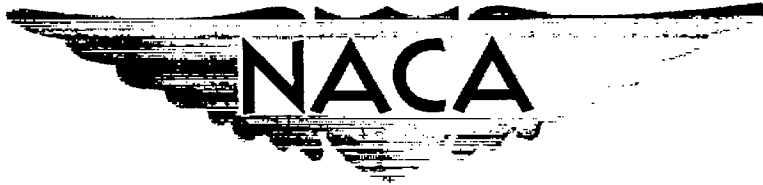


~~CONFIDENTIAL~~  
UNCLASSIFIED

c.2

NACA RM A57K26



# RESEARCH MEMORANDUM

STATIC STABILITY AND CONTROL OF CANARD CONFIGURATIONS  
AT MACH NUMBERS FROM 0.70 TO 2.22 - LONGITUDINAL  
CHARACTERISTICS OF A TRIANGULAR  
WING AND UNSWEPT CANARD

By Victor L. Peterson and Gene P. Menees

CLASSIFIED AS ~~CONFIDENTIAL~~ Langley Aeronautical Laboratory  
Moffett Field, Calif.

**LIBRARY COPY**

FEB 18 1958

To UNCLASSIFIED

LANGLEY AERONAUTICAL LABORATORY  
LIBRARY, NACA  
LANGLEY FIELD, VIRGINIA

By authority of TPA # 17 *Effective* Date 3/18/40  
*95D*

CLASSIFIED DOCUMENT

This material contains information affecting the National Defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

## NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

17 1958

~~CONFIDENTIAL~~

UNCLASSIFIED

## NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

## STATIC STABILITY AND CONTROL OF CANARD CONFIGURATIONS

## AT MACH NUMBERS FROM 0.70 TO 2.22 - LONGITUDINAL

## CHARACTERISTICS OF A TRIANGULAR

## WING AND UNSWEPT CANARD

By Victor L. Peterson and Gene P. Menees

## SUMMARY

The results of an investigation of the static longitudinal stability and control characteristics of a canard airplane configuration are presented without analysis for the Mach number range from 0.70 to 2.22. The configuration consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, a low aspect ratio vertical tail, and a Sears-Haack body. The hinge line of the canard was in the extended chord plane of the wing, 1.15 wing mean aerodynamic chords ahead of the reference center of moments. The ratio of the area of the exposed canard panels to the total area of the wing was 8.1 percent. Data are presented for various combinations of the canard, wing, and vertical tail for an angle-of-attack range from  $-6^{\circ}$  to  $+18^{\circ}$ . The canard deflection angles ranged from  $0^{\circ}$  to  $+20^{\circ}$ .

## INTRODUCTION

The possible gains to be realized at supersonic speeds in the form of reduced trim drag and increased maneuverability by the use of canards rather than conventional tail-aft controls have resulted in increased interest in these arrangements. Therefore, an extensive research program aimed at determining the static longitudinal and directional characteristics of a number of canard configurations has been undertaken by the NACA.

A part of the program conducted at the Ames Aeronautical Laboratory was directed at determining the effects of canard plan form. This report is one of a series pertaining to the program and presents without analysis the longitudinal characteristics of one complete configuration and

its component parts. This configuration, which differed from that of reference 1 only in the canard plan form, consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, a low aspect ratio vertical tail, and a Sears-Haack body.

The longitudinal stability and control characteristics for a similar configuration with an aspect ratio 2.0 triangular canard are presented in reference 1. Results from another phase of the investigation are reported in reference 2.

#### NOTATION

a.c.	aerodynamic center determined at $C_L = 0$ , percent $\bar{c}$
$\bar{c}$	mean aerodynamic chord of wing, ft
$c_c$	canard root chord, ft
$C_D$	drag coefficient, $\frac{\text{drag}}{qS}$
$C_{D_0}$	drag coefficient at zero lift
$C_L$	lift coefficient, $\frac{\text{lift}}{qS}$
$C_{L_\alpha}$	lift-curve slope taken through zero angle of attack, per deg
$C_m$	pitching-moment coefficient, $\frac{\text{pitching moment}}{qS\bar{c}}$ , referred to the projection of the $0.15\bar{c}$ point on the fuselage reference line (Center of moments for data in ref. 1 was obtained by projection of the $0.21\bar{c}$ point on fuselage reference line.)
$C_{h_c}$	canard hinge-moment coefficient, $\frac{\text{canard hinge moment}}{qS_c(c_c/2)}$ , referred to the projection of the $0.50c_c$ point on the fuselage reference line
$C_{z_c}$	force coefficient normal to canard, $\frac{\text{canard normal force}}{qS}$
$\left(\frac{L}{D}\right)_{\text{max}}$	maximum lift-drag ratio
M	free-stream Mach number
q	free-stream dynamic pressure, lb/sq ft

- S wing area formed by extending the leading and trailing edges to the plane of symmetry, sq ft
- $S_c$  canard exposed area, sq ft
- $\alpha$  angle of attack of wing root chord, deg
- $\delta$  angle of deflection of the canard with respect to the extended wing chord plane, positive when trailing edge is down, deg

Configurations are denoted by the following letters used in combination:

- B body
- C canard
- V vertical tail
- W wing

#### APPARATUS AND MODEL

##### Test Facility

The experimental data were obtained in the Ames 6- by 6-foot supersonic wind tunnel which is a closed-circuit variable-pressure type with a Mach number range continuous from 0.70 to 2.22. A recent modification involved perforating the test-section floor and ceiling and adding a boundary-layer removal system to enable uniform flow to be maintained at transonic and low supersonic speeds. At the same time injector flaps were installed downstream of the test section to extend the upper Mach number limit by reducing the required compression ratio across the nozzle and by better matching the weight flow characteristics of the nozzle with those of the compressor.

Analysis of the results of an extensive survey of the modified wind-tunnel characteristics, although incomplete, is sufficiently complete to establish the validity of the results of the present investigation.

##### Description of Model and Balances

The sting-mounted model consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, and a low aspect ratio vertical tail, all mounted on a fineness ratio 12.5 Sears-Haack body. A dimensional sketch of the model is shown in figure 1(a). The wing and vertical tail

had NACA 0003-63 sections streamwise and the constant thickness canard, detailed in figure 1(b), had beveled leading and trailing edges. The canard, which was pivoted about the 0.50 canard root chord, was mounted in the extended wing chord plane 1.15 wing mean aerodynamic chords ahead of the reference center of moments (0.15 $\bar{c}$ ). The ratio of the area of the exposed canard panels to the total area of the wing was 8.1 percent and the ratio of the total areas was 11.5 percent. The wing, canard, and vertical tail were of solid steel construction to minimize aeroelastic effects. The surfaces were polished to give a smooth surface and further treated to prevent corrosion.

The fuselage was cut off as shown in figure 1(a) to accommodate the sting and the six-component strain-gage balance which measured forces and moments on the entire configuration. Canard normal forces and hinge moments were obtained from a two-component strain-gage balance mounted in the nose of the fuselage. The canard, wing, and vertical tail were removable, enabling data to be taken which would permit an evaluation of the contribution of each of the component parts of the model and the interference between parts.

## TEST AND PROCEDURES

### Range of Test Variables

Mach numbers of 0.70, 0.90, 1.00, 1.10, 1.30, 1.70, and 2.22 were covered in the investigation. The test Reynolds number based on the wing mean aerodynamic chord was 1.84 million at Mach numbers of 1.00 and 1.10, and 3.68 million at all other Mach numbers. The smaller Reynolds number at transonic speeds was necessary because of model structural limitations.

At the relatively low Reynolds numbers at which most wind tunnels operate, extensive regions of laminar flow can exist on models at zero lift. At lifting conditions the transition points on the model surfaces usually move forward, thus causing a change in friction drag with changing lift coefficient which is difficult to evaluate and, moreover, not necessarily representative of full scale. In order to induce transition at fixed locations on the component parts, a 0.010-inch-diameter wire was placed on the wing and 0.005-inch-diameter wires were affixed to the canard and vertical tail in the locations shown in figure 1(a). When the model was tested with the canard off, a 0.010-inch-diameter wire was located on the body 4 inches from the nose. The wire sizes were selected on the basis of the results of reference 3. Although there is no conclusive evidence as to the magnitude of the form drag increment contributed by the transition wires, previous studies have indicated this increment to be not more than 0.0010. All of the data presented herein are for transition-fixed conditions.

## Reduction of Data

The data presented herein have been reduced to standard NACA coefficient form. The moment center for data presented herein was chosen so that the minimum static margin in the range of trim lift coefficients between 0 and 0.5 throughout the Mach number range investigated was 0.03c; the resulting moment center was at the 0.15 point of the wing mean aerodynamic chord.<sup>1</sup> The canard hinge moments were computed about a hinge line located at the 0.50 point of the canard root chord. Factors which affect the accuracy of the results are discussed in the following paragraphs.

Stream variations.- Surveys of the stream characteristics of the Ames 6- by 6-foot supersonic wind tunnel showed that in the region of the test section, essentially no stream curvature existed in the pitch plane of the model and that axial static-pressure variations were usually less than  $\pm 1$  percent of the dynamic pressure. This static-pressure variation resulted in negligible longitudinal-buoyancy corrections to the drag of this model. Therefore, no corrections for stream curvature or static-pressure variation were made in the present investigation.

From a test of the model in the normal and inverted attitudes, a stream angle, which was less than  $\pm 0.30^\circ$  throughout the Mach number range, was found to exist in the pitch plane. The data presented herein have been corrected for these stream angles which correlated closely with those obtained from a cone survey.

Support interference.- The effects of model support interference on the aerodynamic characteristics were considered to consist primarily of a change in the pressure at the base of the model. However, the drag data presented herein contain no base drag component since the base pressure was measured and the drag was adjusted to correspond to that in which the base pressure is equal to the free-stream static pressure; therefore, no corrections were made to take into account support interference.

Tunnel-wall interference.- The effectiveness of the perforations in the wind-tunnel test section in preventing choking and absorbing reflected disturbances at transonic and low supersonic speeds has been established experimentally. Unpublished data from the wind-tunnel calibration indicate that reliable data can be obtained throughout the Mach number range if certain restrictions are imposed on the model size and attitude. The configurations and methods of testing used in the present investigation

---

<sup>1</sup>A similar stability criterion was used to select the center of moments for the data presented in reference 1; the resulting center of moments was, however, at the 0.21 point of the wing mean aerodynamic chord.

conform to these restrictions so that data at transonic and low supersonic speeds are reasonably free of interference effects. Thus, no corrections for wall interference have been made.

## RESULTS

The results are presented in this report without analysis in order to expedite publication. All of the experimental data are tabulated in tables I and II. Selected portions of the data are presented in figures 2 through 4. Lift, drag, and pitching-moment characteristics are presented in figure 2 for several test Mach numbers for the canard on and off. Figure 3 shows the variations of canard normal forces and hinge moments as a function of angle of attack at constant canard deflection angles. Summarized in figure 4 are the lift-curve slopes, maximum lift-drag ratios, minimum drag coefficients, and aerodynamic centers as a function of Mach number for the canard on at zero deflection and for the canard off.

Ames Aeronautical Laboratory  
National Advisory Committee for Aeronautics  
Moffett Field, Calif., Nov. 26, 1957

## REFERENCES

1. Boyd, John W., and Peterson, Victor L.: Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Longitudinal Characteristics of a Triangular Wing and Canard. NACA RM A57J15, 1957.
2. Boyd, John W., and Peterson, Victor L.: Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Triangular Wing and Canard on an Extended Body. NACA RM A57K14, 1958.
3. Winter, K. G., Scott-Wilson, J. B., and Davies, F. V.: Methods of Determination and of Fixing Boundary-Layer Transition on Wind Tunnel Models at Supersonic Speeds. R.A.E. TN Aero 2341, British, Sept. 1954.

