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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

ORIGINALLY ISSUED
June 1943 as
Memorandum Report

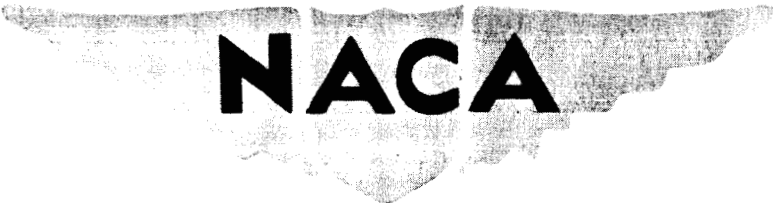
FULL-SCALE TUNNEL MEASUREMENTS OF THE PRESSURES ON
THE ELEVATOR AND FUSELAGE OF THE CURTISS XP-55 AIRPLANE

By Richard C. Dingeldein

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

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MEMORANDUM REPORT

for the

Army Air Forces, Materiel Command

FULL-SCALE TUNNEL MEASUREMENTS OF THE PRESSURES ON THE ELEVATOR AND FUSELAGE OF THE CURTISS XP-55 AIRPLANE

By Richard C. Dingeldein

INTRODUCTION

At the request of the Army Air Forces, Materiel Command, force tests and measurements of the pressure distribution over the elevator and forward part of the fuselage were made on a flying model of the Curtiss XP-55 airplane in the NACA full-scale tunnel. The results of the force tests, which include lift, drag, pitching-moment, and elevator hinge-moment measurements, have been reported in reference 1. The results of the elevator pressure measurements are given in the present paper.

The XP-55 is a low-wing airplane with the engine and propeller located at the rear of the fuselage. Longitudinal and directional control are obtained by means of an elevator located at the nose of the fuselage and by fins and rudders attached near the wing tips.

The pressures were measured over a wide range of elevator and elevator tab deflections for several angles of attack of the fuselage axis with the landing flaps retracted and deflected 45° . A few tests were made to determine the

pressure distribution over the forward part of the fuselage with the elevator removed.

An analysis has been made to show the distribution of normal-force coefficient across the span of the elevator and a comparison is given of the elevator normal-force coefficients determined from the pressure measurements and those determined from the force tests. Some calculations have been made of the fuselage normal-force coefficients by means of existing theoretical knowledge and these results are compared with the experimental data. Owing to the general applicability of the data to canard-type airplanes, the analysis has been extended to include a discussion of the mutual effects of the elevator and fuselage loadings on the normal-force distributions.

SYMBOLS

Δp	difference between free-stream static pressure and local static pressure
q_o	free-stream dynamic pressure
N	normal force
n	section normal force
S	surface area
c	elevator chord
α_F	angle of attack of the fuselage axis relative to free-stream direction, degrees

δ control-surface deflection, degrees; positive with trailing edge down

c_n section normal-force coefficient, n/qc

C_N normal-force coefficient, N/qS

C_L lift coefficient, L/qS

$\frac{dC_{N_e}}{d\delta_e}$ elevator effectiveness

$\frac{dC_{N_e}}{d\delta_T}$ elevator tab effectiveness

Subscripts:

e elevator

f wing flap

T elevator tab

F fuselage

APPARATUS AND TESTS

The flying model of the Curtiss XP-55 airplane, which is designated the Curtiss model 24B, is shown mounted in the NACA full-scale tunnel in figure 1. A three-view drawing giving the important dimensions of the airplane is shown in figure 2. The elevator, which is hinged at 13.42 percent of the chord, has a symmetrical low-drag airfoil section that was developed by the manufacturer. The elevator is equipped with trim tabs having a span of 50 percent of the elevator

span and a chord of 25 percent of the elevator chord. The elevator was directly connected to the stick, but the tab angle was adjusted by means of a separate control in the cockpit.

Flush-type static-pressure orifices were installed in the left elevator and tab and in the left side of the fuselage. The inside diameter of the orifice tubes was 0.090 inch. The location and identification of the orifices are given in tables I to III and in figures 3 to 5.

All the tests were made at a tunnel airspeed of approximately 63 miles per hour and with the airplane propeller removed. Pressure measurements were taken for various elevator deflections with the elevator tab neutral at angles of attack of the fuselage axis of 0.9° , 4.6° , 12.0° , and 15.8° . The effects of deflecting the elevator tab on the pressure distributions over the horizontal tail surfaces were determined at angles of attack of 0.9° and 12.0° . Most of the tests were made with the landing flaps retracted; however, a few tests were made with the flaps deflected 45° . The complete test program is listed in table IV.

RESULTS AND DISCUSSION

The test results (tables V and VI) have been corrected for jet-boundary effects (reference 2), the longitudinal static-pressure gradient in the jet, and stream angle and

blocking effects at the elevator (reference 3), and therefore differ slightly from the data presented in the preliminary reports. Chordwise pressure distributions over the elevator and forward part of the fuselage were plotted from these data. Integration of the chordwise pressure distributions gave the distribution of normal-force coefficient across the horizontal tail span which was then integrated to obtain average values of elevator and fuselage normal-force coefficients. In the determination of the spanwise normal-force distribution, the chord of the fuselage has been taken as 29.8 inches, which corresponds to the chord at the elevator-fuselage juncture. The elevator normal-force coefficients are given in table IV.

Chordwise pressure distributions. - Isometric charts of typical chordwise pressure distributions over the elevator and forward part of the fuselage are presented in figures 6 to 19. The effects of the elevator and fuselage loadings on the resultant pressure distributions are clearly shown in these figures. The normal force on the fuselage increases for positive deflections of the elevator and decreases for negative deflections of the elevator. A greater percentage of the normal force on the horizontal tail surface is carried across the fuselage when the tab is deflected with the elevator neutral than when the elevator is deflected with the tab

neutral inasmuch as the gap between the elevator and the fuselage is smaller for tab deflections than for elevator deflections. The load on the fuselage directly affects the load on the elevator such that, at high angles of attack of the fuselage, the pressure differences between the upper and lower surfaces of the inboard section of the elevator are increased, whereas the outboard sections are not appreciably affected. (See figs. 7 and 16.) It should also be noted that at positive angles of attack of the fuselage the pressures near the trailing edge of the elevator are more negative for the inboard sections than for the outboard sections.

At $\alpha_F = 12.0^\circ$ and $\delta_e = 10^\circ$ (fig. 13), stall occurred over the center section of the elevator, but the fuselage remained unstalled. At an angle of attack of 12.0° (fig. 16), an elevator deflection of -10° would be expected to result in a smaller elevator loading than is shown inasmuch as the angle of the elevator with respect to the free-stream direction is only 2.0° . The high elevator loading for this condition is due to the effects of the upwash ahead of the wing and the fuselage-pressure distribution. The upwash due to the wing increases the effective angle of attack and the normal-force coefficient of the elevator. The pressure differences between the upper and lower surfaces of the fuselage extend across a part of the elevator and tend to increase the negative

pressures on the upper surface at the rear of the elevator. These effects increase with angle of attack and cause the elevator to float nose down with respect to the free-stream direction.

The static-pressure differences between top and bottom longitudinal sections of the fuselage are plotted in figures 20 to 22 for various angles of attack with the elevator and tab neutral. The longitudinal location of the elevator with respect to the fuselage is drawn to scale in each figure. The elevator floating angles determined from the force tests are shown in figure 23. At $\alpha_F = 12.0^\circ$, the elevator floats at -7.0° with respect to the free-stream direction. The floating angles for any particular angle of attack shown in figure 23 are 1.5° less than those given in reference 1. This discrepancy represents a correction for the difference in the average stream angle across the elevator and wing span which has been applied to the data.

Span-load distribution. - The distribution of normal-force coefficient across the span of the elevator for the various test conditions is shown in figures 24 to 29. The loading across the fuselage shown in these figures represents the increment of normal-force coefficient due only to the presence of the elevator and was determined from the difference in the pressures on the fuselage with the elevator attached to the airplane and with the elevator removed.

The spanwise distributions of normal-force coefficient for various elevator deflections with the tab neutral and for various tab deflections with the elevator neutral at $\alpha = 0.9^\circ$ are shown in figures 24 and 25. A comparison of these figures shows that a tab deflection equal to twice that of the elevator produces very nearly the same load on the horizontal tail; that is, the total load on the horizontal tail surface produced by a -10° tab deflection with the elevator neutral is very nearly equal to that produced by a -5° elevator deflection with the tab neutral. (See fig. 26.) In addition, these figures show that for a given tab deflection, the fuselage and the inboard section of the elevator are more highly loaded than for an elevator deflection producing the same normal-force coefficient. Figures 27 to 29 show the spanwise distribution of normal-force coefficient at angles of attack of 4.6° , 12.0° , and 15.8° for various elevator deflections with the tab neutral.

The effect on the elevator span loadings of deflecting the wing flaps 45° at fuselage angles of attack of 0.9° , 4.6° , and 12.0° (figs. 30 to 34) is small. Reference to the force tests (reference 1) showed that the average increment of lift coefficient due to this flap deflection was only about 0.23; hence, the upwash at the elevator due to deflecting the wing flaps is small.

Normal-force coefficients. - A summary of the average elevator normal-force coefficients obtained from the span-load

distributions of figures 24 to 34 is given in table IV. A comparison is made in figure 35 of the elevator effectiveness, $\frac{dC_{Ne}}{d\delta_e}$, determined from the pressure distributions and from the force tests at four angles of attack from 0.9° to 15.8° . The elevator effectiveness obtained from the force tests was determined by comparing the pitching moments of the airplane with the elevator removed and attached. The elevator effectiveness obtained from the pressure measurements was 0.042 at all angles of attack as compared with an average value of 0.040 determined from the force tests. The small difference between these values of $\frac{dC_{Na}}{d\delta_e}$ probably results from the change in pitching moment of the inboard section of the wing due to the elevator trailing vortices. At $\alpha_F = 15.8^\circ$ the value of normal-force coefficient determined from the force tests at any elevator deflection was about 0.14 greater than that determined from the pressure measurements although the slopes, $\frac{dC_{Ne}}{d\delta_e}$, were approximately equal. This discrepancy probably results from the fact that part of the wing was stalled at this angle of attack.

Values of the normal-force coefficient of the elevator for various tab deflections with elevator neutral at an angle of attack of 0.9° are presented in figure 36. The

tab effectiveness, $\frac{dC_{Ne}}{d\delta_T}$, determined from these results is 0.024. This value is about one-half as large as the elevator effectiveness.

The fuselage normal-force coefficients determined from the pressure data with the elevator removed are given in figure 37. A comparison has been made of these values and normal-force coefficients calculated by the methods presented in reference 4. Although the slopes, $\frac{dC_{NF}}{d\alpha_T}$, are in fairly good agreement, the results based on the pressure data indicate that there is a small upload on the fuselage at zero angle of attack of the fuselage axis.

SUMMARY OF RESULTS

1. The elevator effectiveness, $\frac{dC_{Ne}}{d\delta_e}$, obtained from the pressure measurements was 0.042. This value was in good agreement with that determined from force tests.
2. The effectiveness of the elevator tab was about half as great as the elevator effectiveness; a value of $\frac{dC_{Ne}}{d\delta_T}$ of 0.024 was measured.
3. The change in the elevator normal-force coefficient resulting from deflecting the wing flaps 45° was small.
4. The normal-force coefficients of the inboard sections of the elevator increased as the loading on the forward part of the fuselage increased.
5. A greater percentage of the normal force on the elevator surface was carried across the fuselage when the tab was

deflected with the elevator neutral than when the elevator was deflected with the tab neutral inasmuch as the gap between the elevator and the fuselage was smaller for tab deflections than for elevator deflections.

6. The pressure measurements indicated that the elevator will tend to float nose down with respect to the free-stream direction due to the effects of fuselage interference and wing upwash.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., June 14, 1943.

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3. Theodorsen, Theodore, and Silverstein, Abe: Experimental Verification of the Theory of Wind-Tunnel Boundary Interference. Rep. No. 478, NACA, 1934.
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*Table I. Location of Elevator Orifices
(Distances are measured chordwise)*

Row 1	Row 2	Row 3	Row 4	Row 5	Row 6
% C Inches	% C Inches	% C Inches	% C Inches	% C Inches	% C Inches
0 0	0 0	0 0	0 0	0 0	0 0
2.5 0.47	2.5 0.53	2.5 0.60	2.5 0.66	2.5 0.72	2.5 1.0
5 .93	5 1.16	5 1.19	5 1.32	5 1.45	5 2.0
10 1.86	10 2.12	10 2.38	10 2.64	10 2.90	10 3.6
15 2.80	15 3.18	15 3.57	15 3.96	15 4.34	15 5.4
25 4.66	25 5.30	25 5.95	25 6.60	25 7.24	25 8.6
35 6.53	35 7.41	35 8.33	35 9.24	35 10.12	40 13.3
50 9.32	50 10.60	50 11.90	50 13.20	50 14.48	— —
60 11.18	60 12.71	60 14.28	60 15.82	60 17.37	— —
70 13.05	70 14.82	70 16.66	70 18.46	70 20.25	— —
90 16.78	— —	— —	— —	— —	— —

*Table II. Location of Tab Orifices
(Distances measured from leading
edge of tab along the chord)*

Row 2	Row 3	Row 4	Row 5
Inches	Inches	Inches	Inches
0.750	0.750	0.750	0.750
1.250	1.250	1.375	1.500
2.000	2.125	2.375	2.500
3.250	3.500	3.750	4.000
4.375	4.750	5.125	5.500

*Table III. Location of Fuselage Orifices
(Distances measured along the surface
from the fuselage nose tip in inches)*

Row 16	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13
—	0	—	—	—	—	—	—
—	6	—	6	6	6	6	6
—	12	12	12	—	—	12	12
—	20	20	20	—	—	20	20
32	32	32	32	32	32	32	32
42	42	42	42	42	42	42	42
52	52	52	52	52	52	52	52
62	62	62	62	62	62	62	62

Table IV. - Test Conditions and Corresponding Elevator Normal-Force Coefficients Based on Free-Stream Dynamic Pressure

Run	α_F , deg	δ_E , deg	δ_r , deg	δ_f , deg	C_{N_E}
1	0.9	-10	0	0	0.446
2	.9	-5	0	0	-.244
3	.9	-5	-20	0	.570
4	.9	0	-30	0	.553
5	.9	0	-20	0	-.444
6	.9	0	-10	0	.239
7	.9	0	0	0	-.027
8	.9	0	10	0	.240
9	.9	0	19.3	0	.400
10	.9	5	0	0	.212
11	.9	5	-20	0	-.195
12	.9	10	0	0	.421
13	.9	10	-20	0	.017
14	.9	17	0	0	.648
15	.9	17	-20	0	.352
16	4.6	-10	0	0	-.183
17	4.6	-5	0	0	.003
18	4.6	0	0	0	.256
19	4.6	5	0	0	.430
20	4.6	10	0	0	.621
21	12.0	-20	0	0	-.205
22	12.0	-10	0	0	.264
23	12.0	-5	0	0	.479
24	12.0	-5	-20	0	.100
25	12.0	0	0	0	.687
26	12.0	0	-20	0	.298
27	12.0	5	0	0	.791
28	12.0	5	-20	0	.521
29	12.0	10	0	0	.769
30	12.0	10	-20	0	.506
31	15.8	-30	0	0	-.399
32	15.8	-20	0	0	.027
33	15.8	-10	0	0	.470
34	15.8	0	0	0	.859
35	12.0	-10	0	45	.272
36	12.0	10	0	45	.739
37	12.0	0	0	45	.674
38	8.3	0	0	45	.464
39	4.6	0	0	45	.267
40	.9	0	0	45	.021
41	.9	Elevator removed			
42	4.6				
43	8.3				
44	12.0				
45	15.8				

Table V. - Elevator Pressure Coefficients, $\Delta p/q$

Run Orifice	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1-0	0.53	0.60	0.36	1.00	1.00	1.08	1.00	1.00	1.00	0.81	0.96	0.25	0.20	2.84	2.30	0.67	1.00	0.81	0.10	2.02
1-1	.84	.54	.65	.29	.23	.16	.04	.04	.15	.54	.36	1.35	1.05	2.57	2.61	.48	.04	.54	7.17	2.52
1-2	.65	.36	.45	.10	.09	.01	.07	.13	.21	.47	.34	1.04	.81	1.77	1.57	.29	.06	.47	7.00	1.55
1-3	.35	.09	.18	.07	.00	.17	.20	.26	.33	.52	.36	.83	.71	1.30	1.15	.09	.21	.48	.85	1.20
1-4	.18	.02	.03	.14	.16	.25	.27	.36	.39	.52	.38	.79	.64	.93	.96	.04	.28	.50	.77	1.03
1-5	.02	.15	.10	.24	.24	.31	.35	.41	.45	.50	.38	.68	.55	.88	.76	.17	.35	.48	.67	.83
1-6	.19	.28	.23	.29	.33	.36	.40	.47	.50	.50	.40	.63	.51	.75	.63	.28	.43	.48	.64	.74
1-7	.30	.35	.28	.29	.33	.34	.40	.46	.50	.45	.34	.51	.37	.59	.63	.32	.43	.43	.50	.76
1-8	.25	.27	.23	.33	.22	.25	.29	.38	.41	.31	.25	.36	.24	.46	.37	.27	.31	.32	.35	.43
1-9	.13	.04	.12	.06	.02	.01	.21	.10	.17	.08	.01	.17	.03	.76	.09	.06	.06	.07	.15	.23
1-10	.14	.18	.11	.10	.16	.20	.21	.13	.07	.16	.18	.11	.15	.01	.07	.18	.16	.16	.09	.03
1-11	7.66	7.76	7.07	37	24	21	05	.01	.11	.48	.28	.82	.68	.05	1.00	.67	.11	.46	.75	1.00
1-12	7.18	.68	.89	.45	.33	.31	.20	.12	.08	.05	.11	.56	.46	.87	.81	.62	.21	.29	.50	.81
1-13	.98	.63	.79	.48	.42	.36	.29	.26	.18	.03	—	.26	.17	.63	.59	.60	.35	.01	.22	.51
1-14	.80	.58	.71	.50	.46	.38	.33	.30	.23	.08	.21	.11	.07	.42	.38	.55	.36	.10	.09	.33
1-15	.67	.53	.64	.52	.50	.39	.37	.34	.26	.21	.28	.07	.14	.16	.10	.50	.38	.20	.10	.14
1-16	.60	.49	.61	.53	.52	.41	.38	.36	.30	.28	.38	.20	.25	.02	.09	.47	.41	.28	.19	.04
1-17	.47	.43	.56	.53	.50	.39	.39	.34	.31	.34	.44	.28	.35	.20	.34	.42	.38	.32	.30	.21
1-18	.30	.25	.40	.46	.40	.34	.29	.25	.21	.25	.34	.23	.27	.13	.20	.22	.31	.20	.20	.14
1-19	.13	.10	.25	.25	.18	.10	.05	.04	0	.07	.13	.12	.18	.04	.11	.07	.06	.04	.15	.09
1-20	.08	.16	0	.02	.09	.16	.22	.35	.18	.18	.13	.18	.14	.18	.15	.18	.18	.20	.18	.16
2-0	.75	.58	.13	.63	1.00	1.00	1.00	1.00	1.00	.77	.99	.40	.10	.38	2.48	.68	1.00	.76	.39	2.40
2-1	.97	.65	.80	.42	.38	.24	.12	.07	.12	.54	.26	1.63	7.16	2.83	2.58	.58	.03	.67	7.57	2.67
2-2	.68	.36	.49	.14	.10	.01	.09	.21	.30	.52	.34	1.12	.87	2.00	1.65	.26	.18	.55	7.10	1.77
2-3	.39	.15	.28	.01	.07	.12	.20	.33	.38	.56	.36	1.02	.76	1.51	1.28	.11	.21	.55	.95	1.40
2-4	.16	.07	.05	.14	.20	.25	.33	.47	.50	.60	.41	1.02	.77	1.36	1.15	.10	.35	.58	1.00	1.28
2-5	.01	.15	.07	.16	.22	.25	.35	.47	.51	.57	.38	.73	.58	.97	.78	.17	.41	.55	.77	.93
2-6	.12	.25	.13	.18	.24	.32	.38	.53	.57	.54	.38	.68	.48	.78	.58	.27	.43	.54	.67	.78
2-7	.26	.35	.12	.11	.20	.33	.46	.58	.68	.51	.29	.57	.30	.61	.27	.32	.43	.52	.58	.61
2-8	.18	.25	.03	.20	.04	.21	.36	.49	.62	.38	.01	.36	.04	.36	.04	.25	.34	.37	.35	.38
2-9	.07	0	.37	.51	.36	.16	.07	.28	.54	.10	.32	.12	.22	.13	.01	0	.06	.10	.13	.16
2-10	.10	.05	.53	.75	.54	.29	.01	.34	.90	0	.49	.02	.39	.08	.08	.05	.02	0	.02	.09
2-11	.14	.11	.46	.64	.45	.29	.08	.20	.75	.08	.43	—	.41	.08	.13	.11	.09	.05	0	.06
2-12	.20	.18	.43	.59	.42	.29	.13	.08	.52	.13	.40	.05	.39	.07	.21	.16	.15	.11	.03	.04
2-13	.20	.18	.33	.43	.36	.27	.16	.03	.24	.16	.33	.09	.35	.04	.26	.18	.16	.15	.07	.03
2-14	.20	.18	.24	.33	.29	.24	.18	.09	.05	.18	.27	.11	.29	.02	.28	.18	.18	.16	.11	.01
2-15	2.09	.84	1.27	.51	.36	.21	.13	.03	.16	.45	.27	.87	.76	.05	1.00	.82	.12	.46	.85	1.00
2-16	7.20	.69	7.01	.48	.38	.28	.21	.10	.04	.26	.09	.60	.50	.96	.90	.67	.17	.26	.58	.81
2-17	7.04	.66	.91	.53	.49	.38	.30	.25	.11	.05	.14	.36	.24	.70	.64	.65	.28	.05	.33	.59
2-18	.91	.65	.80	.55	.51	.41	.36	.28	.16	.07	.24	.18	.11	.52	.47	.60	.34	.06	.20	.41
2-19	.76	.58	.76	.58	.53	.46	.39	.30	.20	.20	.35	0	.71	.26	.21	.52	.37	.19	.01	.21
2-20	.67	.55	.70	.63	.58	.51	.43	.30	.22	.26	.40	.13	.26	.11	0	.50	.39	.27	.12	.06
2-21	.50	.46	.67	.68	.64	.52	.43	.28	.18	.32	.53	.23	.40	.08	.23	.45	.37	.32	.39	.14
2-22	.29	.28	.53	.63	.58	.46	.32	.20	.07	.23	.48	.15	.38	.07	.25	.27	.30	.22	.15	.11
2-23	.12	.12	.47	.58	.53	.30	.13	.17	.27	.07	.43	.07	.34	0	.28	.12	.10	.06	.06	.04
2-24	.03	.03	.48	.70	.57	.23	.08	.40	.71	.11	.61	.16	.51	.21	.48	.05	.09	.11	.15	.16
2-25	.04	.10	.47	.76	.46	.13	.11	.35	.60	.14	.57	.16	.51	.18	.43	.09	.15	.13	.15	.16
2-26	.07	.15	.47	.76	.33	.10	.16	.33	.50	.20	.48	.21	.46	.22	.33	.15	.18	.18	.20	.19
2-27	.10	.18	.47	.74	.15	.08	.20	.32	.42	.24	.25	.24	.23	.26	.08	.20	.22	.23	.23	.23
2-28	.14	.21	.35	.50	0	.16	.24	.32	.36	.26	.05	.26	0	.24	.15	.23	.26	.26	.26	.23

