SUPPLEMENT TO

ADVANCE CONFIDENTIAL REPORT

PRELIMINARY LOW-DRAG-AIRFOIL AND FLAP DATA FROM TESTS AT LARGE REYNOLDS NUMBERS AND LOW TURBULENCE

By Eastman N. Jacobs, Ira H. Abbott, and Milton Davidson

INTRODUCTION

Data on basic thickness and mean-line forms and airfoil test data giving standard airfoil characteristics are presented herein in tabular and chart form. These charts have been arranged in loose-leaf form as a supplement to the paper entitled "Preliminary Low-Drag-Airfoil and Flap Data from Tests at Large Reynolds Numbers and Low Turbulence." As new test results become available, additional or replacement charts will be forwarded to holders of the report to be inserted in this supplement

The material included herein is conveniently arranged numerically according to the designation of the airfoil section and falls under three headings:

I. - Basic thickness forms

II. - Mean lines

III. - Airfoil section charts

(a) Nonroutine tests

(b) Charts

The airfoil designation is explained in the Introduction of the report.

SYMBOLS

The symbols used in the charts are defined as follows:

c	airfoil chord
c_d	section drag coefficient
c_l	section lift coefficient
c_{l_i}	design lift coefficient for mean line
$c_{m_{c/4}}$	section pitching-moment coefficient about quarter-chord point
c_n	section normal-force coefficient
δ_f	flap deflection
δ_s	deflection of slotted flap
δ_p	deflection of secondary plain flap
M_c	critical Mach number
P	pressure coefficient signifying load distribution along mean line $\left(\frac{dc_n}{dx/c}\right)$
R	Reynolds number
R_e	effective Reynolds number
S	airfoil-surface pressure coefficient measured from stagnation pressure level $\left(\frac{v}{V}\right)^2$
Δu	velocity increment due to mean-line load distribution P
V	velocity of free stream
v	velocity on surface of basic thickness form

Δv_a	surface velocity increment associated with changing angle of attack (additional lift distribution)
x	chord distance from leading edge
y	airfoil ordinate
y_c	camber-line ordinate
α_o	section angle of attack
α_i	angle of attack corresponding to c_{l_i}

