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MEMORANDUM

STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF AN UNSWEPT WING AND UNSWEPT HORIZONTAL-TAIL CONFIGURATION AT MACH NUMBERS FROM 0.70 TO 2.22

By Victor L. Peterson and Gene P. Menees

Ames Research Center
Moffett Field, Calif.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF AN UNSWEPT WING AND UNSWEPT HORIZONTAL-TAIL CONFIGURATION AT MACH NUMBERS FROM 0.70 TO 2.22*

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SUMMARY

Results of an investigation of the static longitudinal stability and control characteristics of an aspect-ratio-3.1, unswept wing configuration equipped with an aspect-ratio-4, unswept horizontal tail are presented without analysis for the Mach number range from 0.70 to 2.22. The hinge line of the all-movable horizontal tail was in the extended wing chord plane, 1.66 wing mean aerodynamic chords behind the reference center of moments. The ratio of the area of the exposed horizontal-tail panels to the total area of the wing was 13.3 percent and the ratio of the total areas was 19.9 percent. Data are presented at angles of attack ranging from -6° to $+18^{\circ}$ for the horizontal tail set at angles ranging from $+5^{\circ}$ to -20° and for the tail removed.

INTRODUCTION

A general research program directed at the investigation of longitudinal control devices capable of achieving low trim drag and adequate maneuverability at supersonic speeds is in progress at the Ames Research Center. As a part of this program, a number of reports have been published showing the longitudinal and lateral-directional characteristics of configurations utilizing canard controls (see refs. 1 through 9). The results for two other trimming devices, a full-span trailing-edge flap and a configuration incorporating camber in the forward part of the body, were also reported in reference 9.

This report is one of the series pertaining to the program and presents without analysis the longitudinal stability and control characteristics of one additional configuration and its component parts. The complete configuration consisted of an aspect-ratio-3.1, unswept wing, an all-movable, unswept horizontal tail of aspect ratio 4, and a low-aspect-ratio vertical tail mounted on a Sears-Haack body of 12.5 fineness ratio. The basic configuration, consisting of the unswept wing, the low-aspect-ratio vertical tail, and the Sears-Haack body, was identical to that tested with the unswept canard of references 5 and 6.

NOTATION

$\bar{c}$ mean aerodynamic chord of wing, ft

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

C_{D_o} drag coefficient at zero lift

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

C_{L_α} lift-curve slope taken through 0° angle of attack, per deg

C_m pitching-moment coefficient, referred to the projection of the $0.15\bar{c}$ point onto the body center line, $\frac{\text{pitching moment}}{qS\bar{c}}$

$\left(\frac{L}{D}\right)_{max}$ 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 vertical plane of symmetry, sq ft

α angle of attack of wing root chord, deg

δ angle of deflection of the horizontal tail 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

H horizontal tail

V vertical tail

W wing

APPARATUS

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. The tunnel floor and ceiling have perforations to permit transonic testing. A somewhat more detailed description is given in reference 1.

The model was sting mounted and the forces and moments were measured with an internal, strain-gage-type, six-component balance.

Model

The model consisted of an aspect-ratio-3.1 unswept wing, an aspect-ratio-4, all-movable, horizontal tail, and a low-aspect-ratio vertical tail mounted on a fineness-ratio-12.5 Sears-Haack body. A dimensional sketch of the model is shown in figure 1. The wing and vertical tail had NACA 2S-(50)(015)-(50)(015) and NACA 0003-63 sections streamwise, respectively. The horizontal tail had NACA 2S-(30)(015)-(30)(015) sections streamwise and was hinged about the line passing through the 0.30 chord points. The hinge line, which was in the extended wing chord plane, was 1.66 wing mean aerodynamic chord lengths behind the reference center of moments ($0.15\bar{c}$). The ratio of the area of the exposed tail panels to the total area of the wing was 13.3 percent and the ratio of the total areas was 19.9 percent.

All of the component parts of the model were of solid steel construction to minimize aeroelastic effects. The surfaces were polished smooth and were further treated to prevent corrosion.

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 and angles of attack ranging from -6° to $+18^{\circ}$ were covered in the investigation. Data were obtained for horizontal-tail deflections ranging from $+5^{\circ}$ to -20° and for the configuration with the horizontal tail removed.

The test Reynolds number based on the wing mean aerodynamic chord was 1.89 million. Wires were placed on the model at the locations shown in figure 1 to induce transition.

Reduction of Data

The data presented herein have been reduced to standard coefficient form. The moment center for the 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 $0.03\bar{c}$; the resulting moment center was at the 0.15 point of the wing mean aerodynamic chord. The results have been adjusted for base drag and stream inclination.

The base pressure was measured and the data were adjusted to correspond to a base pressure equal to the free-stream static pressure.

The data were adjusted for a stream inclination of less than $\pm 0.30^\circ$ which existed throughout the Mach number range of the tests.

RESULTS

The data are presented without analysis in order to expedite publication. All of the experimental data are tabulated in table I. Selected portions of the data are presented in figures 2 and 3. Figure 2 presents the lift, drag, and pitching-moment characteristics with the horizontal tail deflected at various angles and with the tail off for five test Mach numbers. Summarized in figure 3 are the maximum lift-drag ratios, lift-curve slopes, minimum drag coefficients, and aerodynamic center locations as a function of Mach number for the horizontal tail on at zero deflection and for the tail removed. It should be noted that data were not available to cross-plot the parameters shown in figure 3 between the Mach numbers 0.90 and 1.00 and the Mach numbers 1.00 and 1.10. Previous data on this type of wing have shown that results at intermediate Mach numbers are necessary in order to make accurate cross plots. Additional transonic data for a model of the same geometry as that used in the present investigation are available in reference 10.

Ames Research Center
National Aeronautics and Space Administration
Moffett Field, Calif., Mar. 12, 1959

REFERENCES

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TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS