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Run Orifice	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1-0	036	091	021	034	138	084	353	284	201	201	100	090	016	364	086	162	161	015	064	100
1-1	58	42	110	85	205	179	285	272	142	148	91	23	100	289	46	136	228	122	56	0
1-2	34	42	92	69	138	112	198	170	146	156	66	08	83	203	46	147	139	97	53	12
1-3	10	50	80	59	116	94	131	130	156	166	39	12	78	152	49	157	112	82	57	27
1-4	03	50	74	55	100	87	125	110	154	156	25	24	76	128	51	158	101	77	54	33
1-5	19	50	65	51	80	-	97	83	122	112	02	31	69	101	51	119	80	72	51	38
1-6	31	50	62	49	75	60	84	69	87	77	14	40	62	89	53	79	72	60	51	43
1-7	36	44	53	39	61	43	72	51	60	51	28	42	53	74	48	56	56	48	46	43
1-8	29	37	37	23	46	27	56	36	53	43	26	33	40	58	37	52	44	34	23	33
1-9	15	11	16	04	23	07	36	14	43	34	16	06	17	37	11	45	22	15	10	13
1-10	13	15	10	16	04	10	04	0	34	18	13	14	08	10	13	29	03	10	23	16
1-11	88	37	73	53	96	94	100	100	-	99	204	35	67	92	38	95	95	78	49	04
1-12	77	20	49	34	73	61	90	91	89	87	133	39	41	85	13	85	75	48	27	20
1-13	68	03	28	16	43	39	62	66	69	63	710	45	19	60	09	64	49	22	02	31
1-14	62	10	08	0	30	16	42	43	52	48	87	42	04	43	15	46	34	13	08	35
1-15	55	22	10	16	08	04	23	16	23	22	73	42	14	15	22	24	06	02	19	36
1-16	50	28	21	30	07	16	03	06	04	02	65	43	24	02	30	05	09	15	29	38
1-17	43	33	32	39	21	30	17	23	16	21	53	40	33	17	32	16	20	24	32	36
1-18	46	23	24	32	16	23	17	18	16	21	09	31	24	16	24	16	14	19	23	28
1-19	26	04	14	21	07	14	03	12	10	16	20	08	14	10	04	10	09	10	08	25
1-20	12	18	16	14	16	16	15	14	04	04	04	18	14	10	19	02	16	19	19	19
2-0	46	82	06	16	205	138	425	363	243	240	115	97	02	430	76	257	239	46	61	100
2-1	65	44	734	112	245	235	325	292	220	226	100	28	145	340	53	217	269	158	71	07
2-2	34	51	102	87	173	146	234	197	219	224	73	04	102	232	59	221	162	106	61	15
2-3	15	52	94	73	138	117	177	150	177	150	45	18	92	178	59	180	133	91	61	27
2-4	06	58	102	75	130	110	157	132	138	114	23	33	102	157	65	135	126	99	64	38
2-5	17	56	76	60	96	78	113	91	82	77	06	40	78	114	58	85	93	74	59	41
2-6	27	56	71	49	83	61	95	89	75	73	10	43	71	94	57	75	80	65	57	44
2-7	37	54	59	34	64	34	64	30	74	68	27	48	62	68	56	77	62	58	51	47
2-8	27	45	40	04	37	06	40	14	75	65	23	37	43	40	47	76	24	35	38	38
2-9	04	13	15	22	16	08	22	10	75	66	13	09	19	27	14	77	16	14	12	08
2-10	04	03	03	43	07	20	20	06	72	62	05	01	08	20	04	77	07	04	0	0
2-11	10	05	01	41	06	28	18	02	70	60	12	05	04	20	02	74	06	01	05	08
2-12	15	08	05	37	02	30	17	06	70	58	16	11	0	18	07	72	04	03	11	13
2-13	17	13	10	34	0	34	15	14	68	50	16	13	05	16	12	69	02	06	15	14
2-14	17	15	11	25	02	28	11	22	66	42	16	15	08	13	14	67	02	09	19	16
2-15	97	39	73	66	100	99	100	100	104	100	222	23	82	100	43	100	100	86	40	04
2-16	75	22	50	43	87	80	99	93	96	96	129	30	56	-	19	94	82	62	28	12
2-17	71	01	29	16	60	51	74	69	78	76	116	37	26	74	0	75	60	37	10	26
2-18	63	08	17	02	46	32	60	48	58	59	100	40	10	56	10	61	40	20	02	31
2-19	57	18	01	14	22	08	35	18	35	29	80	40	06	32	19	34	17	01	17	36
2-20	52	25	13	25	08	07	15	06	15	07	70	42	16	03	27	19	04	09	22	41
2-21	44	30	22	37	10	28	03	18	06	20	54	42	26	06	31	04	07	18	27	41
2-22	48	23	17	37	07	32	03	21	08	31	38	37	20	03	23	07	07	14	21	33
2-23	52	06	06	35	0	32	01	30	11	47	19	15	11	01	07	12	02	04	04	13
2-24	05	11	13	55	20	49	19	48	07	60	04	03	08	18	10	07	17	16	13	08
2-25	07	13	15	53	18	46	19	37	05	42	01	08	12	18	12	05	17	16	15	09
2-26	14	18	21	43	22	39	23	21	07	23	01	11	15	20	17	07	21	22	18	14
2-27	17	24	24	20	23	16	25	02	05	13	05	17	22	20	21	05	24	26	14	16
2-28	19	25	26	02	25	06	23	14	01	11	07	20	24	20	23	02	24	26	26	16

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Run Orifice	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3-0	293	051	012	098	100	100	100	100	078	096	012	022	304	218	061	100	071	337	329	
3-1	89	59	71	33	22	17	0	12	34	70	42	755	713	297	257	50	04	83	768	259
3-2	65	30	48	13	01	04	15	26	42	65	48	728	701	225	188	26	17	76	735	203
3-3	42	11	27	07	02	10	17	30	40	54	37	92	72	750	724	09	22	62	987	40
3-4	26	02	12	01	08	17	28	36	45	52	37	79	60	721	97	0	28	58	85	713
3-5	03	15	01	07	17	26	38	47	52	58	37	74	53	98	72	17	35	57	76	95
3-6	17	26	07	10	20	30	43	51	60	53	34	67	43	80	53	30	41	56	67	77
3-7	25	34	07	02	13	28	43	59	65	50	21	57	23	55	77	35	43	51	57	35
3-8	17	25	03	26	11	17	35	49	59	32	05	36	03	29	01	27	35	34	54	31
3-9	04	02	42	58	39	21	07	30	41	09	34	12	24	12	01	04	09	29	12	05
3-10	09	05	58	73	55	35	02	38	51	03	52	02	34	13	03	05	03	01	03	04
3-11	11	09	50	65	50	34	04	25	49	07	47	01	35	13	03	07	06	02	01	04
3-12	16	13	40	52	42	29	10	08	46	12	39	08	37	13	08	13	12	09	04	04
3-13	21	18	32	39	34	28	15	05	38	16	29	09	32	05	11	16	16	14	09	03
3-14	21	21	18	24	24	26	17	13	30	20	22	19	22	05	15	18	18	16	12	03
3-15	780	700	734	68	51	40	24	04	09	38	22	88	75	100	100	78	21	50	80	100
3-16	709	64	86	46	36	17	—	05	13	35	14	71	55	94	90	63	04	37	64	90
3-17	98	60	83	53	46	33	27	13	04	09	10	39	24	68	59	60	21	14	37	61
3-18	90	62	83	61	53	41	37	25	13	04	23	21	09	48	39	60	31	14	21	41
3-19	72	53	73	58	54	41	37	25	17	16	33	01	12	25	16	52	33	18	04	23
3-20	64	54	73	66	60	49	40	27	17	22	43	12	23	00	04	50	36	23	11	09
3-21	66	47	70	72	67	53	42	23	12	32	59	23	40	09	28	45	41	29	21	09
3-23	160	12	39	53	46	49	11	15	13	05	41	04	33	01	30	12	09	05	03	01
3-24	03	05	26	77	30	20	12	45	71	10	30	14	28	16	35	05	06	12	16	17
3-25	07	09	26	77	30	12	10	41	66	14	30	18	26	17	30	09	12	14	17	19
3-26	11	13	28	43	28	04	14	36	40	20	30	21	26	21	28	13	18	19	21	23
3-27	13	18	28	46	28	03	20	36	40	24	30	28	25	23	21	20	23	22	25	25
3-28	16	21	32	48	26	09	22	32	27	25	12	24	21	18	10	20	23	22	23	21
4-0	64	55	29	93	94	100	100	100	100	87	97	0	41	233	772	61	100	76	74	770
4-1	90	60	71	37	35	29	09	17	21	53	21	160	703	241	213	53	01	57	152	234
4-2	69	32	52	21	13	13	07	21	33	50	30	711	79	789	761	30	09	57	712	762
4-3	37	05	26	03	04	13	25	34	41	53	36	92	67	142	720	07	23	57	95	729
4-4	29	0	13	0	07	17	29	33	39	50	34	77	54	712	91	02	23	56	80	704
4-5	01	15	01	12	17	25	35	45	49	54	30	71	50	88	67	22	39	55	74	85
4-6	13	27	07	12	20	28	40	50	60	53	28	65	42	73	69	32	44	55	69	72
4-7	25	33	07	04	14	28	43	58	65	51	21	58	25	54	23	37	45	52	57	57
4-8	20	23	07	24	11	17	33	50	58	38	08	38	02	34	0	32	34	34	14	32
4-9	08	02	40	55	39	18	46	39	47	13	36	17	25	15	05	07	10	31	74	72
4-10	09	08	58	73	59	37	01	39	51	0	55	08	35	10	09	03	02	01	06	06
4-11	11	09	49	63	51	29	03	24	51	03	47	02	35	10	13	05	03	03	02	04
4-12	14	15	40	52	43	28	10	07	43	08	41	01	36	08	14	11	11	09	02	04
4-13	16	16	30	37	34	26	19	02	34	13	32	05	33	07	24	15	13	12	05	02
4-14	18	21	20	22	26	16	09	23	15	26	05	25	07	22	17	15	14	10	0	
4-15	763	85	713	39	43	30	74	10	11	42	21	78	78	100	100	60	04	48	82	100
4-16	727	68	94	41	46	36	24	12	05	26	05	55	43	89	83	56	14	33	58	85
4-17	96	54	72	41	43	36	22	11	04	09	07	32	27	67	61	49	19	16	37	66
4-18	80	53	72	49	48	40	30	22	13	07	20	18	09	48	39	50	22	04	22	46
4-19	67	49	66	52	53	40	35	24	15	17	33	01	09	26	13	45	29	09	03	23
4-20	60	48	64	54	59	46	38	25	17	27	41	13	24	08	04	45	34	19	07	07
4-21	49	43	64	67	65	51	38	22	43	33	53	25	40	12	26	43	36	28	19	10

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Run Orifice	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
3-0	056	068	029	032	201	732	435	354	075	062	095	100	010	436	071	070	230	039	077	100
3-1	52	80	161	114	257	225	355	310	64	54	91	01	766	358	75	60	266	765	77	13
3-2	24	77	139	104	202	172	275	231	64	54	65	15	746	275	78	60	190	738	74	25
3-3	10	66	103	75	144	115	180	152	64	56	40	20	94	783	61	60	144	98	59	26
3-4	04	62	87	65	117	96	743	121	66	56	24	30	88	144	59	61	713	81	35	34
3-5	19	62	80	60	96	75	113	89	68	60	03	39	82	714	62	61	94	75	57	42
3-6	30	62	74	48	83	57	87	59	71	61	12	45	74	90	62	65	82	69	59	46
3-7	35	57	63	29	61	28	52	22	75	65	27	49	62	59	55	72	61	57	51	46
3-8	28	43	43	01	37	0	32	13	75	65	20	38	43	37	41	75	36	36	36	34
3-9	04	16	16	21	14	06	22	11	73	61	12	12	17	24	16	71	14	12	12	10
3-10	03	06	06	33	07	10	20	11	67	60	06	0	07	22	06	65	07	04	02	03
3-11	05	02	02	35	06	12	20	08	65	57	04	02	06	22	0	65	07	02	02	05
3-12	11	05	02	35	04	18	20	06	64	55	11	05	0	22	05	65	06	04	07	11
3-13	13	10	06	29	02	22	20	01	60	54	15	12	05	22	10	62	04	07	15	16
3-14	16	13	07	21	0	22	18	07	57	50	15	14	07	22	14	55	04	10	15	16
3-15	94	40	83	72	100	96	100	100	100	100	202	31	74	100	40	97	97	84	54	07
3-16	61	36	67	53	92	90	99	99	96	93	710	22	60	99	31	94	87	69	40	04
3-17	59	12	35	25	63	53	82	70	77	70	704	33	33	81	10	75	59	38	15	23
3-18	61	02	21	10	42	39	60	54	61	54	95	40	19	61	02	60	42	21	04	34
3-19	51	02	04	71	21	14	36	26	38	29	73	40	04	40	12	38	22	05	12	34
3-20	51	24	07	24	06	06	18	07	18	07	70	41	10	22	21	19	07	07	19	38
3-21	47	29	21	40	10	28	06	17	06	24	59	43	24	0	29	04	10	19	28	41
3-23	14	07	06	36	0	30	0	29	10	52	22	14	10	02	10	12	04	06	04	10
3-24	03	07	12	38	16	37	16	42	06	80	06	14	10	16	10	04	32	15	12	09
3-25	06	12	16	38	20	37	18	36	06	57	02	05	12	18	12	05	17	17	15	13
3-26	11	15	20	38	21	35	20	31	06	34	02	12	16	19	17	05	21	21	19	16
3-27	15	21	23	33	23	23	20	13	06	24	06	17	19	24	23	05	22	24	25	22
3-28	16	21	21	26	20	14	14	01	02	26	09	17	19	18	23	07	19	22	25	22
4-0	63	76	10	89	175	120	384	308	46	34	52	100	19	391	67	43	280	33	66	100
4-1	54	72	166	123	241	243	319	274	61	54	86	07	146	318	77	58	231	160	61	03
4-2	32	70	115	95	180	151	246	205	61	54	100	12	119	204	70	58	180	120	61	20
4-3	05	69	104	82	145	119	176	146	64	55	31	29	113	175	67	58	140	107	65	27
4-4	06	63	90	66	116	95	139	114	64	57	15	31	94	139	60	62	111	86	54	28
4-5	23	63	77	58	95	73	102	82	66	62	09	43	82	109	63	63	97	75	55	37
4-6	37	63	73	50	82	57	79	56	72	67	25	54	76	85	63	70	83	70	57	40
4-7	47	60	61	31	64	28	47	18	74	67	40	57	67	53	59	72	62	58	53	43
4-8	35	43	40	01	38	02	26	11	70	62	33	45	45	33	45	70	37	38	34	32
4-9	13	16	17	19	15	04	24	15	66	57	17	18	21	29	18	66	14	0	14	09
4-10	03	04	07	29	08	06	20	13	58	51	01	06	10	26	04	59	07	06	02	04
4-11	01	03	04	31	08	10	20	11	58	51	01	04	07	26	03	59	07	04	02	07
4-12	05	03	02	31	06	12	20	06	56	49	03	02	04	26	03	55	06	0	07	12
4-13	08	05	04	24	06	16	20	05	50	43	05	04	0	26	09	51	06	03	11	16
4-14	11	08	05	19	06	18	18	01	47	41	129	07	04	26	11	47	04	07	15	23
4-15	78	51	85	76	100	99	100	100	100	100	152	04	84	100	51	100	100	85	50	01
4-16	64	32	01	49	88	78	96	94	96	88	719	18	60	—	30	94	88	64	83	09
4-17	50	15	01	26	65	53	81	72	78	69	89	19	65	77	16	77	62	41	18	16
4-18	50	01	02	17	—	36	63	53	62	53	79	24	29	62	06	53	46	27	05	22
4-19	44	08	07	04	24	14	39	29	39	28	69	30	10	39	09	36	26	07	07	30
4-20	47	18	06	20	11	02	21	05	21	06	64	36	06	24	18	18	12	02	12	35
4-21	47	28	16	36	06	25	01	17	01	25	60	42	19	62	26	01	06	14	25	35

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Run Drift	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4-22	—	030	055	060	058	043	030	009	011	023	049	017	040	010	030	032	027	029	014	006
4-23	12	10	37	52	48	30	11	16	35	07	40	08	32	04	30	14	07	05	06	0
4-24	01	08	29	43	46	33	14	46	72	05	48	09	25	11	38	02	05	09	11	13
4-25	03	05	29	41	36	17	16	33	55	03	41	05	35	08	36	02	03	06	07	09
4-26	09	15	29	41	30	02	13	36	50	16	33	18	29	18	30	11	17	19	20	20
4-27	14	21	31	43	25	08	20	36	42	22	25	24	24	22	17	18	22	26	26	23
4-28	14	22	33	47	22	13	22	33	33	24	17	24	16	21	07	20	25	26	26	23
5-0	36	65	30	92	95	99	24	100	100	93	100	27	43	164	114	75	109	79	35	115
5-1	82	58	72	45	34	21	09	14	10	53	20	112	92	184	167	45	0	55	127	183
5-2	61	37	49	26	21	11	04	12	15	46	23	86	66	148	133	10	14	53	92	135
5-3	34	08	23	01	02	12	20	24	34	46	28	86	61	122	102	02	25	55	94	113
5-4	18	04	14	04	08	16	22	28	30	39	27	70	49	92	74	06	09	48	75	95
5-6	17	26	09	13	12	30	44	46	53	49	32	62	43	70	42	32	42	52	66	71
5-7	25	33	09	07	13	27	40	49	59	43	—	49	28	61	27	31	39	47	71	58
5-8	17	23	07	18	05	16	29	41	54	30	16	41	10	48	14	25	29	32	44	45
5-9	07	10	33	46	29	09	18	46	66	23	27	33	08	43	08	11	19	28	29	28
5-10	07	08	51	70	52	22	09	51	83	20	51	23	24	30	02	11	12	19	19	22
5-11	03	01	38	55	39	20	05	40	61	13	41	17	22	27	04	01	07	13	16	17
5-12	08	08	29	43	34	20	01	27	46	07	38	10	20	22	04	02	06	06	06	14
5-13	05	05	09	16	16	12	01	15	30	0	20	07	05	22	04	02	0	0	01	07
5-14	05	08	05	0	05	12	02	10	25	01	12	08	0	20	03	04	02	01	01	07
5-15	734	67	87	41	23	14	01	09	15	46	28	19	63	100	98	49	07	50	80	96
5-16	110	59	74	42	33	22	11	02	01	26	10	60	40	—	70	47	07	31	54	81
5-17	70	43	58	36	28	22	11	07	0	18	05	40	24	62	51	31	07	18	39	58
5-18	66	46	55	42	38	29	22	13	08	02	14	18	11	40	38	36	21	05	25	43
5-19	63	46	58	49	43	27	32	20	15	17	27	0	10	15	12	36	27	10	03	16
5-20	51	41	53	50	47	40	33	23	13	23	33	12	23	01	05	36	27	17	06	05
5-21	46	40	53	54	53	43	35	21	10	26	45	23	36	14	25	36	32	25	18	10
5-22	36	26	34	42	41	35	24	07	09	20	37	13	30	12	24	23	22	13	11	04
5-23	25	17	30	45	41	30	12	21	26	08	33	07	26	09	24	18	14	04	03	0
5-25	13	08	34	63	72	35	02	33	41	08	59	09	45	04	31	11	03	11	10	10
5-26	08	04	21	50	49	33	07	39	41	11	68	09	64	04	24	05	05	13	12	10
5-27	01	01	20	45	26	14	10	29	24	11	25	09	71	01	12	01	07	15	18	09
5-28	03	05	17	42	23	03	12	22	21	13	16	11	43	04	05	04	13	16	12	11
6-0	01	65	42	85	89	90	97	98	96	84	96	34	52	90	66	75	97	79	12	97
6-1	79	52	68	40	37	27	20	11	0	22	01	65	52	122	102	37	11	01	82	127
6-2	54	32	46	20	21	10	07	0	08	26	09	64	45	98	87	21	02	35	71	108
6-3	38	12	24	07	03	05	12	18	22	33	17	51	47	73	64	05	17	44	63	75
6-4	16	01	09	05	11	14	22	25	27	37	23	49	43	65	54	12	28	45	63	68
6-5	07	15	08	13	18	24	27	35	35	38	28	51	39	67	53	27	34	45	60	68
6-6	15	27	10	13	18	29	35	45	48	42	30	51	34	67	46	34	37	47	53	97
6-7	104	48	64	28	18	12	03	10	16	35	28	68	58	93	89	25	11	55	64	89
6-8	78	43	57	30	22	12	09	04	09	23	14	50	40	74	71	25	02	35	55	73
6-9	79	46	59	39	39	29	27	18	12	01	15	16	08	45	37	32	17	13	25	44
6-10	50	40	51	38	38	25	24	12	11	05	15	11	03	30	24	30	12	07	20	33
6-11	55	41	61	43	41	35	29	22	18	20	30	10	20	01	04	32	22	12	04	09
6-12	48	38	54	49	45	37	33	25	16	27	38	20	28	11	17	35	30	21	13	02
7-0	100	100	100	106	100	100	100	100	100	100	100	100	100	104	104	100	100	100	99	97
7-1	47	43	47	46	45	46	37	35	37	37	39	31	35	27	32	30	22	17	11	09

