TABLE II

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS,

AND RESULTS OF CALCULATIONS FOR BASIC CONFIGURATIONS

$[\Gamma = 0^\circ,\ i_v = 0^\circ]$

Configuration	Λ, deg	A	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																					Aperiodic mode		Oscillatory mode	
			h, ft	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
1	0	6.0	0	0.75	0.06	0.71	-1.29	13	0.0196	0.0592	-0.00090	-0.4660	-0.0332	0.0805	0.0116	-0.4116	-0.0046	0.2323	0.0444	-0.1288	863	0.1015	1.637	1.455
			0	.27	.46	5.41	3.41	13	.0197	.0591	.00234	-.4660	-.0269	.0829	.0905	-.4098	-.0358	.2370	.1163	-.1335	-40.1	.284	4.347	3.686
			0	.204	.80	9.41	7.41	13	.0203	.0585	.00506	-.4660	-.0231	.0853	.1569	-.4096	-.0622	.2417	.1775	-.1383	-17.0	.376	5.480	4.008
			50,000	.75	.46	5.41	3.41	85	.0197	.0591	.00234	-.4660	-.0269	.0829	.0905	-.4098	-.0358	.2370	.1163	-.1335	-101.5	.713	4.594	10.919
2	30	4.5	0	.75	.06	.82	-1.18	15	.0210	.0738	-.00110	-.4660	-.0444	.0881	.0353	-.3323	-.0075	.2607	.0533	-.1634	212	.134	1.625	1.514
			0	.27	.46	6.30	4.30	15	.0213	.0735	.00395	-.4660	-.0799	.0904	.2679	-.3299	-.0567	.2654	.1227	-.1686	110	.364	3.960	4.695
			0	.204	.80	10.96	8.96	15	.0223	.0725	.00816	-.4660	-.1088	.0928	.4666	-.3301	-.0990	.2702	.1799	-.1740	122	.472	4.488	6.345
			50,000	.75	.46	6.30	4.30	98	.0213	.0735	.00395	-.4660	-.0799	.0904	.2679	-.3299	-.0567	.2654	.1227	-.1686	280	.890	4.275	19.960
3	45	3.0	0	.75	.06	1.03	-.97	18.4	.0237	.1025	-.00138	-.4660	-.0574	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	78.6	.207	1.538	1.500
			0	.27	.46	7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	19.0	.511	3.383	8.559
			0	.204	.80	13.80	11.80	18.4	.0270	.0992	.01580	-.4660	-.1728	.1191	.7425	-.2325	-.1712	.3413	.1766	-.2757	15.8	.628	3.541	35.587
			50,000	.75	.46	7.94	5.94	120.5	.0245	.1017	.00806	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	48.4	1.212	3.692	71.472
4	60	1.5	0	.75	.06	1.58	-.42	26	.0313	.1890	-.00110	-.4660	-.0837	.1613	.0883	-.1266	-.0343	.4693	.1343	-.3246	20.0	.439	1.466	1.568
			0	.27	.46	12.10	10.10	26	.0360	.1842	.02720	-.4660	-.1880	.1684	.6765	-.1224	-.2655	.4835	.1317	-.5531	7.8	.745	2.616	-9.218
			0	.204	.80	21.05	19.05	26	.0477	.1723	.04850	-.4660	-.3149	.1684	1.1763	-.1448	-.4639	.4835	.1244	-.5531	7.9	.817	2.381	-4.151
			50,000	.75	.46	12.10	10.10	170.5	.0360	.1842	.02720	-.4660	-.1880	.1684	.6765	-.1224	-.2655	.4835	.1317	-.5531	20.0	1.775	2.842	-17.036
5	0	3.0	0	.75	.06	.91	-1.09	18.4	.0237	.1012	-.00149	-.4660	-.0497	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	119.0	.1975	1.532	1.418
			0	.27	.46	6.98	4.98	18.4	.0243	.1006	.00673	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	243	.532	3.775	4.141
			0	.204	.80	12.13	10.13	18.4	.0261	.0988	.01340	-.4660	-.0671	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-127	.680	4.453	5.291
			50,000	.75	.46	6.98	4.98	120.5	.0243	.1006	.00673	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	620	1.320	4.021	12.746

TABLE III

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS,

AND RESULTS OF CALCULATIONS TO DETERMINE EFFECTS OF MASS PARAMETERS

AND INDIVIDUAL STABILITY DERIVATIVES

Basic configuration	Λ, deg	A	Changes from basic configuration	i_v, deg	Γ, deg	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																								Aperiodic mode		Oscillatory mode	
						h, ft	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
1	0	6	Derivatives changed one at a time to the values for configuration 3. Derivatives changed are underlined.	0	0	0	0.27	0.46	7.94	5.94	18.4	0.0245	0.1017	0.00806	-0.4660	-0.0269	0.0829	0.0905	-0.4098	-0.0358	0.2370	0.1163	-0.1335	-41.6	0.340	4.681	4.604
									5.41	3.41	13	.0197	.0591	.00234	-.4660	-.1200	.0829	.0905	-.4098	-.0358	.2370	.1163	-.1335	45.8	.277	3.986	4.713
									5.41	3.41	13	.0197	.0591	.00234	-.4660	-.0269	.1168	.0905	-.4098	-.0358	.2370	.1163	-.1335	-33.4	.263	3.695	3.996
									5.41	3.41	13	.0197	.0591	.00234	-.4660	-.0269	.0829	.0905	-.2301	-.0358	.2370	.1163	-.1335	-24.1	.482	4.287	4.048
									5.41	3.41	13	.0197	.0591	.00234	-.4660	-.0269	.0829	.0905	-.4098	-.0978	.2370	.1163	-.1335	-30.3	.324	4.646	6.369
									5.41	3.41	13	.0197	.0591	.00234	-.4660	-.0269	.0829	.0905	-.4098	-.0358	.2370	.1163	-.2689	-101.5	.283	4.397	2.169
3	45	3	Derivatives changed one at a time to the values for configuration 1. Derivatives changed are underlined.	0	0	0	.27	.46	5.41	3.41	13	.0197	.0591	.00234	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	17.1	.401	3.280	5.067
									7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.0269	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	-27.7	.576	3.873	3.679
									7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.1200	.0829	.4275	-.2301	-.0978	.3365	.1303	-.2689	12.9	.501	3.716	11.786
									7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.1200	.1168	.4275	-.4098	-.0978	.3365	.1303	-.2689	27.2	.341	3.479	3.817
									7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.1200	.1168	.4275	-.2301	-.0358	.3365	.1303	-.2689	16.0	.568	3.503	4.424
									7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.1335	411	.507	3.357	51.649

TABLE IV

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS, AND RESULTS

OF CALCULATIONS FOR DETERMINING MEANS OF IMPROVING DUTCH ROLL STABILITY

(a) Basic configuration 3 ($\Lambda = 45^\circ$; $A = 3$)

Changes from basic configuration	i_w, deg	Γ, deg	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																					Aperiodic mode		Oscillatory mode	
			h, ft	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
Reduced i_w	-5	0	0	0.75	0.06	6.03	4.03	18.4	0.0241	0.1021	0.00550	-0.4660	-0.0458	0.1168	0.0946	-0.2305	-0.0347	0.3366	0.0587	-0.2690	96.2	0.226	1.438	1.126
			0	.27	.46	12.94	10.94	18.4	.0265	.0997	.01470	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	19.2	.566	3.033	4.638
			0	.204	.80	18.80	16.80	18.4	.0303	.0959	.02180	-.4660	-.1926	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	16.2	.679	3.142	11.434
			50,000	.75	.46	12.94	10.94	120.5	.0265	.0997	.01470	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	49.0	1.387	3.102	14.664
Reduced Γ	0	-5.4	0	.75	.06	1.03	-.97	18.4	.0237	.1025	-.00138	-.4660	0	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	-57.0	.218	1.537	1.242
			0	.27	.46	7.94	5.94	18.4	.0245	.1017	.00806	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	161.0	.549	3.660	4.927
			0	.204	.80	13.80	11.80	18.4	.0270	.0992	.01580	-.4660	-.1154	.1191	.7425	-.2385	-.1712	.3413	.1766	-.2757	31.0	.660	3.865	11.908
			50,000	.75	.46	7.94	5.94	120.5	.0245	.1017	.00806	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	-2510	1.320	3.766	20.515
Reduced i_w and Γ	-5	-4.3	0	.75	.06	6.03	4.03	18.4	.0241	.1021	.00500	-.4660	0	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	-71.5	.223	1.499	1.146
			0	.27	.46	12.94	10.94	18.4	.0265	.0997	.01470	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	47.8	.585	3.274	3.880
			0	.204	.80	18.80	16.80	18.4	.0303	.0959	.02180	-.4660	-.1468	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	23.5	.698	3.367	8.446
			50,000	.75	.46	12.94	10.94	120.5	.0265	.0997	.01470	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	121.5	1.440	3.337	11.485
Reduced K_{X_0}	0	0	0	.75	.06	1.03	-.97	18.4	.0100	.1025	-.00160	-.4660	-.0574	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	78.7	.089	1.517	1.601
			0	.27	.46	7.94	5.94	18.4	.0110	.1015	.00950	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	19.2	.278	2.989	2.331
			0	.204	.80	13.80	11.80	18.4	.0139	.0985	.01850	-.4660	-.1726	.1191	.7425	-.2385	-.1712	.3413	.1766	-.2757	15.9	.432	2.799	1.907
			50,000	.75	.46	7.94	5.94	120.5	.0110	.1015	.00950	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	49.0	.735	2.929	5.352
Reduced i_w and K_{X_0}	-5	0	0	.75	.06	6.03	4.03	18.4	.0105	.1021	.00640	-.4660	-.0458	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	96.3	.100	1.420	.854
			0	.27	.46	12.94	10.94	18.4	.0133	.0992	.01730	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	19.4	.353	2.536	1.232
			0	.204	.80	18.80	16.80	18.4	.0177	.0948	.02560	-.4660	-.1926	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	16.4	.535	2.382	1.319
			50,000	.75	.46	12.94	10.94	120.5	.0133	.0992	.01720	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	49.5	.992	2.375	2.724
Reduced Γ and K_{X_0}	0	-5.4	0	.75	.06	1.03	-.97	18.4	.0100	.1025	-.00160	-.4660	0	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	-56.8	.092	1.537	1.225
			0	.27	.46	7.94	5.94	18.4	.0110	.1015	.00950	-.4660	-.0626	.1168	.4275	-.2301	-.0974	.3365	.1303	-.2689	161.5	.273	3.368	2.420
			0	.204	.80	13.80	11.80	18.4	.0139	.0986	.01850	-.4660	-.1154	.1194	.7425	-.2385	-.1712	.3413	.1766	-.2757	31.4	.418	3.190	1.985
			50,000	.75	.46	7.94	5.94	120.5	.0110	.1015	.00950	-.4660	-.0626	.1168	.4275	-.2301	-.0974	.3365	.1303	-.2689	-2520.0	.715	3.386	5.943
Reduced i_w, Γ, and K_{X_0}	-5	-4.3	0	.75	.06	6.03	4.03	18.4	.0105	.1021	.00640	-.4660	0	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	-71.5	.094	1.503	1.085
			0	.27	.46	12.94	10.94	18.4	.0133	.0992	.01730	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	48.2	.330	2.875	1.373
			0	.204	.80	18.80	16.80	18.4	.0177	.0948	.02560	-.4660	-.1469	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	23.9	.520	2.369	1.350
			50,000	.75	.46	12.94	10.94	120.5	.0133	.0992	.01720	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	123.0	.940	2.681	2.911