(a) BVW

M	α, deg	C_L	C_D	C_m
0.70	-06.2	-0.464	.0561	.0311
	-04.1	-0.308	.0305	.0139
	-02.0	-0.156	.0173	.0097
	-01.6	-0.127	.0160	.0092
	-00.1	-0.011	.0132	.0013
	00.4	0.023	.0132	.0040
	01.9	0.126	.0159	.0003
	03.9	0.281	.0273	-.0071
	05.9	0.440	.0506	-.0232
	07.9	0.586	.0857	-.0596
	09.9	0.705	.1313	-.1084
0.90	-05.9	-0.578	.0720	.0963
	-03.9	-0.381	.0364	.0431
	-01.9	-0.169	.0181	.0118
	-01.5	-0.135	.0166	.0120
	00.1	-0.002	.0135	.0059
	00.6	0.046	.0142	.0030
	02.1	0.175	.0180	-.0006
	04.1	0.395	.0388	-.0399
	06.0	0.583	.0710	-.0835
	08.1	0.740	.1173	-.1255
	10.0	0.884	.1693	-.1636
	12.1	1.034	.2339	-.2133
1.00	-05.8	-0.528	.0790	.1116
	-03.7	-0.352	.0459	.0643
	-01.7	-0.157	.0297	.0217
	-01.2	-0.120	.0259	.0182
	00.2	0.020	.0260	-.0018
	00.8	0.072	.0243	-.0095
	02.2	0.212	.0324	-.0316
	04.2	0.404	.0546	-.0782
	06.3	0.583	.0901	-.1273
	08.2	0.742	.1350	-.1747
	10.2	0.886	.1854	-.2176
	12.3	1.028	.2494	-.2616
	14.3	1.147	.3175	-.2982
	16.3	1.253	.3919	-.3321
	18.3	1.343	.4682	-.3621
1.10	-05.8	-0.501	.0775	.1079
	-03.8	-0.340	.0490	.0647
	-01.7	-0.165	.0302	.0235
	-01.3	-0.128	.0286	.0197
	00.2	0.006	.0222	-.0067
	00.8	0.052	.0218	-.0126
	02.2	0.196	.0322	-.0325
	04.2	0.361	.0518	-.0725
	06.2	0.522	.0822	-.1157
	08.2	0.673	.1253	-.1582
	10.2	0.812	.1742	-.1996
	14.2	1.058	.2971	-.2762
	16.2	1.155	.3639	-.3073
	18.2	1.248	.4366	-.3382
1.30	-06.0	-0.424	.0654	.1118
	-04.0	-0.290	.0410	.0750
	-01.9	-0.145	.0254	.0357
	-01.5	-0.115	.0234	.0275
	-00.0	0.002	.0202	-.0013
	00.5	0.035	.0206	-.0078
	02.0	0.142	.0253	-.0350
	04.1	0.288	.0407	-.0724
	06.0	0.417	.0631	-.1084
	08.1	0.561	.0988	-.1470
	10.0	0.686	.1400	-.1810
	11.9	0.795	.1871	-.2102
	14.0	0.917	.2447	-.2448
	16.1	1.022	.3085	-.2714
	18.0	1.153	.3856	-.3073
1.70	-06.1	-0.309	.0511	.0940
	-04.2	-0.212	.0331	.0653
	-02.1	-0.116	.0219	.0362
	-01.6	-0.086	.0199	.0265
	-00.2	-0.005	.0171	.0023
	00.4	0.018	.0171	-.0031
	01.8	0.092	.0199	-.0253
	03.9	0.195	.0301	-.0557
	05.9	0.292	.0462	-.0846
	07.9	0.394	.0709	-.1154
	09.9	0.496	.1027	-.1463
	11.8	0.588	.1396	-.1740
	13.9	0.680	.1841	-.2037
	15.9	0.769	.2354	-.2310
	17.9	0.852	.2912	-.2552
2.22	-05.6	-0.215	.0356	.0685
	-03.5	-0.139	.0225	.0439
	-01.6	-0.062	.0151	.0203
	-01.2	-0.044	.0139	.0145
	00.4	0.014	.0130	-.0020
	00.8	0.027	.0134	-.0054
	02.4	0.086	.0167	-.0238
	04.3	0.159	.0253	-.0464
	06.4	0.235	.0392	-.0702
	08.4	0.310	.0585	-.0946
	10.3	0.385	.0830	-.1181
	12.4	0.463	.1144	-.1428
	14.4	0.543	.1523	-.1680
	16.4	0.622	.1968	-.1933
	18.4	0.694	.2449	-.2172

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Continued

(b) BVWH; $\delta = 0^{\circ}$

M	α, deg	C_L	C_D	C_m
0.70	-06.1	-0.480	.0593	.0582
	-04.1	-0.319	.0335	.0312
	-02.1	-0.160	.0195	.0168
	-00.6	-0.048	.0154	.0070
	-00.1	-0.017	.0151	.0083
	00.4	0.015	.0151	.0070
	01.9	0.129	.0178	-.0049
	03.9	0.295	.0303	-.0204
	05.9	0.456	.0540	-.0458
	07.8	0.621	.0923	-.0975
	09.9	0.744	.1390	-.1632
0.90	-03.8	-0.376	.0383	.0420
	-02.0	-0.179	.0204	.0133
	-00.5	-0.039	.0161	.0053
	00.0	0.003	.0150	.0049
	00.6	0.048	.0161	.0014
	02.0	0.162	.0193	-.0023
	04.0	0.379	.0370	-.0313
	06.0	0.593	.0751	-.0907
	08.1	0.749	.1201	-.1359
	10.0	0.913	.1767	-.2000
	12.1	1.097	.2508	-.2820
	14.0	1.248	.3270	-.3509
	16.0	1.405	.4204	-.4398
1.00	-05.7	-0.547	.0820	.1385
	-03.6	-0.346	.0499	.0702
	-01.7	-0.163	.0321	.0253
	-00.2	-0.024	.0259	.0056
	00.3	0.026	.0277	-.0013
	00.8	0.062	.0264	-.0031
	02.2	0.210	.0352	-.0272
	04.2	0.404	.0550	-.0751
	06.3	0.610	.0950	-.1698
	08.2	0.795	.1441	-.2519
	10.2	0.960	.2026	-.3298
	12.2	1.111	.2707	-.4057
	14.2	1.250	.3460	-.4788
	16.2	1.379	.4291	-.5540
	18.2	1.509	.5237	-.6402
1.10	-05.7	-0.517	.0829	.1382
	-03.8	-0.345	.0526	.0764
	-01.7	-0.168	.0341	.0264
	-00.2	-0.018	.0273	-.0008
	00.3	0.028	.0273	-.0060
	00.7	0.064	.0289	-.0135
	02.1	0.198	.0354	-.0398
	04.2	0.383	.0563	-.1005
	06.1	0.553	.0891	-.1653
	08.2	0.724	.1357	-.2363
	10.2	0.879	.1899	-.3079
	12.2	1.027	.2546	-.3786
	14.1	1.161	.3246	-.4503
	16.2	1.283	.4035	-.5233
	18.2	1.398	.4902	-.5979
1.30	-06.0	-0.468	.0728	.1856
	-04.0	-0.314	.0449	.1217
	-02.0	-0.171	.0292	.0668
	-00.5	-0.040	.0230	.0179
	00.0	-0.000	.0226	.0038
	00.5	0.038	.0231	-.0092
	02.0	0.149	.0281	-.0502
	04.0	0.309	.0446	-.1113
	05.9	0.460	.0707	-.1734
	08.0	0.615	.1091	-.2379
	09.8	0.753	.1519	-.2971
	12.0	0.896	.2127	-.3604
	14.0	1.036	.2766	-.4574
	15.9	1.153	.3468	-.5030
	17.9	1.275	.4266	-.5172
1.70	-06.1	-0.353	.0582	.1689
	-04.0	-0.241	.0371	.1163
	-02.2	-0.129	.0245	.0640
	-00.7	-0.040	.0196	.0230
	-00.1	-0.006	.0191	.0068
	00.2	0.015	.0190	-.0026
	01.8	0.105	.0223	-.0455
	03.9	0.222	.0334	-.0995
	05.7	0.337	.0521	-.1531
	07.8	0.451	.0807	-.2071
	09.8	0.561	.1155	-.2598
	11.8	0.679	.1596	-.3166
	13.8	0.775	.2084	-.3648
	15.8	0.872	.2647	-.4129
	17.8	0.971	.3291	-.4600
2.22	-05.7	-0.247	.0408	.1192
	-03.7	-0.166	.0267	.0806
	-01.6	-0.075	.0175	.0377
	-00.2	-0.010	.0148	.0078
	00.4	0.009	.0149	-.0008
	00.9	0.034	.0151	-.0127
	02.3	0.094	.0185	-.0407
	04.3	0.182	.0285	-.0825
	06.3	0.267	.0442	-.1228
	08.3	0.356	.0669	-.1658
	10.3	0.438	.0945	-.2064
	12.3	0.530	.1313	-.2516
	14.3	0.617	.1713	-.2944
	16.3	0.708	.2225	-.3400
	18.5	0.797	.2816	-.3847