Table V. - continued

NATIONAL ADVISORY

COMMITTEE ON AERONAUTICS

Run Drift	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
4-22	037	020	012	036	004	030	007	024	004	035	049	033	016	019	020	004	006	012	017	027
4-23	18	11	04	33	01	28	03	29	04	49	29	16	12	02	11	06	0	04	04	07
4-24	06	06	10	40	11	37	13	47	05	83	15	06	05	12	09	03	12	13	11	07
4-25	06	03	07	38	11	37	10	42	03	59	13	07	04	12	05	01	12	12	08	07
4-26	05	16	19	38	19	34	19	31	12	37	04	06	16	19	18	09	21	20	20	18
4-27	13	22	25	36	24	23	23	15	13	21	01	14	21	21	24	11	26	27	26	23
4-28	13	22	25	26	23	12	17	01	07	16	03	16	19	17	24	06	23	27	26	23
5-0	79	66	10	29	156	114	310	267	138	92	01	100	12	355	63	126	143	10	75	100
5-1	35	80	152	104	799	200	279	236	155	125	77	02	158	284	79	163	198	142	61	07
5-2	16	65	110	88	763	138	210	184	139	118	46	12	110	219	61	140	162	114	49	01
5-3	06	65	106	88	138	119	162	139	113	100	18	33	107	170	61	104	135	97	54	20
5-4	14	58	88	70	108	95	110	101	88	71	01	39	92	132	65	73	111	84	51	25
5-6	42	63	72	52	76	59	76	46	72	64	40	56	76	78	62	68	79	68	54	36
5-7	44	55	55	31	60	35	49	22	69	57	49	56	61	45	52	68	61	53	47	36
5-8	35	36	41	11	47	12	35	11	58	54	42	44	47	35	33	56	44	44	34	28
5-9	22	31	33	05	21	02	23	08	51	48	27	32	38	30	27	53	23	27	25	17
5-10	22	24	21	10	14	0	21	06	46	46	31	28	31	24	26	44	15	19	17	13
5-11	18	19	14	07	12	0	20	06	47	43	25	25	21	24	19	44	11	12	14	06
5-12	13	14	10	05	01	0	18	04	46	43	22	20	14	21	12	44	06	06	04	02
5-13	14	11	04	04	04	02	18	10	47	52	25	16	10	20	06	44	03	0	02	03
5-14	14	12	02	15	04	06	18	01	53	50	33	16	12	18	12	53	03	0	02	03
5-15	39	73	88	78	100	91	98	100	100	100	106	13	84	97	55	100	100	82	47	01
5-16	39	36	65	55	90	77	96	95	98	93	83	01	64	99	35	95	84	58	30	12
5-17	40	22	47	39	71	36	80	76	80	74	54	01	45	85	23	80	67	46	17	07
5-18	33	11	32	19	51	34	62	58	65	54	54	11	29	66	12	61	48	27	05	20
5-19	35	04	07	03	25	12	39	29	37	26	62	23	12	42	04	35	24	07	07	28
5-20	39	12	02	11	12	02	20	10	21	10	62	30	0	28	12	20	15	02	12	31
5-21	47	24	16	31	02	21	04	08	02	15	65	46	16	06	23	01	01	12	19	31
5-22	35	21	12	33	0	25	04	15	0	22	52	42	16	04	21	01	01	07	12	21
5-23	32	15	07	34	02	30	04	22	04	34	44	32	12	04	16	04	01	04	06	10
5-25	28	02	10	56	18	55	12	61	07	71	42	18	0	12	02	05	17	13	13	05
5-26	25	02	12	48	16	43	12	34	04	42	38	15	02	06	04	03	17	15	15	09
5-27	20	05	14	38	16	39	08	31	07	38	35	13	04	10	04	09	15	15	15	11
5-28	14	11	16	33	16	23	04	24	07	32	29	09	10	10	12	06	17	17	19	13
6-0	79	59	16	10	733	96	282	230	26	755	77	93	07	349	64	207	152	04	81	96
6-1	35	55	107	80	773	135	216	791	157	128	62	09	121	236	62	149	158	92	33	11
6-2	16	55	90	76	143	122	173	151	133	115	42	20	100	189	60	130	142	75	40	03
6-3	08	55	80	64	109	92	124	104	104	82	11	35	95	142	54	107	106	76	39	12
6-4	20	63	77	61	102	80	104	89	80	61	10	43	87	116	62	78	97	67	47	23
6-5	35	55	61	48	72	55	78	61	51	52	32	40	55	75	58	51	71	60	54	43
6-6	47	55	64	42	70	46	68	46	62	54	54	54	65	71	56	58	68	55	47	35
6-7	16	55	80	70	95	91	98	98	98	100	55	16	78	96	56	100	93	76	53	02
6-8	25	40	65	53	82	75	92	89	94	96	47	12	64	94	37	96	78	63	35	08
6-9	28	16	37	27	54	48	69	61	73	69	50	06	35	72	18	72	64	31	13	22
6-10	25	13	29	21	44	33	58	50	57	55	41	08	29	58	13	57	47	24	02	22
6-11	43	06	07	01	21	10	31	22	28	23	70	24	10	34	04	27	16	04	14	31
6-12	49	20	09	18	05	08	15	04	10	01	74	43	07	17	16	13	03	07	17	31
7-0	91	85	84	86	82	84	85	80	80	86	87	77	69	62	84	81	80	93	100	100
7-1	04	16	22	13	31	22	33	25	25	20	16	28	40	49	13	20	26	02	17	40

Table V - continued

NATIONAL ADVISORY
COMMITTEE FOR AERONAUTICS

Run Orifice	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7-2	021	016	022	020	020	015	014	014	010	013	013	008	013	001	001	009	002	004	010	026
7-3	02	04	0	0	01	07	08	11	11	09	08	15	12	20	15	15	19	22	27	26
7-4	04	07	02	02	03	07	11	11	11	09	07	12	10	16	12	15	17	19	22	20
7-5	03	0	03	03	03	01	01	01	01	01	01	07	01	05	02	06	06	06	10	10
7-6	02	01	01	03	03	01	01	01	01	02	01	0	01	01	01	04	04	06	07	04
7-7	04	04	04	04	03	05	05	05	03	03	04	04	04	07	0	07	07	07	10	07
8-2	22	18	22	20	20	15	14	09	07	07	13	01	05	07	0	05	0	06	12	17
8-3	02	0	05	03	03	03	09	12	12	09	04	15	10	25	17	15	17	22	27	30
8-5	08	05	09	13	11	09	04	01	01	04	09	01	05	01	01	01	02	0	04	04
8-6	20	0	0	0	01	01	03	03	03	01	0	0	0	03	02	04	02	04	07	06
8-7	08	08	08	08	07	10	09	02	09	07	07	08	08	11	10	12	12	12	12	06
9-1	54	51	50	50	52	46	46	46	46	46	47	39	42	33	39	38	35	32	26	21
9-3	03	08	03	01	04	07	15	17	26	23	10	33	18	48	36	06	20	30	43	48
9-4	04	08	11	15	09	01	13	20	26	15	03	17	03	22	10	06	14	17	19	19
9-5	05	01	01	04	08	02	02	07	13	07	05	08	02	11	04	03	01	04	07	07
9-6	04	04	04	01	02	10	04	04	10	07	02	08	03	09	07	06	06	07	07	07
9-7	04	04	04	01	01	10	04	02	07	04	02	08	03	07	07	06	06	07	07	07
10-1	54	53	52	54	52	49	50	52	52	50	50	48	51	48	49	48	46	44	43	42
10-4	33	15	28	14	15	22	23	30	36	09	0	25	05	24	10	21	18	22	45	39
10-5	07	05	30	34	15	07	03	12	28	07	05	08	10	11	02	03	08	03	07	13
10-6	17	08	20	14	10	09	08	08	20	15	08	13	05	12	10	12	09	06	10	17
10-7	12	07	13	10	10	07	08	07	13	10	07	10	05	11	10	12	09	06	06	13
11-1	47	50	47	51	49	49	52	54	54	52	50	54	53	57	57	51	53	55	55	56
11-4	14	12	23	22	25	17	08	09	18	0	20	03	11	09	14	09	06	01	05	09
11-5	12	08	23	25	20	11	02	08	04	01	13	08	05	16	0	09	06	0	03	09
11-6	08	07	12	12	10	09	04	0	02	04	10	02	09	12	04	09	06	02	02	01
11-7	10	08	12	11	10	11	08	04	07	07	10	07	09	12	08	09	09	06	06	02
12-1	43	47	39	46	56	43	48	52	52	50	50	55	51	59	56	53	58	61	61	64
12-2	0	11	01	12	11	26	19	22	24	26	16	32	27	37	34	23	28	35	58	48
12-3	28	20	26	22	21	16	12	16	02	07	13	01	07	07	0	09	02	03	08	16
12-4	15	12	20	20	20	16	08	02	03	04	13	0	11	01	10	06	02	01	03	07
12-5	10	07	15	19	13	09	04	01	03	02	10	01	07	02	04	03	01	01	03	05
12-6	12	10	15	19	13	12	08	03	07	07	10	07	11	07	08	09	06	04	06	02
12-7	12	10	13	12	12	12	12	04	10	10	10	10	11	01	10	09	06	06	07	06
13-1	41	43	39	44	57	44	48	—	55	50	47	55	51	59	56	59	59	63	68	71
13-2	11	13	05	09	11	12	16	52	22	20	16	26	22	29	35	26	31	33	36	42
13-3	15	12	20	18	15	12	10	22	02	04	10	01	05	02	04	01	04	07	09	13
13-4	0	01	02	03	02	01	15	08	08	05	0	08	04	07	02	11	12	13	11	14
13-5	04	04	07	05	07	05	02	08	01	0	04	0	01	01	04	11	04	05	05	07
13-6	08	08	10	11	10	11	10	04	04	07	08	07	07	07	08	01	01	02	02	0
13-7	07	04	04	05	07	07	04	04	04	09	07	04	04	04	07	0	0	0	0	0
14-4	04	07	0	0	02	04	08	10	12	12	07	12	04	13	12	12	03	11	19	19
14-5	13	04	0	0	02	12	04	07	10	11	04	10	04	10	08	10	0	12	13	13
14-6	04	12	10	10	0	0	12	13	15	15	13	16	10	13	13	15	03	17	19	17
14-7	12	12	01	0	0	12	0	0	02	07	02	02	0	02	02	04	04	06	06	06

Table V. - concluded

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Run Orifice	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
7-2	0.20	0.30	0.34	0.24	0.42	0.29	0.40	0.37	0.37	0.33	0.23	0.35	0.43	0.56	0.25	0.37	0.37	0.21	0.02	0.15
7-3	34	40	43	36	50	40	49	46	51	47	39	43	52	59	39	49	45	35	21	08
7-4	25	30	32	24	36	29	36	34	41	36	29	31	35	42	30	37	32	27	17	08
7-5	13	16	17	13	17	13	19	16	23	18	14	16	19	25	16	22	16	12	07	0
7-6	11	11	13	11	13	11	13	12	16	13	12	10	14	16	13	01	16	07	06	02
7-7	13	13	15	13	15	15	12	14	16	13	14	14	16	18	14	01	16	12	10	04
8-2	22	33	42	29	48	41	52	49	46	40	23	38	55	68	33	44	45	27	07	13
8-3	32	40	46	34	52	42	52	46	55	48	37	43	55	61	39	51	47	35	21	07
8-5	04	06	08	06	11	06	13	10	23	17	04	14	12	16	06	22	08	06	0	05
8-6	13	13	13	13	13	13	15	14	16	13	18	14	18	18	13	16	13	07	06	0
8-7	20	18	18	20	18	18	19	21	18	15	34	19	24	25	20	18	18	16	12	07
9-1	30	04	01	03	04	10	13	10	02	15	13	0	18	28	06	01	04	19	30	46
9-3	18	38	51	37	64	49	68	55	59	52	47	60	66	80	41	52	62	—	29	18
9-4	28	21	23	07	24	06	24	14	50	42	38	46	28	30	21	47	26	22	15	17
9-5	28	10	10	04	13	06	17	10	37	28	27	13	16	27	10	37	14	08	06	04
9-6	18	10	12	07	18	06	15	12	20	13	27	20	10	16	10	16	16	13	07	08
9-7	18	10	06	12	08	04	11	16	12	08	27	20	12	15	12	10	07	19	07	08
10-1	40	50	23	30	23	25	14	22	30	29	39	25	10	01	29	29	21	31	43	46
10-4	30	25	23	21	22	04	29	07	53	48	49	03	36	18	27	56	26	31	27	16
10-5	18	0	12	16	03	05	13	0	55	34	35	19	02	18	14	50	02	01	03	0
10-6	22	16	10	18	08	01	06	14	23	17	40	28	18	11	16	17	11	11	07	15
10-7	22	14	12	18	08	03	08	10	10	15	35	27	18	11	16	10	11	11	06	10
11-1	56	54	53	55	51	55	49	50	55	58	57	53	44	39	52	56	46	54	54	49
11-4	13	02	04	12	13	06	13	02	06	17	27	13	02	15	02	45	12	05	02	08
11-5	18	06	0	18	03	13	01	10	18	22	29	16	06	01	06	16	02	01	0	07
11-6	14	06	04	10	01	06	01	04	14	08	23	15	07	03	06	14	02	03	02	08
11-7	14	10	07	12	04	08	06	07	07	08	25	18	14	08	12	07	07	08	02	14
12-1	65	69	71	71	74	73	72	74	75	76	71	72	72	72	67	76	71	65	60	46
12-2	35	46	53	50	62	57	62	61	63	62	39	48	60	65	46	64	60	47	35	15
12-3	01	15	25	16	31	22	33	30	32	23	04	13	28	41	15	31	31	16	03	16
12-4	03	05	12	02	15	05	15	06	10	01	04	05	12	20	05	12	15	05	0	10
12-5	03	04	08	0	10	03	07	04	0	04	04	03	08	13	04	02	10	03	0	07
12-6	06	04	0	06	01	03	01	04	06	06	09	03	02	03	02	04	02	03	04	12
12-7	06	06	04	06	03	04	04	06	06	06	11	05	06	01	06	06	04	06	07	15
13-1	81	85	91	85	91	69	90	92	91	86	87	89	96	97	83	88	90	79	61	49
13-2	47	57	59	57	62	58	62	64	61	56	57	64	70	74	55	62	62	47	30	18
13-3	22	26	29	27	35	29	33	32	32	26	28	39	39	44	27	31	50	20	07	13
13-4	23	25	27	25	31	28	26	26	25	23	30	34	37	39	27	27	29	20	13	0
13-5	18	17	20	18	24	17	17	18	16	15	24	27	26	27	17	16	19	13	05	04
13-6	08	10	12	12	17	10	10	08	08	07	18	20	20	19	10	07	12	03	0	08
13-7	10	12	10	11	12	13	10	11	10	10	18	17	21	17	13	10	10	17	0	07
14-4	24	26	32	23	32	22	37	30	39	37	26	29	29	38	26	38	31	24	14	08
14-5	19	19	23	18	21	17	25	22	30	25	20	19	21	26	18	29	23	17	10	07
14-6	23	23	25	22	23	22	28	25	25	23	26	24	21	26	22	28	25	23	17	16
14-7	14	12	12	12	12	08	14	14	10	14	14	14	12	14	11	12	12	10	06	04

Table VI. - Fuselage Pressure Coefficients, $\Delta p/q_0$

Run Drift	41	42	43	44	45
7-0	1.00	1.00	1.00	0.90	0.80
7-1	.38	.20	.11	-.06	-.24
7-2	.16	.03	-.06	-.19	-.29
7-3	-.03	-.12	-.21	-.33	-.38
7-4	-.09	-.13	-.20	-.25	-.29
7-5	-.04	-.06	-.11	-.16	-.17
7-6	-.01	-.04	-.06	-.12	-.14
7-7	-.07	-.10	-.13	-.14	-.16
8-2	.12	.03	-.06	-.19	-.29
8-3	.02	-.04	-.11	-.19	-.27
8-4					
8-5	.02	0	-.04	-.12	-.17
8-6	.02	-.02	-.06	-.12	-.17
8-7	-.09	-.12	-.14	-.19	-.26
9-1	.42	.33	.23	.12	-.02
9-3	-.18	.56	-.18	-.16	-.15
9-4	.04	.01	-.03	-.08	-.15
9-5	-.05	-.07	-.13	-.18	-.26
9-6	-.07	-.10	-.14	-.20	-.26
9-7	-.05	-.07	-.13	-.18	-.25
10-1	.46	.44	.38	-.34	.23
10-4	-.03	-.04	-.06	-.13	-.18
10-5	-.09	-.10	-.14	-.18	-.26
10-6	-.14	-.13	-.20	-.25	-.34
10-7	-.09	-.10	-.16	-.22	-.30
11-1	.48	.50	.48	.49	.48
11-4	.02	.03	.03	-.01	-.04
11-5	-.11	-.10	-.11	-.13	-.16
11-6	-.09	-.06	-.08	-.11	-.15
11-7	-.11	-.10	-.13	-.16	-.20
12-1	.48	.55	.60	.63	-.09
12-2	-.18	-.17	-.18	-.14	-.15
12-3	-.18	-.17	-.18	-.16	-.15
12-4	.01	.05	.06	.11	.11
12-5	-.05	0	.01	.03	.03
12-6	-.12	-.10	-.08	-.08	-.06
12-7	-.12	-.10	-.08	-.08	-.06
13-1	.48	.64	.72	.81	.90
13-2	.20	.35	.42	.49	.63
13-3	-.01	.11	.20	.25	.40
13-4	.04	.13	.20	.25	.37
13-5	.01	.05	.12	.20	.28
13-6	.20	-.19	-.18	.06	-.15
13-7	-.03	.01	.05	.13	.18
14-4	-.05	-.12	-.19	-.23	-.28
14-5	-.07	-.12	-.17	-.22	-.25
14-6	-.12	-.16	-.19	-.22	-.25
14-7	-.11	-.14	-.17	-.18	-.20

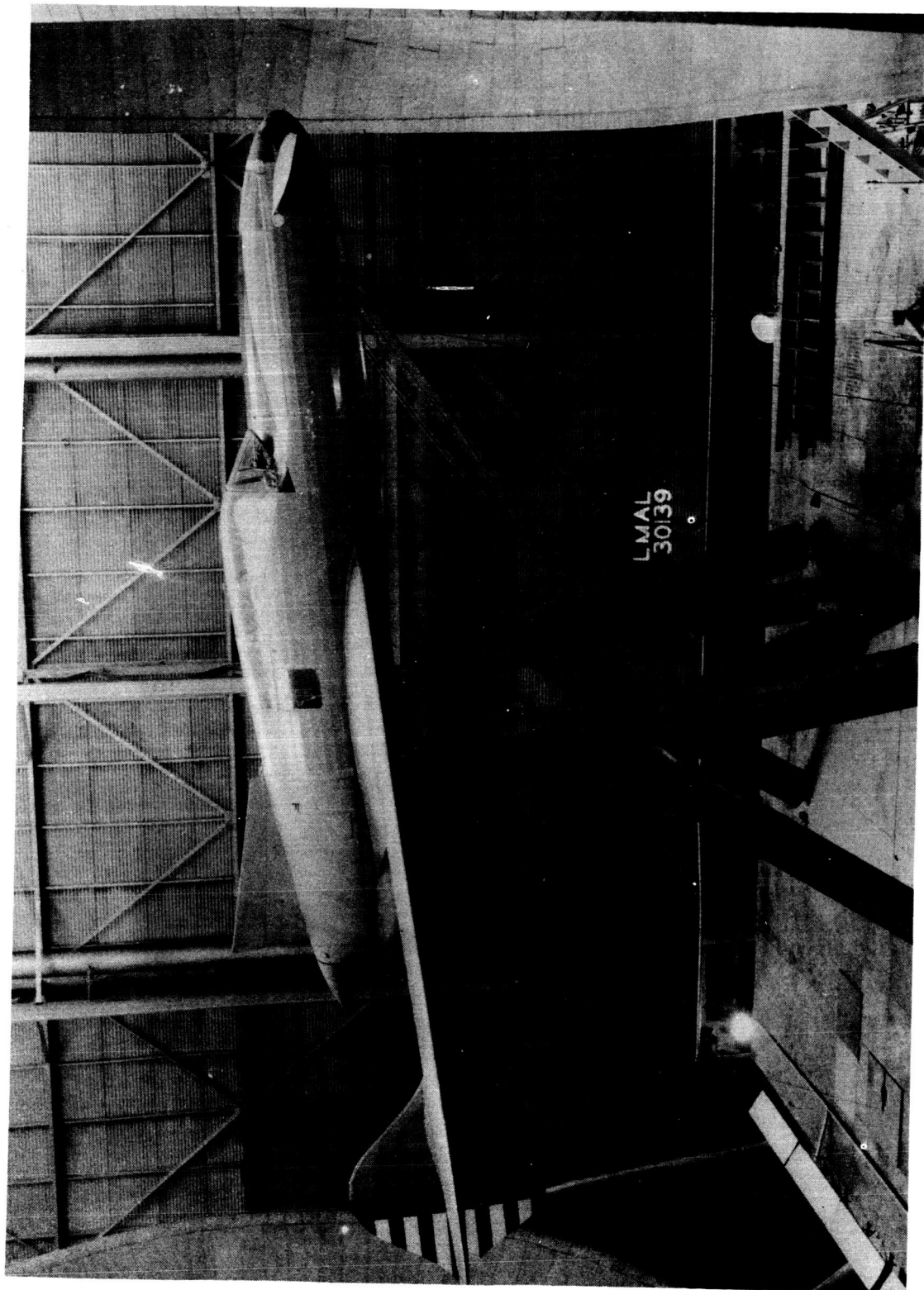
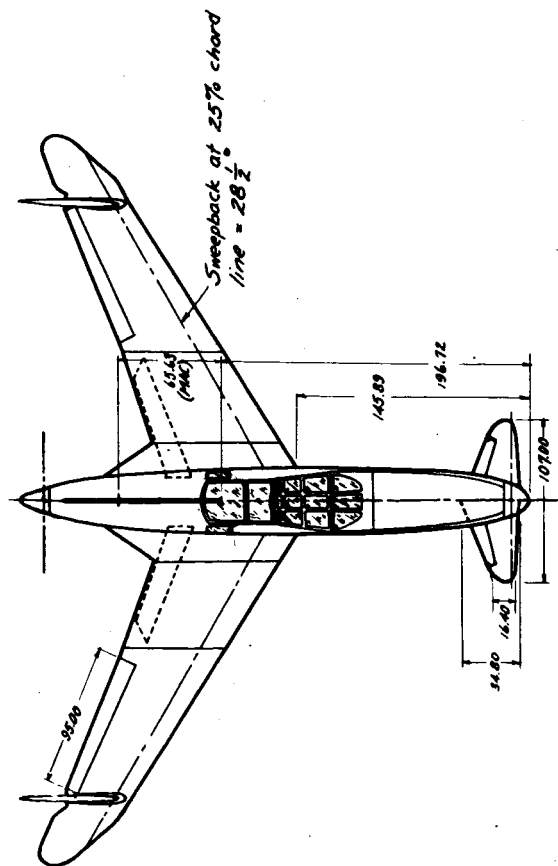
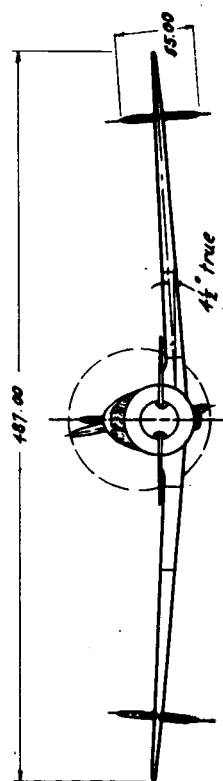
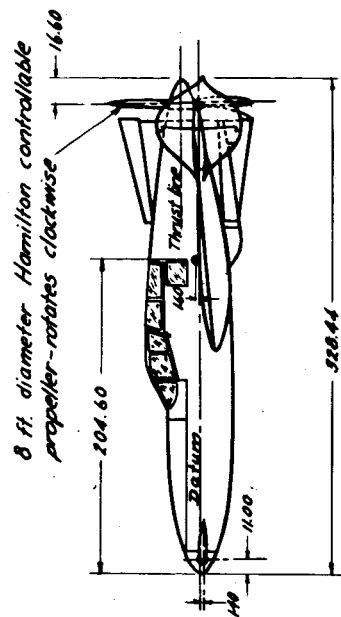


Figure 1.- The XP-55 airplane mounted in the full-scale tunnel.