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON  
(a) BVW

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$
0.70	-6.4	-0.311	0.0404	0.0792	1.00	-5.8	-0.347	0.0483	0.1233	1.30	-6.0	-0.291	0.0418	0.1070	2.22	-5.9	-0.185	0.0308	0.0624
	-4.2	-.196	.0214	.0507		-3.8	-.222	.0295	.0807		-4.0	-.189	.0254	.0691		-3.6	-.114	.0191	.0383
	-2.2	-.101	.0130	.0268		-1.8	-.109	.0174	.0409		-2.0	-.093	.0169	.0384		-1.7	-.057	.0139	.0200
	-7	-.039	.0107	.0131		-.3	-.031	.0149	.0156		-5	-.026	.0145	.0102		-.3	-.013	.0124	.0060
	-2	-.018	.0104	.0080		.2	-.007	.0154	.0060		0	-.005	.0139	.0038		.2	.003	.0123	.0009
	.4	.004	.0103	.0041		.7	.024	.0155	-.0036		.6	.019	.0145	-.0041		.8	.022	.0126	-.0046
	1.9	.066	.0113	-.0114		2.2	.104	.0178	-.0299		2.1	.087	.0167	-.0286		2.2	.068	.0145	-.0204
	3.9	.164	.0183	-.0356		4.2	.222	.0288	-.0710		4.0	.181	.0246	-.0617		4.2	.129	.0207	-.0407
	5.8	.260	.0317	-.0591		6.3	.345	.0490	-.1131		6.0	.278	.0399	-.0951		6.2	.187	.0309	-.0790
	7.8	.368	.0538	-.0858		8.2	.459	.0768	-.1503		8.0	.374	.0620	-.1286		8.3	.244	.0453	-.0774
	9.8	.478	.0844	-.1117		10.3	.580	.1153	-.1891		10.0	.470	.0910	-.1625		10.2	.300	.0629	-.0945
	11.7	.588	.1210	-.1379		12.2	.686	.1585	-.2228		12.0	.562	.1264	-.1952		12.3	.357	.0862	-.1116
	13.8	.702	.1681	-.1664		14.2	.792	.2089	-.2592		14.1	.650	.1677	-.2273		14.2	.409	.1115	-.1260
	15.8	.808	.2225	-.1897		16.3	.897	.2704	-.2966		16.1	.735	.2146	-.2565		16.2	.465	.1426	-.1404
	17.8	.919	.2862	-.2146		18.2	.990	.3326	-.3296		18.1	.809	.2660	-.2808		18.3	.519	.1777	-.1559
0.90	-6.0	-.324	.0411	.0725	1.10	-6.0	-.334	.0484	.1232	1.70	-6.3	-.239	.0376	.0847					
	-3.9	-.202	.0221	.0578		-4.0	-.215	.0294	.0824		-4.1	-.160	.0238	.0568					
	-1.9	-.098	.0125	.0312		-2.0	-.106	.0194	.0427		-2.2	-.084	.0163	.0309					
	-.6	-.037	.0110	.0138		-.4	-.027	.0162	.0162		-.7	-.031	.0140	.0122					
	0	-.012	.0107	.0078		.1	-.004	.0160	.0081		-.1	-.010	.0136	.0050					
	.6	.010	.0107	.0026		.6	.024	.0163	-.0026		.4	.012	.0137	-.0019					
	2.0	.077	.0120	-.0162		2.1	.102	.0186	-.0291		1.8	.065	.0152	-.0203					
	4.0	.180	.0200	-.0448		4.1	.214	.0279	-.0712		3.8	.143	.0215	-.0472					
	6.0	.291	.0370	-.0762		6.1	.330	.0469	-.1133		5.8	.216	.0327	-.0720					
	7.9	.410	.0620	-.1105		8.1	.446	.0723	-.1532		7.8	.290	.0493	-.0973					
	10.0	.540	.0992	-.1518		10.1	.544	.1043	-.1821		9.8	.362	.0721	-.1215					
	12.0	.661	.1434	-.1890		12.1	.636	.1449	-.2170		11.8	.430	.0988	-.1455					
	14.0	.789	.1983	-.2356		14.1	.739	.1934	-.2573		13.9	.499	.1299	-.1684					
	16.0	.913	.2627	-.2814		16.1	.838	.2506	-.2933		15.9	.565	.1666	-.1890					
						18.1	.924	.3105	-.3227		17.9	.627	.2063	-.2068					



TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued  
(b) BVWC;  $\delta = 0.3^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{z_c}$	$C_{h_c}$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{z_c}$	$C_{h_c}$
0.70	-6.3	-0.329	0.0436	0.0296	-0.0412	-0.1329	1.30	-5.8	-0.283	0.0441	0.0450	-0.0382	-0.0486
	-4.2	-.213	.0246	.0207	-.0271	-.1033		-4.0	-.194	.0291	.0313	-.0271	-.0377
	-2.1	-.110	.0155	.0130	-.0139	-.0520		-1.9	-.094	.0200	.0146	-.0143	-.0245
	-.8	-.049	.0121	.0096	-.0054	-.0203		-.5	-.035	.0175	.0055	-.0058	-.0138
	.3	-.002	.0116	.0066	.0008	-.0021		.5	.015	.0171	.0014	.0009	-.0015
	1.7	.060	.0125	.0037	.0096	.0272		2.1	.078	.0195	-.0111	.0097	.0136
	3.9	.161	.0185	-.0028	.0225	.0836		4.1	.176	.0270	-.0267	.0225	.0304
	5.8	.264	.0332	-.0102	.0352	.1236		5.9	.269	.0422	-.0421	.0342	.0404
	7.8	.373	.0557	-.0184	.0486	.1314		8.0	.369	.0647	-.0581	.0466	.0501
	9.8	.494	.0882	-.0309	.0596	.1184		10.0	.474	.0957	-.0735	.0581	.0566
	11.9	.610	.1301	-.0545	.0615	.0796		12.0	.568	.1311	-.0886	.0679	.0624
	13.8	.717	.1761	-.0799	.0607	.0591		14.0	.666	.1742	-.1049	.0780	.0635
	15.8	.824	.2313	-.1009	.0627	.0593		16.2	.761	.2275	-.1246	.0864	.0614
	17.9	.950	.3030	-.1216	.0676	.0612		18.0	.842	.2798	-.1401	.0944	.0536
	0.90	-6.1	-.348	0.0463	0.0364	-.0483		-.1444	1.70	-6.3	-.241	0.0411	0.0375
-4.0		-.227	.0258	.0257	-.0308	-.1218	-4.2	-.170		.0277	.0279	-.0208	-.0122
-1.9		-.109	.0150	.0160	-.0142	-.0524	-2.2	-.092		.0193	.0161	-.0111	-.0065
-.6		-.046	.0120	.0103	-.0054	-.0207	-.8	-.038		.0163	.0075	-.0044	-.0038
.6		.007	.0121	.0057	.0016	.0042	.3	0		.0158	.0019	.0003	-.0021
2.0		.075	.0136	.0001	.0108	.0369	1.8	.056		.0173	-.0064	.0074	.0048
4.0		.184	.0222	-.0096	.0258	.1006	3.8	.135		.0238	-.0182	.0171	.0098
6.0		.299	.0386	-.0183	.0426	.1421	5.9	.215		.0362	-.0296	.0268	.0163
8.0		.428	.0667	-.0345	.0577	.1509	7.9	.295		.0539	-.0399	.0364	.0235
10.0		.561	.1044	-.0529	.0719	.1584	9.8	.366		.0756	-.0501	.0449	.0272
12.1		.679	.1499	-.0920	.0688	.0941	11.8	.445		.1051	-.0608	.0540	.0312
14.0		.806	.2055	-.1325	.0729	.0677	13.8	.515		.1377	-.0710	.0620	.0342
16.0		.926	.2698	-.1699	.0749	.0522	15.9	.589		.1776	-.0814	.0701	.0354
18.1		1.045	.3447	-.2083	.0782	.0474	17.9	.656		.2213	-.0920	.0771	.0333
1.00		-5.8	-.352	0.0524	0.0626	-.0453	-.0907	2.22		-5.7	-.185	.0323	.0269
	-3.7	-.227	.0326	.0438	-.0292	-.0773	-3.6		-.122	.0217	.0182	-.0135	-.0059
	-1.8	-.115	.0218	.0246	-.0148	-.0427	-1.8		-.060	.0158	.0094	-.0072	-.0038
	-.4	-.034	.0191	.0104	-.0043	-.0117	-.3		-.017	.0141	.0025	-.0025	-.0023
	.8	.023	.0188	.0009	.0025	-.0006	.8		.020	.0142	-.0033	.0011	-.0017
	2.2	.110	.0229	-.0152	.0134	.0245	2.3		.065	.0161	-.0107	.0058	.0013
	4.3	.220	.0332	-.0340	.0277	.0645	4.3		.129	.0224	-.0196	.0128	.0031
	6.3	.353	.0536	-.0551	.0443	.0828	6.2		.187	.0330	-.0269	.0194	.0046
	8.1	.466	.0794	-.0734	.0574	.0870	8.3		.249	.0483	-.0340	.0263	.0075
	10.3	.587	.1185	-.0944	.0704	.0889	10.2		.312	.0677	-.0408	.0339	.0080
	12.3	.704	.1644	-.1126	.0831	.0842	12.3		.370	.0919	-.0462	.0411	.0107
	14.2	.808	.2148	-.1308	.0941	.0800	14.3		.427	.1197	-.0516	.0482	.0132
	16.2	.906	.2734	-.1472	.1036	.0786	16.3		.485	.1526	-.0565	.0553	.0172
	18.3	1.009	.3429	-.1773	.1072	.0612	18.4		.539	.1889	-.0617	.0622	.0207
	1.10	-6.1	-.342	.0547	.0662	-.0444	-.0788			-6.1	-.342	.0547	.0662
-4.0		-.231	.0351	.0467	-.0297	-.0675	-4.0	-.231		.0351	.0467	-.0297	-.0675
-2.1		-.120	.0241	.0299	-.0145	-.0398	-2.1	-.120		.0241	.0299	-.0145	-.0398
-.4		-.040	.0211	.0136	-.0045	-.0101	-.4	-.040		.0211	.0136	-.0045	-.0101
.6		.013	.0197	.0056	.0020	-.0013	.6	.013		.0197	.0056	.0020	-.0013
2.0		.077	.0227	-.0048	.0111	.0226	2.0	.077		.0227	-.0048	.0111	.0226
3.8		.188	.0293	-.0243	.0257	.0547	3.8	.188		.0293	-.0243	.0257	.0547
6.1		.317	.0482	-.0457	.0412	.0689	6.1	.317		.0482	-.0457	.0412	.0689
8.0		.430	.0734	-.0661	.0537	.0756	8.0	.430		.0734	-.0661	.0537	.0756
10.0		.559	.1098	-.0906	.0654	.0780	10.0	.559		.1098	-.0906	.0654	.0780
12.0		.663	.1513	-.1047	.0755	.0756	12.0	.663		.1513	-.1047	.0755	.0756
14.1		.760	.1989	-.1142	.0867	.0742	14.1	.760		.1989	-.1142	.0867	.0742
16.2		.842	.2529	-.1252	.0961	.0733	16.2	.842		.2529	-.1252	.0961	.0733
18.1		.923	.3115	-.1444	.1034	.0698	18.1	.923		.3115	-.1444	.1034	.0698

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued  
(c) BVWC;  $\delta = 4.7^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$	
0.70	-6.2	-0.321	0.0407	0.0655	-0.0142	-0.0436	1.30	-6.0	-0.291	0.0435	0.0866	-0.0124	-0.0107	
	-2.2	-.108	.0147	.0446	.0097	.0423		-1.9	-.101	.0206	.0546	.0121	.0251	
	-.2	-.020	.0123	.0390	.0225	.0930		.1	-.013	.0188	.0412	.0249	.0381	
	5.8	.265	.0391	.0221	.0348	.1247		1.9	.066	.0221	.0311	.0358	.0486	
	1.7	.059	.0147	.0382	.0584	.1218		6.0	.265	.0476	-.0024	.0588	.0616	
	9.8	.490	.0946	-.0292	.0596	.0717		10.1	.472	.1034	-.0407	.0785	.0681	
	13.8	.715	.1819	-.0746	.0634	.0687		14.0	.665	.1841	-.0769	.0954	.0587	
	17.9	.942	.3067	-.1112	.0727	.0706		18.1	.832	.2871	-.1056	.1075	.0528	
	0.90	-6.0	-.335	.0426	.0814	-.0140		-.0342	1.70	-6.2	-.241	.0385	.0712	-.0087
-1.9		-.106	.0150	.0499	.0122	.0601	-2.2	-.088		.0193	.0479	.0100	.0132	
.1		-.013	.0129	.0442	.0269	.1194	-.2	-.017		.0175	.0365	.0196	.0187	
2.0		.075	.0161	.0452	.0435	.1519	1.8	.056		.0202	.0267	.0290	.0241	
6.0		.297	.0457	.0251	.0715	.1660	5.8	.217		.0412	.0026	.0474	.0350	
10.1		.547	.1100	-.0481	.0713	.0717	9.8	.374		.0842	-.0220	.0637	.0432	
14.0		.801	.2116	-.1226	.0761	.0539	13.8	.523		.1483	-.0454	.0790	.0396	
18.0		1.011	.3391	-.1770	.0824	.0522	17.9	.658		.2317	-.0689	.0927	.0325	
1.00		-5.9	-.352	.0504	.1097	-.0140	-.0203	2.22		-5.8	-.177	.0308	.0519	-.0044
	-1.8	-.106	.0241	.0613	.0140	.0455	-1.7		-.053	.0160	.0328	.0087	.0078	
	.2	.001	.0188	.0421	.0299	.0775	.4		.012	.0154	.0227	.0157	.0086	
	2.2	.093	.0241	.0322	.0443	.0916	2.2		.066	.0183	.0147	.0216	.0117	
	6.3	.340	.0588	-.0110	.0708	.1035	6.3		.196	.0378	-.0014	.0366	.0136	
	10.2	.576	.1247	-.0528	.0945	.0909	10.3		.320	.0751	-.0149	.0515	.0182	
	14.2	.799	.2221	-.1053	.1067	.0696	14.3		.437	.1294	-.0280	.0652	.0272	
	18.3	.999	.3505	-.1583	.1141	.0354	18.3		.539	.1971	-.0371	.0772	.0306	
	1.10	-6.0	-.345	.0523	.1094	-.0138	-.0272							
-2.0		-.115	.0239	.0632	.0132	.0432								
.1		-.020	.0203	.0479	.0286	.0662								
1.9		.067	.0247	.0393	.0411	.0731								
6.2		.302	.0550	0	.0659	.0889								
10.1		.552	.1184	-.0526	.0877	.0826								
14.1		.777	.2142	-.1058	.0990	.0614								
18.1	.920	.3192	-.1324	.1074	.0339									