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Continued

(c) BVWH; δ = -5°

M	α, deg	C_L	C_D	C_m
0.70	-06.2	-0.549	.0707	.1504
	-04.1	-0.382	.0408	.1207
	-02.1	-0.216	.0239	.1060
	-00.6	-0.100	.0184	.0915
	-00.1	-0.067	.0174	.0906
	00.4	-0.028	.0174	.0859
	01.9	0.080	.0186	.0748
	03.8	0.237	.0281	.0608
	05.9	0.402	.0503	.0352
	07.9	0.564	.0865	-.0159
	09.9	0.691	.1317	-.0827
0.90	-06.0	-0.650	.0858	.2083
	-03.8	-0.443	.0451	.1514
	-01.9	-0.246	.0263	.1278
	-00.4	-0.105	.0200	.1169
	00.0	-0.062	.0189	.1128
	00.5	-0.028	.0192	.1111
	02.1	0.108	.0210	.1015
	04.0	0.316	.0362	.0735
	05.9	0.528	.0713	.0148
	08.0	0.683	.1134	-.0309
	10.1	0.865	.1712	-.1115
1.00	-05.8	-0.612	.0956	.2542
	-03.6	-0.414	.0564	.1788
	-01.7	-0.226	.0368	.1329
	-00.2	-0.088	.0312	.1152
	00.3	-0.040	.0303	.1071
	00.8	0.014	.0347	.0910
	02.2	0.143	.0356	.0815
	04.3	0.355	.0571	.0146
	06.3	0.549	.0901	-.0632
	08.2	0.724	.1350	-.1386
	10.3	0.892	.1913	-.2137
	14.2	1.177	.3251	-.3508
	18.2	1.424	.4908	-.5136
1.10	-05.9	-0.582	.0950	.2465
	-03.7	-0.397	.0584	.1762
	-01.7	-0.224	.0382	.1238
	-00.3	-0.084	.0310	.0978
	00.2	-0.038	.0306	.0908
	00.7	0.009	.0310	.0823
	02.2	0.148	.0360	.0571
	04.2	0.327	.0551	-.0033
	06.2	0.504	.0868	-.0687
	08.2	0.662	.1279	-.1321
	10.1	0.805	.1765	-.1937
	14.2	1.097	.3067	-.3353
	18.2	1.334	.4640	-.4893
1.30	-06.0	-0.513	.0822	.2658
	-04.0	-0.366	.0535	.2061
	-02.0	-0.200	.0328	.1391
	-00.5	-0.086	.0264	.0959
	-00.0	-0.046	.0252	.0811
	00.5	-0.010	.0257	.0686
	02.0	0.106	.0287	.0276
	04.0	0.258	.0422	-.0289
	06.0	0.410	.0662	-.0891
	08.0	0.564	.1019	-.1533
	10.0	0.700	.1440	-.2105
	14.0	0.980	.2588	-.3661
	18.0	1.218	.4064	-.4057
1.70	-06.1	-0.389	.0674	.2280
	-04.2	-0.270	.0434	.1713
	-02.1	-0.147	.0278	.1124
	-00.6	-0.062	.0223	.0719
	-00.1	-0.035	.0214	.0591
	00.4	-0.006	.0212	.0456
	01.8	0.077	.0228	.0072
	03.8	0.187	.0314	-.0435
	05.8	0.304	.0490	-.0969
	07.8	0.422	.0757	-.1533
	09.8	0.529	.1080	-.2030
	13.8	0.740	.1963	-.3048
	17.9	0.938	.3131	-.4021
2.22	-05.7	-0.267	.0459	.1575
	-03.7	-0.177	.0293	.1140
	-01.6	-0.090	.0195	.0721
	-00.1	-0.029	.0165	.0438
	00.3	-0.009	.0159	.0342
	00.8	0.012	.0162	.0243
	02.3	0.075	.0187	-.0050
	04.3	0.161	.0270	-.0447
	06.2	0.243	.0408	-.0833
	08.3	0.331	.0620	-.1263
	10.4	0.415	.0888	-.1666
	14.3	0.590	.1615	-.2498
	18.4	0.766	.2642	-.3355

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Continued

(d) BVWH; $\delta = -10^{\circ}$

M	α, deg	C_L	C_D	C_m
0.70	-06.0	-0.593	.0851	.2333
	-04.1	-0.436	.0552	.2008
	-02.0	-0.259	.0352	.1797
	-00.5	-0.151	.0281	.1712
	-00.0	-0.112	.0268	.1673
	00.4	-0.080	.0259	.1647
	01.9	0.027	.0261	.1550
	03.8	0.177	.0331	.1436
	05.9	0.343	.0529	.1176
	07.9	0.514	.0872	.0628
	09.8	0.635	.1274	-.0046
0.90	-05.8	-0.701	.1002	.2986
	-03.7	-0.479	.0584	.2351
	-01.9	-0.294	.0393	.2045
	-00.4	-0.156	.0318	.1950
	00.0	-0.108	.0308	.1920
	00.6	-0.067	.0296	.1884
	02.0	0.052	.0309	.1840
	04.1	0.274	.0465	.1569
	06.0	0.460	.0765	.1119
	07.9	0.610	.1148	.0732
	10.1	0.765	.1647	.0178
	14.0	1.103	.3028	-.1353
1.00	-05.7	-0.664	.1110	.3505
	-03.6	-0.486	.0741	.2826
	-01.6	-0.274	.0509	.2298
	-00.1	-0.138	.0429	.2121
	00.2	-0.093	.0432	.2035
	00.7	-0.053	.0429	.1964
	02.2	0.084	.0462	.1752
	04.2	0.289	.0645	.1199
	06.2	0.482	.0949	.0402
	08.2	0.661	.1369	-.0344
	10.2	0.823	.1873	-.1063
1.10	-05.7	-0.628	.1092	.3345
	-03.5	-0.447	.0713	.2654
	-01.7	-0.270	.0491	.2135
	-00.3	-0.135	.0411	.1878
	00.1	-0.093	.0405	.1794
	00.7	-0.034	.0405	.1692
	02.2	0.096	.0439	.1450
	04.2	0.273	.0609	.0884
	06.1	0.443	.0884	.0269
	08.2	0.606	.1280	-.0389
	10.2	0.764	.1786	-.1037
	14.0	1.029	.2934	-.2352
	16.5	1.265	.4055	-.3311