Areas, sq. ft.	
Wing (including flaps)	203.4
Aileron (total)	13.10
Flaps (total)	14.85
Rudder (each)	6.61
Wing fin (each)	8.80
Upper cowl fin	7.88
Lower cowl fin	4.26
Elevator (including fuselage)	18.00
Elevator (excluding fuselage)	12.78
Elevator tabs (total)	2.25

Gross weight 4000 pounds



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Figure 2.- Three-view drawing of the Curtiss XP-55 airplane

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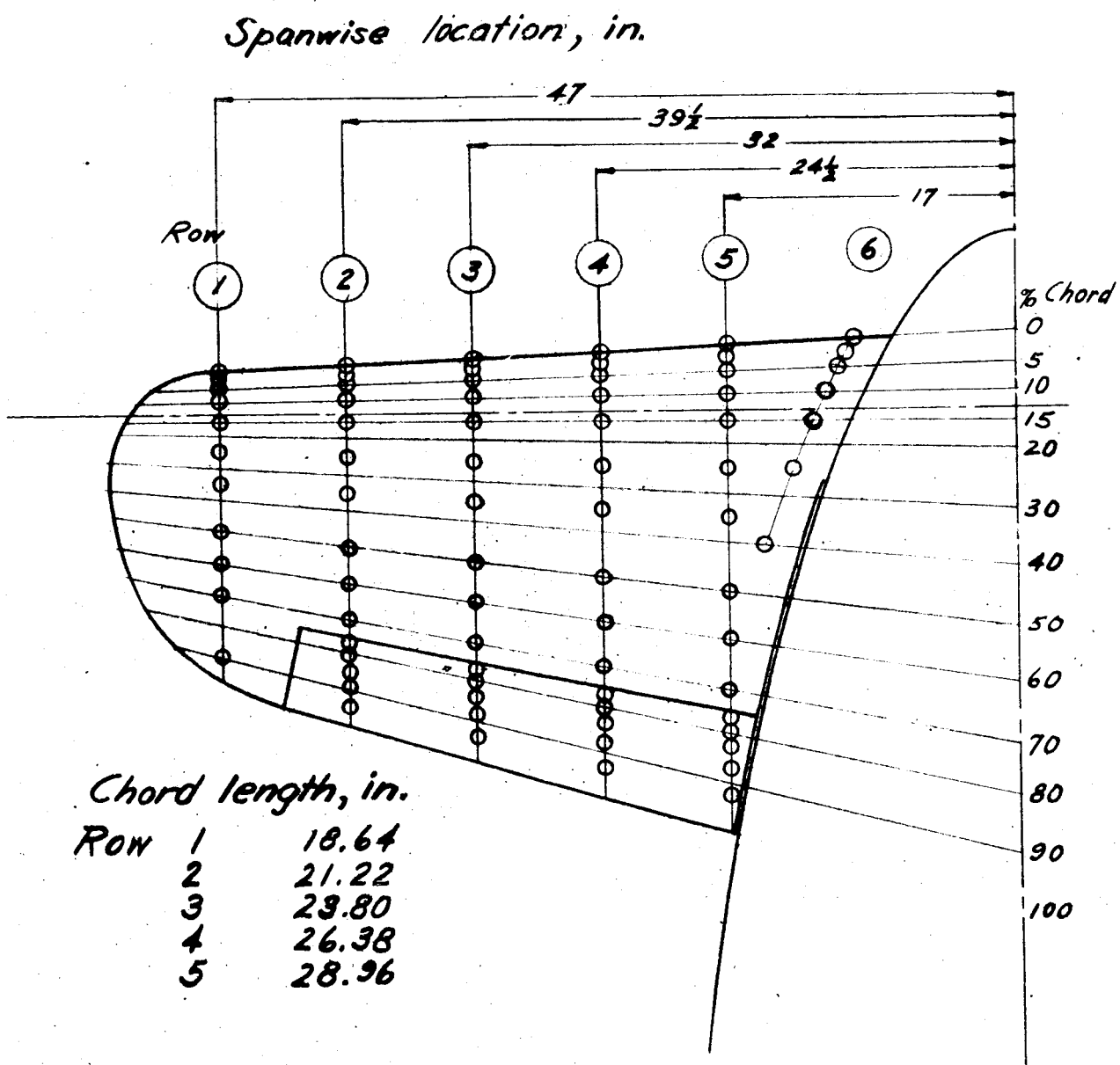


Figure 3.-Location of elevator orifices.

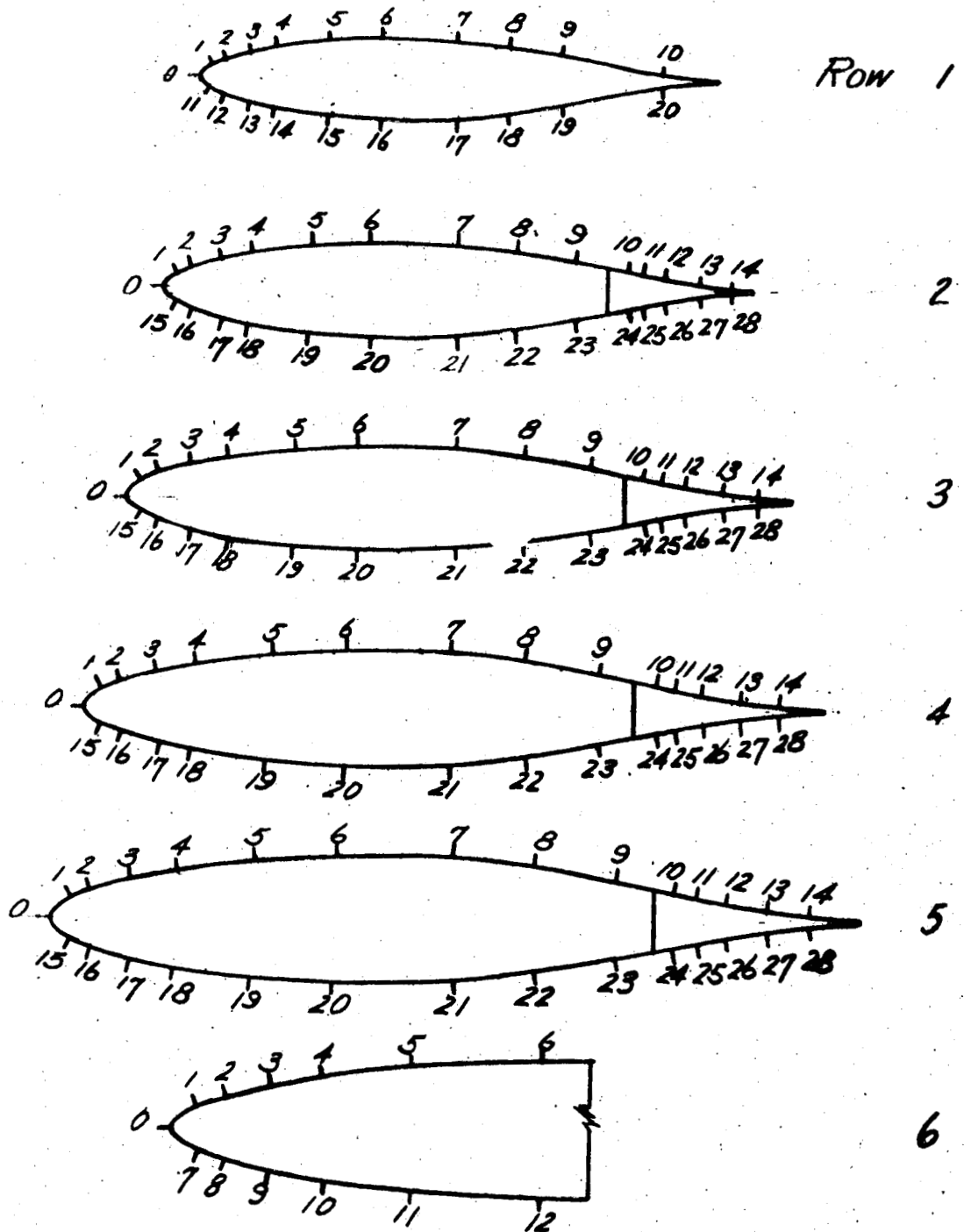
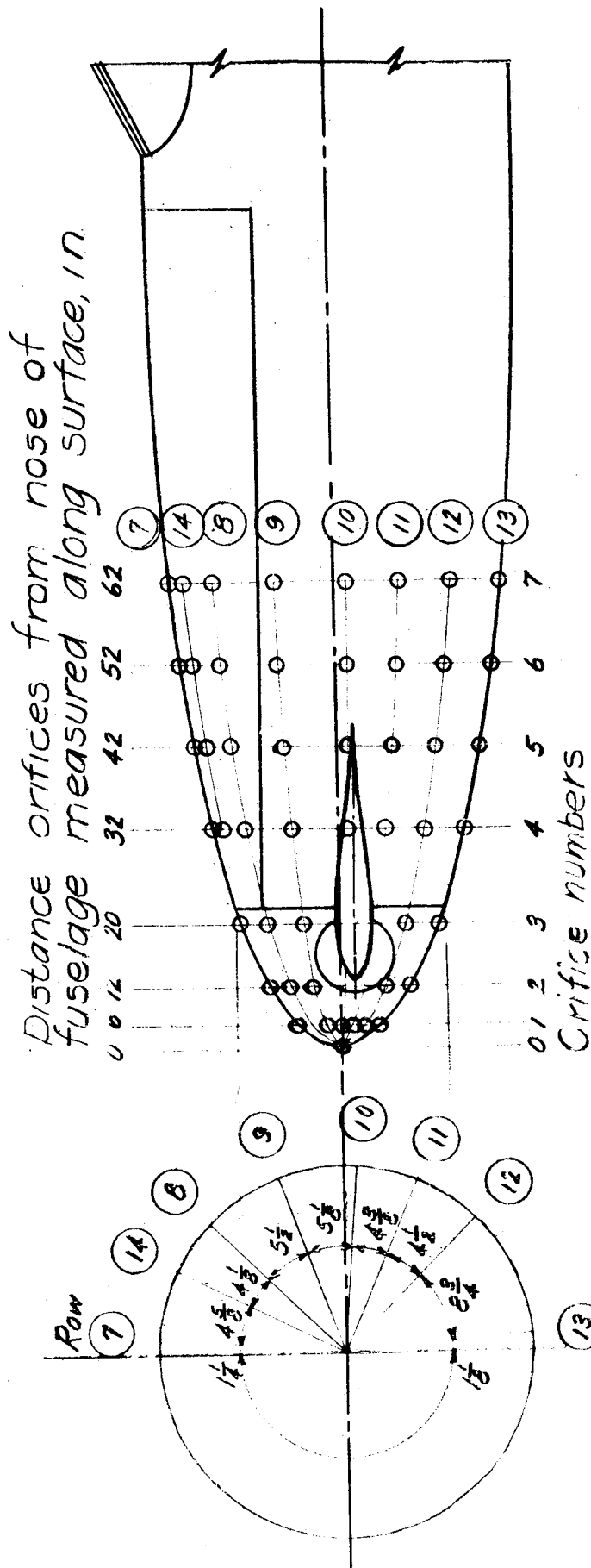
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Figure 4.-Identification of elevator orifices



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Figure 5. - Identification and location of fuselage orifices

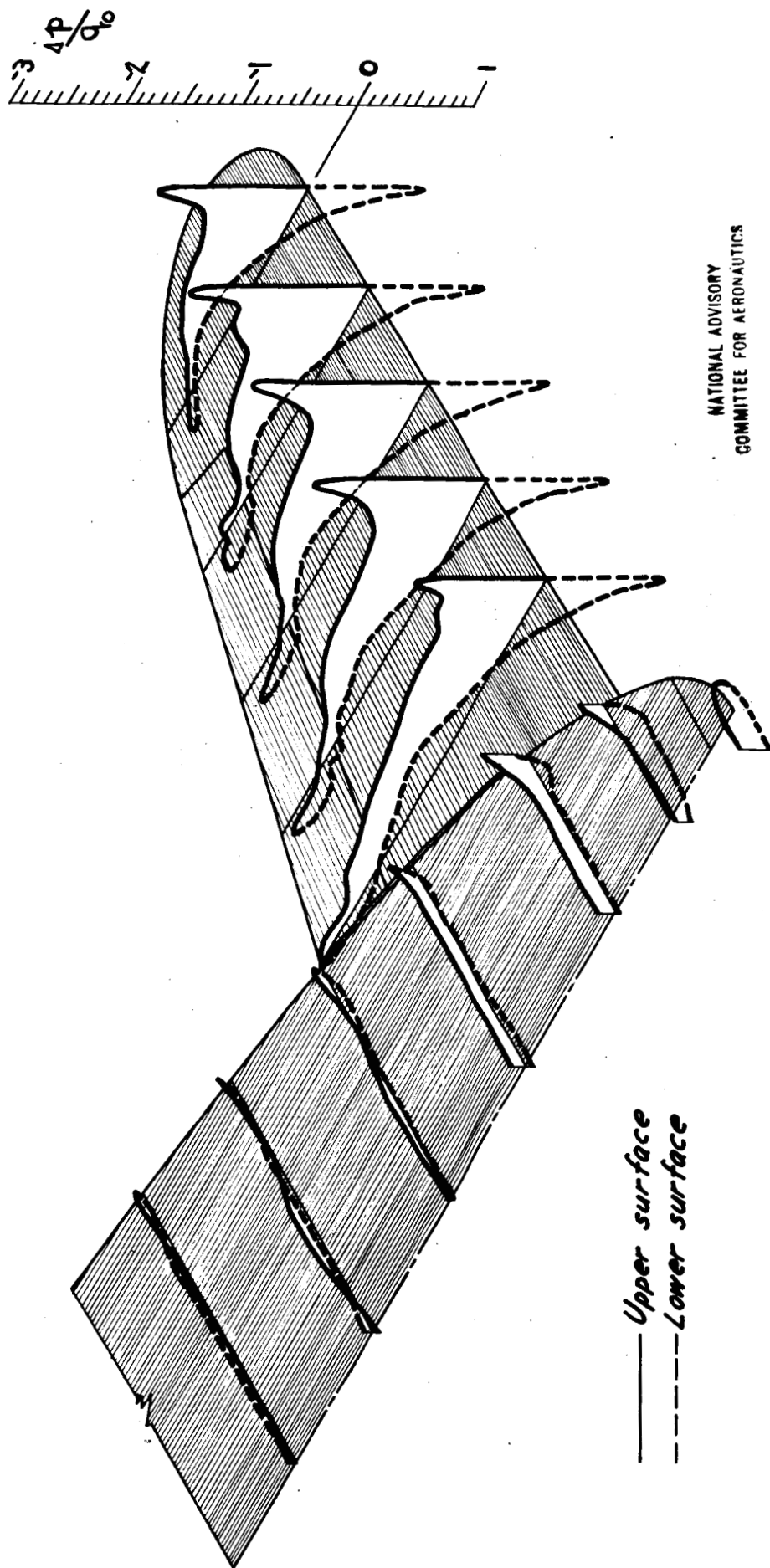
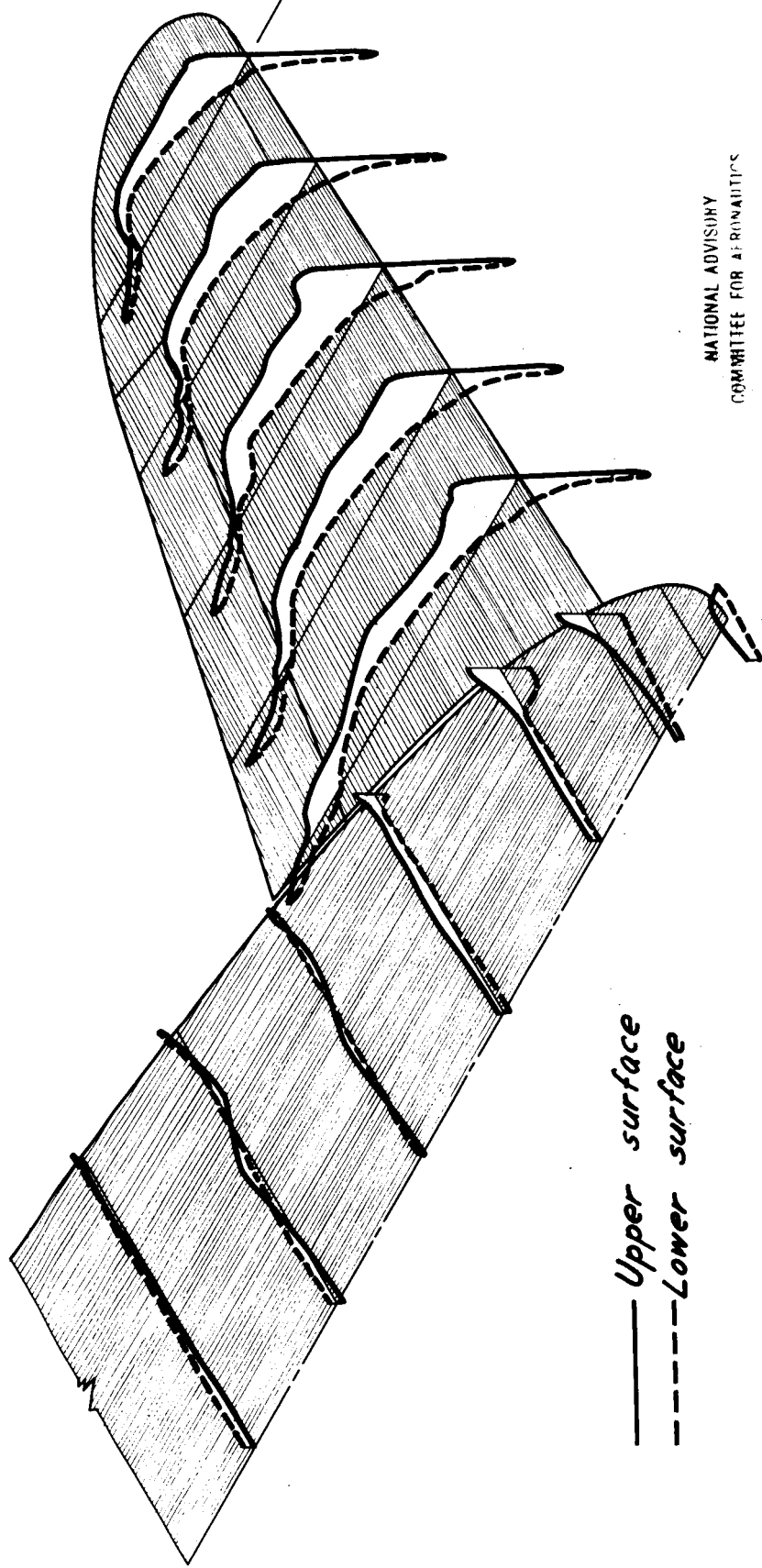
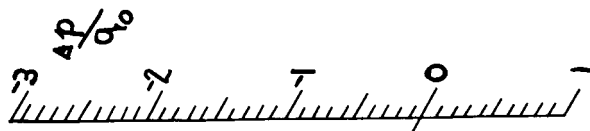


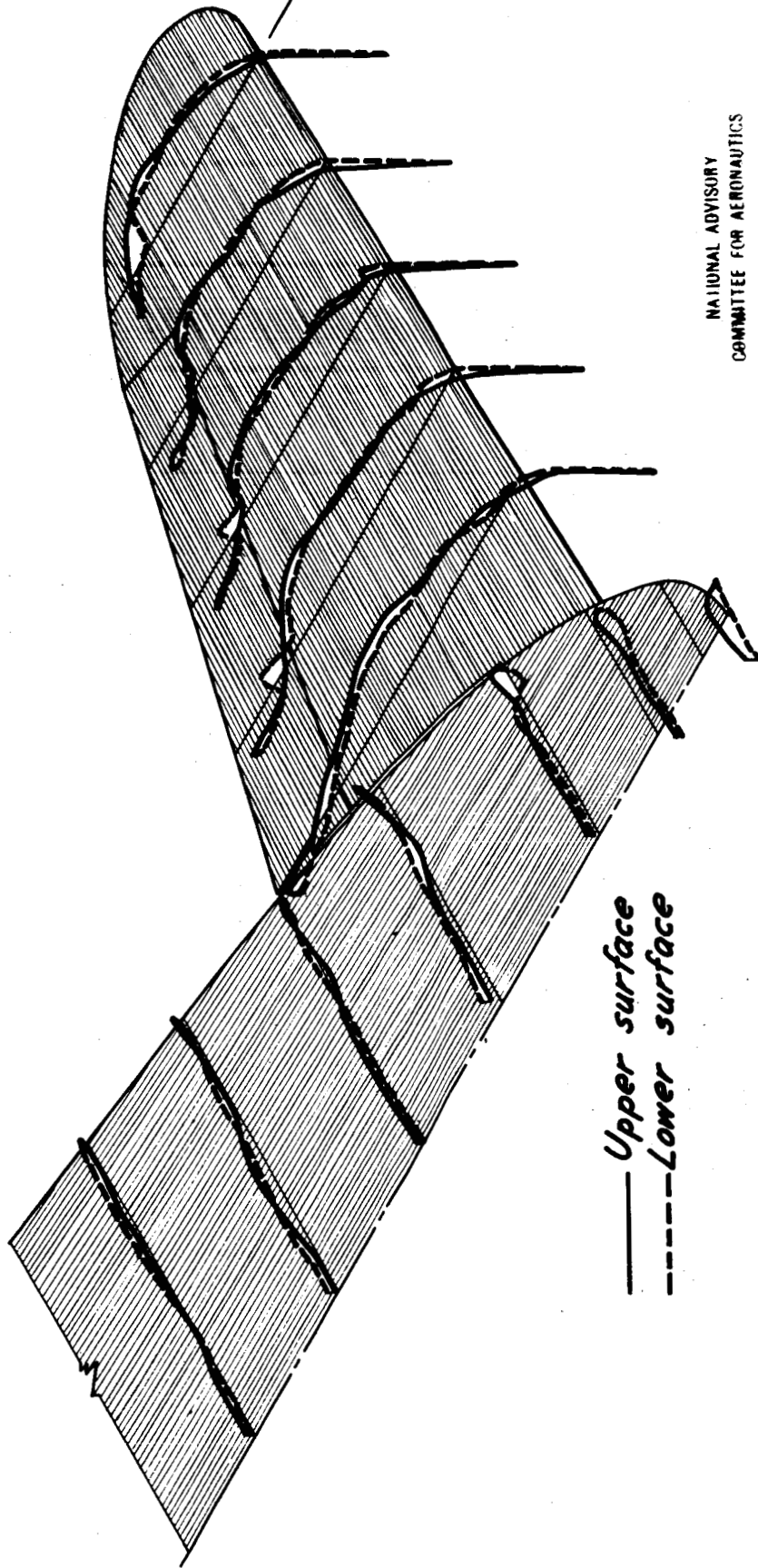
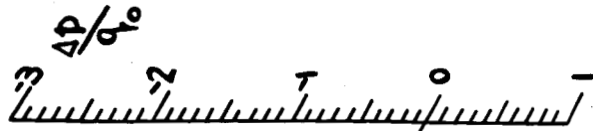
Figure 6. - Pressure distribution over the elevator and fuselage
 $\alpha_e, 0.0^\circ; \delta_e, 10^\circ; \delta_f, 0^\circ; \delta_f, 0^\circ$



— Upper surface
 --- Lower surface

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Figure 7. — Pressure distribution over the elevator and fuselage
 $\alpha_e, 0.0^\circ; \delta_e, 5^\circ; \delta_r, 0^\circ; \delta_f, 0^\circ$



— Upper surface
 --- Lower surface

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Figure 8. — Pressure distribution over the elevator and fuselage
 $\alpha_e, 0.9^\circ; \alpha_f, 0^\circ; \delta_e, 0^\circ; \delta_f, 0^\circ$