I. - BASIC THICKNESS FORMS

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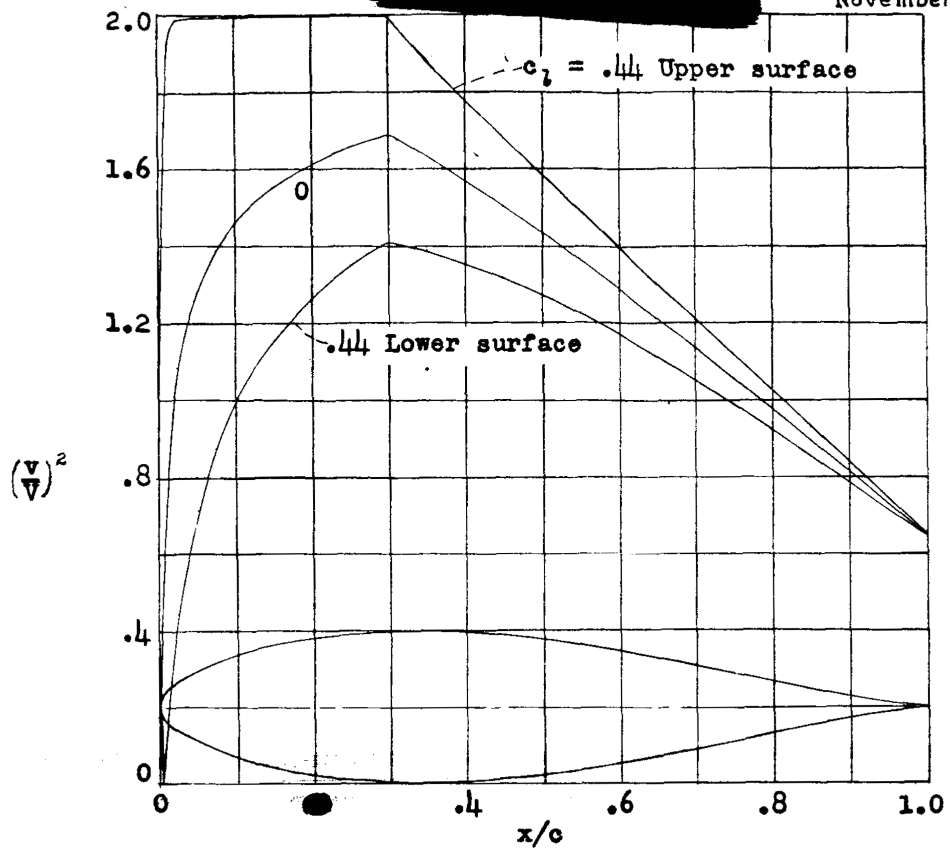
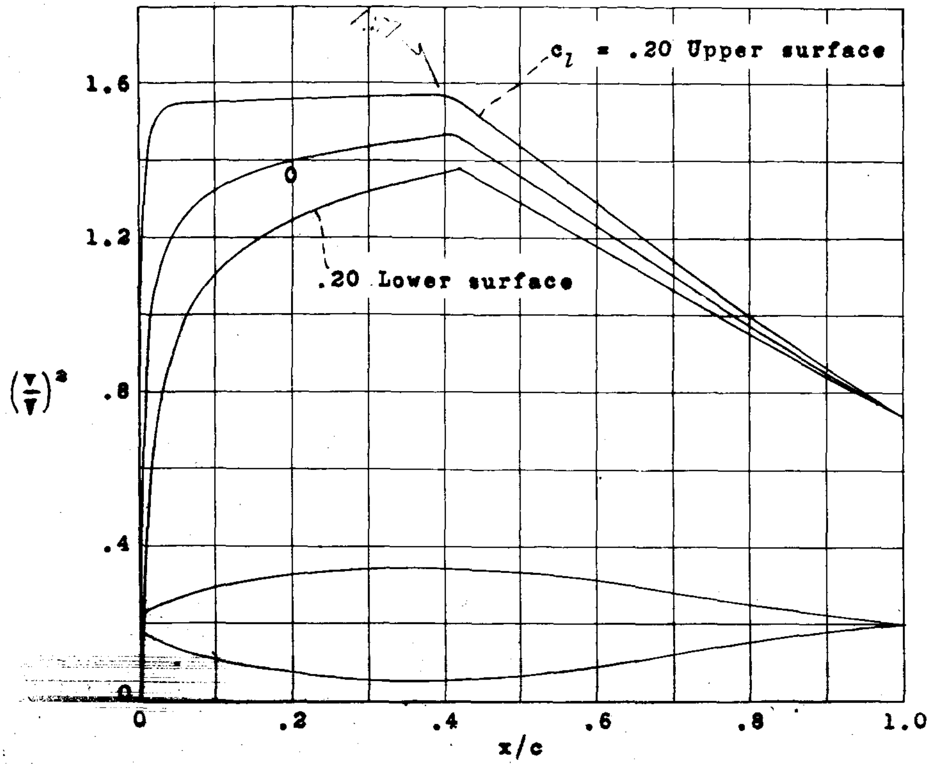
COPY NO. 82

November 5, 1942



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.395
.5	1.714	.444	.666	1.280
.75	2.081	.605	.778	1.201
1.25	2.638	.820	.906	1.072
2.5	3.606	1.080	1.039	.846
5.0	4.947	1.277	1.130	.645
7.5	5.964	1.383	1.176	.543
10	6.800	1.456	1.207	.475
15	8.090	1.551	1.245	.386
20	9.006	1.614	1.270	.330
25	9.630	1.659	1.288	.289
30	9.955	1.689	1.300	.257
35	9.978	1.630	1.277	.219
40	9.765	1.567	1.252	.192
45	9.366	1.500	1.225	.169
50	8.819	1.433	1.197	.148
55	8.143	1.362	1.167	.128
60	7.351	1.288	1.135	.112
65	6.464	1.213	1.101	.097
70	5.496	1.137	1.066	.084
75	4.466	1.059	1.029	.071
80	3.401	.978	.989	.059
85	2.342	.896	.947	.046
90	1.348	.811	.901	.036
95	.501	.728	.853	.023
100	0	.651	.807	0
L. E. radius: 3.16 percent c				