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued  
 (d) BVWC;  $\delta = 10.1^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$
0.70	-6.2	-0.310	0.0410	0.0947	0.0090	0.0432	1.30	-6.0	-0.289	0.0457	0.1243	0.0125	0.0342
	-2.2	-.097	.0169	.0761	.0350	.1178		-1.8	-.091	.0249	.0886	.0380	.0492
	-.3	-.013	.0174	.0695	.0460	.1222		.1	-.018	.0241	.0751	.0481	.0536
	1.7	.066	.0206	.0632	---	---		2.0	.064	.0274	.0622	.0588	.0589
	6.0	.275	.0467	.0184	.0584	.0748		6.1	.270	.0568	.0243	.0777	.0652
	9.8	.493	.0998	-.0271	.0623	.0650		10.0	.473	.1129	-.0162	.0947	.0560
	13.8	.720	.1899	-.0681	.0691	.0689		14.1	.671	.1966	-.0616	.1072	.0453
	17.9	.958	.3198	-.1081	.0789	.0683		18.2	.860	.3092	-.1276	.1109	.0180
0.90	-6.1	-.342	.0461	.1186	.0101	.0633	1.70	-6.2	-.235	.0404	.1021	.0114	.0187
	-2.0	-.102	.0196	.0912	.0430	.1473		-2.2	-.086	.0237	.0784	.0298	.0304
	.2	0	.0194	.0827	.0590	.1542		-.2	-.015	.0226	.0659	.0391	.0327
	2.1	.083	.0238	.0733	.0709	.1547		1.8	.057	.0259	.0553	.0477	.0358
	6.0	.305	.0533	.0170	.0707	.0719		5.9	.222	.0493	.0278	.0641	.0467
	10.1	.552	.1181	-.0441	.0775	.0541		9.9	.377	.0936	.0008	.0787	.0427
	14.2	.805	.2237	-.1141	.0831	.0471		13.8	.527	.1589	-.0250	.0930	.0325
	18.1	1.039	.3585	-.1883	.0898	.0438		18.0	.665	.2460	-.0531	.1042	.0218
1.00	-5.8	-.344	.0512	.1464	.0146	.0451	2.22	-5.8	-.168	.0311	.0740	.0104	.0128
	-1.9	-.106	.0278	.1021	.0446	.0849		-1.5	-.039	.0191	.0540	.0243	.0140
	.2	0	.0230	.0805	.0581	.0937		.4	.015	.0191	.0458	.0310	.0126
	2.3	.102	.0309	.0584	.0709	.0956		2.3	.073	.0235	.0380	.0375	.0159
	6.3	.339	.0647	.0214	.0944	.0853		6.3	.201	.0447	.0219	.0522	.0243
	10.2	.580	.1337	-.0430	.1027	.0591		10.1	.319	.0813	.0082	.0657	.0319
	14.2	.799	.2328	-.0988	.1130	.0323		14.3	.436	.1373	-.0087	.0776	.0346
	18.2	1.024	.3686	-.1591	.1231	.0170		18.3	.544	.2078	-.0246	.0890	.0298
1.10	-6.1	-.343	.0542	.1437	.0127	.0390		-6.1	-.343	.0542	.1437	.0127	.0390
	-2.0	-.117	.0285	.1025	.0418	.0727		-2.0	-.117	.0285	.1025	.0418	.0727
	-.1	-.039	.0266	.0916	.0528	.0773		-.1	-.039	.0266	.0916	.0528	.0773
	2.0	.065	.0303	.0691	.0647	.0830		2.0	.065	.0303	.0691	.0647	.0830
	6.0	.295	.0621	.0339	.0865	.0767		6.0	.295	.0621	.0339	.0865	.0767
	10.0	.537	.1263	-.0367	.0947	.0576		10.0	.537	.1263	-.0367	.0947	.0576
	14.1	.785	.2259	-.1088	.1044	.0323		14.1	.785	.2259	-.1088	.1044	.0323
	18.0	.938	.3343	-.1315	.1133	.0180		18.0	.938	.3343	-.1315	.1133	.0180

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued  
(e) BVWC;  $\delta = 20.0^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	$C_{Zc}$	$C_{hc}$
0.70	-6.3	-0.296	0.0562	0.1469	0.0495	0.1234	1.30	-6.0	-0.280	0.0626	0.1864	0.0539	0.0654
	-2.2	-.086	.0311	.0988	.0539	.0767		-1.9	-.095	.0444	.1399	.0678	.0702
	-.2	-.005	.0303	.0792	.0554	.0765		.1	-.014	.0447	.1191	.0745	.0635
	1.8	.070	.0324	.0637	.0577	.0752		2.0	.058	.0487	.0998	.0806	.0572
	5.8	.260	.0564	.0278	.0647	.0742		6.1	.261	.0756	.0507	.0894	.0396
	9.8	.479	.1109	-.0124	.0703	.0756		10.1	.472	.1338	.0001	.0979	.0193
	13.8	.704	.2014	-.0509	.0786	.0677		14.2	.675	.2190	-.0633	.1054	.0115
	17.8	.935	.3290	-.0905	.0870	.0591		18.1	.853	.3274	-.1185	.1116	.0008
0.90	-5.9	-.303	.0577	.1634	.0528	.1132	1.70	-6.2	-.218	.0542	.1534	.0444	.0536
	-2.0	-.087	.0349	.1141	.0634	.0736		-2.1	-.078	.0405	.1240	.0580	.0583
	.1	0	.0339	.0911	.0657	.0648		-.1	-.013	.0409	.1082	.0639	.0583
	2.0	.084	.0377	.0761	.0701	.0643		1.8	.053	.0441	.0942	.0698	.0530
	6.1	.297	.0674	.0282	.0762	.0599		5.8	.221	.0691	.0630	.0809	.0421
	10.0	.530	.1297	-.0247	.0817	.0503		9.8	.379	.1152	.0304	.0904	.0224
	14.1	.789	.2347	-.0954	---	---		13.9	.524	.1802	-.0102	.0964	.0109
	18.1	1.019	.3706	-.1666	.0951	.0363		17.9	.649	.2619	-.0437	.1045	-.0044
1.00	-5.8	-.335	.0725	.2182	.0629	.0964	2.22	-5.7	-.145	.0426	.1147	.0389	.0302
	-1.7	-.089	.0472	.1534	.0773	.0815		-1.7	-.031	.0344	.0960	.0507	.0354
	.3	.007	.0462	.1171	.0829	.0706		.3	.023	.0360	.0851	.0559	.0402
	2.2	.103	.0499	.0884	.0849	.0534		2.2	.083	.0405	.0751	.0613	.0438
	6.3	.327	.0825	.0358	.0949	.0339		6.3	.211	.0640	.0546	.0712	.0486
	10.2	.564	.1506	-.0226	.1071	.0243		10.3	.329	.1040	.0351	.0797	.0404
	14.3	.792	.2497	-.0892	.1103	.0166		14.3	.438	.1590	.0153	.0880	.0268
	18.2	.990	.3753	-.1502	.1134	.0090		18.3	.538	.2279	-.0055	.0946	.0107
1.10	-6.0	-.334	.0738	.2125	.0608	.0863		-6.0	-.334	.0738	.2125	.0608	.0863
	-2.0	-.124	.0503	.1659	.0754	.0746		-2.0	-.124	.0503	.1659	.0754	.0746
	.1	-.023	.0477	.1322	.0776	.0641		.1	-.023	.0477	.1322	.0776	.0641
	2.0	.069	.0518	.1028	.0803	.0524		2.0	.069	.0518	.1028	.0803	.0524
	6.1	.311	.0853	.0325	.0911	.0325		6.1	.311	.0853	.0325	.0911	.0325
	10.0	.542	.1489	-.0262	.1015	.0212		10.0	.542	.1489	-.0262	.1015	.0212
	14.1	.779	.2438	-.1064	.1030	.0128		14.1	.779	.2438	-.1064	.1030	.0128
	18.1	.950	.3565	-.1320	.1072	.0080		18.1	.950	.3565	-.1320	.1072	.0080

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Concluded  
(f) BW

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	
0.70	-6.3	-0.307	0.0378	0.0783	1.00	-5.9	-0.338	0.0483	0.1187	1.30	-6.1	-0.286	0.0400	0.1024	2.22	-5.8	-0.173	0.0274	0.0558	
	-4.3	-.200	.0206	.0513		-3.8	-.212	.0253	.0746		-4.0	-.185	.0236	.0660		-3.8	-.114	.0177	.0368	
	-2.3	-.099	.0117	.0257		-1.8	-.094	.0191	.0334		-2.0	-.086	.0150	.0312		-1.7	-.050	.0122	.0164	
	-8	-.040	.0095	.0134		-3	-.021	.0145	.0089		-5	-.024	.0131	.0086		-2	-.006	.0109	.0027	
	-3	-.018	.0087	.0084		.2	.010	.0172	-.0002		-.1	0	.0130	.0017		.3	.009	.0109	-.0017	
	.2	.004	.0091	.0044		.7	.031	.0147	-.0080		.5	.018	.0131	-.0045		.7	.024	.0111	-.0061	
	1.7	.065	.0101	-.0100		2.1	.110	.0179	-.0348		2.0	.089	.0154	-.0294		2.2	.070	.0131	-.0215	
	3.7	.162	.0165	-.0343		4.1	.233	.0346	-.0763		3.9	.183	.0229	-.0628		4.2	.130	.0195	-.0412	
	5.7	.264	.0305	-.0589		6.2	.348	.0489	-.1184		6.0	.282	.0389	-.0981		6.2	.187	.0298	-.0598	
	7.8	.376	.0534	-.0870		8.2	.471	.0799	-.1595		8.0	.379	.0612	-.1308		8.3	.244	.0443	-.0778	
	9.8	.489	.0845	-.1131		10.2	.584	.1150	-.1982		10.0	.475	.0906	-.1643		10.2	.297	.0615	-.0934	
	11.7	.602	.1229	-.1403		12.1	.694	.1589	-.2351		12.0	.564	.1253	-.1958		12.2	.351	.0834	-.1097	
	13.7	.715	.1700	-.1676		14.2	.799	.2107	-.2736		13.9	.653	.1659	-.2279		14.2	.406	.1091	-.1243	
	15.7	.829	.2259	-.1933		16.2	.906	.2707	-.3110		16.0	.738	.2131	-.2567		16.2	.463	.1399	-.1392	
	17.7	.934	.2881	-.2160		18.2	.997	.3351	-.3440		18.0	.820	.2662	-.2852		18.2	.514	.1747	-.1541	
0.90	-6.0	-.326	.0399	.0937	1.10	-6.0	-.322	.0459	.1161	1.70	-6.3	-.236	.0357	.0400						
	-4.0	-.206	.0211	.0587		-4.0	-.203	.0277	.0771		-4.3	-.162	.0229	.0261						
	-2.0	-.097	.0119	.0232		-2.0	-.088	.0177	.0347		-2.2	-.078	.0147	.0173						
	-5	-.031	.0096	.0127		-5	-.018	.0153	.0099		-8	-.027	.0126	.0145						
	0	-.010	.0094	.0071		0	.007	.0156	.0022		-2	-.007	.0123	.0136						
	.2	.025	.0165	0		.5	.028	.0157	-.0048		.3	.012	.0125	.0138						
	2.0	.084	.0108	-.0169		2.0	.106	.0179	-.0310		1.8	.068	.0141	.0147						
	4.0	.190	.0202	-.0467		4.0	.216	.0282	-.0711		3.8	.144	.0205	.0198						
	6.0	.305	.0371	-.0794		6.0	.329	.0453	-.1131		5.8	.219	.0319	.0304						
	8.0	.436	.0657	-.1208		8.0	.452	.0725	-.1572		7.8	.294	.0494	.0464						
	10.0	.556	.1008	-.1582		10.0	.555	.1052	-.1865		9.8	.365	.0711	.0673						
	12.0	.683	.1476	-.2014		11.9	.638	.1427	-.2114		11.8	.432	.0974	.0929						
	14.0	.804	.2018	-.2437		14.0	.751	.1956	-.2596		13.7	.498	.1277	.1217						
	16.0	.936	.2699	-.2917		16.0	.843	.2499	-.2935		15.8	.567	.1646	.1574						
	18.0	.933	.3039	-.2621		18.0	.933	.3114	-.3256		17.8	.632	.2054	.1971						