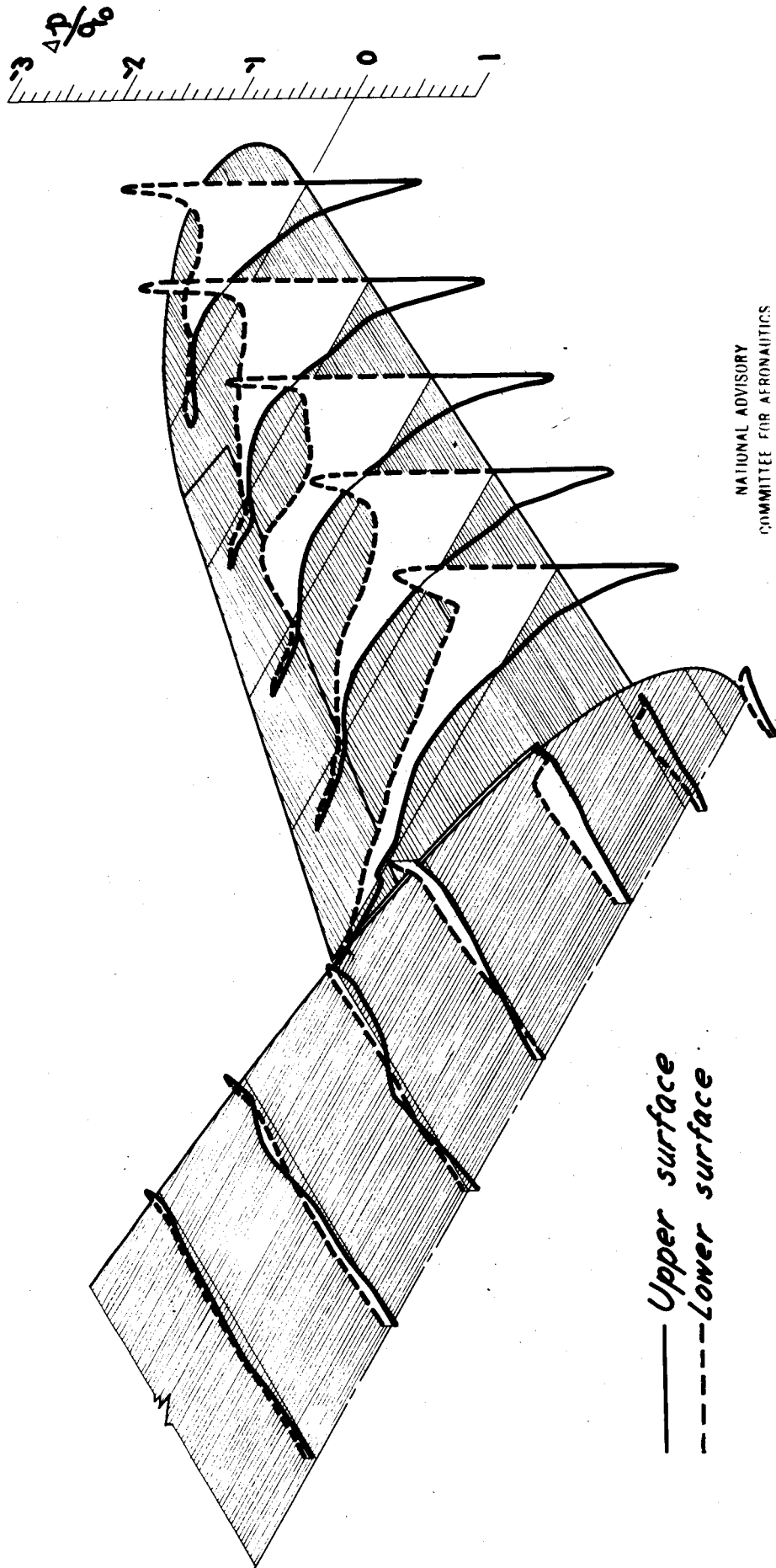
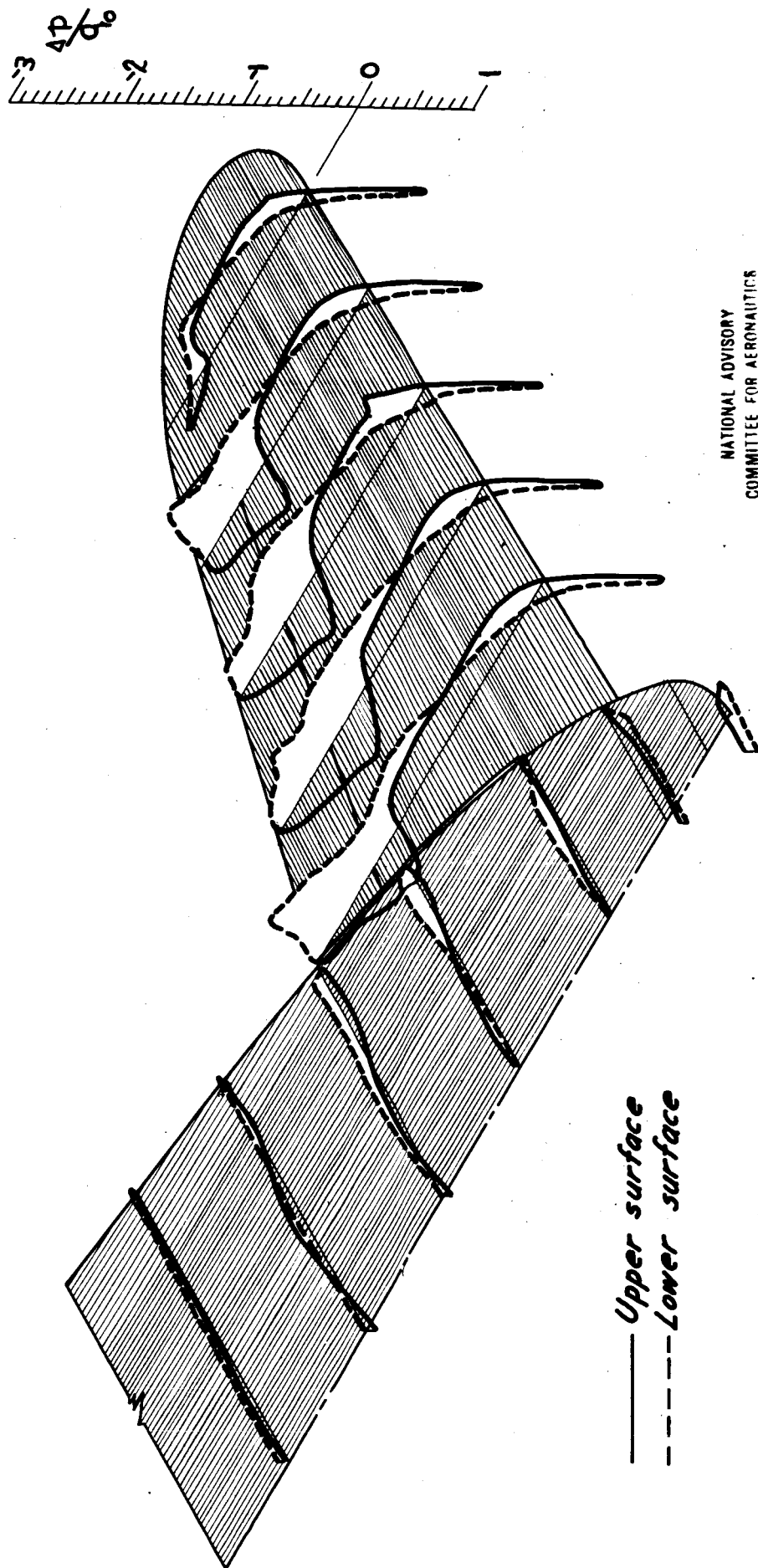


Figure 9. — Pressure distribution over the elevator and fuselage
 $\alpha_r, 0.9^\circ; \delta_e, -10^\circ; \delta_r, 0^\circ; \delta_f, 0^\circ$



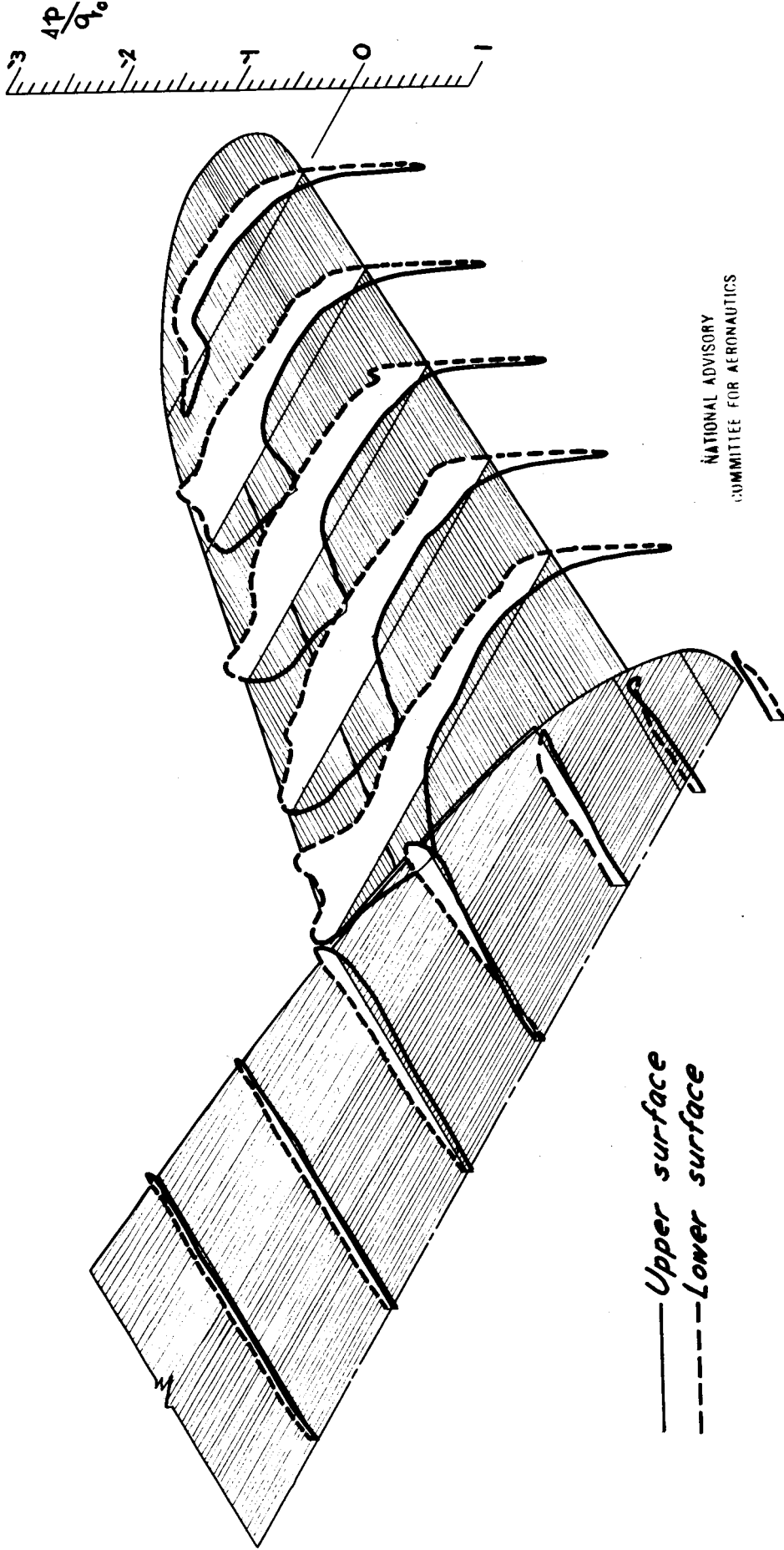


Figure 11. — Pressure distribution over the elevator and fuselage
 $\alpha_r, 0.9^\circ; \delta_e, 0^\circ; \delta_r, -20^\circ; \delta_f, 0^\circ$

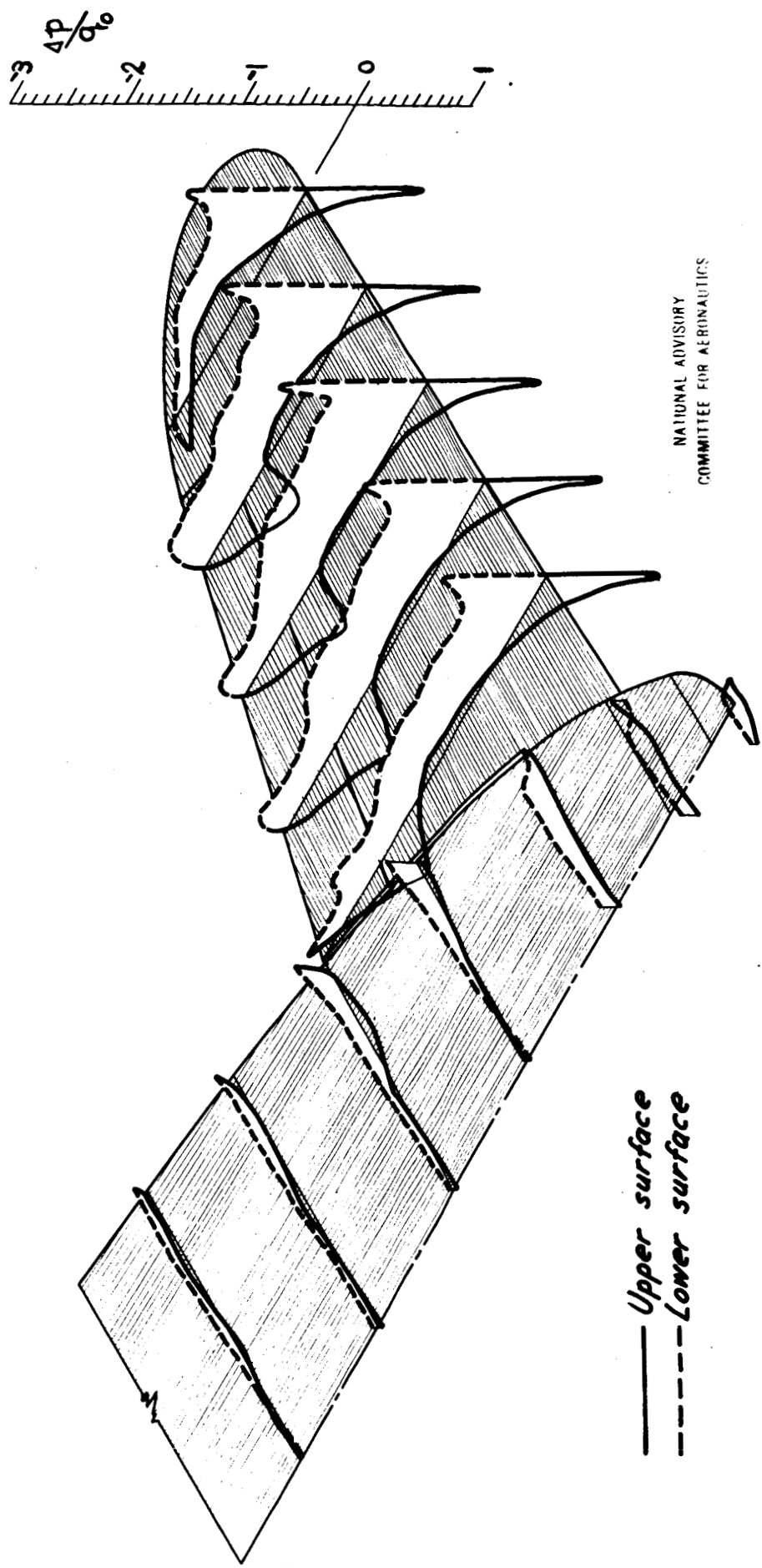


Figure 12. — Pressure distribution over the elevator and fuselage
 $\alpha_f, 0.9; \delta_e, -5^\circ; \delta_f, -20^\circ; \delta_f, 0^\circ$

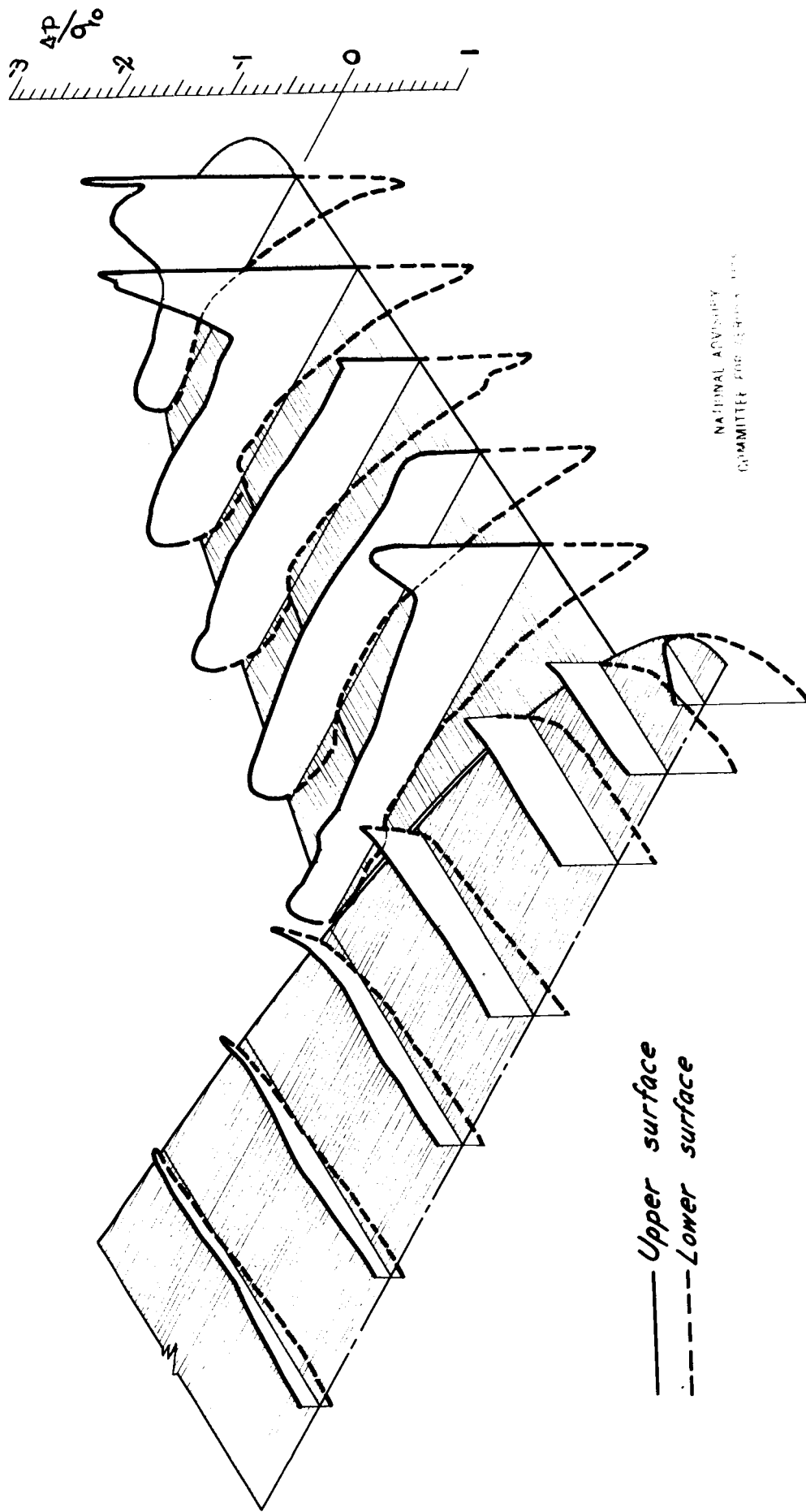


Figure 13. — Pressure distribution over the elevator and fuselage
 $\alpha_f, 12.0^\circ; \delta_e, 10^\circ; \delta_f, 0^\circ; \delta_f, 0^\circ$

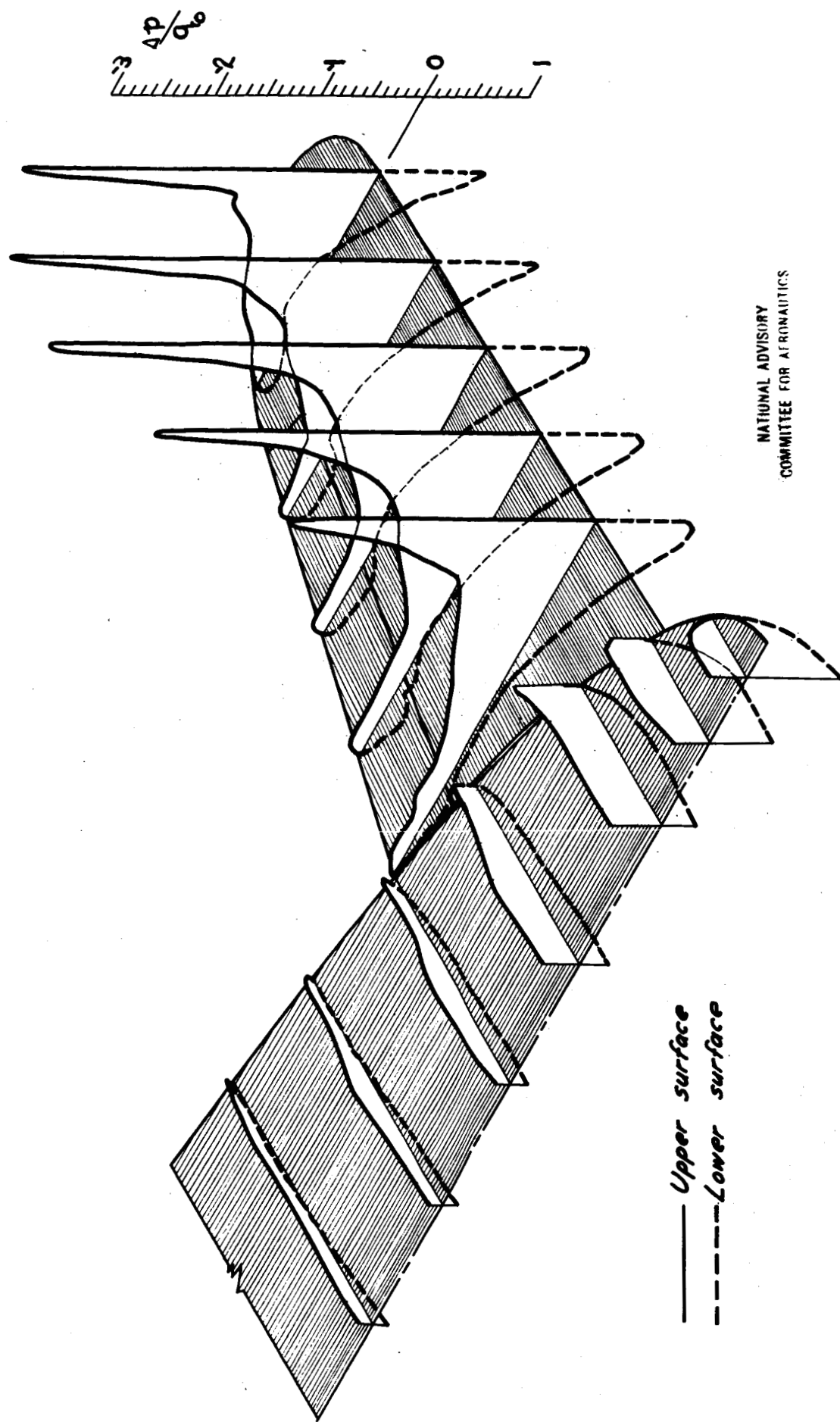


Figure 14. — Pressure distribution over the elevator and fuselage
 $\alpha_e, 12.0^\circ$; $\alpha_f, 5^\circ$; $\alpha_f, 0^\circ$; $\alpha_f, 0^\circ$.