NACA 63,4-020 basic thickness form



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.930
.5	1.216	.710	.843	1.500
.75	1.453	.825	.908	1.359
1.25	1.829	.962	.981	1.161
2.5	2.528	1.122	1.059	.911
5.0	3.514	1.234	1.111	.676
7.5	4.243	1.288	1.135	.553
10	4.838	1.323	1.150	.477
15	5.781	1.371	1.171	.383
20	6.464	1.401	1.184	.325
25	6.967	1.422	1.192	.285
30	7.307	1.441	1.200	.253
35	7.481	1.458	1.207	.227
40	7.480	1.471	1.213	.202
45	7.268	1.432	1.197	.175
50	6.850	1.366	1.169	.156
55	6.311	1.299	1.140	.137
60	5.670	1.234	1.111	.122
65	4.944	1.168	1.081	.102
70	4.158	1.102	1.050	.086
75	3.338	1.039	1.019	.080
80	2.506	.973	.986	.071
85	1.698	.910	.954	.056
90	.961	.849	.921	.039
95	.351	.791	.889	.027
100	0	.739	.860	0
L. E. radius: 1.65 percent c				

NACA 64,2-015 basic thickness form

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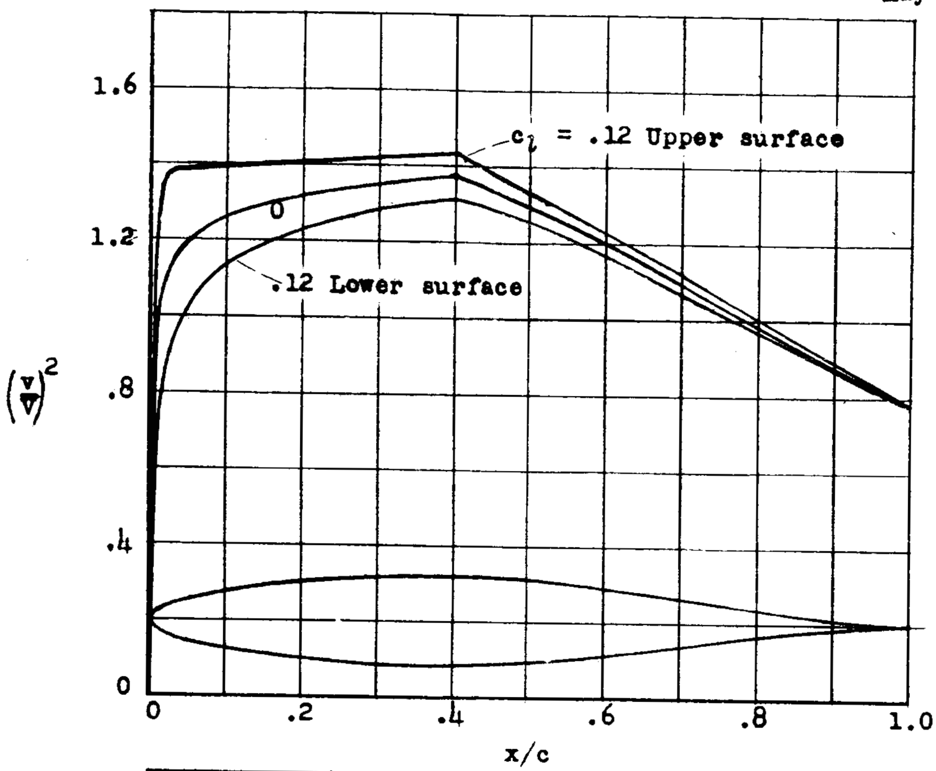
May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.379
.5	.978	.750	.866	1.663
.75	1.179	.885	.941	1.508
1.25	1.490	1.020	1.010	1.271
2.5	2.035	1.129	1.063	.943
5.0	2.810	1.204	1.097	.685
7.5	3.394	1.240	1.114	.559
10	3.871	1.264	1.124	.482
15	4.620	1.296	1.139	.388
20	5.173	1.320	1.149	.328
25	5.576	1.338	1.156	.281
30	5.844	1.351	1.162	.247
35	5.978	1.362	1.167	.221
40	5.981	1.372	1.171	.199
45	5.798	1.335	1.156	.177
50	5.480	1.289	1.136	.158
55	5.056	1.243	1.115	.138
60	4.548	1.195	1.093	.122
65	3.974	1.144	1.070	.103
70	3.350	1.091	1.044	.088
75	2.695	1.037	1.018	.074
80	2.029	.981	.990	.063
85	1.382	.928	.963	.052
90	.786	.874	.935	.045
95	.288	.825	.908	.028
100	0	.775	.880	0