TABLE IV.- Continued

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS, AND RESULTS

OF CALCULATIONS FOR DETERMINING MEANS OF IMPROVING DUTCH ROLL STABILITY

(a) Basic configuration 3 ($\Lambda = 45^{\circ}$; $A = 3$).- Concluded

Changes from basic configuration	i_w, deg	Γ, deg	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																					Aperiodic mode		Oscillatory mode	
			h, ft	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
Increased K_{Z_0}	0	0	0	0.75	0.06	1.03	-0.97	18.4	0.0238	0.2000	-0.00290	-0.4660	-0.0574	0.1120	0.0559	-0.2338	-0.0128	0.3271	0.0745	-0.2557	80.5	0.206	2.129	2.808
			0	.27	.46	7.94	5.94	18.4	.0255	.1981	.01820	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	23.4	.551	4.068	11.036
			0	.204	.80	13.80	11.80	18.4	.0311	.1926	.03530	-.4660	-.1728	.1191	.7485	-.2325	-.1712	.3413	.1766	-.2757	21.1	.734	3.957	14.790
			50,000	.75	.46	7.94	5.94	120.5	.0255	.1981	.01820	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	59.6	1.325	4.232	94.121
Reduced i_w and increased K_{Z_0}	-5	0	0	.75	.06	6.03	4.03	18.4	.0246	.1991	.01240	-.4660	-.0458	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	98.3	.238	1.939	1.417
			0	.27	.46	12.94	10.94	18.4	.0300	.1937	.03290	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	23.4	.682	3.502	3.825
			0	.204	.80	18.80	16.80	18.4	.0384	.1853	.04080	-.4660	-.1926	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	21.3	.874	3.376	5.610
			50,000	.75	.46	12.94	10.94	120.5	.0300	.1937	.03290	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	60.0	1.730	3.506	10.059
Reduced Γ and increased K_{Z_0}	0	-5.4	0	.75	.06	1.03	-.97	18.4	.0238	.2000	-.00290	-.4660	0	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	-57.0	.219	2.143	1.909
			0	.27	.46	7.94	5.94	18.4	.0255	.1981	.01820	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	187.5	.573	4.617	7.101
			0	.204	.80	13.80	11.80	18.4	.0311	.1926	.03530	-.4660	-.1154	.1191	.7485	-.2325	-.1712	.3413	.1766	-.2757	40.5	.730	4.436	10.512
			50,000	.75	.46	7.94	5.94	120.5	.0255	.1981	.01820	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	-2940	1.385	4.745	32.167
Reduced i_w and Γ and increased K_{Z_0}	-5	-4.3	0	.75	.06	6.03	4.03	18.4	.0246	.1991	.01240	-.4660	0	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	-72.0	.225	2.082	1.704
			0	.27	.46	12.94	10.94	18.4	.0300	.1937	.03290	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	56.1	.665	3.919	3.794
			0	.204	.80	18.80	16.80	18.4	.0384	.1853	.04080	-.4660	-.1460	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	30.8	.876	3.692	5.354
			50,000	.75	.46	12.94	10.94	120.5	.0300	.1937	.03290	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	144.5	1.720	3.915	9.811
Increased K_{Z_0} and reduced K_{X_0}	0	0	0	.75	.06	1.03	-.97	18.4	.0100	.1600	-.00254	-.4660	-.0574	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	79.8	.089	1.879	2.409
			0	.27	.46	7.94	5.94	18.4	.0116	.1576	.01550	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	21.8	.895	3.414	2.180
			0	.204	.80	13.80	11.80	18.4	.0163	.1539	.03020	-.4660	-.1728	.1191	.7485	-.2325	-.1712	.3413	.1766	-.2757	19.1	.500	2.989	1.571
			50,000	.75	.46	7.94	5.94	120.5	.0116	.1576	.01550	-.4660	-.1200	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	55.5	.839	3.209	4.068
Reduced i_w, increased K_{Z_0}, and reduced K_{X_0}	-5	0	0	.75	.06	6.03	4.03	18.4	.0108	.1593	.01040	-.4660	-.0458	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	97.5	.101	1.755	.975
			0	.27	.46	12.94	10.94	18.4	.0154	.1546	.02790	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	21.9	.415	2.799	1.064
			0	.204	.80	18.80	16.80	18.4	.0225	.1473	.04150	-.4660	-.1926	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	19.4	.670	2.400	1.127
			50,000	.75	.46	12.94	10.94	120.5	.0154	.1546	.02790	-.4660	-.1250	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	56.0	1.248	2.506	2.292
Reduced Γ, increased K_{Z_0}, and reduced K_{X_0}	0	-5.4	0	.75	.06	1.03	-.97	18.4	.0100	.1600	-.00254	-.4660	0	.1120	.0559	-.2338	-.0128	.3271	.0745	-.2557	-56.9	.092	1.918	1.648
			0	.27	.46	7.94	5.94	18.4	.0116	.1576	.01550	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	177.0	.880	3.985	2.558
			0	.204	.80	13.80	11.80	18.4	.0163	.1539	.03020	-.4660	-.1154	.1191	.7485	-.2325	-.1712	.3413	.1766	-.2757	37.0	.468	3.495	1.720
			50,000	.75	.46	7.94	5.94	120.5	.0116	.1576	.01550	-.4660	-.0626	.1168	.4275	-.2301	-.0978	.3365	.1303	-.2689	-2760	.785	3.779	4.851
Reduced i_w and Γ, increased K_{Z_0}, and reduced K_{X_0}	-5	-4.3	0	.75	.06	6.03	4.03	18.4	.0108	.1593	.01040	-.4660	0	.1168	.0946	-.2305	-.0347	.3366	.0587	-.2690	-71.5	.095	1.873	1.426
			0	.27	.46	12.94	10.94	18.4	.0154	.1546	.02790	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	53.4	.369	3.281	1.249
			0	.204	.80	18.80	16.80	18.4	.0225	.1473	.04150	-.4660	-.1460	.1191	.9110	-.2384	-.2158	.3412	.1893	-.2750	28.1	.640	2.701	1.163
			50,000	.75	.46	12.94	10.94	120.5	.0154	.1546	.02790	-.4660	-.0792	.1191	.5362	-.2318	-.1331	.3412	.1294	-.2750	136.2	1.150	2.891	2.459

TABLE IV.- Continued

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS, AND RESULTS

OF CALCULATIONS FOR DETERMINING MEANS OF IMPROVING DUTCH ROLL STABILITY

(b) Basic configuration 5 ($\Lambda = 0^\circ$; $A = 3$)

