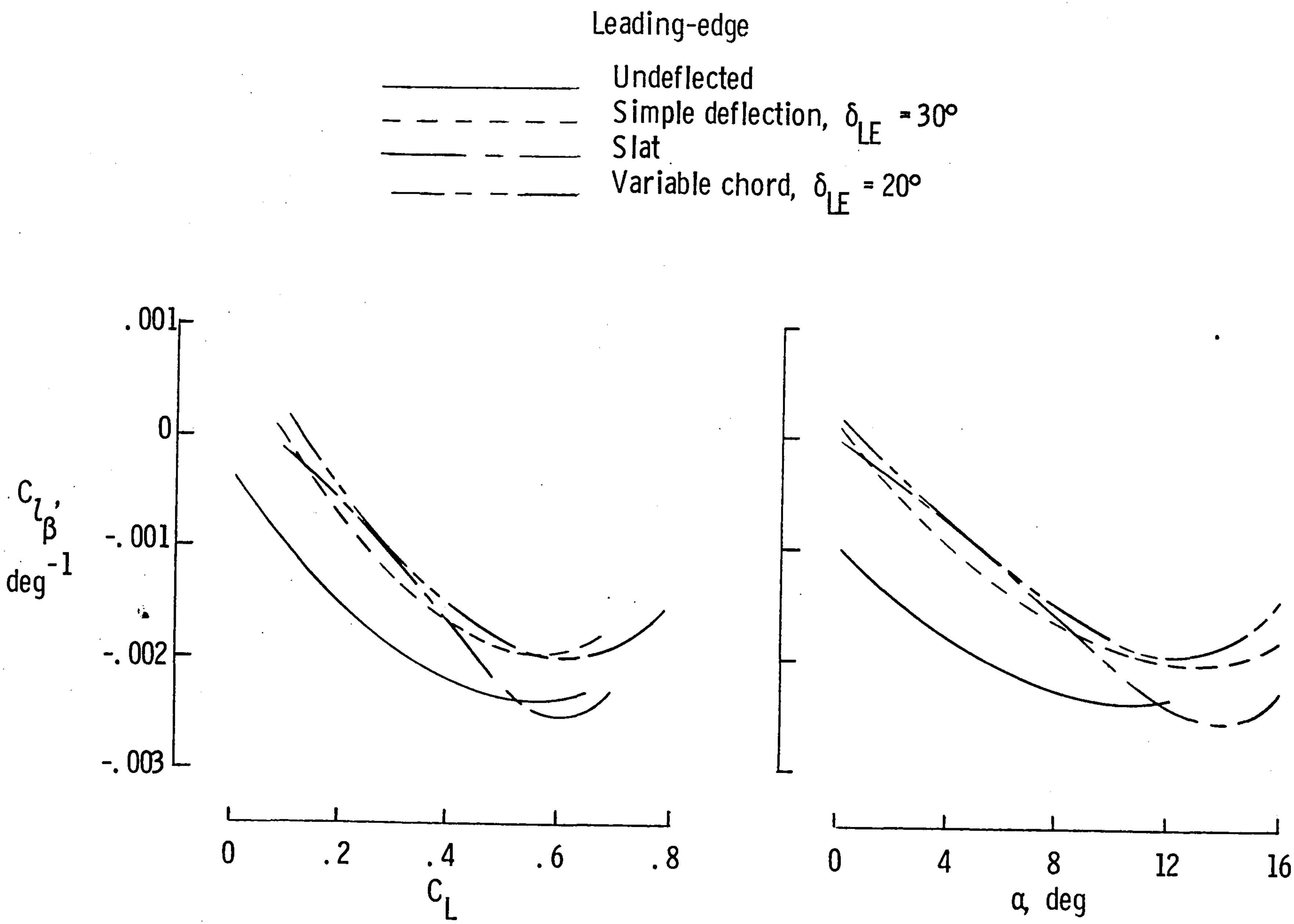


Figure 16. - Influence Of Leading-Edge Configuration On Effective Dihedral.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-172531		

4. Title and Subtitle	5. Report Date
EFFECTS OF LEADING-EDGE DEVICES ON THE LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A HIGHLY-SWEPT ARROW-WING	February 1985
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Samuel J. Scott, Oran W. Nicks and P. K. Imbrie	
9. Performing Organization Name and Address	10. Work Unit No.
TEKWORLD Company Drawer 9005, Briarfield Station Hampton, VA 23670	11. Contract or Grant No. P.O. L-69215B
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered Contractor Report
National Aeronautics and Space Administration Washington, DC 20546	14. Sponsoring Agency Code 505-43-43-01

15. Supplementary Notes

Langley Technical Monitors: Samuel M. Dollyhigh and Domenic J. Maglieri

16. Abstract

An investigation was conducted in the Texas A&M University 7-by 10-foot Low-Speed Wind Tunnel to provide a direct comparison of the effect of several leading-edge devices on the aerodynamic performance of a highly-swept wing configuration. The tests were conducted over an angle-of-attack range of -6° to 16°, for a Mach number of 0.21 and a Reynolds number (based on the mean aerodynamic chord) of 4.1×10^6.

Analysis of the data indicates that for the configuration with undeflected leading edges, vortex separation first occurs on the outboard wing panel for angles of attack of approximately 2°, and wing apex vorticies become apparent for $\alpha \geq 4°$. However, the occurence of the leading-edge vortex flow may be postponed with leading-edge devices. Of the devices considered, the most promising were a simple leading-edge deflection of 30°, and a leading-edge slat system. The trailing-edge flap effectiveness was found to be essentially the same for the configuration employing either of these more promising leading-edge devices.

Analysis of the lateral-directional data showed that for all of the concepts considered, deflecting leading edge downward in an attempt to postpone leading-edge vortex flows, has the favorable effect of reducing the effective dihedral.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Leading-Edge Devices Supersonic Transports Low Speed Aerodynamics	UNCLASSIFIED - UNLIMITED STAR CATEGORY 02 - AERODYNAMICS

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	66	A04

For sale by the National Technical Information Service, Springfield, Virginia 22161