M	α, deg	C_L	C_D	C_m
1.30	-05.9	-0.553	.0970	.3376
	-03.9	-0.400	.0645	.2747
	-01.9	-0.238	.0430	.2083
	-00.4	-0.122	.0348	.1651
	-00.0	-0.088	.0338	.1539
	00.4	-0.051	.0333	.1418
	01.9	0.059	.0353	.1046
	03.9	0.213	.0472	.0488
	05.9	0.359	.0681	-.0074
	07.9	0.515	.1008	-.0726
	09.9	0.661	.1432	-.1324
	13.9	0.927	.2472	-.2763
	17.9	1.163	.3878	-.3402
1.70	-06.0	-0.406	.0774	.2757
	-04.1	-0.295	.0538	.2234
	-02.1	-0.182	.0368	.1672
	-00.5	-0.093	.0292	.1240
	-00.1	-0.067	.0283	.1116
	00.3	-0.041	.0275	.0993
	01.8	0.043	.0275	.0603
	03.8	0.167	.0352	.0025
	05.7	0.277	.0500	-.0486
	07.9	0.392	.0746	-.1011
	09.8	0.497	.1046	-.1500
	13.7	0.706	.1872	-.2494
	17.8	0.905	.2998	-.3472
2.22	-05.5	-0.279	.0534	.1931
	-03.6	-0.196	.0369	.1513
	-01.5	-0.109	.0253	.1086
	-00.1	-0.048	.0214	.0796
	00.3	-0.026	.0206	.0682
	00.8	-0.007	.0203	.0585
	02.4	0.057	.0220	.0283
	04.3	0.141	.0288	-.0107
	06.3	0.222	.0415	-.0488
	08.2	0.306	.0601	-.0878
	10.3	0.394	.0859	-.1296
	14.3	0.569	.1558	-.2130
	18.4	0.737	.2532	-.2939

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Continued

(e) BVWH; $\delta = -15^{\circ}$

M	α, deg	C_L	C_D	C_m
0.70	-05.9	-0.606	.1012	.2631
	-04.1	-0.455	.0714	.2332
	-01.9	-0.274	.0496	.2118
	-00.6	-0.176	.0432	.2064
	-00.1	-0.143	.0415	.2048
	00.4	-0.105	.0405	.2004
	01.8	-0.001	.0399	.1928
	03.9	0.158	.0463	.1858
	05.9	0.309	.0638	.1714
	07.8	0.460	.0943	.1309
	09.4	0.563	.1252	.0834
0.90	-05.9	-0.734	.1211	.3481
	-03.8	-0.537	.0796	.2920
	-02.0	-0.313	.0541	.2410
	-00.4	-0.177	.0466	.2305
	00.0	-0.134	.0438	.2241
	00.6	-0.094	.0454	.2312
	01.9	0.018	.0466	.2412
	04.1	0.243	.0571	.2021
	06.0	0.437	.0895	.1617
	08.0	0.576	.1286	.1370
	10.0	0.705	.1711	.1039
	11.4	0.823	.2122	.0525
1.00	-05.7	-0.717	.1380	.4341
	-03.7	-0.520	.0944	.3605
	-01.7	-0.335	.0719	.3143
	-00.2	-0.191	.0628	.2927
	00.2	-0.146	.0635	.2852
	00.7	-0.103	.0618	.2759
	02.3	0.046	.0634	.2501
	04.4	0.254	.0825	.1992
	10.3	0.776	.1975	-.0114
	14.1	1.054	.3162	-.1405
1.10	-05.8	-0.679	.1357	.4168
	-03.7	-0.505	.0960	.3496
	-01.7	-0.324	.0707	.2964
	-00.3	-0.181	.0604	.2713
	00.2	-0.133	.0595	.2629
	00.7	-0.092	.0588	.2541
	02.2	0.042	.0612	.2291
	04.2	0.223	.0740	.1743
	06.2	0.403	.1031	.1084
	08.2	0.560	.1388	.0476
	10.3	0.711	.1865	-.0126
	14.1	0.986	.2998	-.1457

M	α, deg	C_L	C_D	C_m
1.30	-05.9	-0.579	.1169	.3979
	-04.0	-0.438	.0847	.3391
	-02.1	-0.287	.0617	.2764
	-00.4	-0.160	.0513	.2321
	-00.1	-0.127	.0498	.2220
	00.5	-0.092	.0488	.2114
	02.0	0.020	.0493	.1749
	04.0	0.171	.0594	.1216
	05.9	0.316	.0780	.0670
	08.1	0.476	.1099	.0014
	10.0	0.619	.1489	-.0576
	13.8	0.877	.2433	-.1864
	15.9	0.998	.3097	-.2245
1.70	-06.1	-0.435	.0963	.3256
	-04.1	-0.324	.0697	.2726
	-02.2	-0.211	.0511	.2147
	-00.6	-0.122	.0420	.1733
	-00.2	-0.096	.0405	.1622
	00.4	-0.063	.0390	.1472
	01.9	0.017	.0384	.1111
	03.7	0.120	.0433	.0653
	05.8	0.250	.0573	.0049
	07.9	0.360	.0789	-.0473
	09.8	0.471	.1083	-.0989
	13.8	0.684	.1877	-.2001
	17.9	0.893	.3007	-.3025
2.22	-05.7	-0.307	.0707	.2383
	-03.6	-0.218	.0499	.1915
	-01.8	-0.138	.0375	.1502
	-00.1	-0.070	.0313	.1164
	00.3	-0.048	.0304	.1068
	00.8	-0.029	.0294	.0973
	02.4	0.035	.0297	.0662
	04.3	0.122	.0353	.0240
	06.3	0.203	.0462	-.0147
	08.3	0.291	.0638	-.0572
	10.4	0.380	.0887	-.0983
	14.3	0.554	.1552	-.1802
	18.3	0.723	.2480	-.2576