Changes from basic configuration	i_v, deg	Γ, deg	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																					Aperiodic mode		Oscillatory mode	
			h, ft	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
Reduced i_v	-5	0	0	0.75	0.06	5.91	3.91	18.4	0.0241	0.1008	0.00526	-0.4660	-0.0350	0.1157	0.0516	-0.2455	-0.0275	0.3340	0.0550	-0.2665	182.0	0.212	1.456	1.112
			0	.27	.46	11.98	9.98	18.4	.0260	.0989	.01320	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-52.1	.569	3.612	3.009
			0	.204	.80	17.13	15.13	18.4	.0290	.0959	.01930	-.4660	-.0524	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-59.7	.762	4.289	3.803
			50,000	.75	.46	11.98	9.98	120.5	.0260	.0989	.01320	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-1116.0	1.480	3.610	7.806
Reduced Γ	0	-4	0	.75	.06	.91	-1.09	18.4	.0237	.1012	-.00149	-.4660	0	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	-60.9	.205	1.528	1.234
			0	.27	.46	6.98	4.98	18.4	.0243	.1006	.00673	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-17.0	.558	4.029	3.171
			0	.204	.80	12.13	10.13	18.4	.0261	.0988	.01340	-.4660	-.0174	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-12.4	.712	4.906	3.882
			50,000	.75	.46	6.98	4.98	120.5	.0243	.1006	.00673	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-43.0	1.403	4.059	8.496
Reduced i_v and Γ	-5	-2.8	0	.75	.06	5.91	3.91	18.4	.0241	.1008	.00526	-.4660	0	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	-81.1	.210	1.498	1.147
			0	.27	.46	11.98	9.98	18.4	.0260	.0989	.01320	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-21.5	.585	3.865	2.800
			0	.204	.80	17.13	15.13	18.4	.0290	.0959	.01950	-.4660	-.0174	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-15.4	.760	4.639	3.384
			50,000	.75	.46	11.98	9.98	120.5	.0260	.0989	.01320	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-54.4	1.455	3.860	7.221
Reduced K_{X_0}	0	0	0	.75	.06	.91	-1.09	18.4	.0100	.1012	-.00180	-.4660	-.0497	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	118.5	.084	1.517	1.512
			0	.27	.46	6.98	4.98	18.4	.0107	.1005	.00790	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	842.0	.249	3.594	2.491
			0	.204	.80	12.13	10.13	18.4	.0128	.0948	.01570	-.4660	-.0671	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-128.0	.356	4.062	2.125
			50,000	.75	.46	6.98	4.98	120.5	.0107	.1005	.00790	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	620.0	.675	3.484	5.121
Reduced i_v and K_{X_0}	-5	0	0	.75	.06	5.91	3.91	18.4	.0104	.1008	.00620	-.4660	-.0350	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	182.0	.091	1.449	.903
			0	.27	.46	11.98	9.98	18.4	.0127	.0984	.01560	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-4530.0	.276	3.433	1.589
			0	.204	.80	17.13	15.13	18.4	.0162	.0950	.02290	-.4660	-.0524	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-69.5	.414	3.861	1.491
			50,000	.75	.46	11.98	9.98	120.5	.0127	.0984	.01560	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-1140.0	.838	3.116	2.850
Reduced Γ and K_{X_0}	0	-4	0	.75	.06	.91	-1.09	18.4	.0100	.1012	-.00180	-.4660	0	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	-60.7	.086	1.527	1.218
			0	.27	.46	6.98	4.98	18.4	.0107	.1005	.00790	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-16.8	.344	3.998	2.629
			0	.204	.80	12.13	10.13	18.4	.0128	.0984	.01570	-.4660	-.0174	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-12.2	.333	4.756	2.428
			50,000	.75	.46	6.98	4.98	120.5	.0107	.1005	.00790	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-42.5	.639	3.941	6.025
Reduced i_v, Γ, and K_{X_0}	-5	-2.8	0	.75	.06	5.91	3.91	18.4	.0104	.1008	.00620	-.4660	0	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	-86.3	.088	1.502	1.096
			0	.27	.46	11.98	9.98	18.4	.0127	.0984	.01560	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-21.2	.256	3.813	1.971
			0	.204	.80	17.13	15.13	18.4	.0162	.0950	.02290	-.4660	-.0174	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-15.3	.372	4.440	1.775
			50,000	.75	.46	11.98	9.98	120.5	.0127	.0984	.01560	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-54.0	.735	3.581	3.631

TABLE IV.- Concluded

CONDITIONS FOR WHICH CALCULATIONS WERE MADE, DERIVATIVES USED IN CALCULATIONS, AND RESULTS

OF CALCULATIONS FOR DETERMINING MEANS OF IMPROVING DUTCH ROLL STABILITY

(b) Basic configuration 5 ($\Lambda = 0^{\circ}$; $A = 3$).- Concluded

Changes from basic configuration	i_w, deg	Γ, deg	Flight conditions					Mass parameters				Aerodynamic derivatives									Results			
																					Aperiodic mode		Oscillatory mode	
			h_{ft}	M	C_L	α, deg	η, deg	μ	K_X^2	K_Z^2	K_{XZ}	C_{Y_β}	C_{l_β}	C_{n_β}	C_{Y_p}	C_{l_p}	C_{n_p}	C_{Y_r}	C_{l_r}	C_{n_r}	$T_{1/2}$, sec	$T_{1/2}$, sec	P, sec	$T_{1/2}$, sec
Increased K_{Z_0}	0	0	0	0.73	0.06	0.91	-1.09	18.4	0.0238	0.1999	-0.00340	-0.4660	-0.0497	0.1120	0.0227	-0.2489	-0.0070	0.3271	0.0743	-0.2557	121.0	0.195	2.140	2.622
			0	.27	.46	6.98	4.98	18.4	.0250	.1987	.01530	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	280.0	.535	4.860	6.494
			0	.204	.80	12.13	10.13	18.4	.0292	.1945	.03040	-.4660	-.0671	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-162.2	.718	5.402	6.966
			50,000	.73	.46	6.98	4.98	120.5	.0250	.1987	.01530	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	720.0	1.345	4.945	20.974
Reduced i_w and increased K_{Z_0}	-5	0	0	.73	.06	5.91	3.91	18.4	.0245	.1992	.01200	-.4660	-.0350	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	183.0	.220	1.995	1.467
			0	.27	.46	11.98	9.98	18.4	.0290	.1947	.03010	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-524.0	.625	4.569	3.518
			0	.204	.80	17.13	15.13	18.4	.0357	.1880	.04440	-.4660	-.0524	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-87.0	.835	5.107	4.065
			50,000	.73	.46	11.98	9.98	120.5	.0290	.1947	.03010	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-1310.0	1.660	4.476	8.275
Reduced Γ and increased K_{Z_0}	0	-4	0	.73	.06	.91	-1.09	18.4	.0238	.1999	-.00340	-.4660	0	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	-60.8	.206	2.143	1.912
			0	.27	.46	6.98	4.98	18.4	.0250	.1987	.01530	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-18.0	.557	5.488	4.760
			0	.204	.80	12.13	10.13	18.4	.0292	.1945	.03040	-.4660	-.0174	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-14.4	.729	6.346	5.404
			50,000	.73	.46	6.98	4.98	120.5	.0250	.1987	.01530	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-45.5	1.410	5.539	13.074
Reduced i_w and Γ and increased K_{Z_0}	-5	-2.8	0	.73	.06	5.91	3.91	18.4	.0245	.1992	.01200	-.4660	0	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	-81.5	.210	2.096	1.727
			0	.27	.46	11.98	9.98	18.4	.0290	.1947	.03010	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-23.2	.603	5.141	3.666
			0	.204	.80	17.13	15.13	18.4	.0357	.1880	.04440	-.4660	-.0174	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-18.2	.810	5.834	4.014
			50,000	.73	.46	11.98	9.98	120.5	.0290	.1947	.03010	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-58.2	1.580	5.065	8.741
Increased K_{Z_0} and reduced K_{X_0}	0	0	0	.73	.06	.91	-1.09	18.4	.0101	.1599	-.00288	-.4660	-.0497	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	120.0	.085	1.894	2.265
			0	.27	.46	6.98	4.98	18.4	.0111	.1589	.01305	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	268.0	.252	4.290	2.863
			0	.204	.80	12.13	10.13	18.4	.0146	.1554	.02590	-.4660	-.0671	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-149.0	.368	4.675	2.165
			50,000	.73	.46	6.98	4.98	120.5	.0111	.1589	.01305	-.4660	-.0594	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	681.0	.718	4.055	4.732
Reduced i_w, increased K_{Z_0}, and reduced K_{X_0}	-5	0	0	.73	.06	5.91	3.91	18.4	.0107	.1593	.01020	-.4660	-.0350	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	184.0	.092	1.808	1.078
			0	.27	.46	11.98	9.98	18.4	.0145	.1555	.02560	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-498.0	.292	4.104	1.650
			0	.204	.80	17.13	15.13	18.4	.0202	.1498	.03770	-.4660	-.0524	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-80.0	.449	4.411	1.425
			50,000	.73	.46	11.98	9.98	120.5	.0145	.1555	.02560	-.4660	-.0440	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-1242.0	.975	3.508	2.512
Reduced Γ, increased K_{Z_0}, and reduced K_{X_0}	0	-4	0	.73	.06	.91	-1.09	18.4	.0101	.1599	-.00288	-.4660	0	.1120	.0227	-.2489	-.0070	.3271	.0743	-.2557	-60.7	.087	1.917	1.654
			0	.27	.46	6.98	4.98	18.4	.0111	.1589	.01305	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-14.4	.242	4.938	3.338
			0	.204	.80	12.13	10.13	18.4	.0146	.1554	.02590	-.4660	-.0174	.1191	.2981	-.2462	-.0919	.3413	.1714	-.2757	-13.4	.334	5.707	2.795
			50,000	.73	.46	6.98	4.98	120.5	.0111	.1589	.01305	-.4660	-.0097	.1168	.1703	-.2452	-.0530	.3365	.1280	-.2689	-44.0	.648	4.827	6.666
Reduced i_w and Γ, increased K_{Z_0}, and reduced K_{X_0}	-5	-2.8	0	.73	.06	5.91	3.91	18.4	.0107	.1593	.01020	-.4660	0	.1157	.0516	-.2455	-.0275	.3340	.0550	-.2665	-81.1	.088	1.885	1.456
			0	.27	.46	11.98	9.98	18.4	.0145	.1555	.02560	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-22.4	.261	4.677	2.289
			0	.204	.80	17.13	15.13	18.4	.0202	.1498	.03770	-.4660	-.0174	.1197	.3270	-.2492	-.1131	.3424	.1503	-.2770	-17.0	.384	5.267	1.862
			50,000	.73	.46	11.98	9.98	120.5	.0145	.1555	.02560	-.4660	-.0090	.1193	.2006	-.2462	-.0753	.3416	.1064	-.2760	-56.8	.798	4.246	3.420