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF  
(a) BV

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$
0.70	-6.3	-0.007	0.0068	-0.0122	1.00	-5.8	-0.008	0.0095	-0.0129	1.30	-6.0	-0.010	0.0099	-0.0118	2.22	-5.7	-0.016	0.0092	-0.0090
	-4.3	-.003	.0064	-.0090		-3.8	-.007	.0089	-.0085		-4.0	-.005	.0088	-.0087		-3.6	-.010	.0081	-.0054
	-2.2	-.002	.0060	-.0050		-1.8	-.007	.0086	-.0040		-1.9	-.001	.0084	-.0047		-1.7	-.007	.0073	-.0016
	-1.7	0	.0057	-.0018		-.3	-.003	.0073	-.0014		-.5	0	.0082	-.0017		-.2	-.002	.0070	.0005
	-1.2	.001	.0057	-.0009		.2	-.001	.0075	-.0007		0	.001	.0082	-.0005		.3	-.003	.0070	.0020
	-.3	.002	.0055	.0001		.8	-.001	.0069	.0013		.6	.001	.0081	.0003		.8	-.001	.0070	.0032
	1.7	.003	.0055	.0038		2.2	0	.0070	.0033		2.0	.004	.0073	.0035		2.2	.001	.0069	.0056
	3.8	.004	.0057	.0079		4.3	.003	.0073	.0093		4.1	.007	.0081	.0078		4.3	.005	.0069	.0099
	5.7	.007	.0056	.0117		6.2	.005	.0074	.0133		6.0	.008	.0084	.0115		6.3	.011	.0080	.0133
	7.8	.011	.0072	.0151		8.2	.010	.0089	.0169		8.0	.013	.0093	.0148		8.3	.017	.0093	.0165
	9.8	.015	.0076	.0182		10.2	.015	.0097	.0203		10.1	.019	.0107	.0184		10.3	.028	.0119	.0196
	11.8	.021	.0083	.0218		12.3	.021	.0092	.0241		12.0	.027	.0130	.0221		12.3	.041	.0157	.0221
	13.8	.029	.0102	.0250		14.2	.028	.0120	.0280		14.1	.035	.0162	.0261		14.3	.058	.0213	.0257
	15.8	.036	.0126	.0287		16.3	.036	.0154	.0330		16.1	.047	.0199	.0303		16.4	.075	.0289	.0298
	17.9	.043	.0159	.0335		18.3	.047	.0191	.0369		18.1	.059	.0247	.0347		18.4	.093	.0372	.0335
0.90	-6.0	-.008	.0069	-.0124	1.10	-6.1	-.013	.0132	-.0108	2.22	-5.7	-.016	.0092	-.0090	2.22	-5.7	-.016	.0092	-.0090
	-3.9	-.004	.0062	-.0087		-3.9	-.010	.0122	-.0071		-3.6	-.010	.0081	-.0054		-3.6	-.010	.0081	-.0054
	-1.9	0	.0060	-.0050		-1.9	-.006	.0109	-.0032		-1.7	-.007	.0073	-.0016		-1.7	-.007	.0073	-.0016
	-1.5	.001	.0057	-.0020		-.5	-.007	.0111	.0005		-.2	-.002	.0070	.0005		-.2	-.002	.0070	.0005
	.1	.001	.0053	-.0003		.1	-.004	.0106	.0005		.3	-.003	.0070	.0020		.3	-.003	.0070	.0020
	.5	.002	.0054	.0004		.5	-.004	.0103	.0017		.8	-.001	.0070	.0032		.8	-.001	.0070	.0032
	2.0	.003	.0053	.0038		2.0	0	.0101	.0038		2.2	.001	.0069	.0056		2.2	.001	.0069	.0056
	4.1	.005	.0054	.0082		4.1	0	.0100	.0095		4.3	.005	.0069	.0099		4.3	.005	.0069	.0099
	6.0	.009	.0058	.0115		6.0	.003	.0101	.0135		6.3	.011	.0080	.0133		6.3	.011	.0080	.0133
	8.0	.012	.0065	.0152		8.1	.008	.0107	.0163		8.3	.017	.0093	.0165		8.3	.017	.0093	.0165
	10.1	.019	.0078	.0182		10.1	.012	.0117	.0198		10.3	.028	.0119	.0196		10.3	.028	.0119	.0196
	12.1	.024	.0091	.0219		12.0	.021	.0130	.0227		12.3	.041	.0157	.0221		12.3	.041	.0157	.0221
	14.1	.031	.0117	.0256		14.0	.029	.0147	.0264		14.3	.058	.0213	.0257		14.3	.058	.0213	.0257
	16.1	.038	.0140	.0296		16.2	.037	.0183	.0309		16.4	.075	.0289	.0298		16.4	.075	.0289	.0298
	18.1	.048	.0176	.0342		18.1	.047	.0219	.0348		18.4	.093	.0372	.0335		18.4	.093	.0372	.0335

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued  
(b) BVC;  $\delta = 0^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$
0.70	-6.1	-0.053	0.0116	-0.0639	1.00	-5.7	-0.060	0.0156	-0.0722	1.30	-5.8	-0.051	0.0162	-0.0629	2.22	-5.7	-0.037	0.0127	-0.0373
	-4.1	-.032	.0091	-.0416		-3.7	-.039	.0104	-.0458		-3.8	-.033	.0131	-.0429		-3.6	-.025	.0104	-.0230
	-2.1	-.015	.0072	-.0205		-1.7	-.017	.0105	-.0213		-2.0	-.018	.0111	-.0228		-1.7	-.014	.0086	-.0096
	-1.0	-.005	.0068	-.0090		-1	-.003	.0094	-.0032		-4	-.003	.0106	-.0064		-1	-.004	.0083	-.0001
	-.2	-.001	.0066	-.0012		.2	-.003	.0102	.0006		0	0	.0105	-.0025		.4	-.001	.0082	.0032
	.3	.002	.0065	.0033		.8	.004	.0109	.0077		.6	.004	.0106	.0043		.9	.003	.0083	.0065
	1.6	.014	.0069	.0161		2.2	.017	.0102	.0240		2.1	.018	.0115	.0192		2.3	.010	.0086	.0155
	3.7	.031	.0084	.0377		4.2	.037	.0117	.0483		4.1	.037	.0129	.0402		4.3	.022	.0097	.0291
	5.7	.050	.0104	.0597		6.2	.058	.0158	.0740		6.0	.054	.0154	.0614		6.3	.035	.0124	.0425
	7.6	.068	.0145	.0814		8.1	.079	.0188	.0962		7.9	.069	.0199	.0815		8.1	.048	.0155	.0551
	9.6	.085	.0197	.0987		10.1	.097	.0247	.1187		9.8	.085	.0251	.1001		10.2	.059	.0205	.0686
	11.7	.091	.0247	.1067		12.0	.113	.0310	.1388		11.9	.102	.0322	.1185		12.1	.083	.0279	.0801
	13.5	.094	.0285	.1111		14.0	.129	.0380	.1593		13.8	.117	.0397	.1341		14.1	.104	.0369	.0919
	15.6	.103	.0347	.1191		15.9	.145	.0475	.1767		15.8	.132	.0483	.1479		16.0	.126	.0471	.1040
	17.4	.111	.0399	.1287		17.9	.154	.0551	.1896		17.8	.149	.0585	.1626		18.0	.150	.0602	.1175
0.90	-5.8	-.057	.0121	-.0716	1.10	-5.9	-.059	.0194	-.0676	1.70	-6.0	-.044	.0153	-.0501					
	-3.8	-.035	.0087	-.0449		-3.8	-.040	.0161	-.0428		-4.1	-.029	.0126	-.0338					
	-1.9	-.015	.0077	-.0214		-1.9	-.020	.0139	-.0210		-2.1	-.016	.0107	-.0167					
	-.4	-.002	.0069	-.0047		-.4	-.004	.0127	-.0036		-5	-.005	.0099	-.0029					
	0	.001	.0072	-.0010		0	-.003	.0136	-.0001		-.2	-.001	.0099	-.0003					
	.7	.007	.0070	.0055		.6	.002	.0134	.0066		.4	.002	.0098	.0044					
	2.0	.019	.0073	.0199		2.1	.016	.0135	.0231		1.9	.013	.0103	.0168					
	3.7	.036	.0085	.0413		4.0	.038	.0157	.0466		3.9	.028	.0118	.0340					
	6.1	.062	.0123	.0741		6.0	.056	.0187	.0688		5.7	.041	.0143	.0502					
	7.9	.082	.0170	.0956		7.9	.073	.0229	.0888		7.7	.056	.0181	.0672					
	9.8	.099	.0227	.1172		9.9	.087	.0284	.1101		9.7	.072	.0230	.0835					
	11.9	.117	.0301	.1382		11.8	.103	.0346	.1297		11.7	.087	.0293	.0991					
	13.9	.115	.0343	.1328		13.8	.119	.0423	.1490		13.6	.104	.0367	.1130					
	15.8	.123	.0400	.1401		15.8	.136	.0519	.1659		15.6	.123	.0464	.1258					
	17.7	.132	.0470	.1479		17.7	.146	.0599	.1802		17.5	.145	.0580	.1369					

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued  
(c) BVC;  $\delta = 4.7^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	
0.70	-6.0	-0.027	0.0089	-0.0277	1.00	-5.6	-0.025	0.0105	-0.0273	1.30	-5.9	-0.026	0.0128	-0.0288	2.22	-5.7	-0.023	0.0109	-0.0148	
	-2.2	.010	.0071	.0080		-1.7	.016	.0088	.0134		-2.0	.012	.0112	.0105		-1.7	.004	.0086	.0083	
	-7	.022	.0076	.0225		-2	.033	.0132	.0327		.1	.031	.0127	.0315		.3	.018	.0098	.0217	
	-3	.025	.0079	.0278		.3	.040	.0108	.0384		2.1	.049	.0151	.0521		2.4	.031	.0113	.0356	
	1.9	.047	.0101	.0513		2.2	.058	.0159	.0630		6.1	.083	.0242	.0925		6.0	.054	.0176	.0618	
	5.7	.079	.0186	.0880		6.2	.100	.0232	.1052		9.9	.112	.0366	.1262		10.2	.083	.0232	.0891	
	9.6	.093	.0264	.0996		10.1	.135	.0381	.1478		13.8	.141	.0530	.1566		14.3	.124	.0480	.1118	
	13.5	.108	.0360	.1123		14.0	.160	.0526	.1748		17.8	.168	.0740	.1807		17.9	.166	.0718	.1321	
	17.6	.134	.0519	.1323		17.9	.178	.0705	.1881											
0.90	-5.8	-.025	.0085	-.0289	1.10	-5.8	-.027	.0152	-.0266	1.70	-6.1	-.026	.0126	-.0219						
	-1.9	.012	.0076	.0097		-2.1	.013	.0138	.0107		-2.1	.010	.0104	.0092						
	0	.032	.0085	.0339		.1	.036	.0153	.0359		-.2	.022	.0119	.0261						
	2.1	.056	.0115	.0616		2.1	.057	.0186	.0589		1.9	.038	.0140	.0430						
	6.1	.099	.0226	.1078		6.0	.091	.0275	.0984		5.8	.066	.0214	.0759						
	9.9	.109	.0313	.1189		9.8	.122	.0407	.1376		9.6	.094	.0325	.1057						
	13.8	.128	.0430	.1363		13.8	.145	.0559	.1673		13.7	.125	.0493	.1345						
	17.7	.152	.0594	.1565		17.7	.163	.0733	.1797		17.4	.162	.0713	.1536						



TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued  
 (d) BVC;  $\delta = 10.1^\circ$