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Continued

(f) BVWH; $\delta = -20^{\circ}$

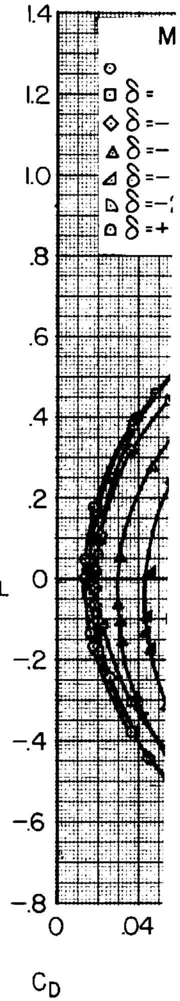
M	α, deg	C_L	C_D	C_m
0.70	-06.1	-0.620	.1148	.2630
	-04.0	-0.447	.0784	.2292
	-02.0	-0.287	.0603	.2106
	-00.6	-0.170	.0518	.2005
	-00.1	-0.128	.0504	.1952
	00.3	-0.099	.0491	.1918
	01.8	0.010	.0487	.1826
	03.9	0.168	.0559	.1731
	05.8	0.321	.0740	.1568
	07.8	0.474	.1082	.1315
	09.8	0.567	.1442	.0944
0.90	-05.9	-0.750	.1391	.3780
	-03.8	-0.539	.0938	.3066
	-01.9	-0.326	.0706	.2706
	-00.4	-0.180	.0589	.2455
	00.1	-0.146	.0602	.2538
	00.5	-0.103	.0565	.2383
	02.0	0.026	.0578	.2355
	04.0	0.240	.0702	.2032
	05.9	0.518	.1196	.1773
	08.0	0.586	.1366	.1128
	10.0	0.732	.1839	.0667
1.00	-05.8	-0.739	.1579	.4677
	-03.8	-0.561	.1185	.4073
	-01.8	-0.362	.0926	.3603
	-00.3	-0.214	.0841	.3365
	00.3	-0.166	.0819	.3284
	00.7	-0.128	.0812	.3208
	02.2	0.013	.0815	.2960
	04.2	0.216	.1007	.2459
	06.1	0.393	.1270	.1895
	08.2	0.572	.1652	.1183
	10.2	0.727	.2120	.0546
	14.2	1.014	.3301	-.0694
1.10	-05.9	-0.711	.1602	.4639
	-03.6	-0.515	.1149	.3913
	-01.8	-0.352	.0925	.3457
	-00.3	-0.211	.0822	.3262
	00.2	-0.162	.0809	.3147
	00.6	-0.129	.0800	.3085
	02.2	0.016	.0815	.2817
	04.2	0.192	.0956	.2259
	06.1	0.359	.1192	.1660
	08.1	0.522	.1541	.1057
	10.3	0.672	.1999	.0503
	14.1	0.934	.3068	-.0662
1.30	-06.0	-0.609	.1417	.4478
	-04.0	-0.461	.1046	.3845
	-01.9	-0.304	.0802	.3212
	-00.5	-0.193	.0709	.2862
	00.0	-0.151	.0691	.2736
	00.5	-0.121	.0680	.2640
	02.0	-0.012	.0677	.2286
	04.0	0.141	.0762	.1771
	06.0	0.289	.0940	.1191
	07.9	0.442	.1224	.0600
	09.9	0.580	.1592	.0067
	13.9	0.833	.2517	-.1073
1.70	-06.2	-0.464	.1179	.3715
	-04.1	-0.347	.0872	.3135
	-02.2	-0.234	.0663	.2560
	-00.7	-0.149	.0575	.2190
	-00.0	-0.118	.0553	.2049
	00.3	-0.097	.0541	.1958
	01.8	-0.014	.0522	.1605
	03.9	0.100	.0566	.1106
	05.7	0.211	.0678	.0605
	07.8	0.327	.0880	.0077
	09.9	0.440	.1160	-.0457
	13.8	0.654	.1926	-.1508
	17.7	0.860	.2957	-.2521
2.22	-05.6	-0.333	.0876	.2814
	-03.6	-0.241	.0647	.2312
	-00.2	-0.096	.0447	.1598
	00.4	-0.073	.0432	.1483
	00.8	-0.056	.0421	.1401
	02.3	0.007	.0410	.1095
	04.3	0.094	.0446	.0662
	06.3	0.181	.0541	.0236
	08.3	0.269	.0704	-.0204
	10.3	0.355	.0922	-.0618
	14.3	0.531	.1558	-.1450
	18.3	0.707	.2483	-.2289

TABLE I.- LONGITUDINAL AERODYNAMIC CHARACTERISTICS - Concluded

(g) BVWH; $\delta = +5^{\circ}$

M	α, deg	C_L	C_D	C_m
0.70	-06.1	-0.430	.0555	-.0208
	-04.1	-0.267	.0313	-.0488
	-02.1	-0.117	.0201	-.0619
	-00.6	-0.004	.0175	-.0726
	-00.1	0.030	.0173	-.0755
	00.4	0.074	.0192	-.0803
	01.8	0.181	.0226	-.0904
	03.9	0.348	.0371	-.1086
	05.8	0.509	.0626	-.1344
	07.9	0.678	.1057	-.1865
	10.0	0.795	.1551	-.2525
0.90	-05.9	-0.518	.0730	-.0118
	-03.9	-0.306	.0366	-.0699
	-01.9	-0.113	.0229	-.0963
	-00.4	0.017	.0191	-.1009
	00.0	0.060	.0201	-.1069
	00.5	0.094	.0201	-.1076
	02.0	0.241	.0269	-.1179
	04.0	0.459	.0479	-.1482
	06.0	0.661	.0871	-.2061
	08.0	0.833	.1363	-.2592
	09.9	0.995	.1952	-.3274
1.00	-05.7	-0.488	.0787	.0346
	-03.8	-0.298	.0513	-.0288
	-01.7	-0.111	.0352	-.0763
	-00.2	0.028	.0302	-.0959
	00.3	0.072	.0312	-.1027
	00.7	0.115	.0328	-.1092
	02.2	0.266	.0401	-.1323
	04.2	0.476	.0669	-.2035
	06.1	0.669	.1078	-.2836
	08.1	0.856	.1610	-.3689
	10.2	1.021	.2222	-.4457
	14.2	1.312	.3740	-.5870
	18.2	1.548	.5534	-.7310
1.10	-05.8	-0.466	.0809	.0407
	-03.7	-0.284	.0512	-.0231
	-01.8	-0.114	.0358	-.0719
	-00.3	0.019	.0321	-.0958
	00.3	0.069	.0323	-.1047
	00.6	0.104	.0325	-.1086
	02.1	0.252	.0409	-.1397
	04.1	0.436	.0650	-.2022
	06.1	0.612	.1018	-.2710
	08.2	0.790	.1520	-.3458
	10.1	0.934	.2073	-.4107
	14.1	1.213	.3480	-.5467
	18.1	1.434	.5154	-.6813