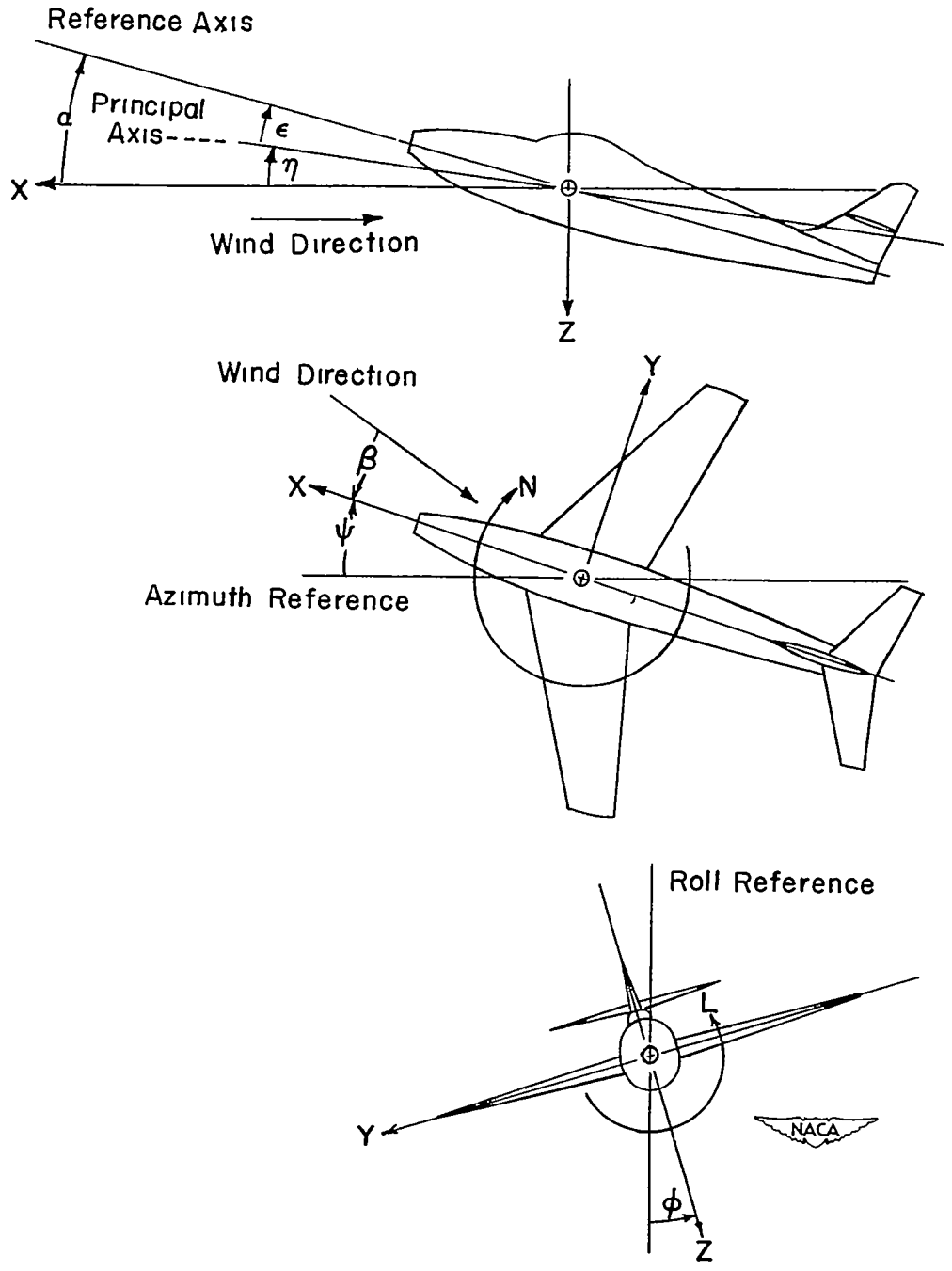


Figure 1.- The stability system of axes. Arrows indicate positive directions of moments, forces, and angles. This system of axes is defined as an orthogonal system having the origin at the center of gravity and in which the Z-axis is in the plane of symmetry and perpendicular to the relative wind, the X-axis is in the plane of symmetry and perpendicular to the Z-axis, and the Y-axis is perpendicular to the plane of symmetry. At a constant angle of attack, these axes are fixed in the airplane.

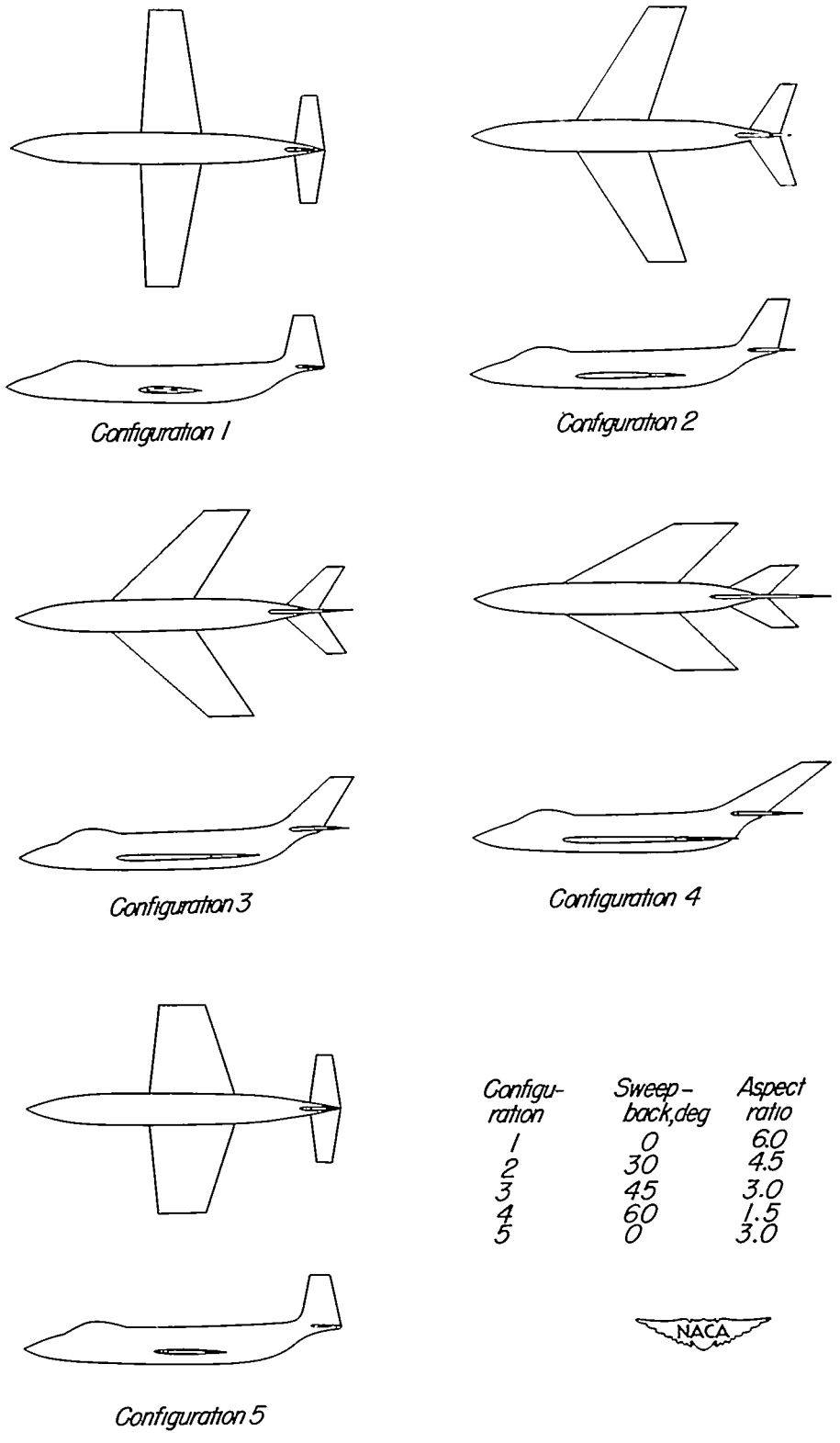


Figure 2.- Basic configurations for which calculations were made.