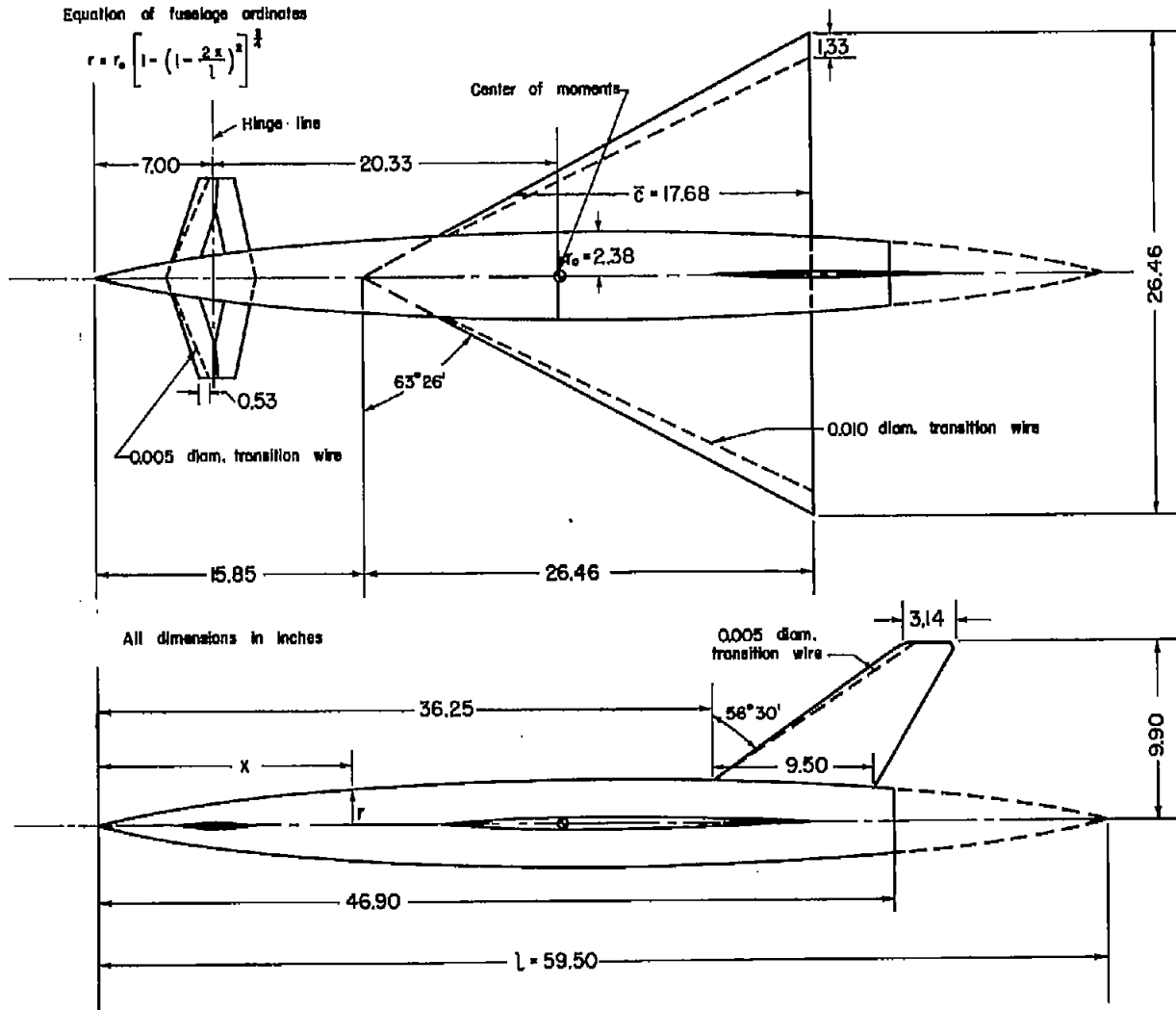
M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$
0.70	-6.1	0.001	0.0076	0.0025	1.00	-5.7	0.010	0.0105	0.0080	1.30	-5.9	0.004	0.0127	0.0068	2.22	-5.5	-0.002	0.0105	0.0067
	-2.2	.038	.0108	.0433		-1.7	.049	.0143	.0579		-2.0	.041	.0159	.0463		-1.7	.023	.0121	.0314
	-.2	.054	.0143	.0634		.2	.068	.0188	.0792		.1	.056	.0195	.0660		.3	.034	.0143	.0443
	1.8	.067	.0182	.0800		2.2	.086	.0238	.1000		2.1	.073	.0241	.0846		2.3	.047	.0174	.0581
	5.7	.078	.0250	.0897		6.1	.123	.0369	.1391		6.0	.102	.0350	.1176		6.2	.071	.0268	.0855
	9.6	.094	.0330	.1031		10.1	.135	.0479	.1593		9.9	.127	.0498	.1501		10.1	.095	.0396	.1107
	13.5	.112	.0444	.1226		14.1	.153	.0639	.1823		13.8	.148	.0657	.1742		14.0	.127	.0573	.1297
	17.5	.134	.0605	.1431		17.9	.170	.0801	.1999		17.7	.163	.0832	.1860		18.0	.167	.0831	.1483
0.90	-5.8	.006	.0082	.0056	1.10	-5.9	.005	.0152	.0080	1.70	-6.0	0	.0125	.0065					
	-1.9	.049	.0124	.0564		-1.9	.044	.0193	.0537		-2.1	.030	.0149	.0386					
	.1	.068	.0166	.0798		.1	.061	.0229	.0742		-.2	.044	.0176	.0546					
	2.1	.084	.0216	.0980		2.0	.077	.0277	.0937		1.9	.058	.0216	.0705					
	6.0	.095	.0292	.1062		5.9	.110	.0402	.1301		5.8	.084	.0315	.0997					
	9.9	.113	.0396	.1267		9.9	.123	.0517	.1513		9.7	.108	.0441	.1286					
	13.8	.132	.0523	.1453		13.8	.141	.0665	.1740		13.6	.133	.0617	.1537					
	17.7	.151	.0685	.1634		17.7	.161	.0854	.1905		17.6	.163	.0839	.1716					

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Concluded  
(e) BVC;  $\delta = 20.0^\circ$

M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$	M	$\alpha$ , deg	$C_L$	$C_D$	$C_m$
0.70	-6.1	0.052	0.0189	0.0562	1.00	-5.5	0.068	0.0275	0.0799	1.30	-5.8	0.055	0.0247	0.0630	2.22	-5.5	0.032	0.0200	0.0443
	-2.2	.062	.0231	.0677		-1.7	.094	.0361	.1172		-1.9	.081	.0339	.0944		-1.7	.056	.0259	.0682
	-.1	.066	.0266	.0741		.3	.101	.0405	.1242		.1	.093	.0394	.1088		.4	.066	.0305	.0808
	1.8	.070	.0294	.0810		2.2	.107	.0437	.1322		2.0	.105	.0452	.1221		2.3	.077	.0356	.0914
	5.7	.083	.0367	.0977		6.2	.131	.0575	.1538		6.0	.122	.0572	.1421		6.0	.093	.0468	.1127
	9.7	.105	.0471	.1118		10.1	.148	.0714	.1744		9.9	.141	.0729	.1644		10.2	.112	.0618	.1346
	13.5	.124	.0611	.1313		13.9	.149	.0828	.1875		13.8	.151	.0870	.1805		14.1	.138	.0807	.1516
				17.9	.160	.0985	.2033	17.6	.155	.1016	.1937	18.0	.169	.1044	.1654				
0.90	-5.8	.055	.0204	.0609	1.10	-5.8	.065	.0291	.0724	1.70	-6.0	.042	.0231	.0520					
	-1.9	.073	.0278	.0828		-1.9	.089	.0392	.1074		-2.1	.067	.0303	.0792					
	.1	.080	.0313	.0920		.1	.093	.0431	.1137		-.2	.078	.0348	.0922					
	2.0	.087	.0360	.1027		2.1	.102	.0481	.1225		1.9	.088	.0406	.1050					
	6.0	.100	.0441	.1161		6.0	.120	.0604	.1446		5.6	.108	.0529	.1286					
	10.0	.121	.0565	.1339		9.9	.139	.0750	.1655		9.7	.128	.0689	.1524					
	13.8	.139	.0698	.1498		13.8	.144	.0888	.1763		13.7	.142	.0849	.1676					
				17.7	.150	.1004	.1915	17.6	.161	.1051	.1824								

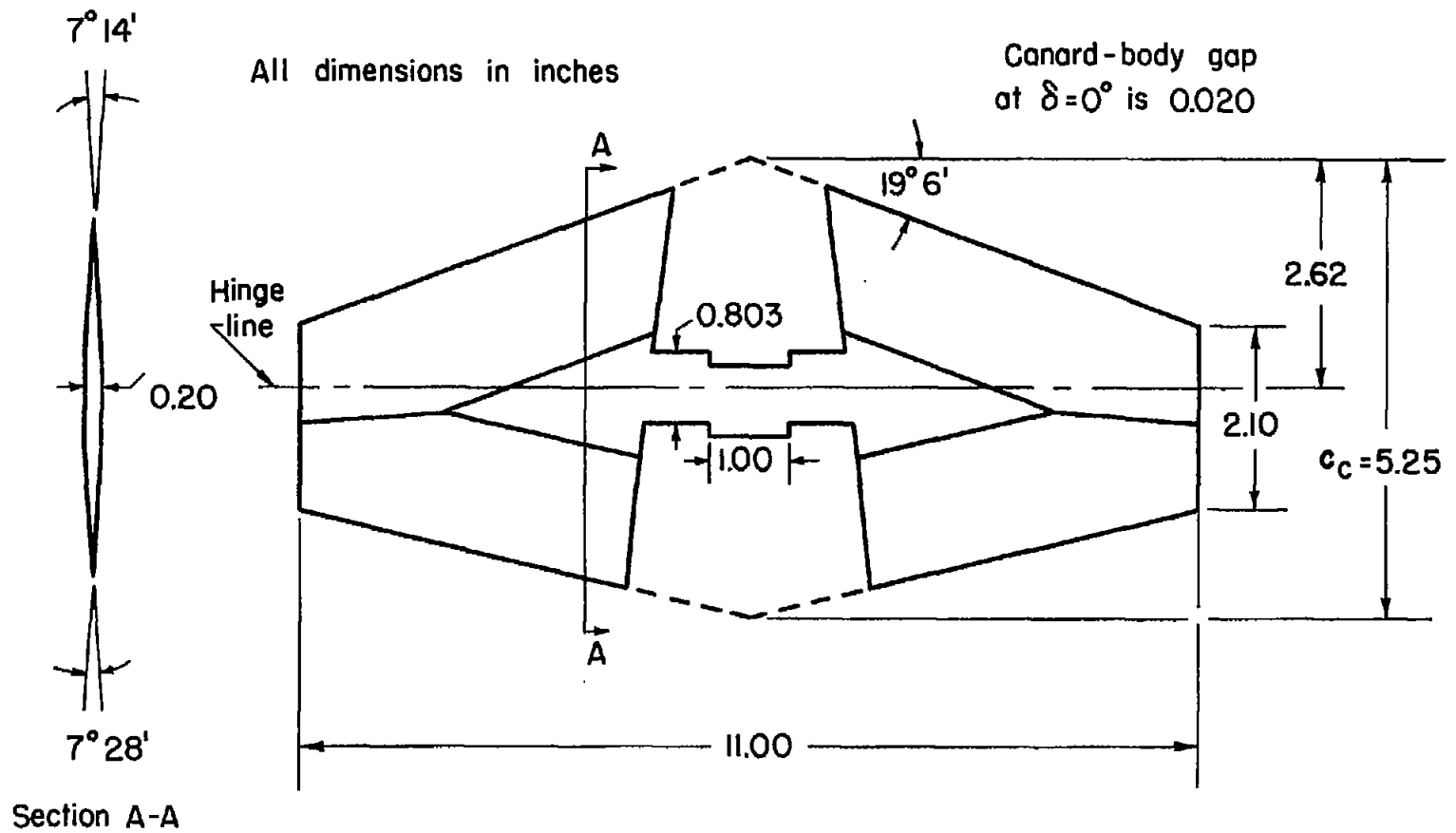
~~CONFIDENTIAL~~

~~CONFIDENTIAL~~



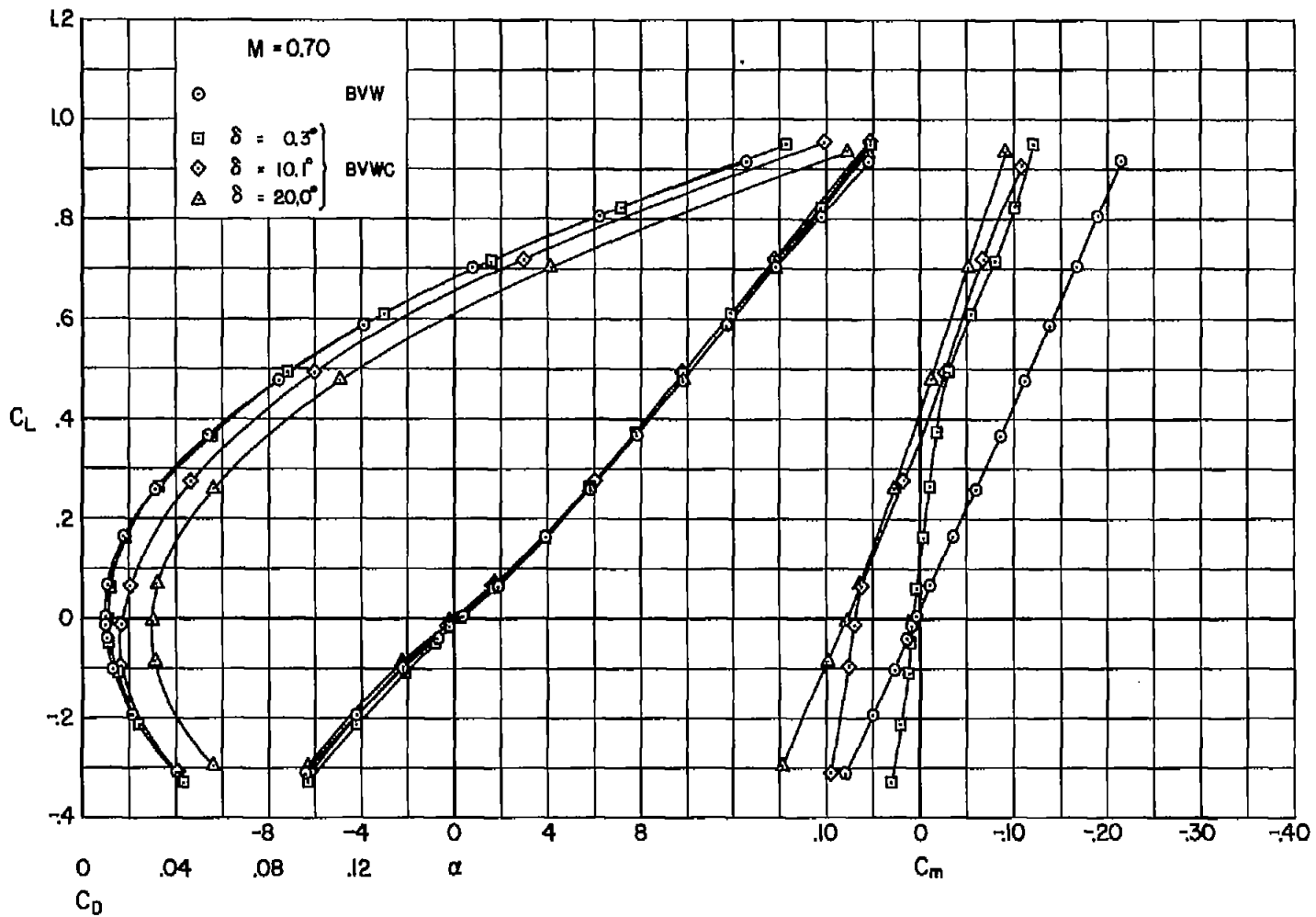
(a) Dimensional sketch of complete model.