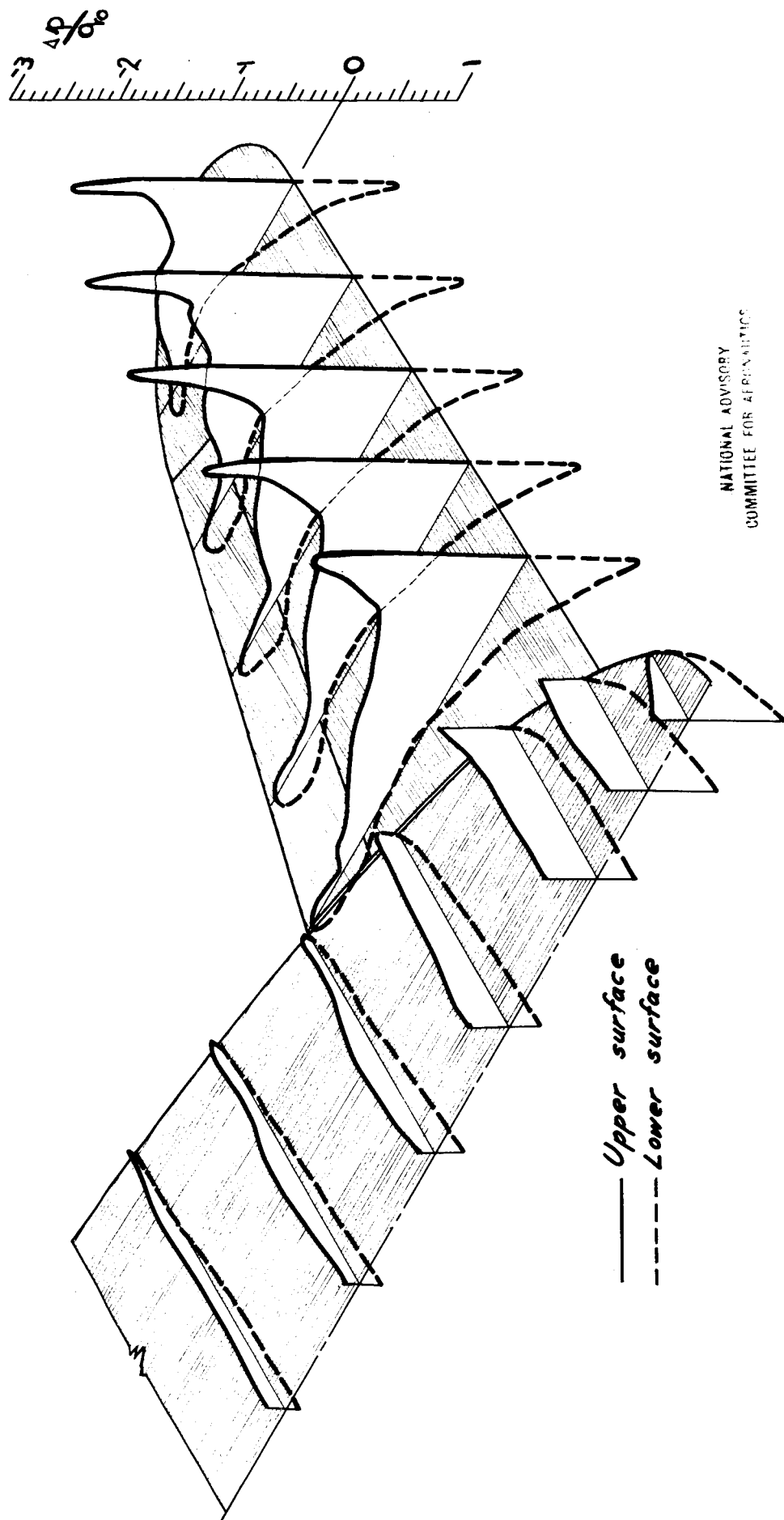


Figure 15. - Pressure distribution over the elevator and fuselage
 $\alpha_f, 12.0^\circ$; $\delta_e, 0^\circ$; $\delta_r, 0^\circ$; $\delta_f, 0^\circ$.

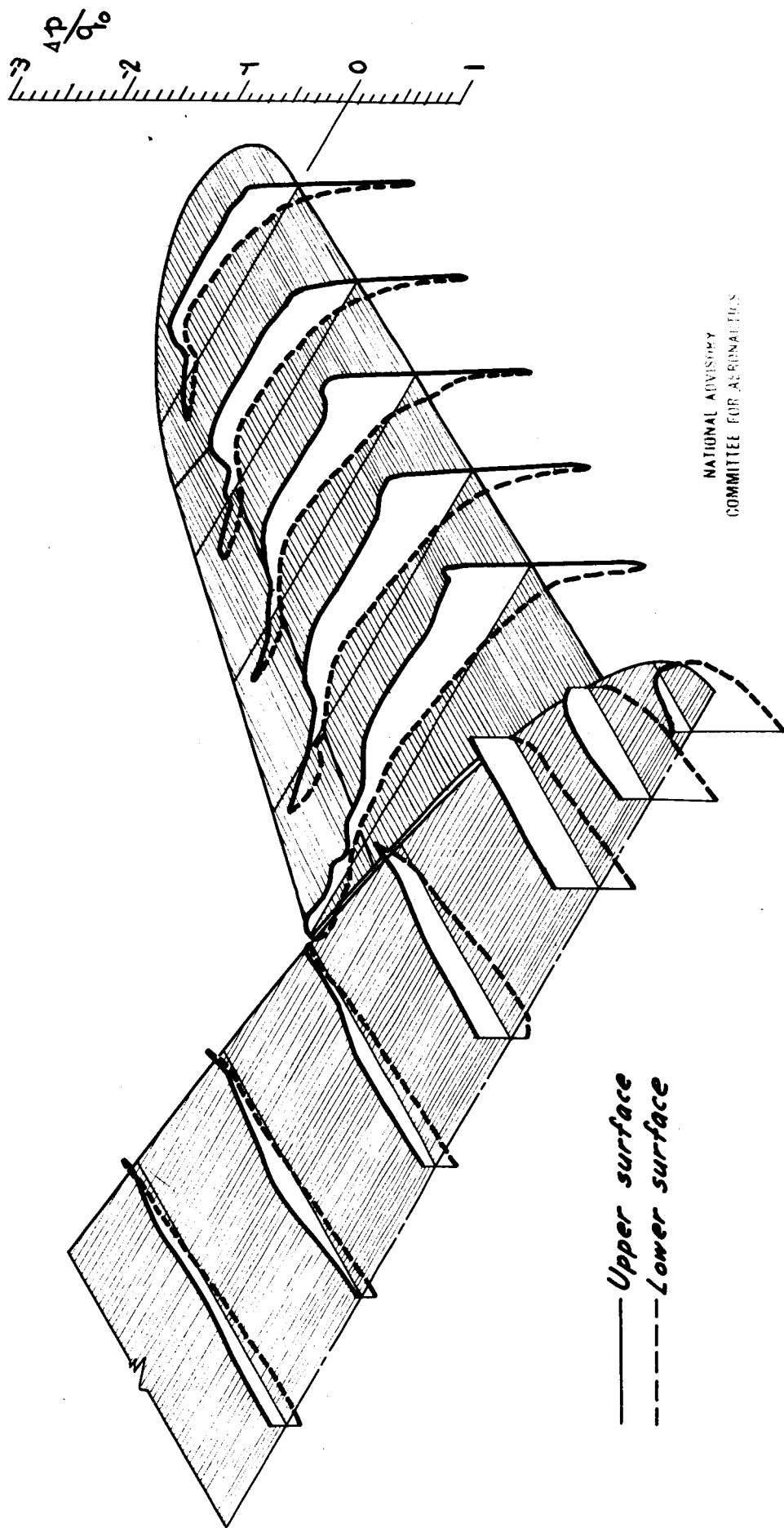


Figure 16.— Pressure distribution over the elevator and fuselage
 $\alpha_r, 12.0^\circ$; $\delta_e, -10^\circ$; $\delta_f, 0^\circ$; $\delta_f, 0^\circ$.

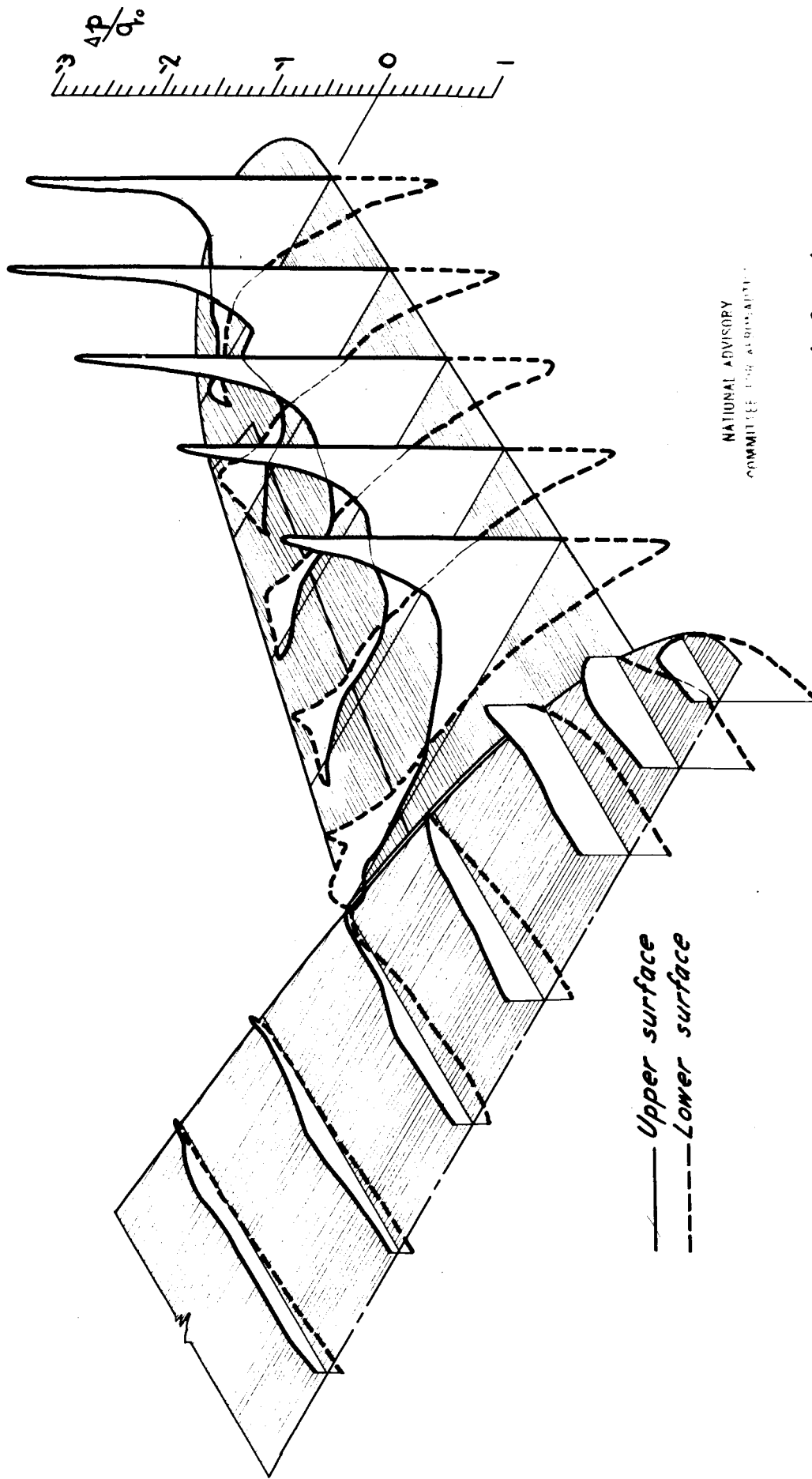


Figure 17. — Pressure distribution over the elevator and fuselage
 $\alpha_e, 12.0^\circ$; $\delta_e, 5^\circ$; $\delta_r, -20^\circ$; $\delta_f, 0^\circ$.

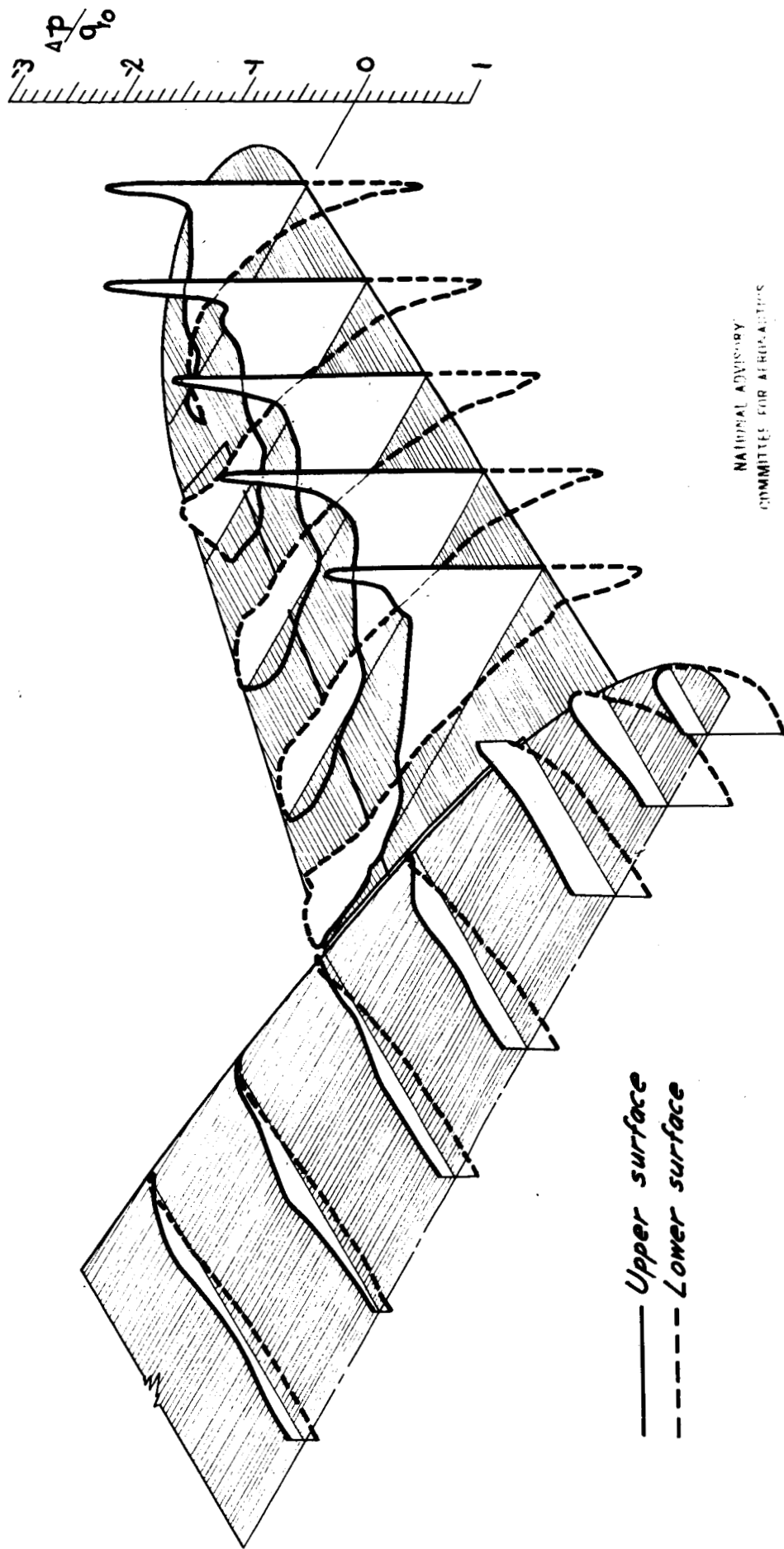
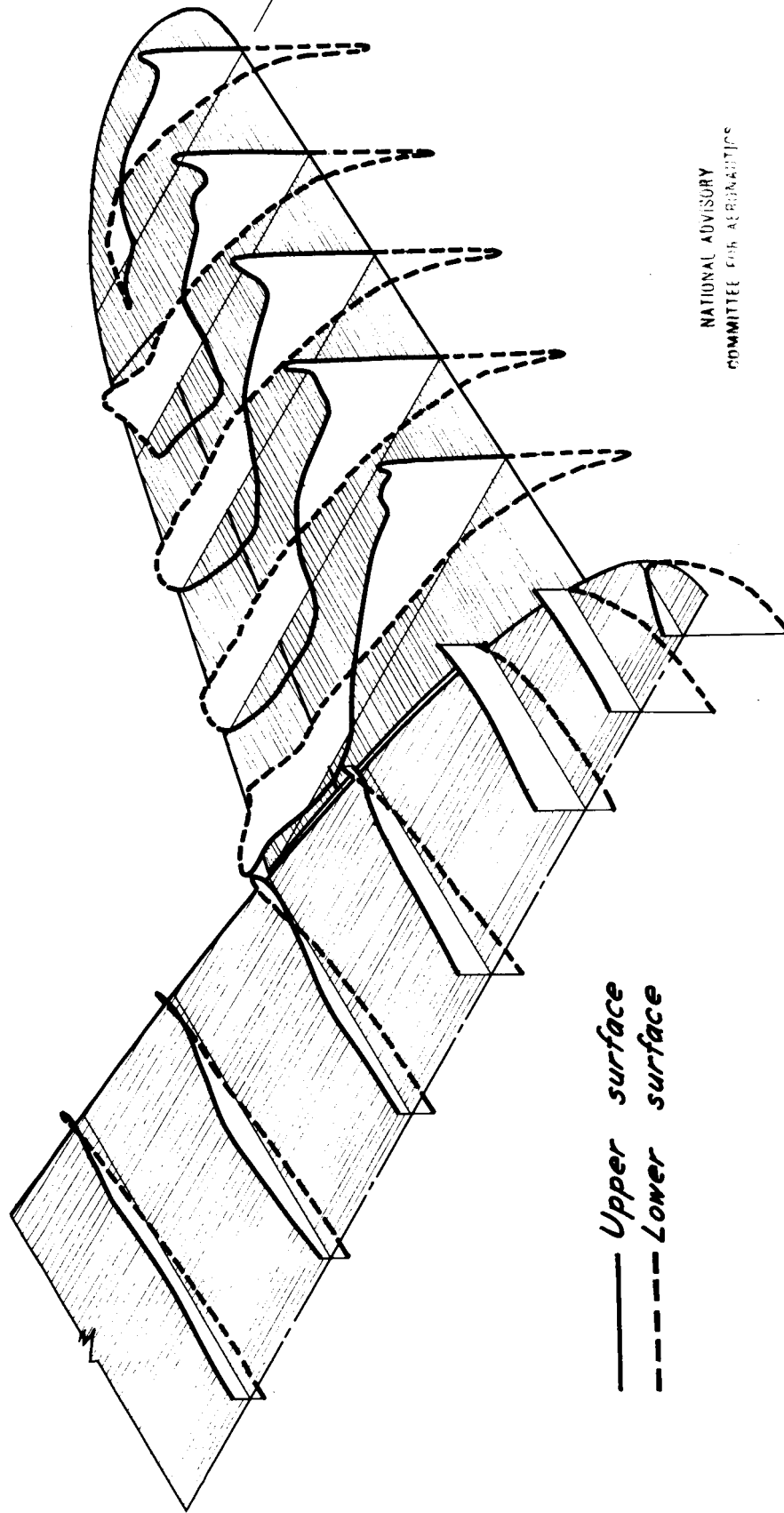
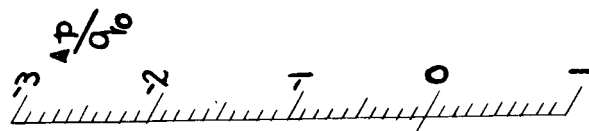


Figure 18. — Pressure distribution over the elevator and fuselage



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Figure 19. — Pressure distribution over the elevator and fuselage
 $\alpha_f 12.0^\circ$; $\delta_e -5^\circ$; $\delta_f -20^\circ$; $\delta_r 0^\circ$.

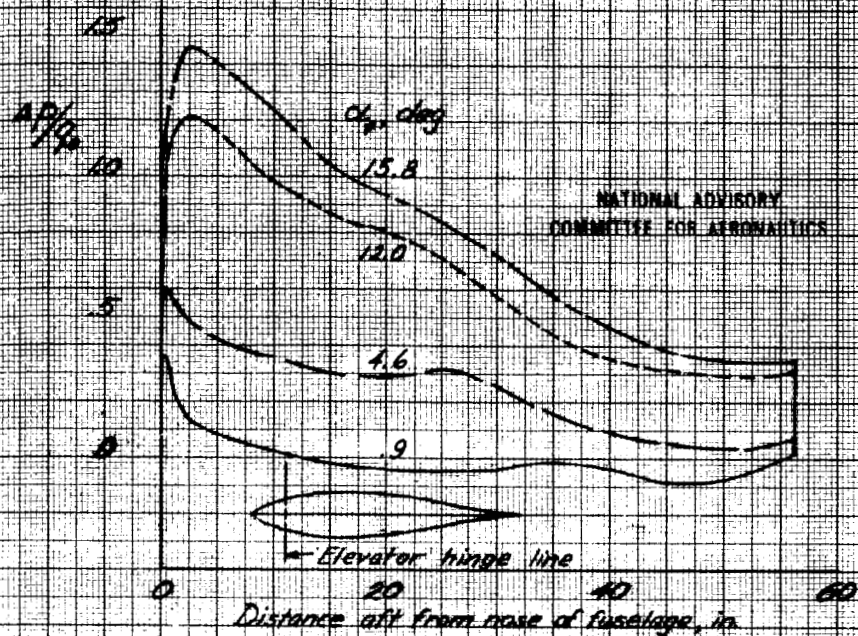


Figure 20 - Pressure difference along fuselage between upper row 7 and lower row 13. $\delta_e, 0^\circ; \delta_r, 0^\circ; \delta_f, 0^\circ$