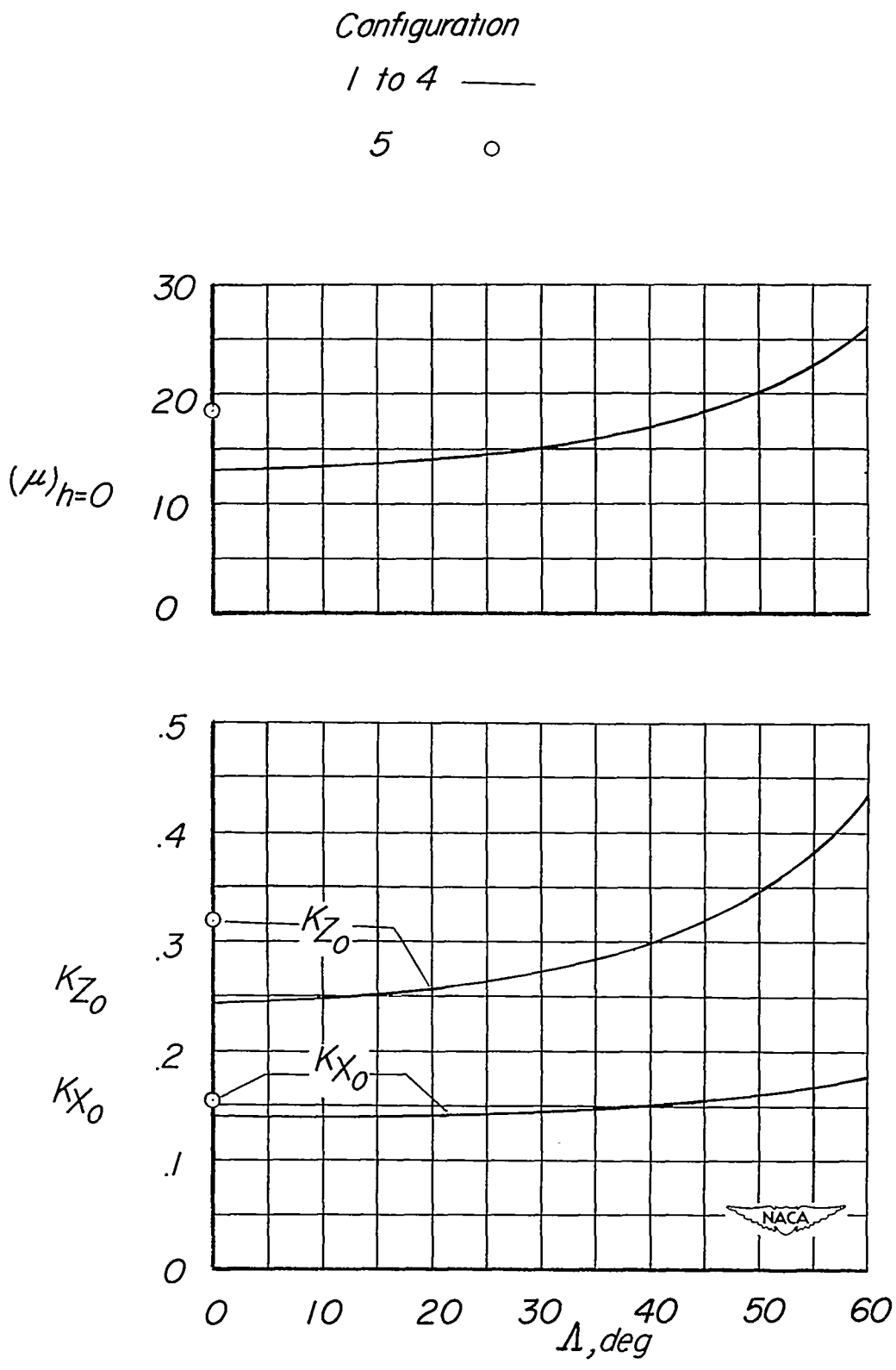
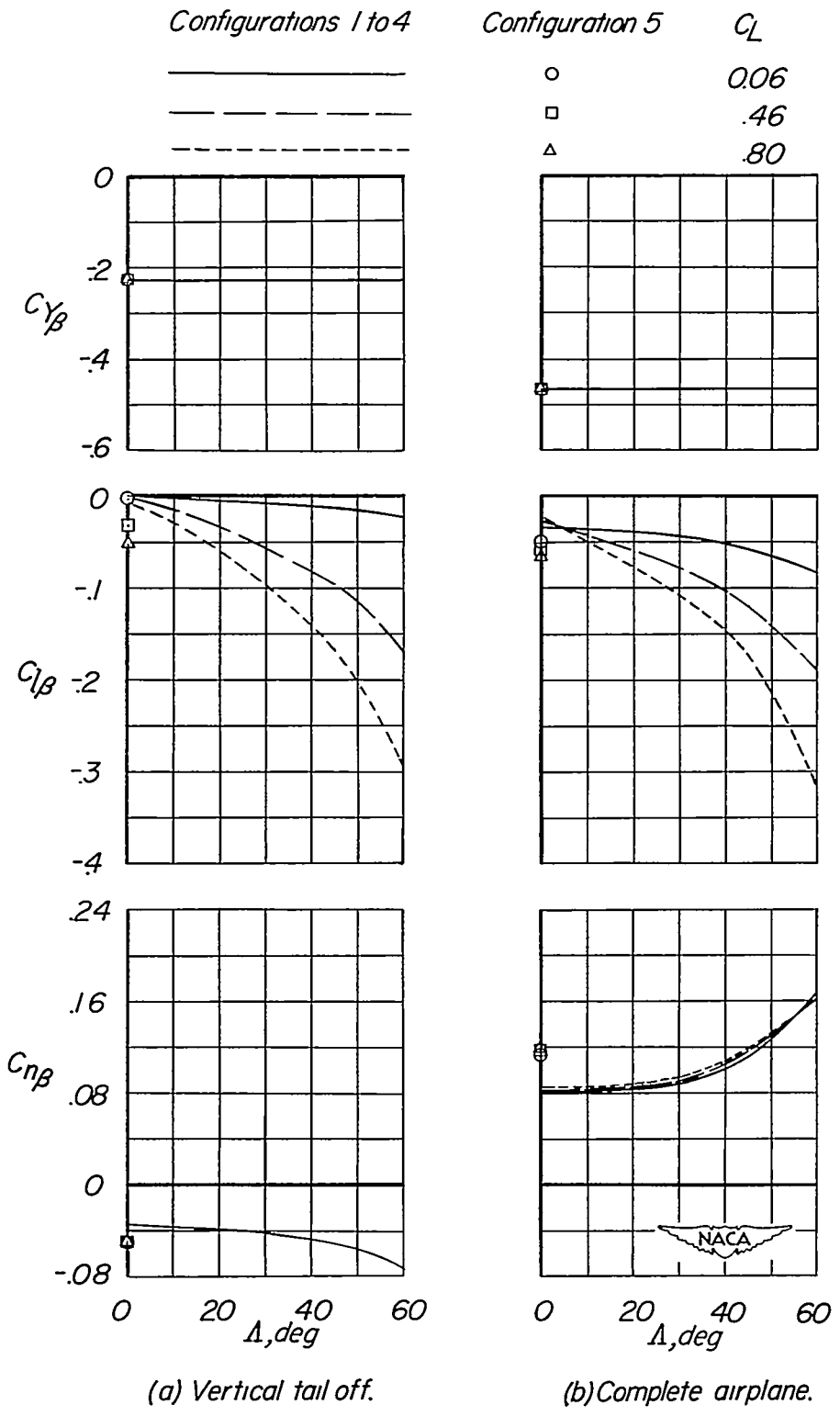


Figure 3.- Variation of mass parameters with sweepback.



(a) Vertical tail off.

(b) Complete airplane.

Figure 4.- Variation of sideslip stability derivatives with sweepback and lift coefficient.