Figure 1.- Model details and dimensions.



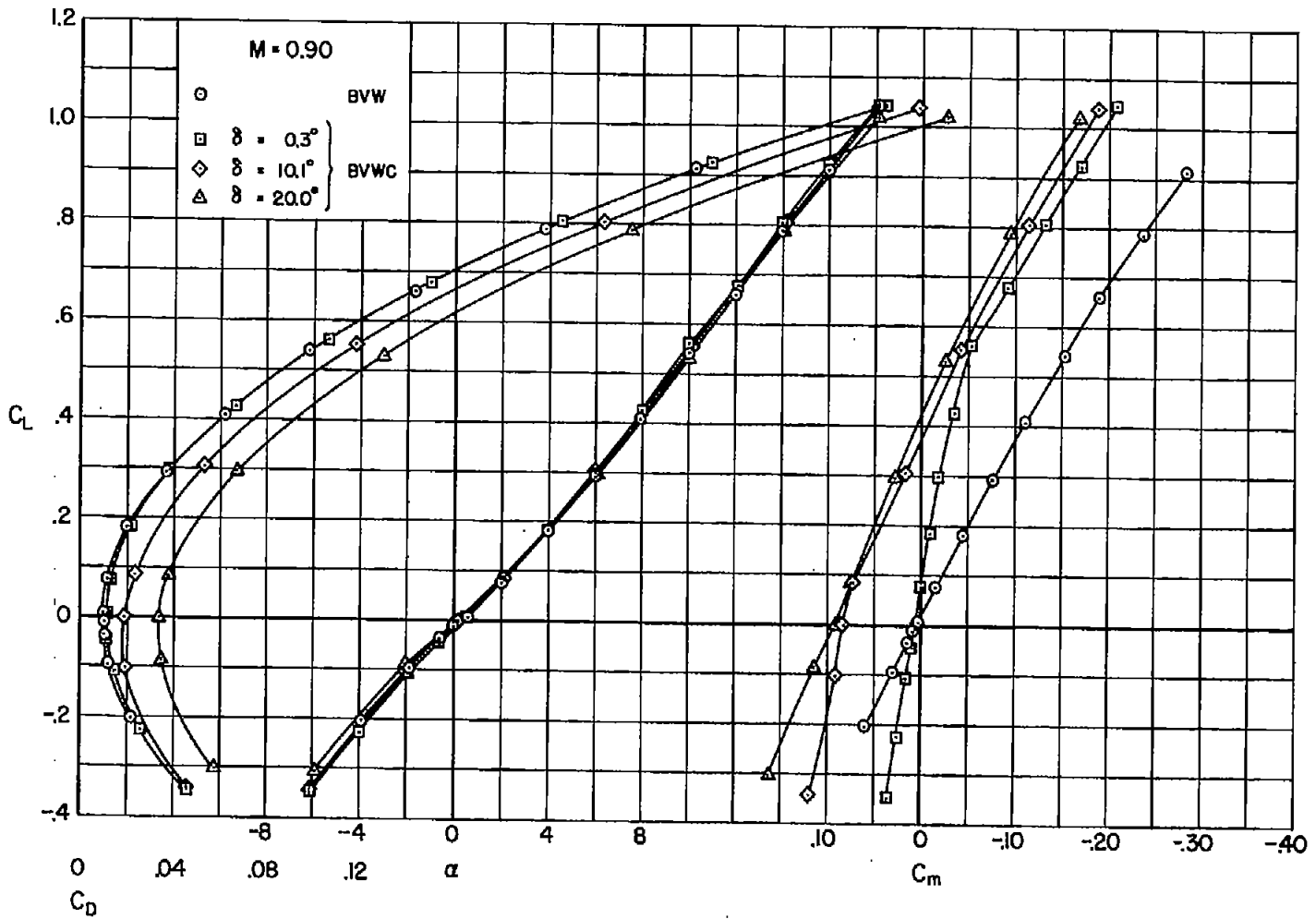
(b) Details of canard surface.

Figure 1.- Concluded.



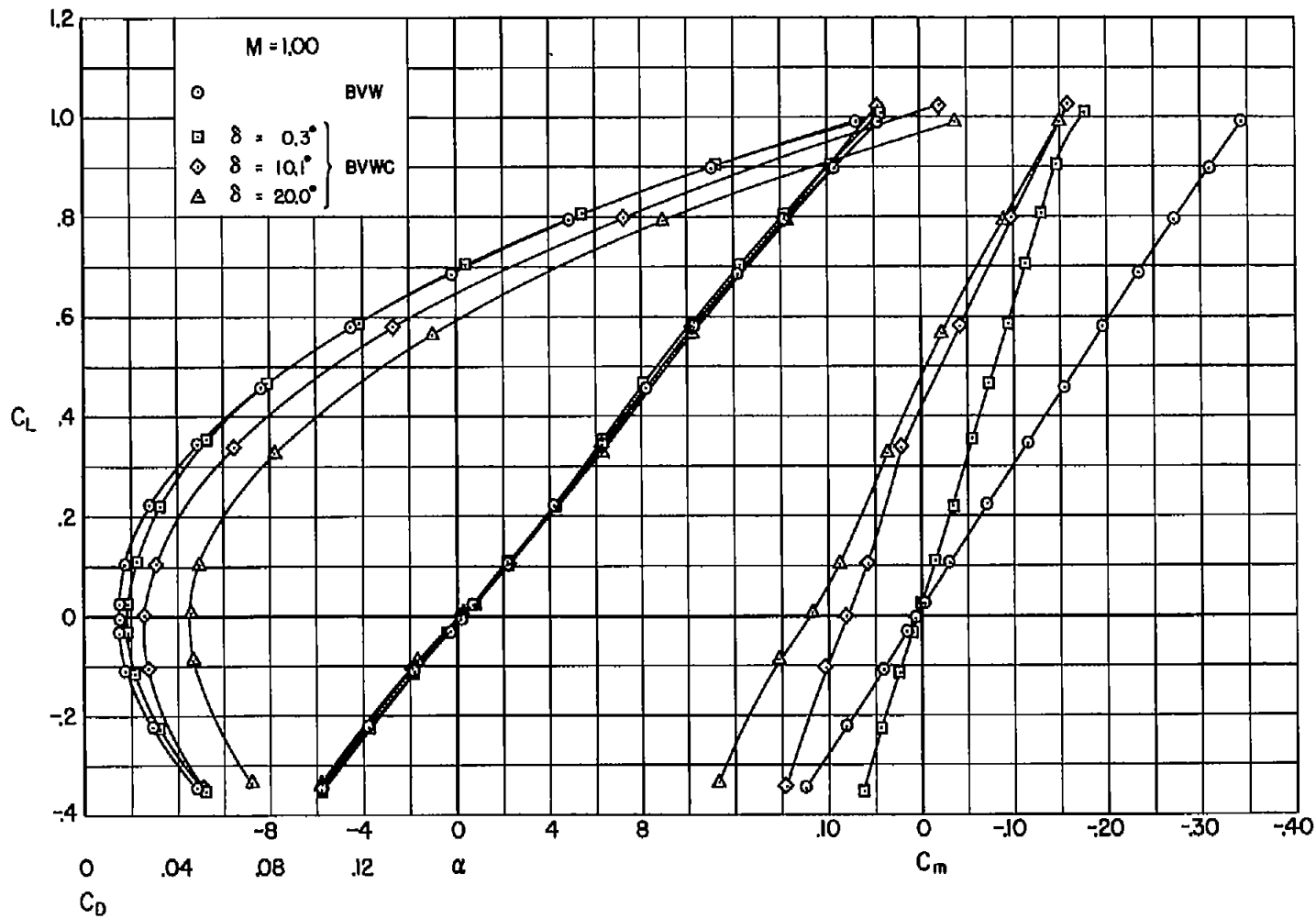
(a) M = 0.70

Figure 2.- Lift, drag, and pitching-moment characteristics for the canard on and deflected and the canard off.



(b)  $M = 0.90$

Figure 2.- Continued.



(c)  $M = 1.00$

Figure 2.- Continued.



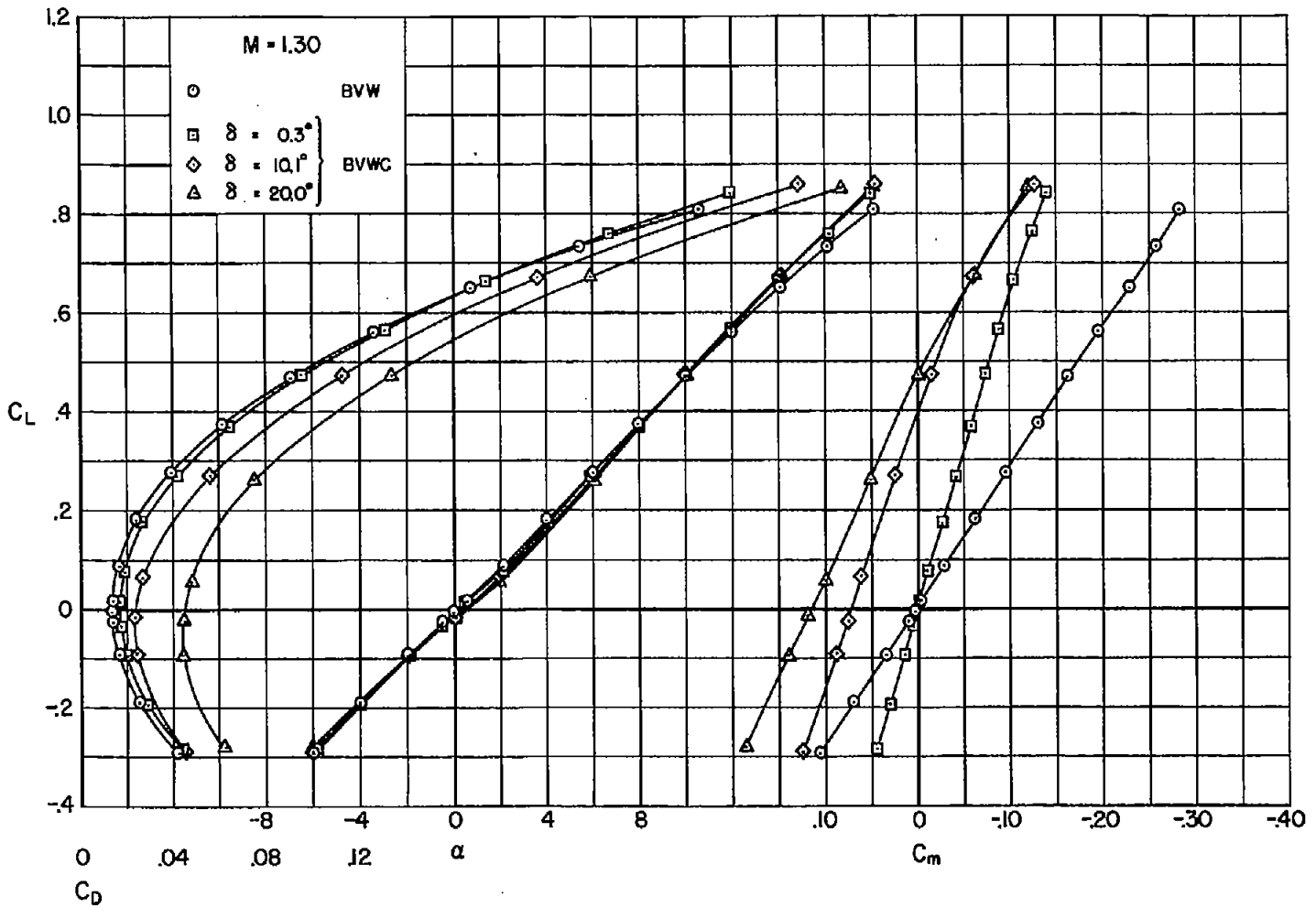
(d)  $M = 1.30$ 

Figure 2.- Continued.