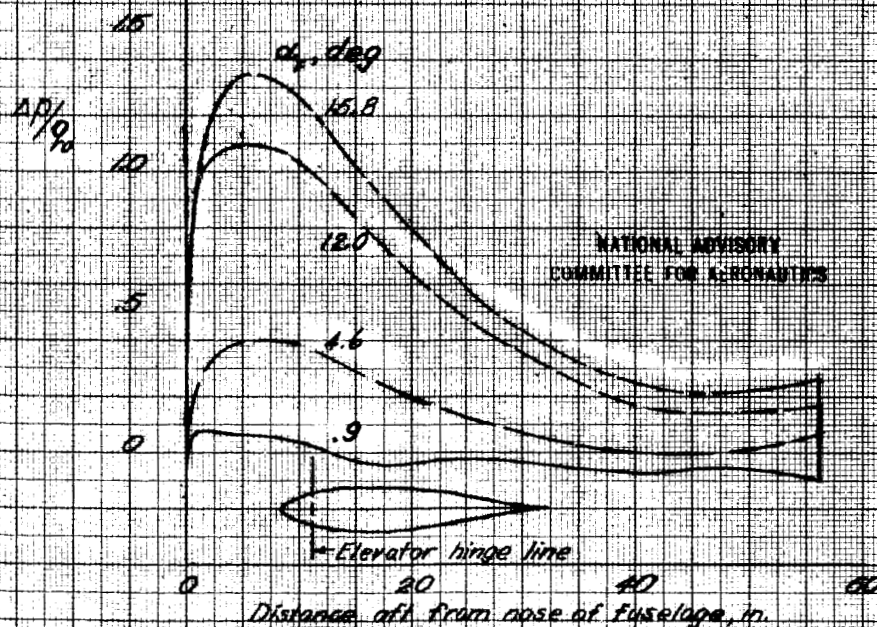
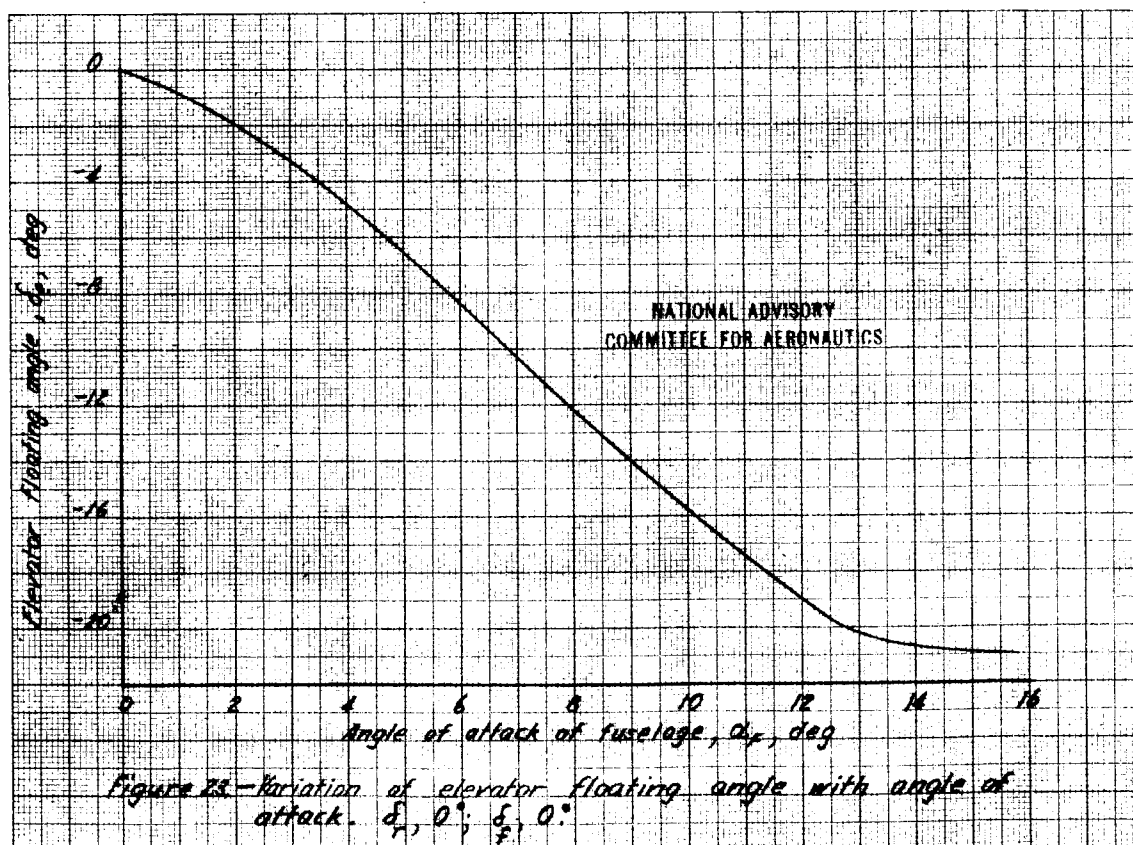
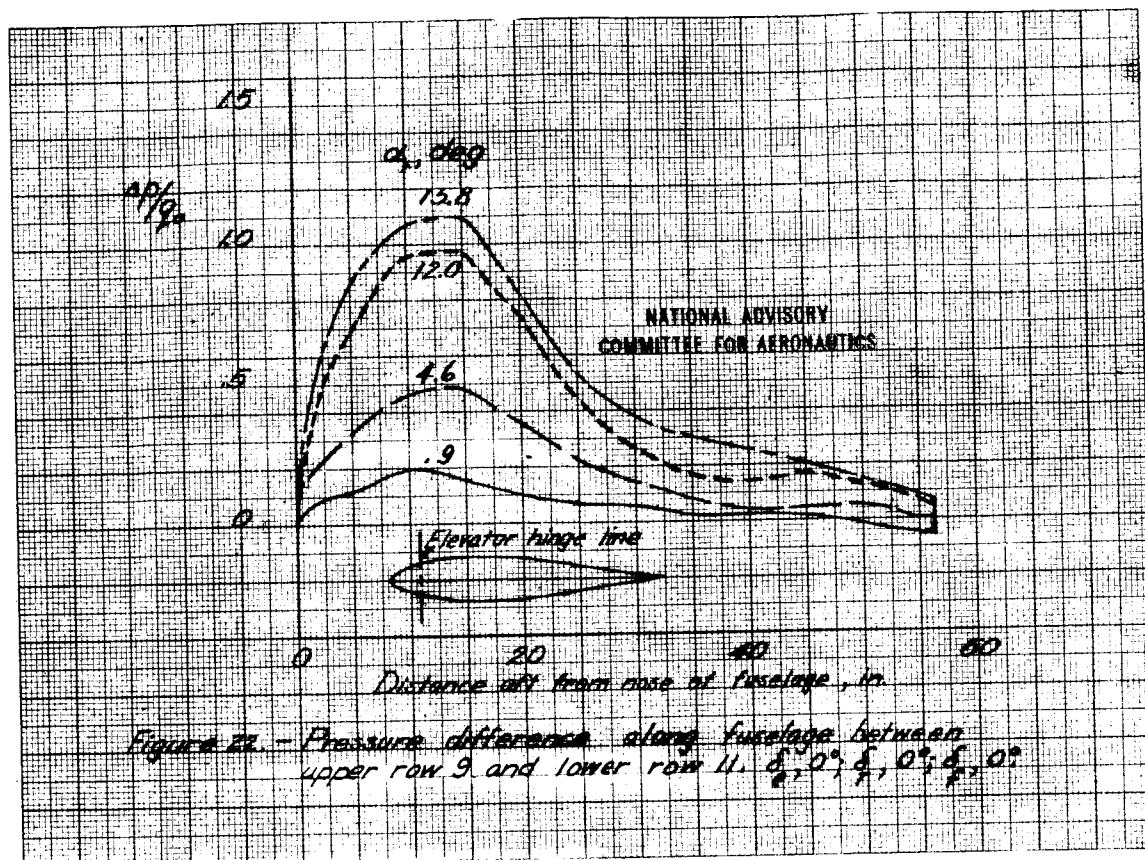
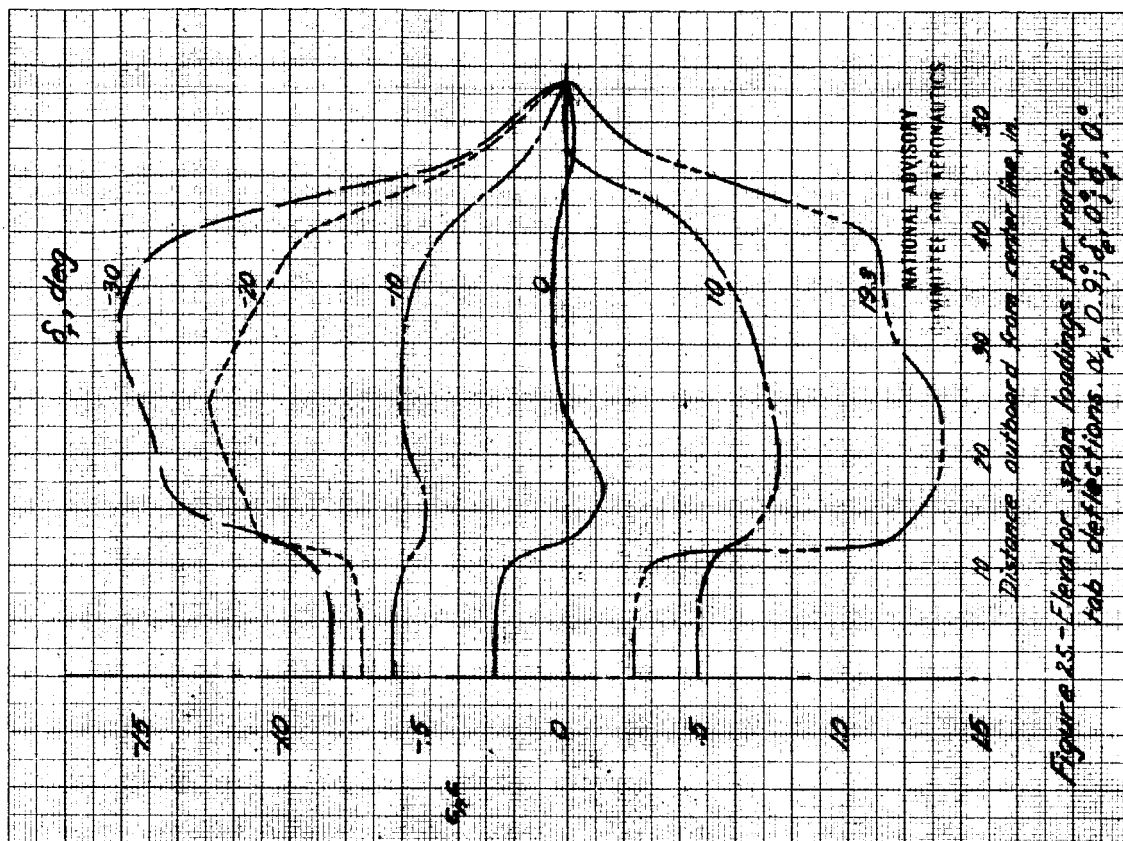
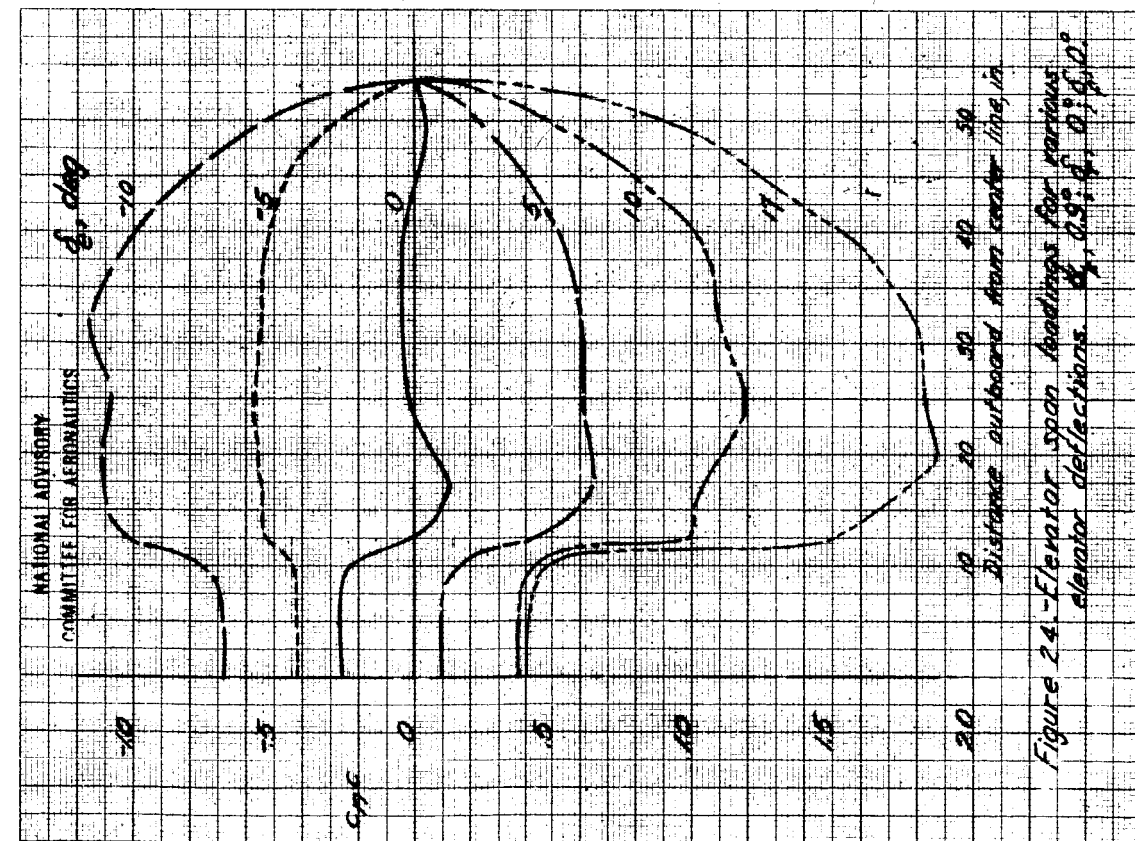
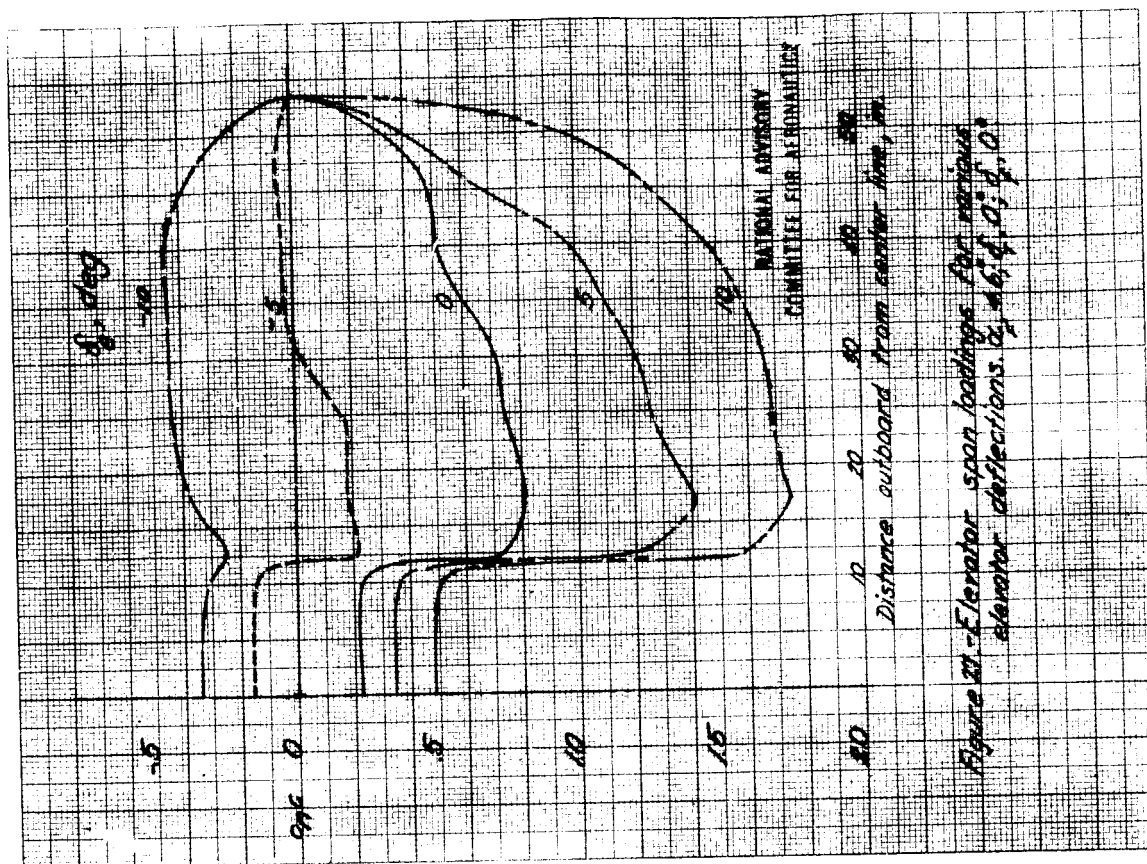
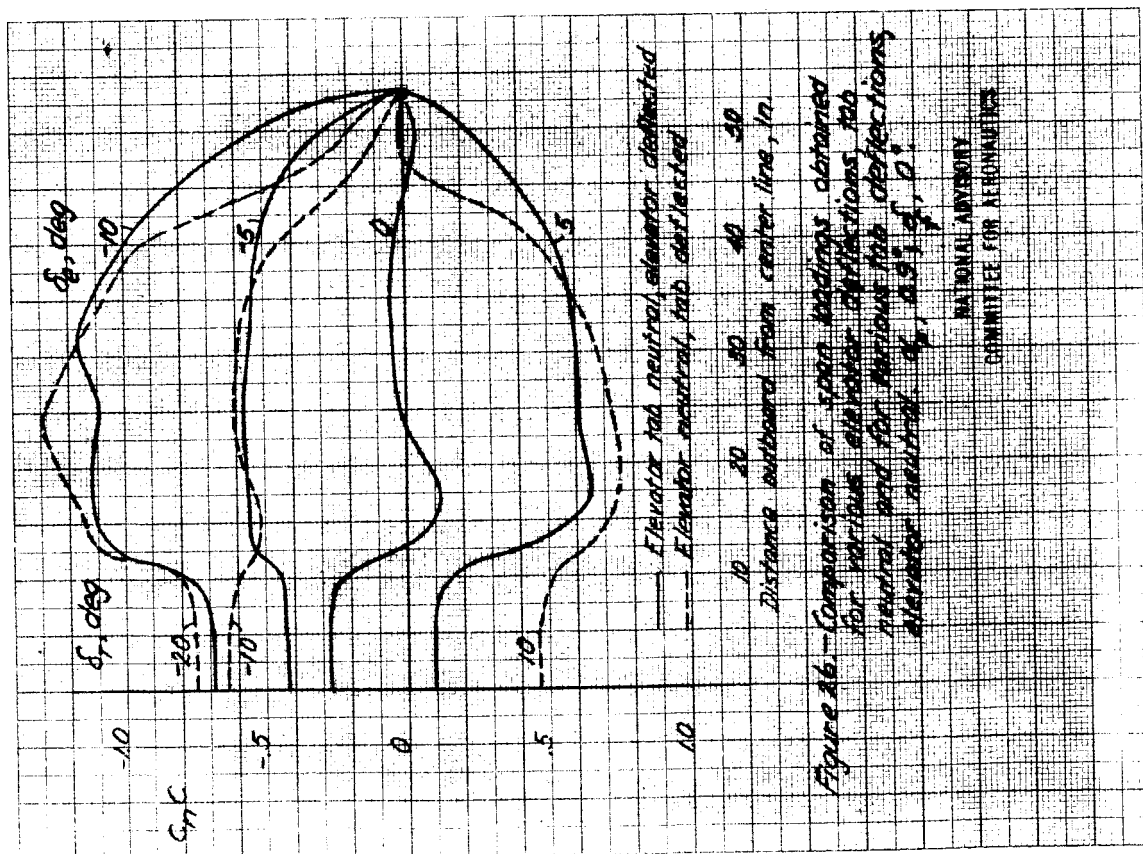
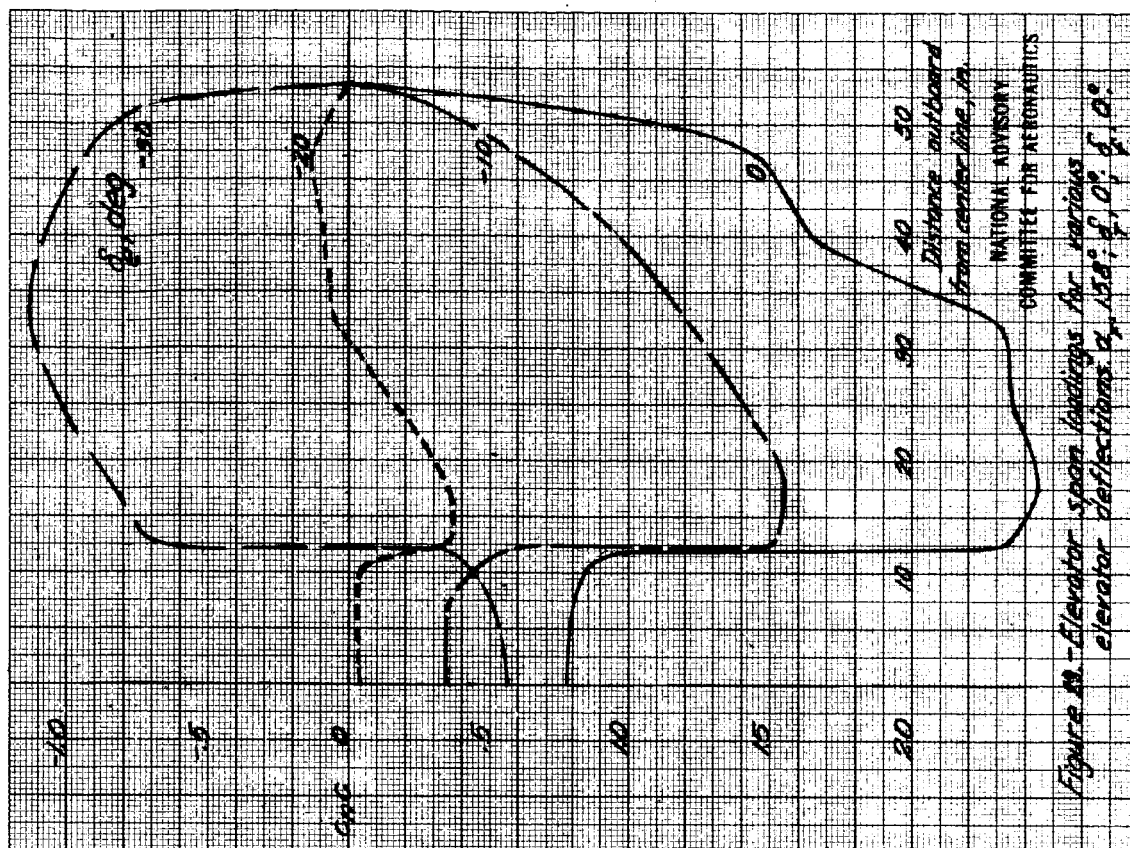
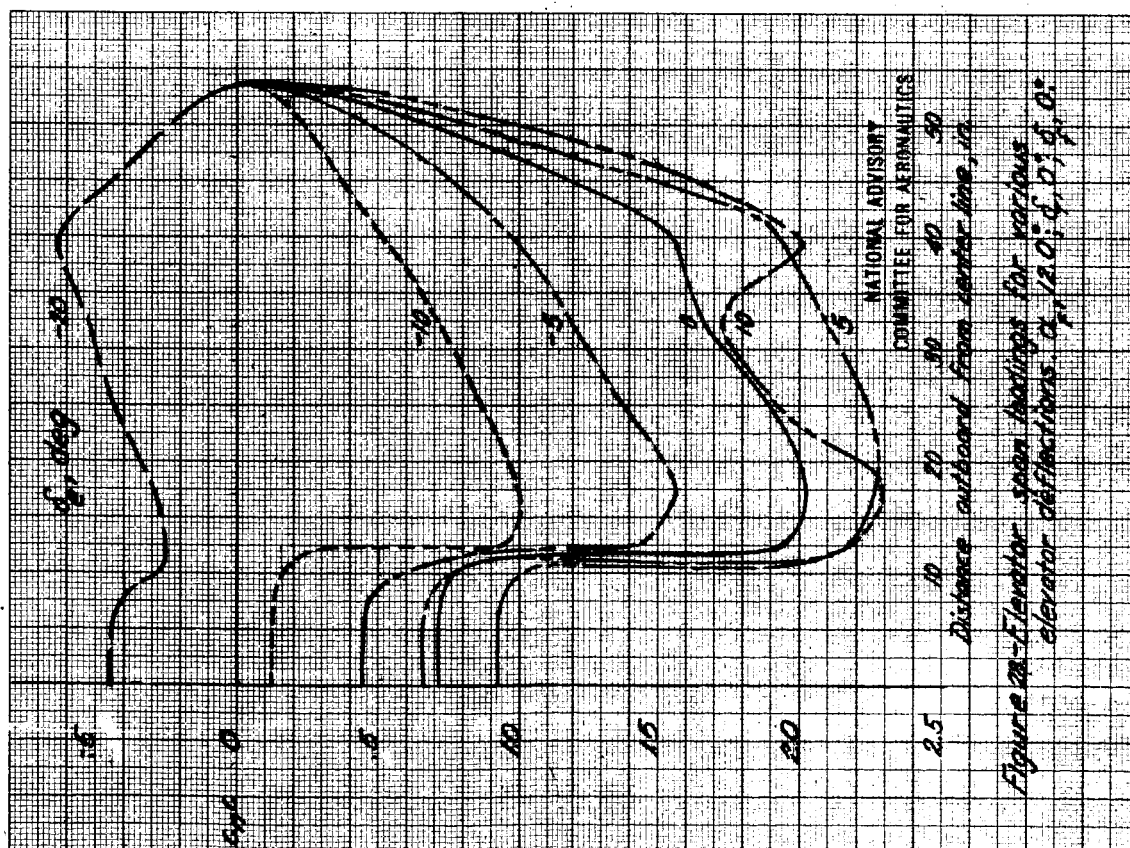


Figure 21 - Pressure difference along fuselage between upper row 8 and lower row 12. $\delta_e, 0^\circ; \delta_r, 0^\circ; \delta_f, 0^\circ$









$C_L = 0.04$
 $C_L = 0.22$

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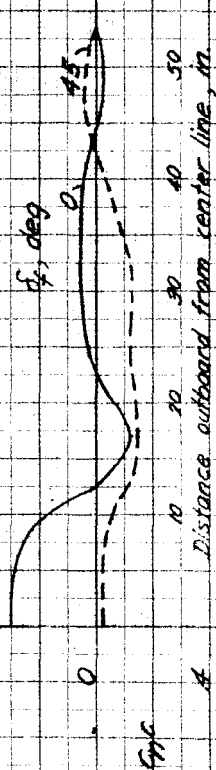


Figure 30. - Effect of flap deflection on the elevator span loading.
 $\alpha_e, 0.9^\circ; \delta_e, 0^\circ; \delta_f, 0^\circ$

Distance outboard from center line, in.