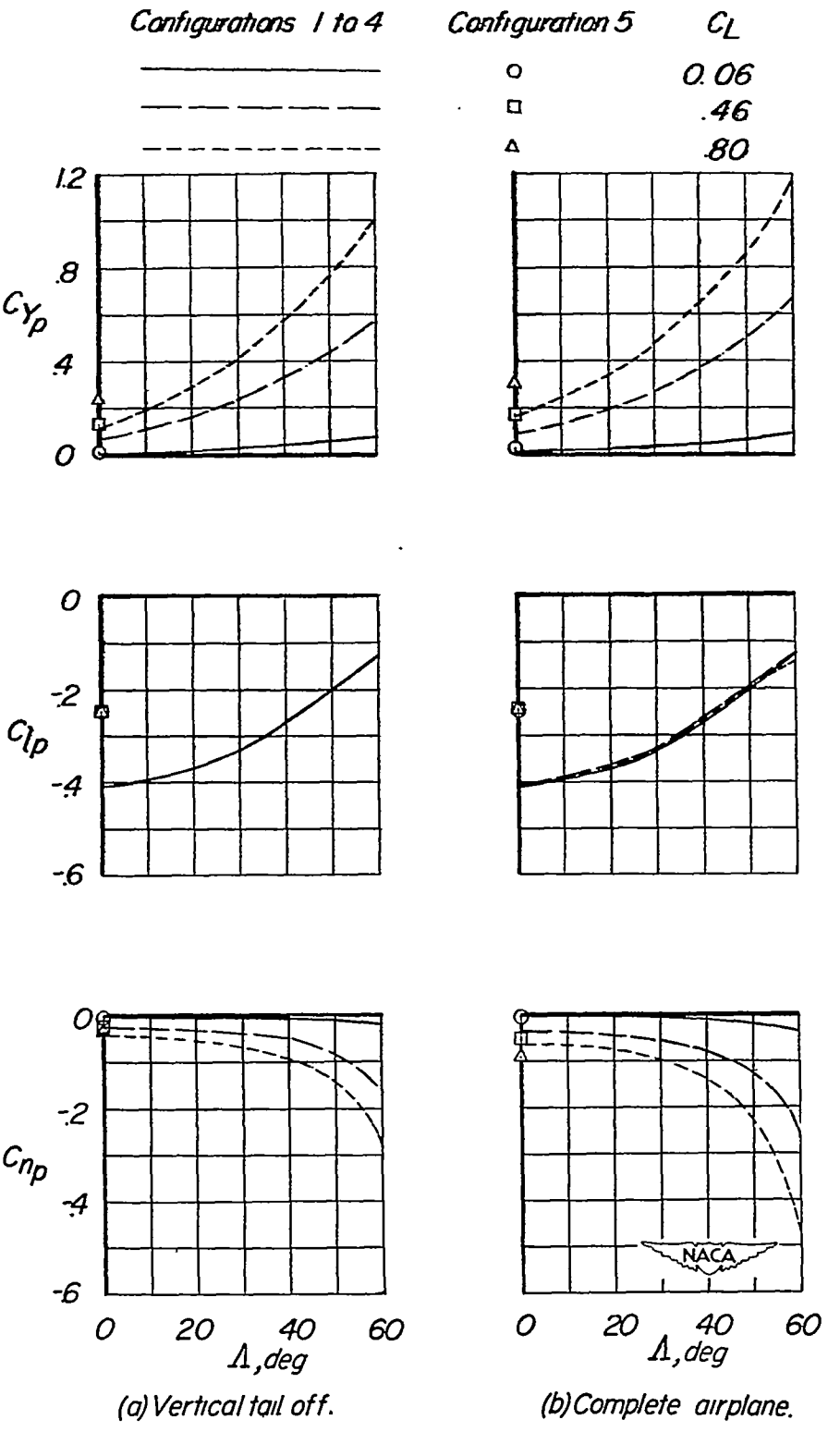
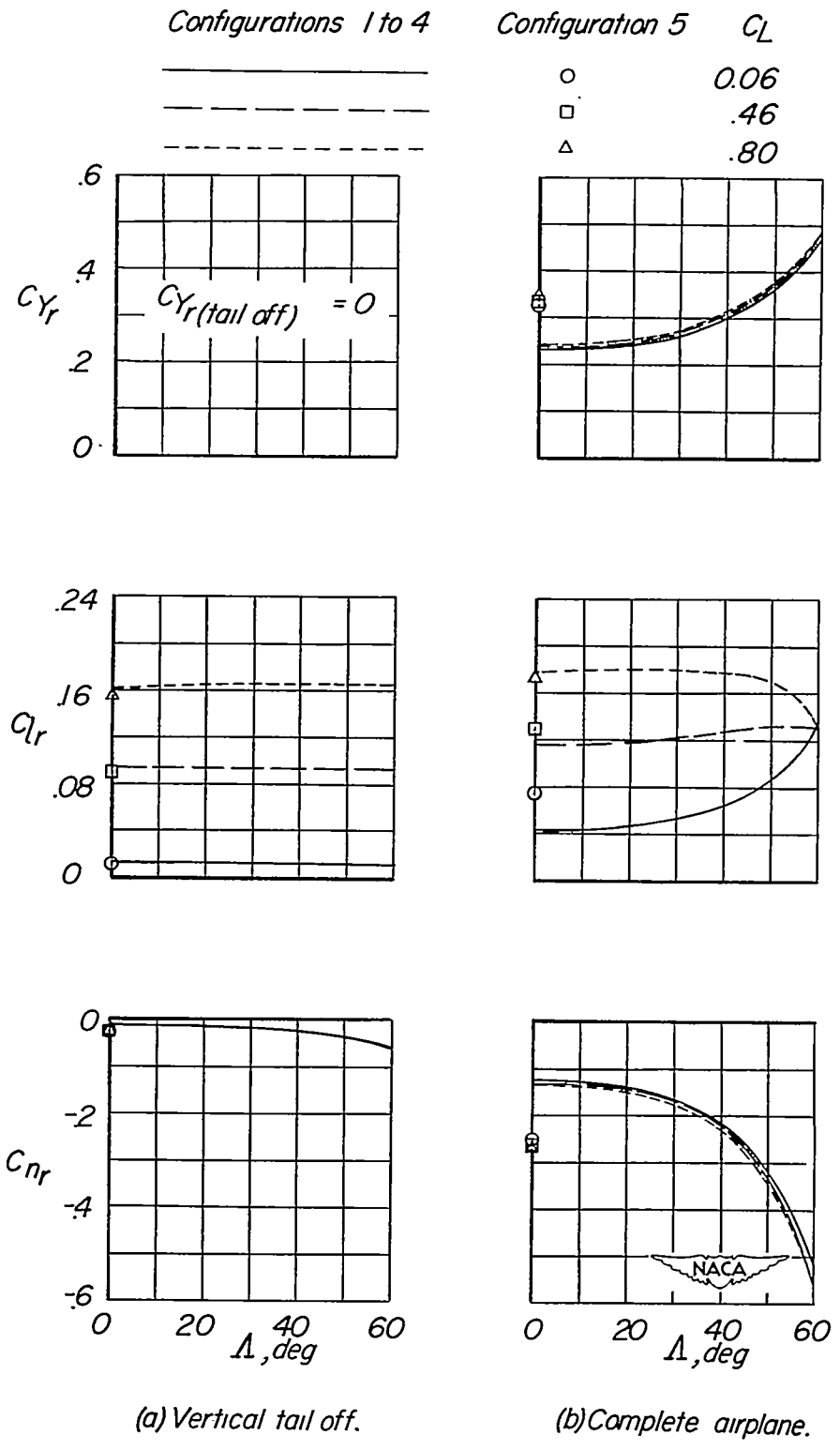


Figure 5.- Variation of rolling stability derivatives with sweepback and lift coefficient.



(a) Vertical tail off.

(b) Complete airplane.

Figure 6.- Variation of yawing stability derivatives with sweepback and lift coefficient.

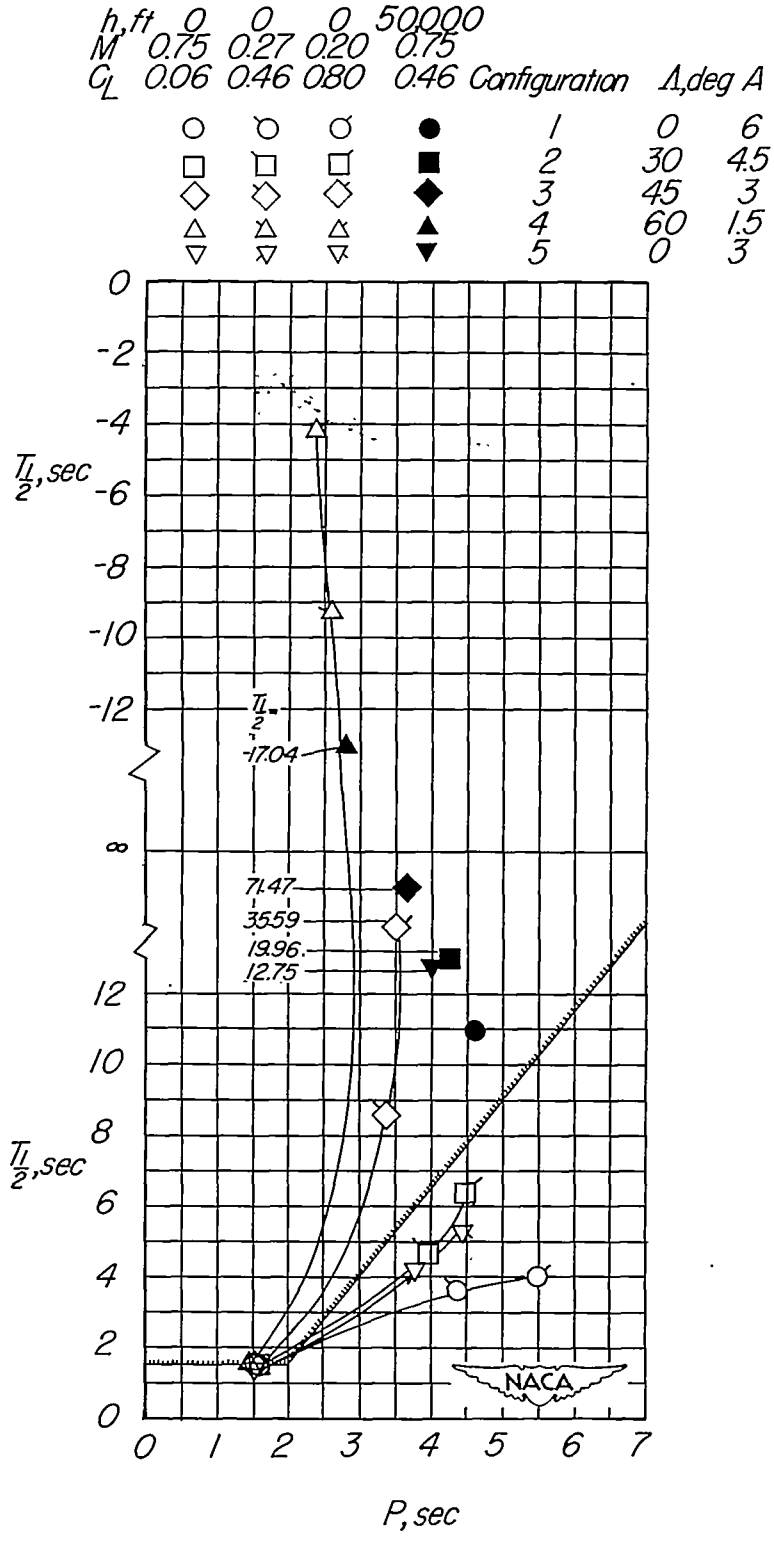


Figure 7.- Stability of basic configurations. Hatched boundary is period-damping requirement of references 2 and 3.