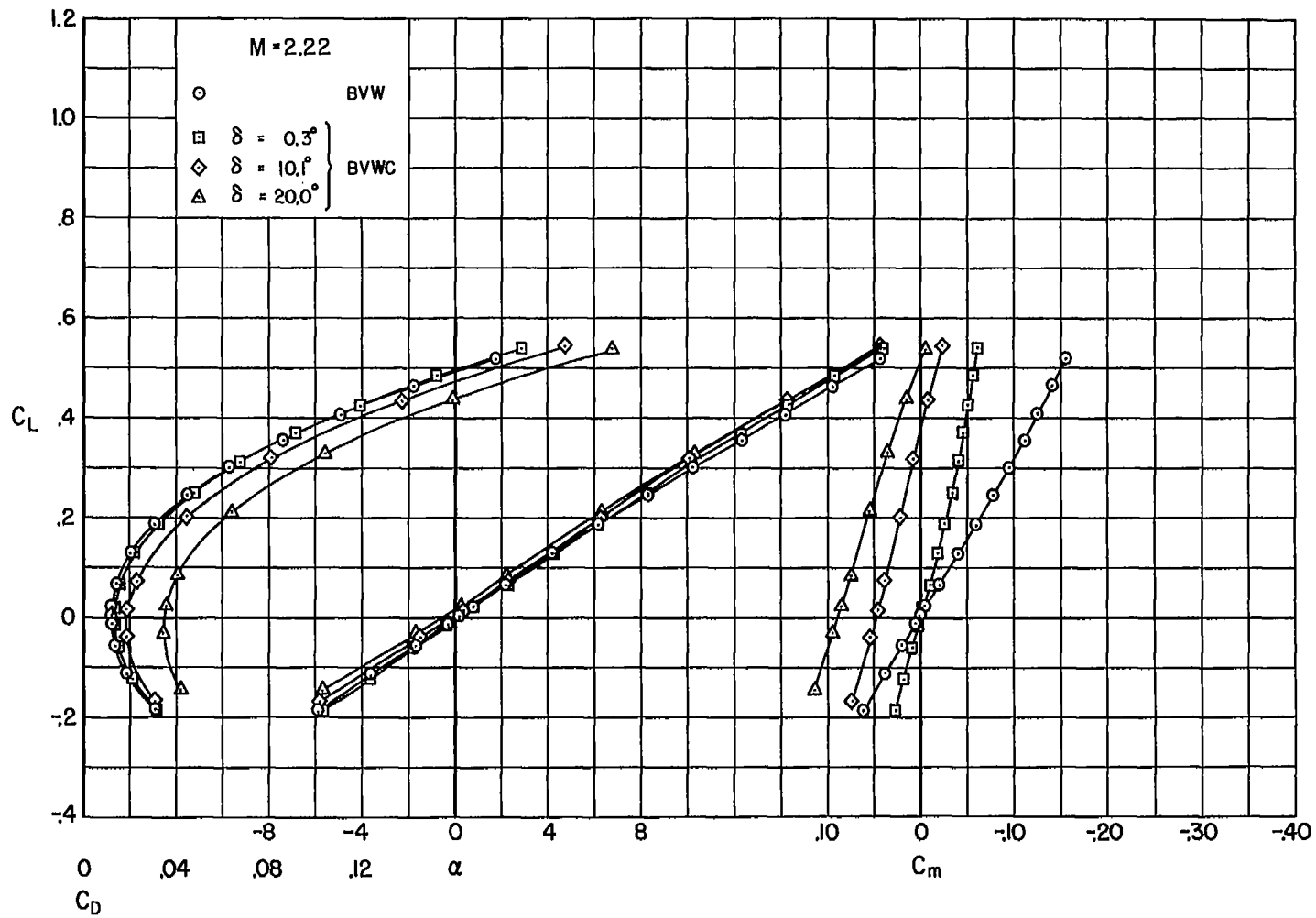
(e)  $M = 2.22$ 

Figure 2.- Concluded.

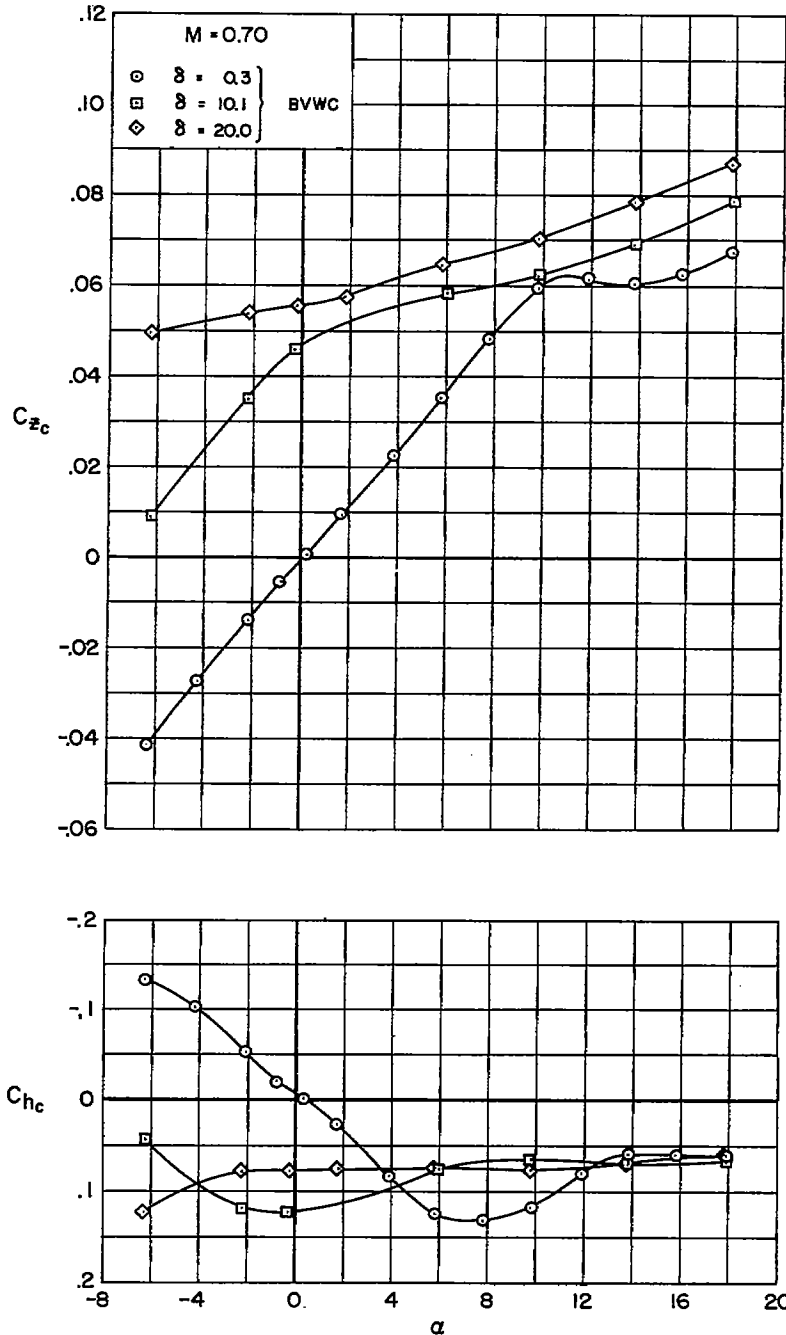
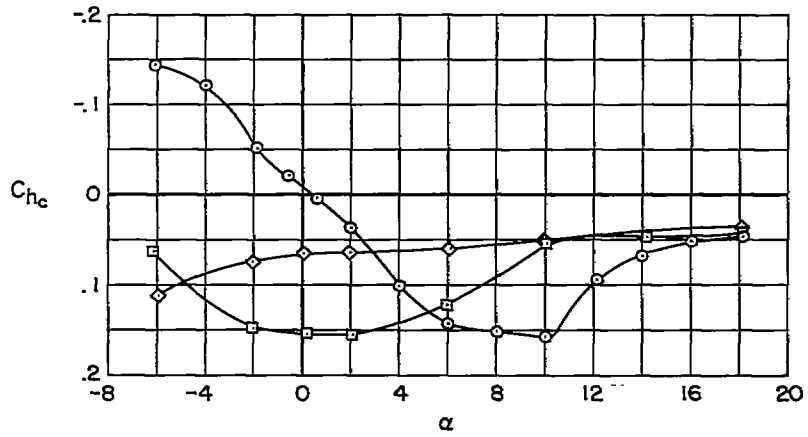
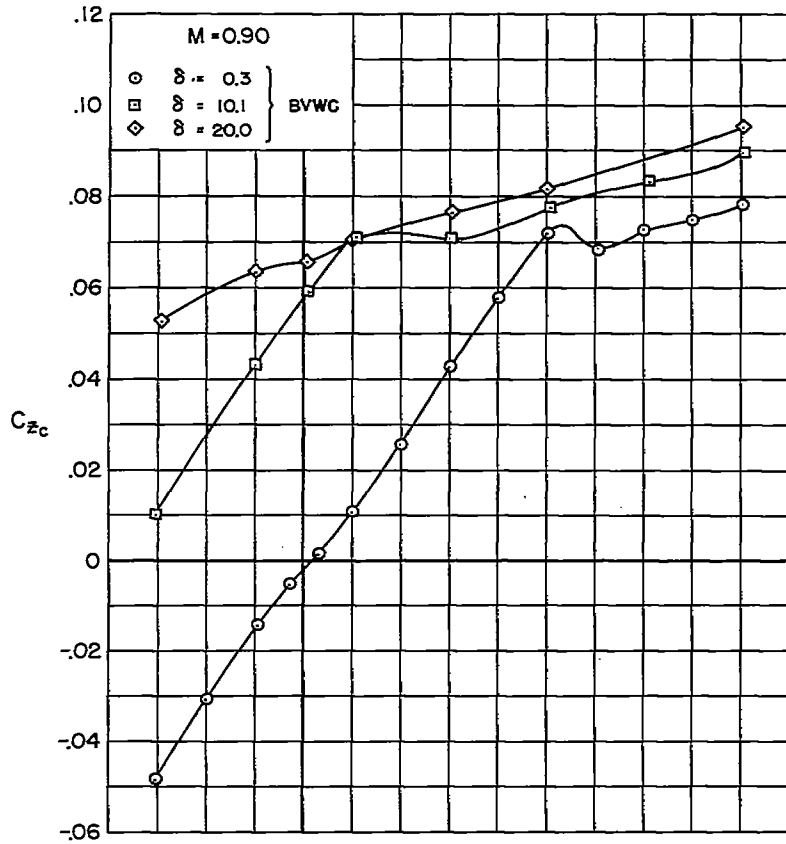
(a)  $M = 0.70$ 

Figure 3.- Variation of canard normal-force and hinge-moment coefficients as a function of angle of attack at constant canard deflection angles.



(b) M = 0.90

Figure 3.- Continued.