M	α, deg	C_L	C_D	C_m
1.30	-06.0	-0.423	.0685	.1023
	-03.9	-0.269	.0433	.0399
	-02.0	-0.120	.0296	-.0166
	-00.5	-0.009	.0255	-.0564
	00.0	0.036	.0258	-.0725
	00.4	0.069	.0263	-.0837
	01.9	0.191	.0332	-.1297
	04.0	0.355	.0527	-.1939
	05.9	0.502	.0809	-.2533
	07.9	0.654	.1207	-.3144
	09.9	0.800	.1699	-.3753
	13.9	1.074	.2965	-.5311
	18.0	1.316	.4529	-.6096
1.70	-06.2	-0.328	.0551	.1177
	-04.1	-0.213	.0353	.0628
	-02.1	-0.104	.0249	.0125
	-00.6	-0.019	.0216	-.0268
	-00.2	0.009	.0213	-.0397
	00.3	0.039	.0216	-.0542
	01.8	0.130	.0263	-.0969
	03.8	0.251	.0398	-.1543
	05.7	0.362	.0598	-.2074
	07.8	0.477	.0902	-.2629
	09.8	0.591	.1289	-.3175
	13.3	0.804	.2248	-.4185
	17.3	0.995	.3479	-.5077
2.22	-05.7	-0.229	.0387	.0833
	-03.6	-0.137	.0247	.0405
	-01.6	-0.062	.0171	.0048
	-00.1	0.011	.0167	-.0292
	00.4	0.030	.0169	-.0379
	00.7	0.049	.0175	-.0472
	02.3	0.115	.0220	-.0785
	04.3	0.201	.0335	-.1191
	06.2	0.290	.0508	-.1619
	08.3	0.373	.0743	-.2038
	10.3	0.460	.1044	-.2469
	14.2	0.636	.1841	-.3356
	18.3	0.812	.2938	-.4232