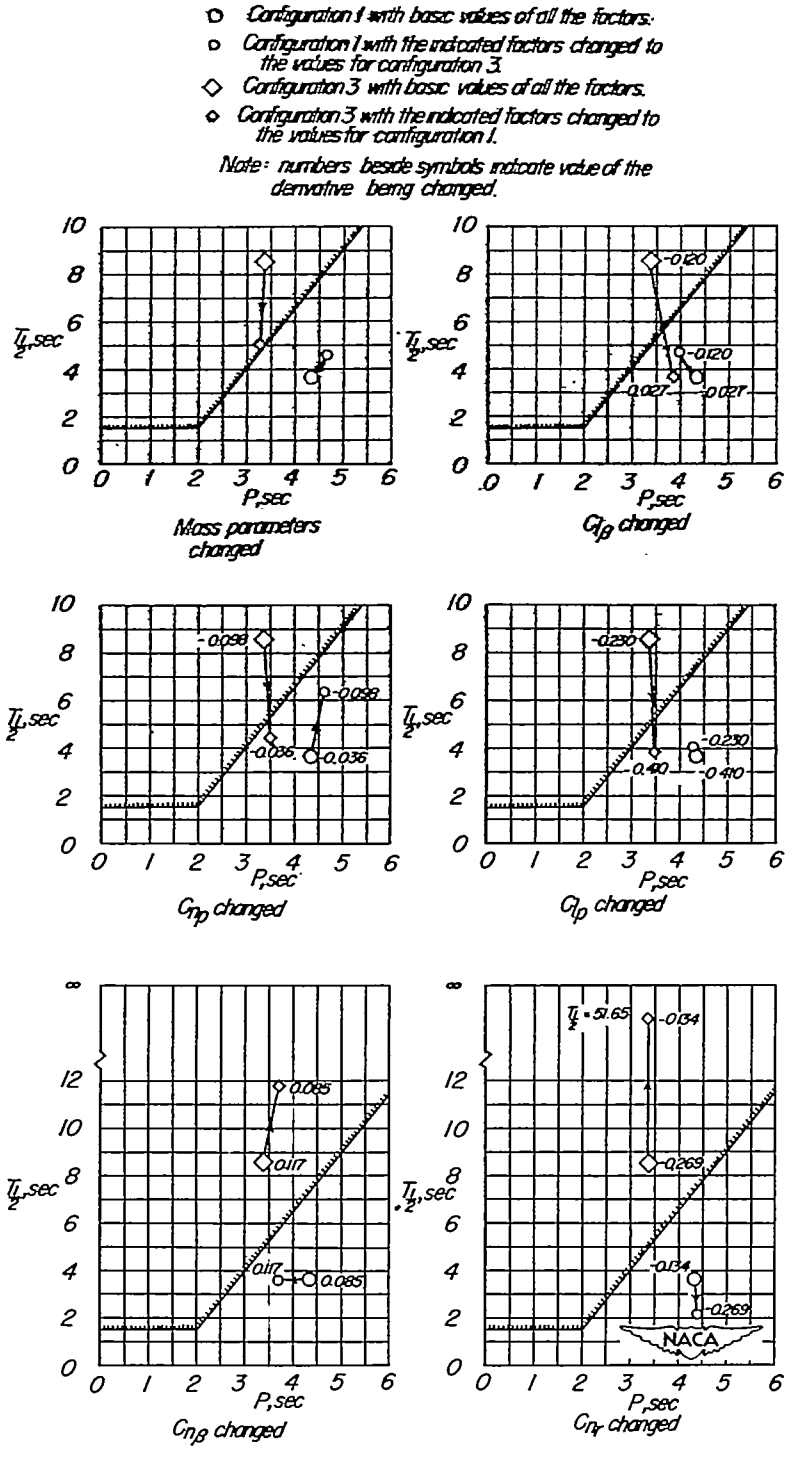
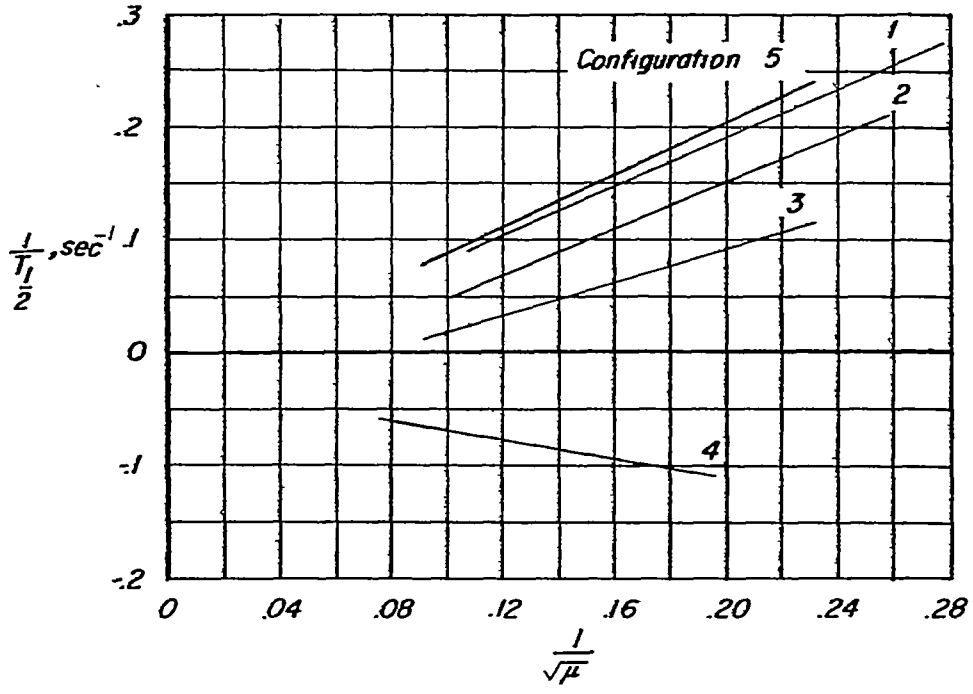
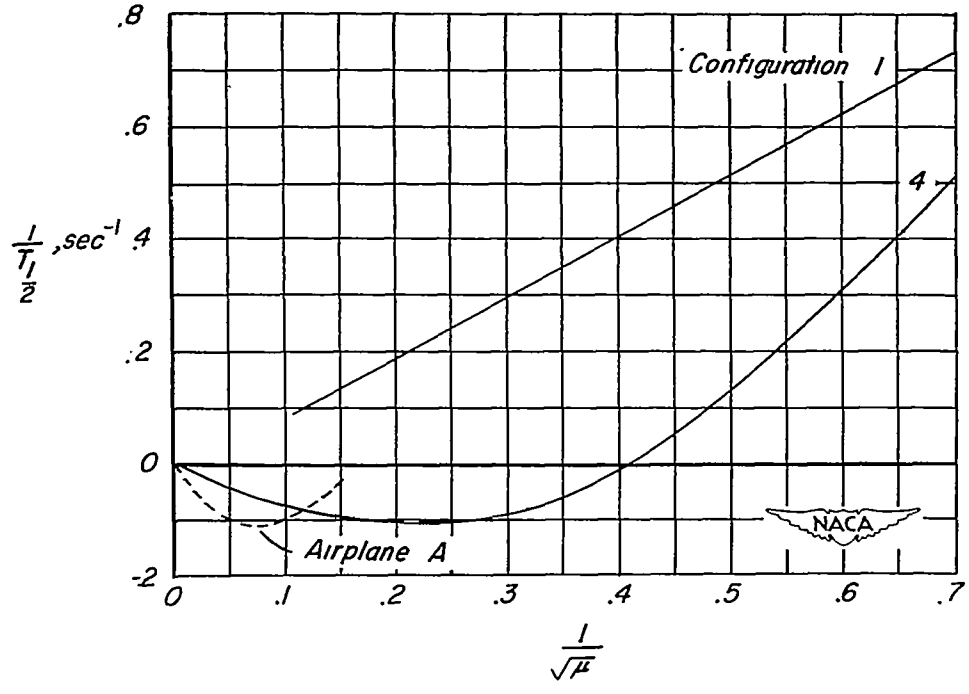


Figure 8.- Effect of the differences in mass parameters and individual stability derivatives on stability of configurations 1 and 3. C_L = 0.46; h = 0 feet.



(a) Basic configurations. Data taken from table II for altitudes of 0 and 50,000 feet.



(b) Configurations 1 and 4 for an extended range of μ, and an actual airplane for altitudes from sea level to infinity.

Figure 9.- Variation of damping with relative-density factor. $C_L = 0.46$.