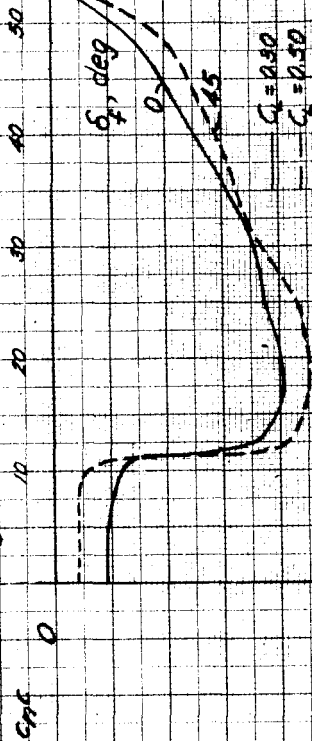
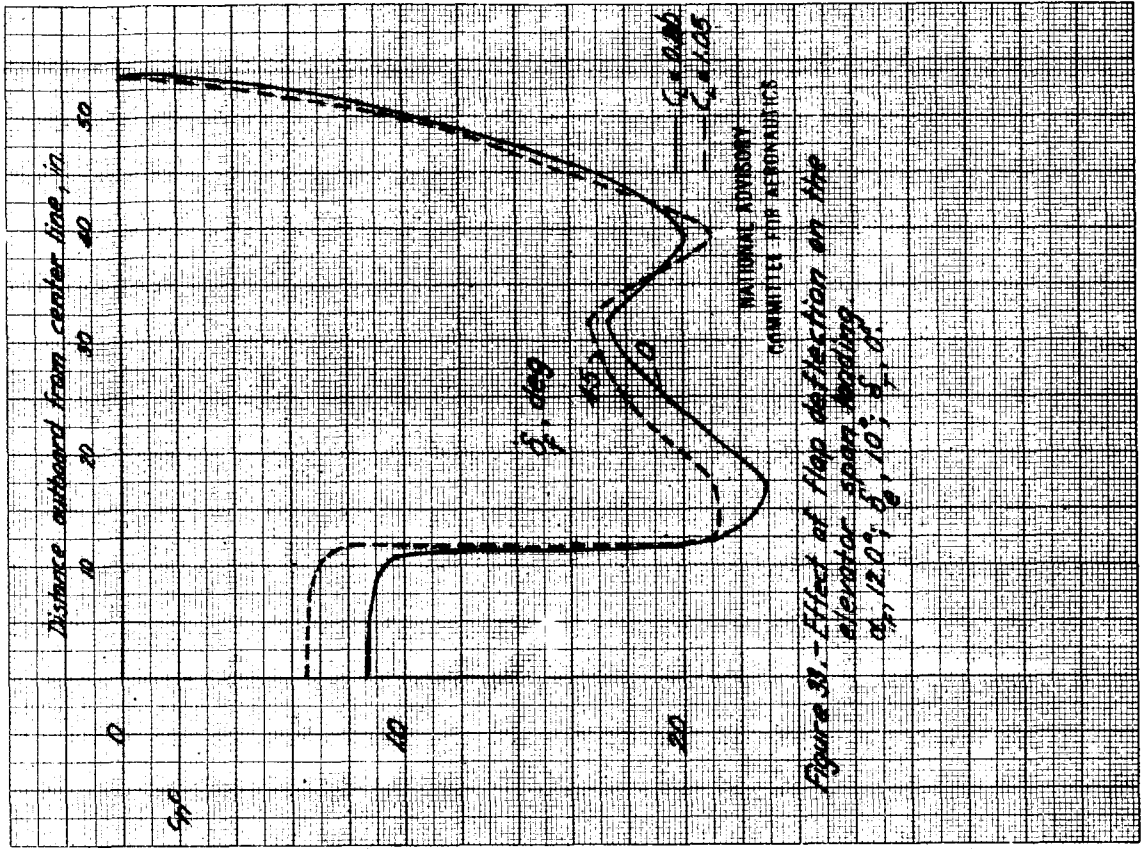
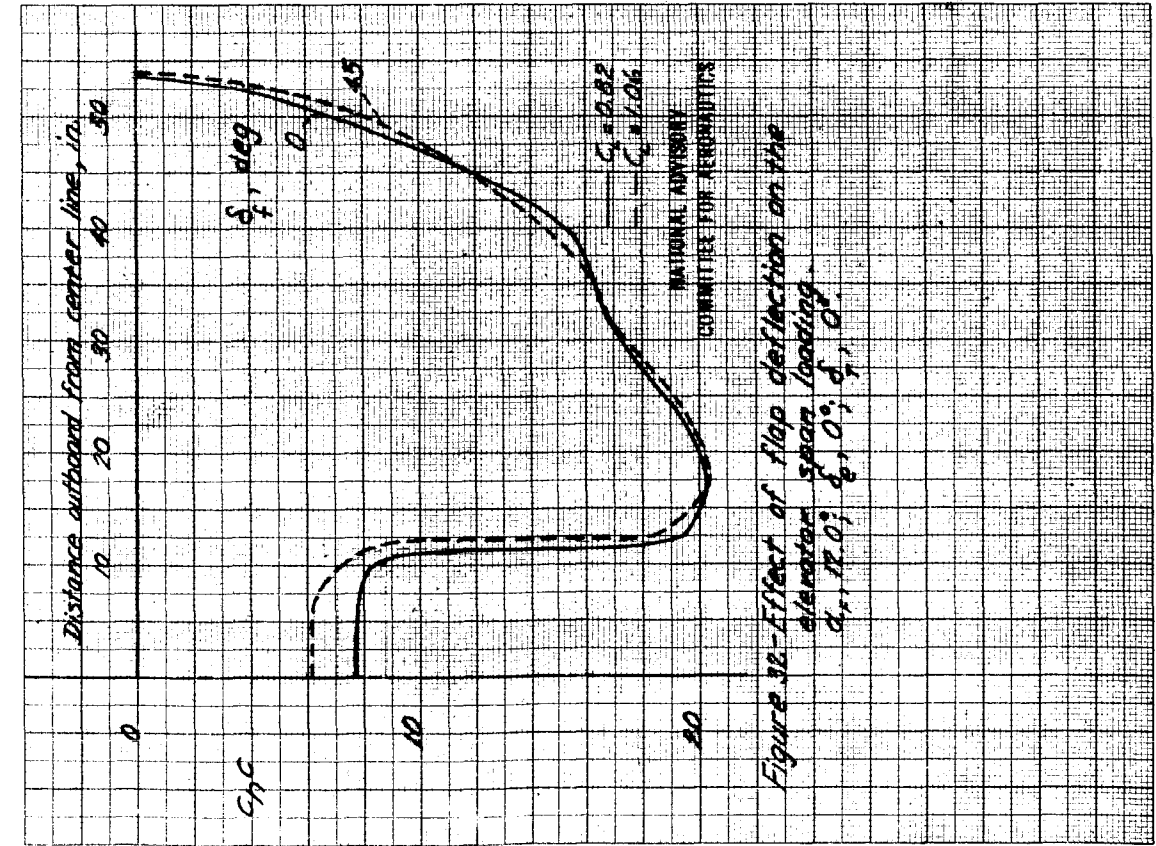
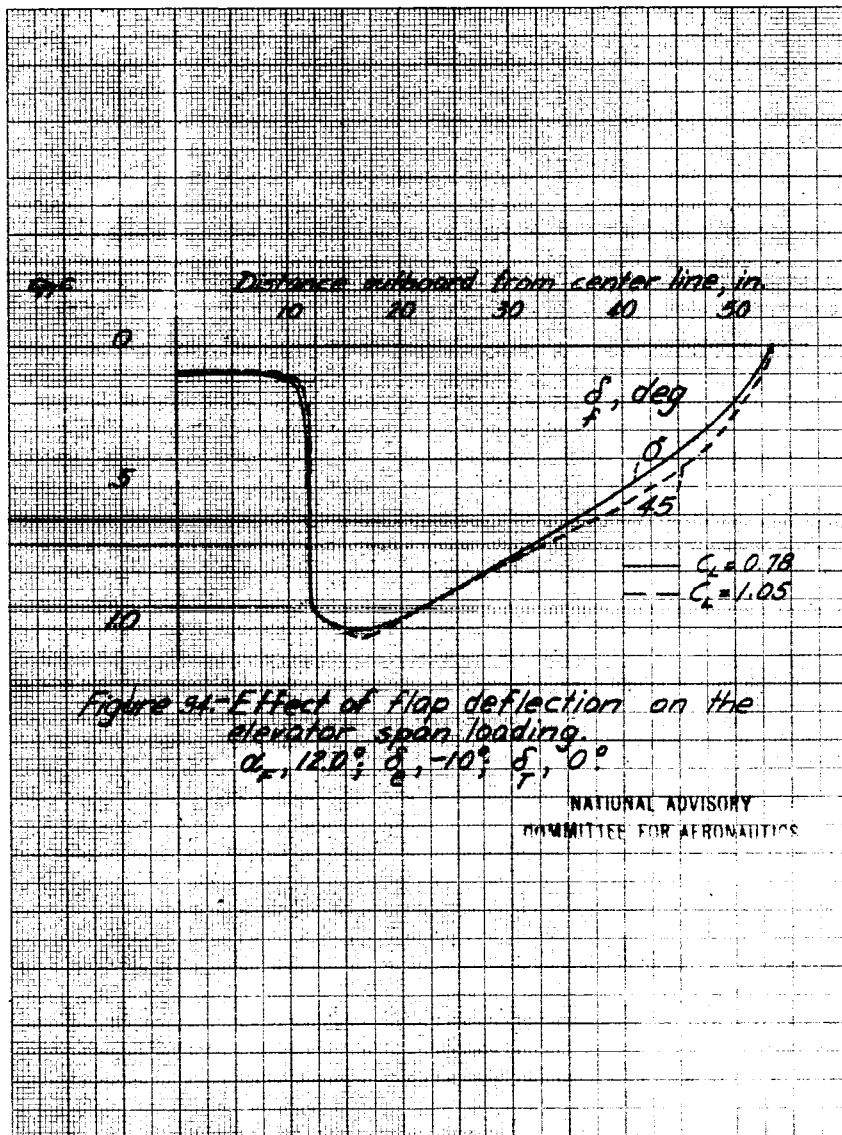


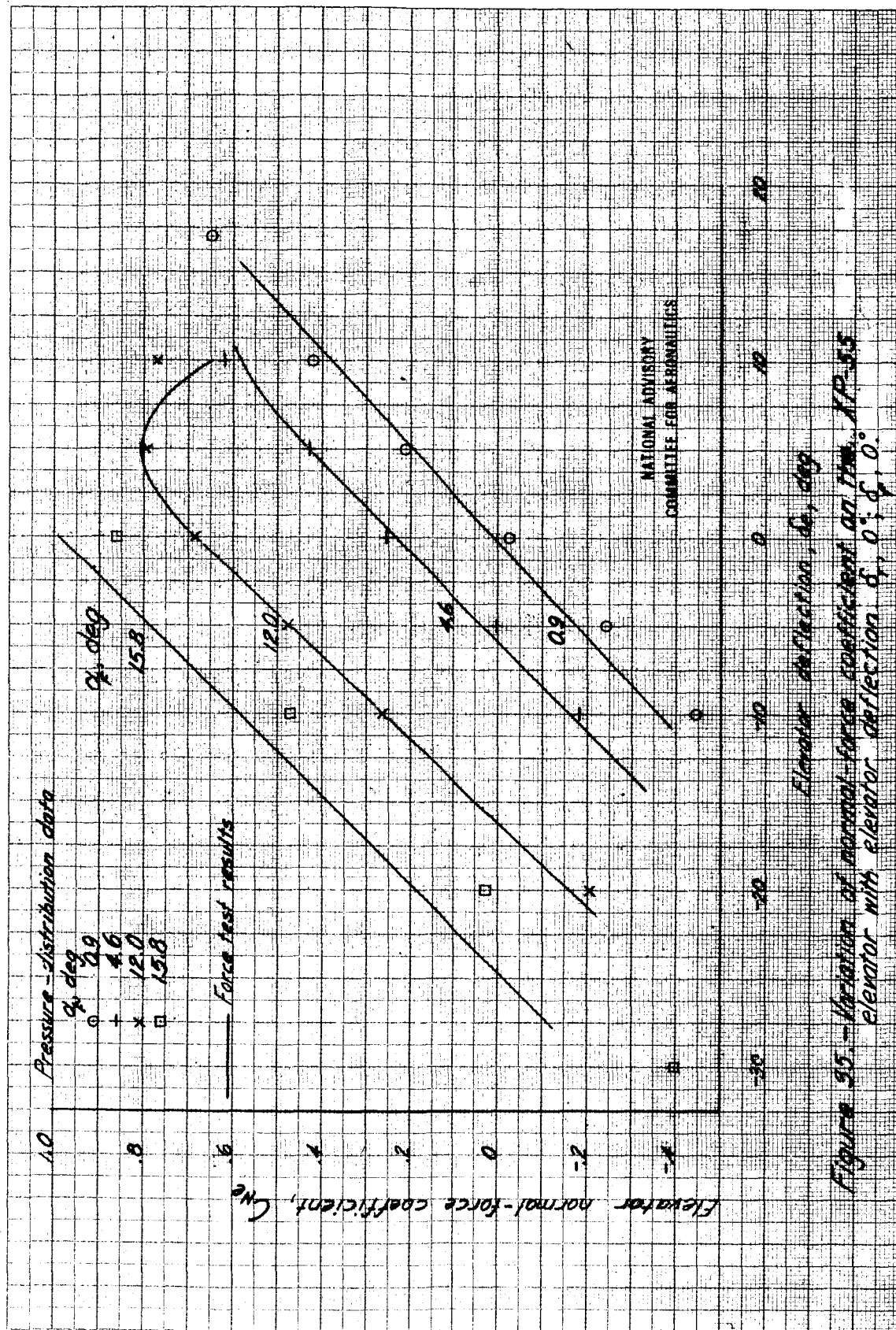
Figure 31. - Effect of flap deflection on the elevator span loading.
 $\alpha_e, 4.6^\circ; \delta_e, 0^\circ; \delta_f, 0^\circ$

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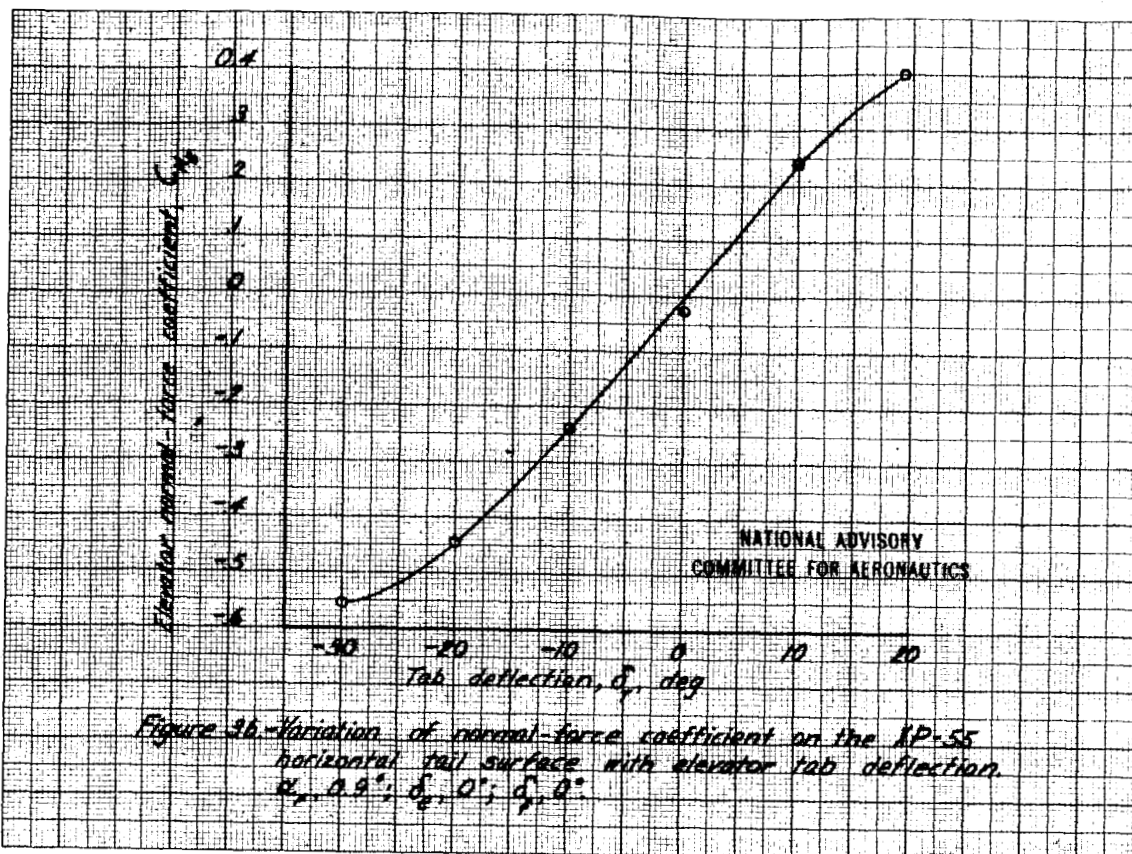


Figure 36-Variation of normal-force coefficient on the KP-55 horizontal tail surface with elevator tab deflection. $\alpha_r, 0.9^\circ$; $\delta_r, 0^\circ$; $\delta_p, 0^\circ$.

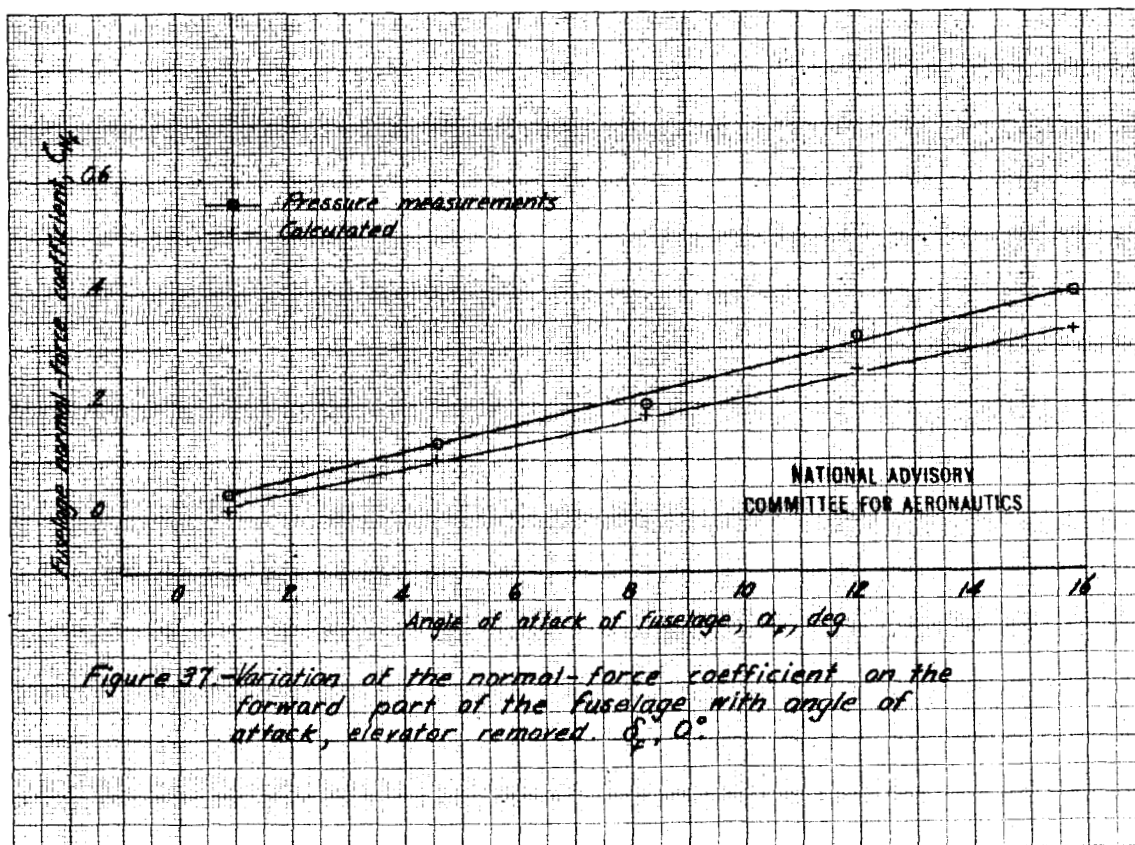


Figure 37-Variation of the normal-force coefficient on the forward part of the fuselage with angle of attack, elevator removed. $\delta_r, 0^\circ$.

TITLE: Full-Scale Tunnel Measurements of the Pressures on the Elevator and Fuselage of the Curtiss XP-55 Airplane

AUTHOR(S): Dingeldien, R. C.

ORIGINATING AGENCY: National Advisory Committee for Aeronautics, Washington, D. C.

PUBLISHED BY: (Same)

ATI- 8831

DIVISION

(None)

ORD. AGENCY NO.

MR-L-630

PUBLISHED AGENCY NO.

DATE	DOC. CLASS.	COUNTRY	LANGUAGE	PAGES	ILLUSTRATIONS
June '43	Unclass.	U.S.	Eng.	50	photos, tables, graph drawings

ABSTRACT:

240400

Force tests and pressure distribution measurements were made over a wide range of elevator and elevator tab deflections for several angles of attack of the fuselage axis with landing flaps retracted and deflected. Analysis of distribution of normal force coefficients across span of elevator is given and pressure measurement and force test methods of obtaining these coefficients are compared. Extension of analysis may prove useful for canard-type airplane design.

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*Fuselages

Pressure distribution.

Flaps (Control surfaces)

Fcd 25

XP-55 aircraft

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TITLE:

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Full Scale Tunnel Measurements of the Pressure on the

Elevator and Fuselage of the Curtiss XP-55 Airplane

AUTHOR(S):

Dingeldein, Richard C.

OA:

National Advisory Committee for Aeronautics

Foreign Title:

Previously cataloged under No:

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