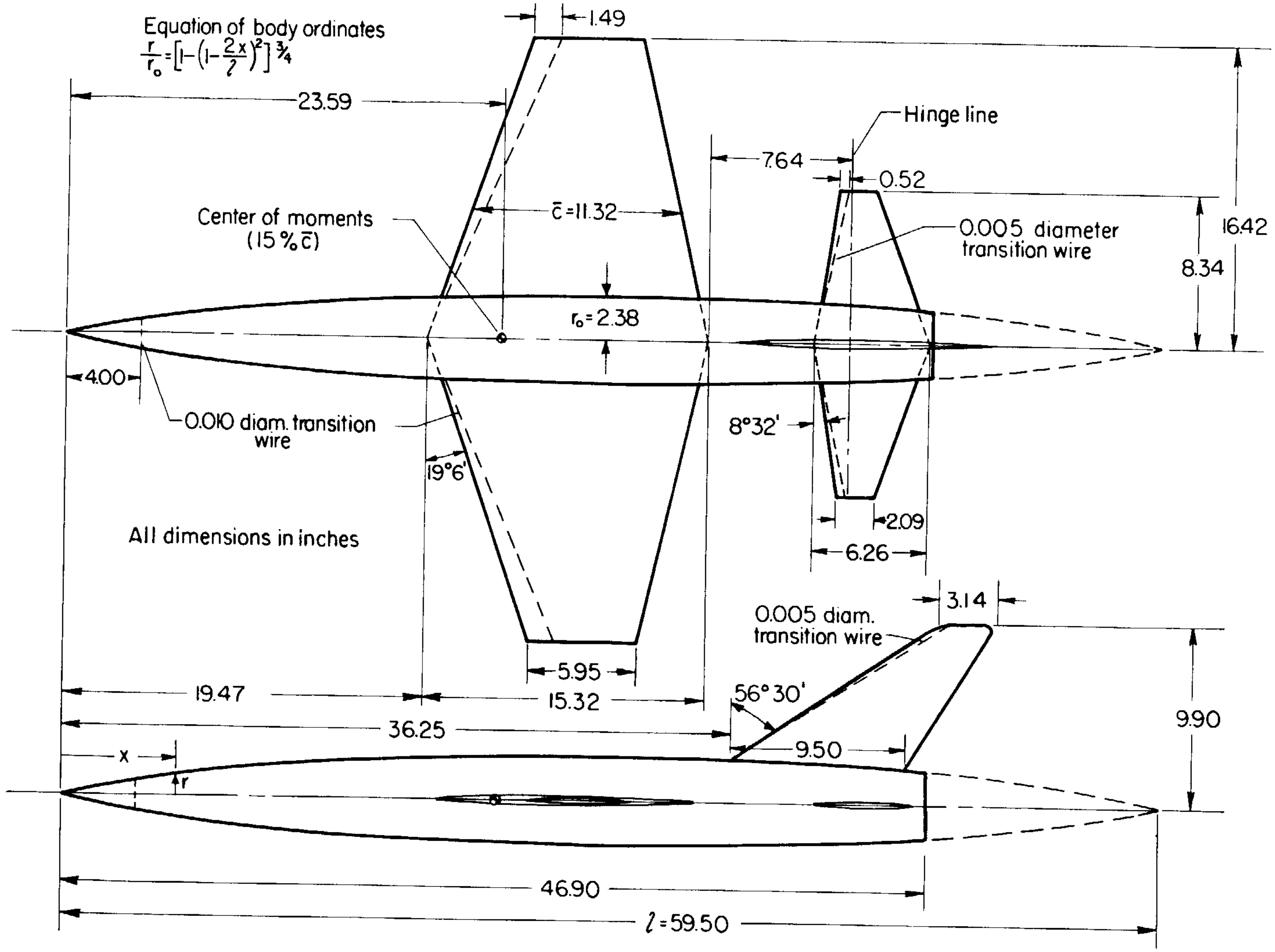
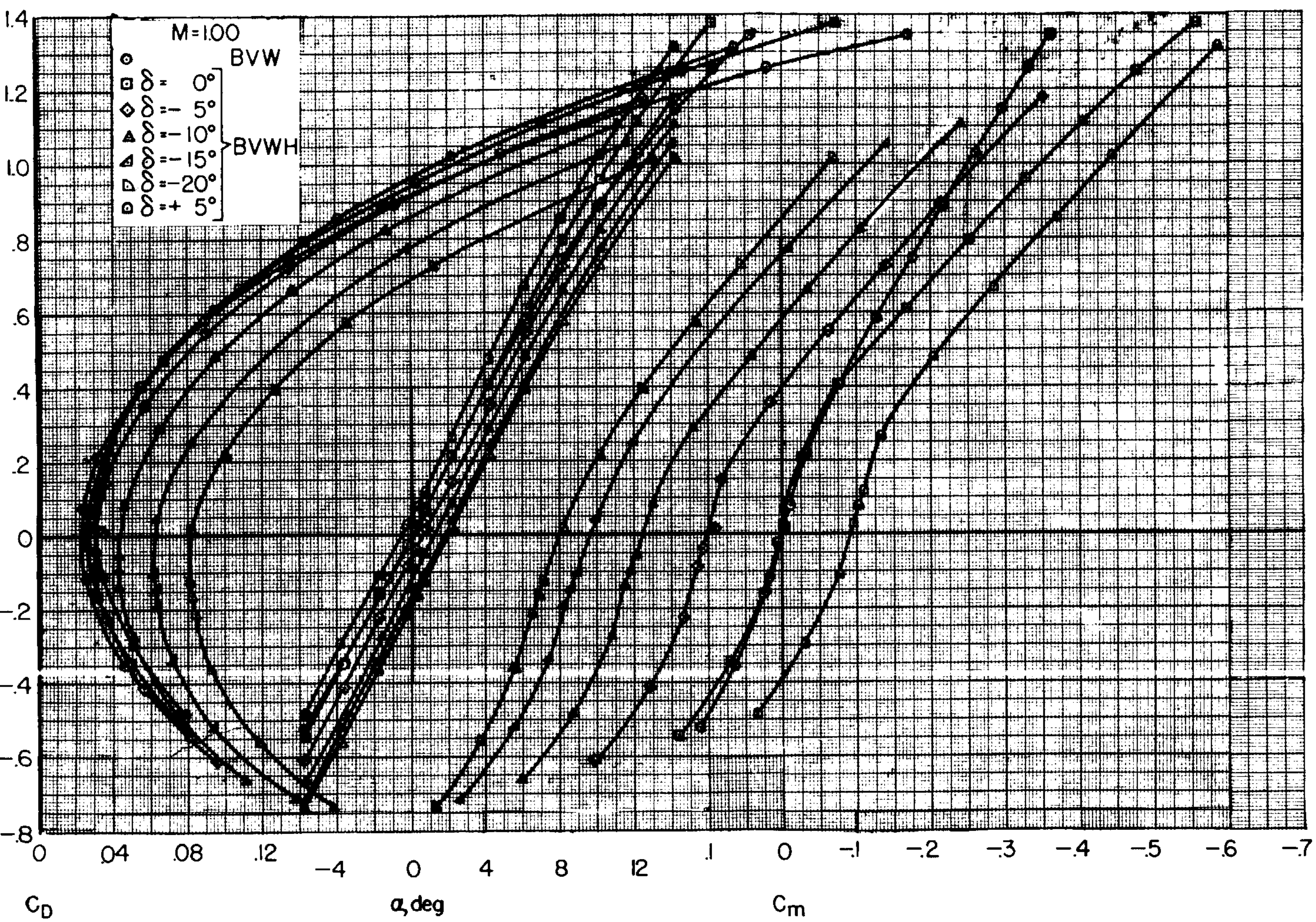
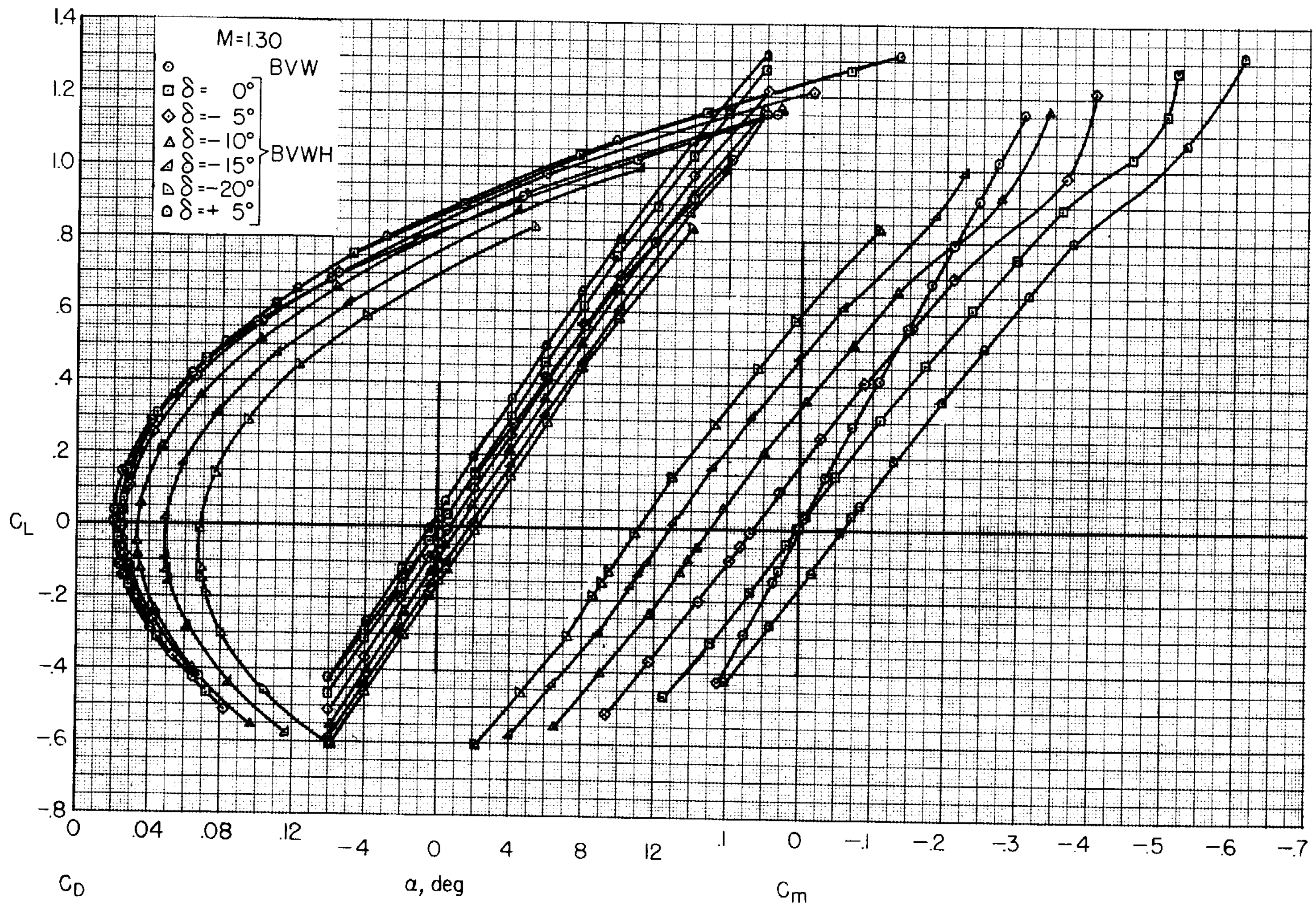


Figure 1.- Dimensional sketch of complete model.