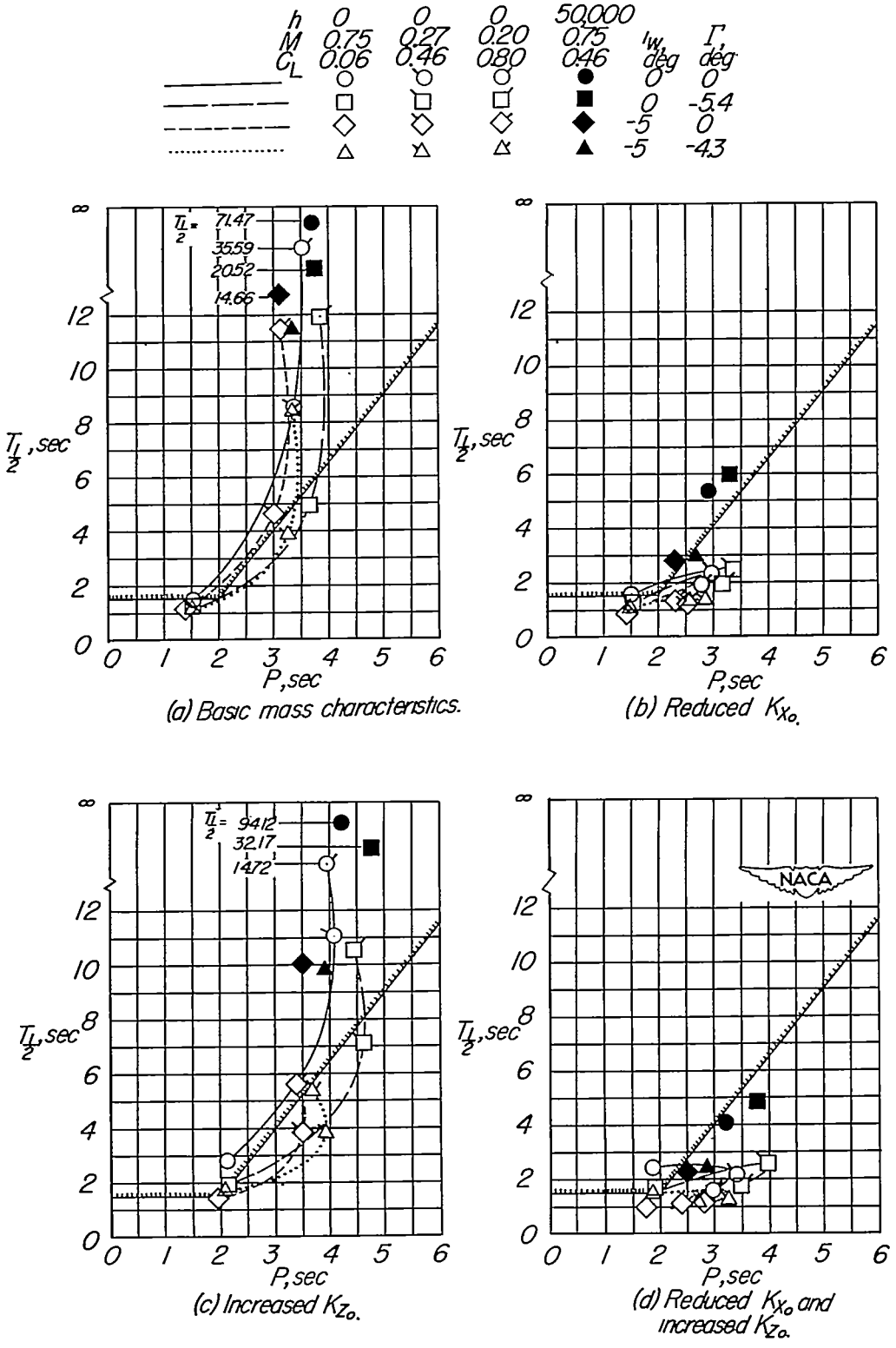


Figure 10.- Stability of modified configuration derived from configuration 3.

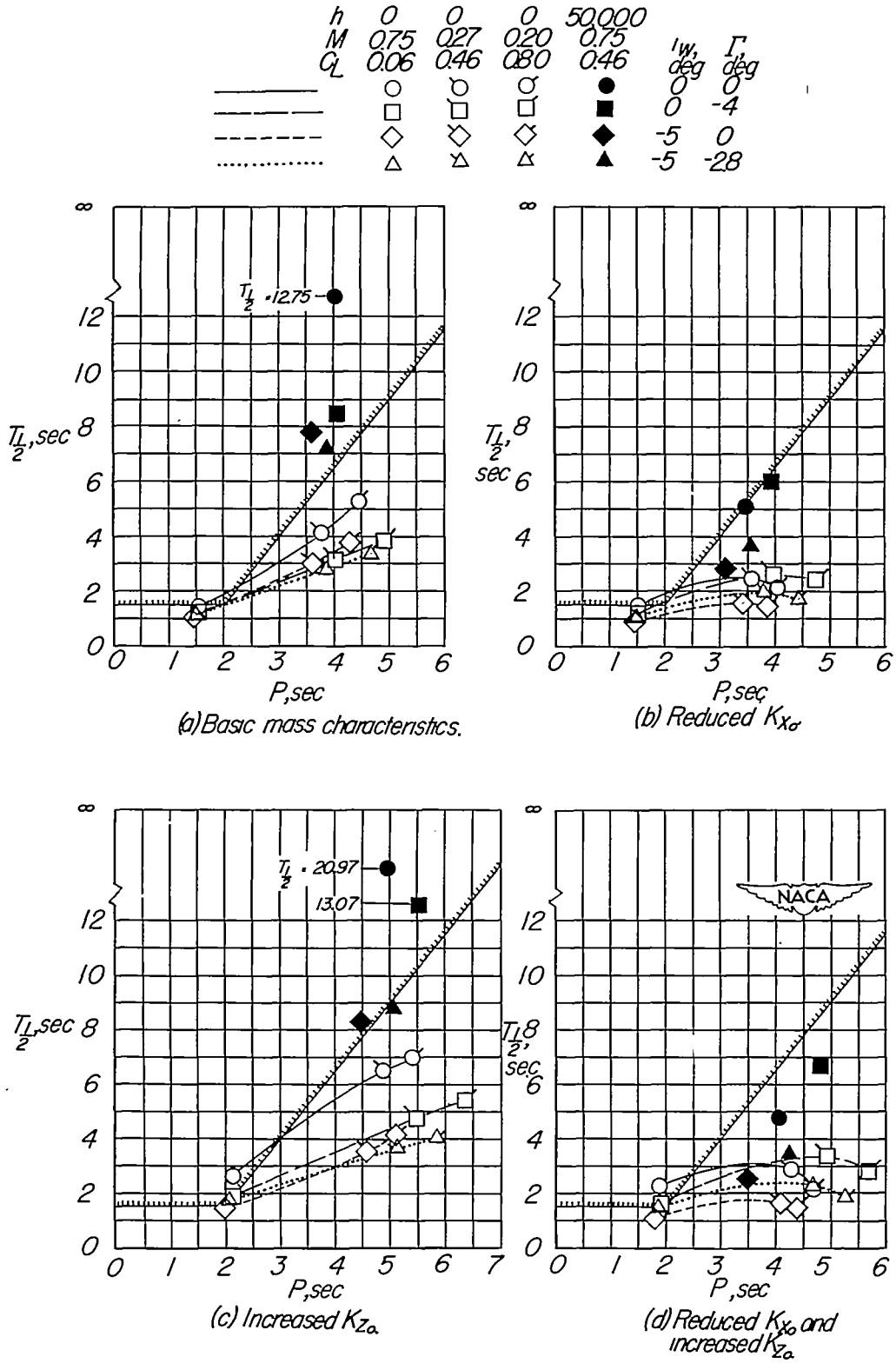
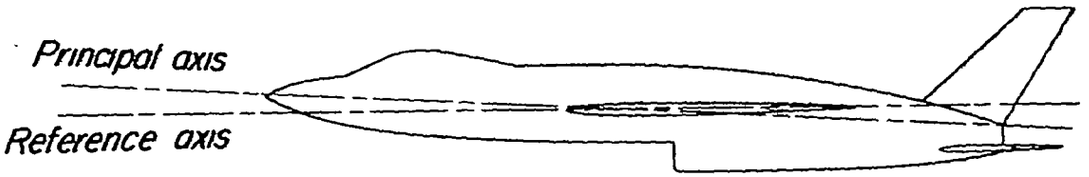
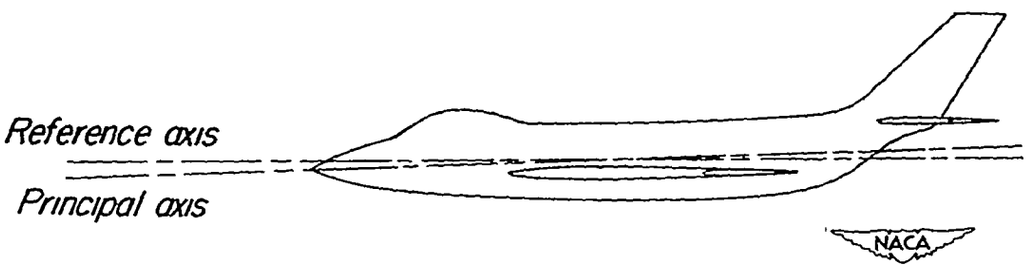


Figure 11.- Stability of modified configuration derived from configuration 5.



(a) Modified design.



(b) Configuration 3.

Figure 12.- Illustration of profile of an airplane designed to have positive inclination of the principal longitudinal axis of inertia and comparison with profile of configuration 3 which is representative of many designs.

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