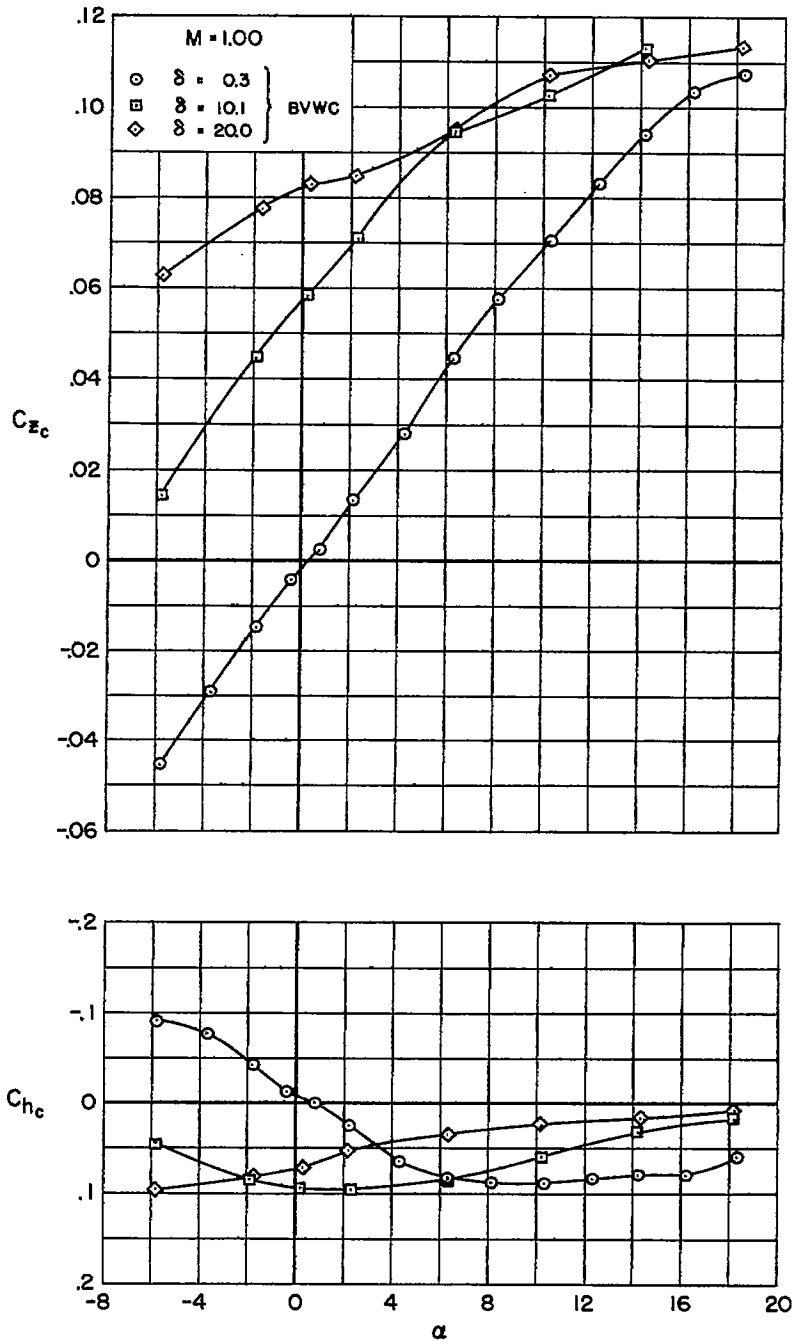
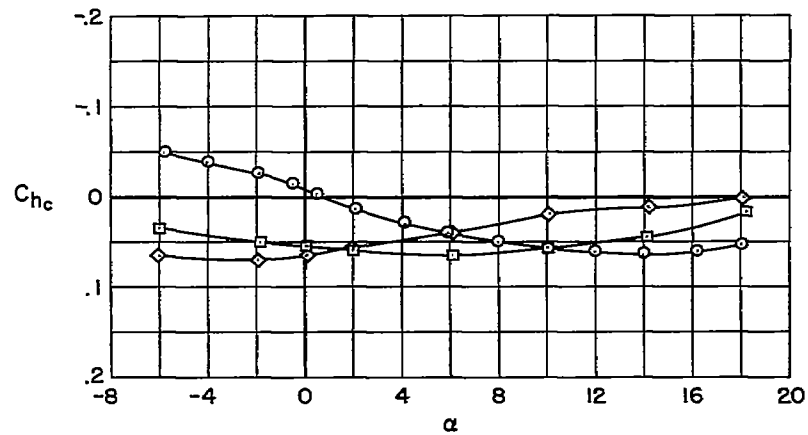
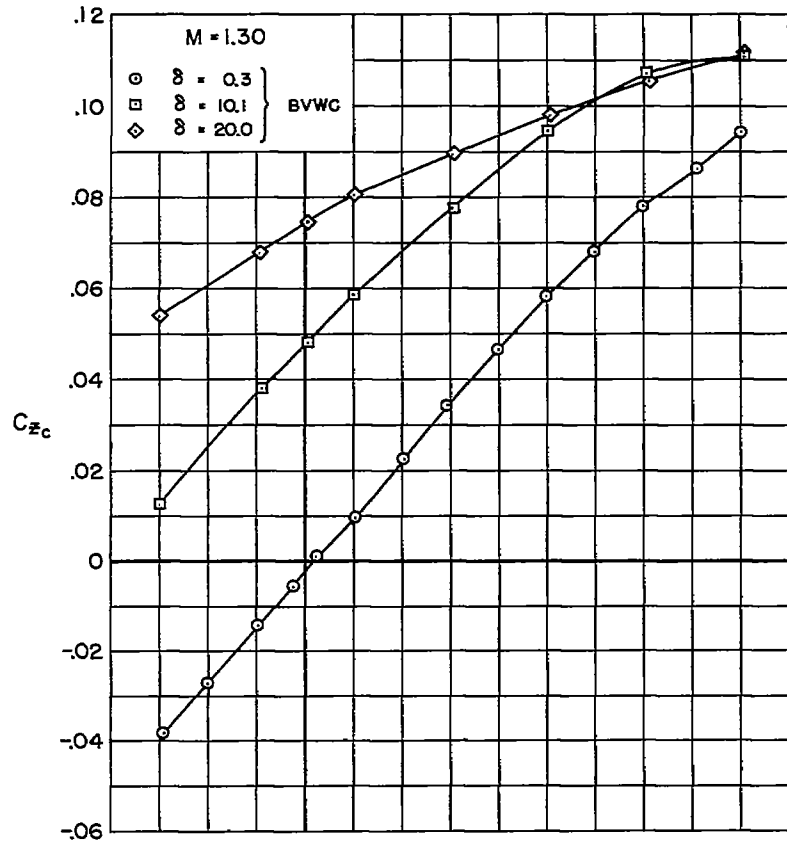
(c)  $M = 1.00$ 

Figure 3.- Continued.



(d) M = 1.30

Figure 3.- Continued.

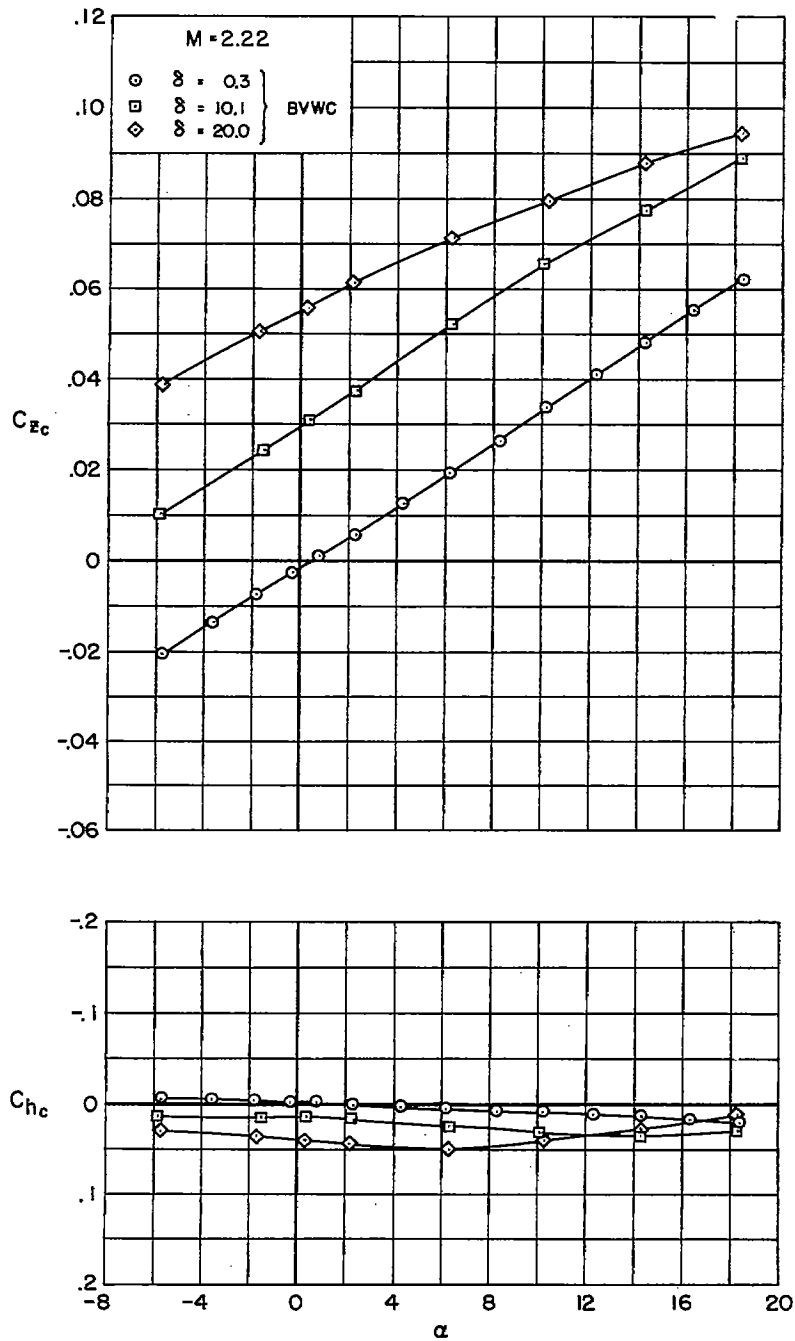
(e)  $M = 2.22$ 

Figure 3.- Concluded.

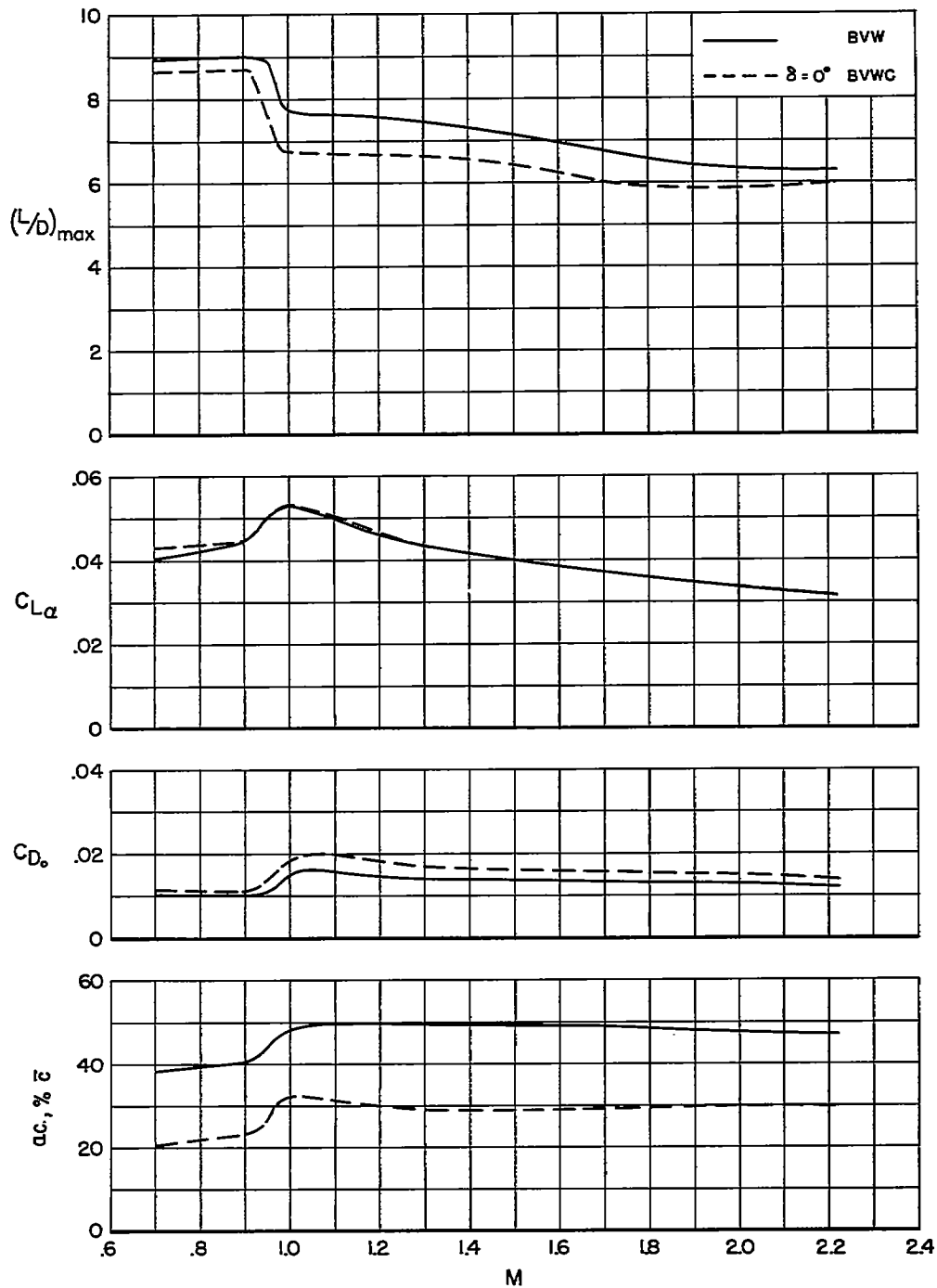


Figure 4.- Variation of maximum lift-drag ratios, lift-curve slopes, minimum drag coefficients, and aerodynamic centers as a function of Mach number for the canard on and off.



LANGLEY RESEARCH CENTER  
  
3 1176 01362 0878

~~CONFIDENTIAL~~