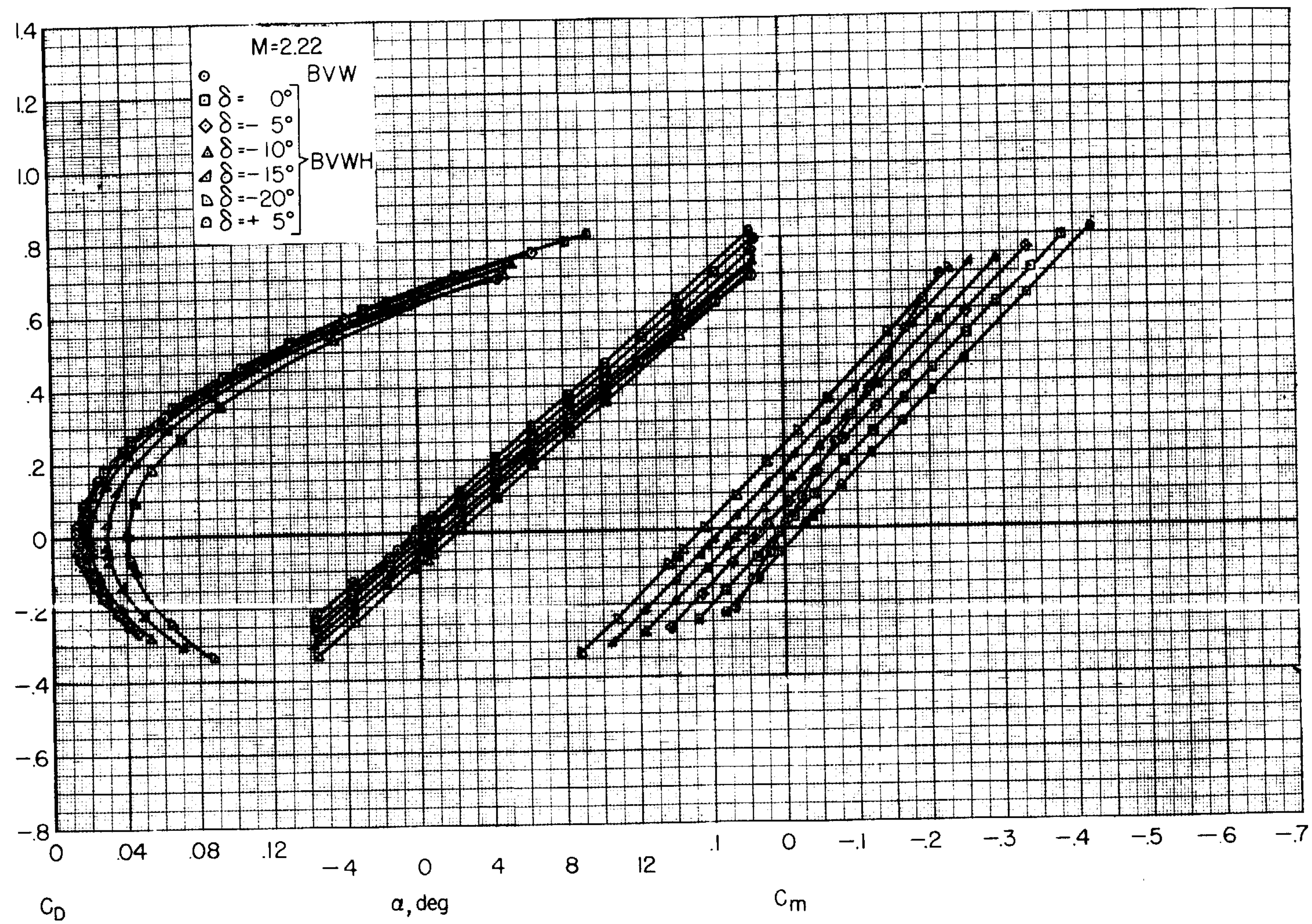
(c) M = 1.00

Figure 2.- Continued.



(d) M = 1.30

Figure 2.- Continued.



(e) M = 2.22

Figure 2.- Concluded.

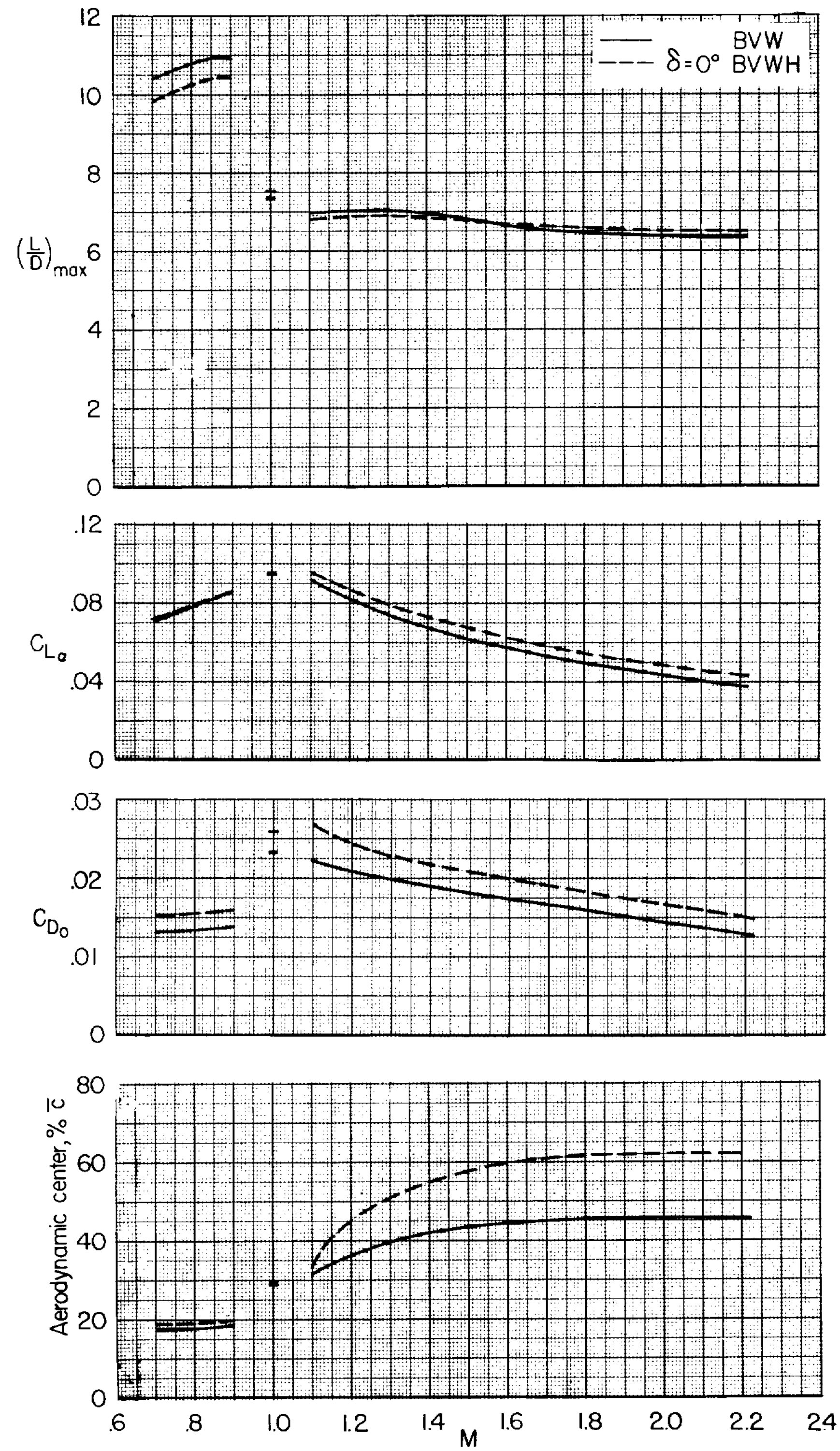


Figure 3.- Variation of maximum lift-drag ratios, lift-curve slopes, minimum drag coefficients, and aerodynamic centers with Mach number.