L. E. radius: 1.040 percent c

NACA 64_1-012 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

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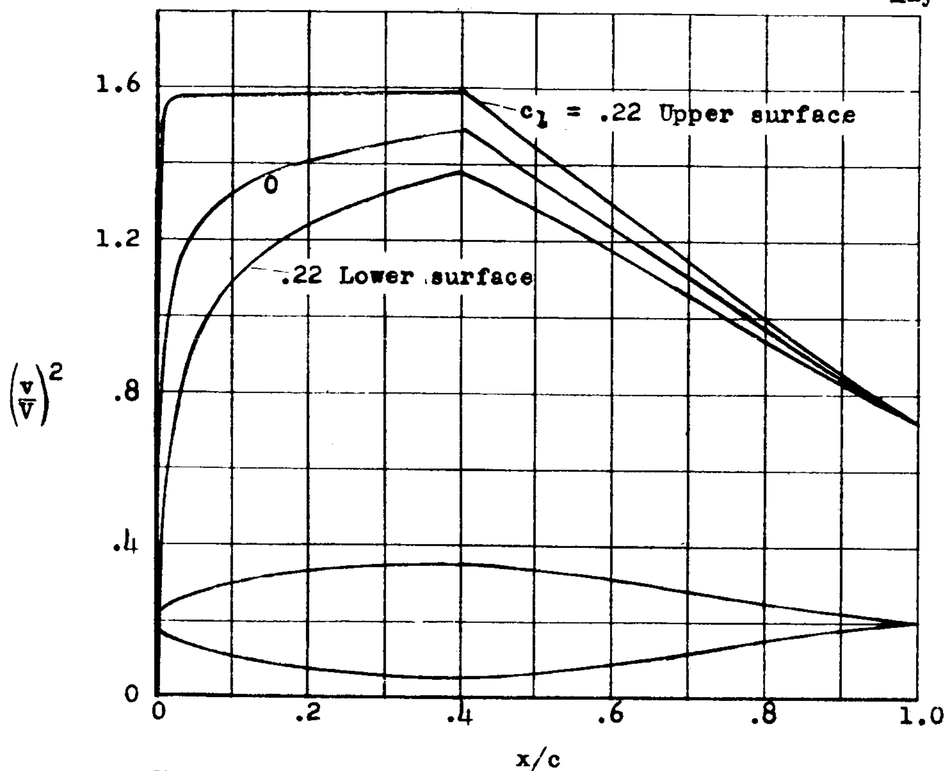
May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.939
.5	1.208	.670	.819	1.476
.75	1.456	.762	.873	1.354
1.25	1.842	.896	.947	1.188
2.5	2.528	1.113	1.055	.916
5.0	3.504	1.231	1.109	.670
7.5	4.240	1.284	1.133	.559
10	4.842	1.323	1.150	.482
15	5.785	1.375	1.172	.389
20	6.480	1.410	1.187	.326
25	6.985	1.434	1.198	.285
30	7.319	1.454	1.206	.250
35	7.482	1.470	1.213	.225
40	7.473	1.485	1.218	.202
45	7.224	1.426	1.195	.179
50	6.810	1.365	1.168	.158
55	6.266	1.300	1.140	.135
60	5.620	1.233	1.110	.121
65	4.895	1.167	1.080	.105
70	4.113	1.101	1.049	.090
75	3.296	1.033	1.016	.078
80	2.472	.967	.983	.065
85	1.677	.902	.950	.054
90	.950	.841	.917	.041
95	.346	.785	.886	.031
100	0	.730	.855	0

L. E. radius: 1.590 percent c

NACA 64_2-015 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

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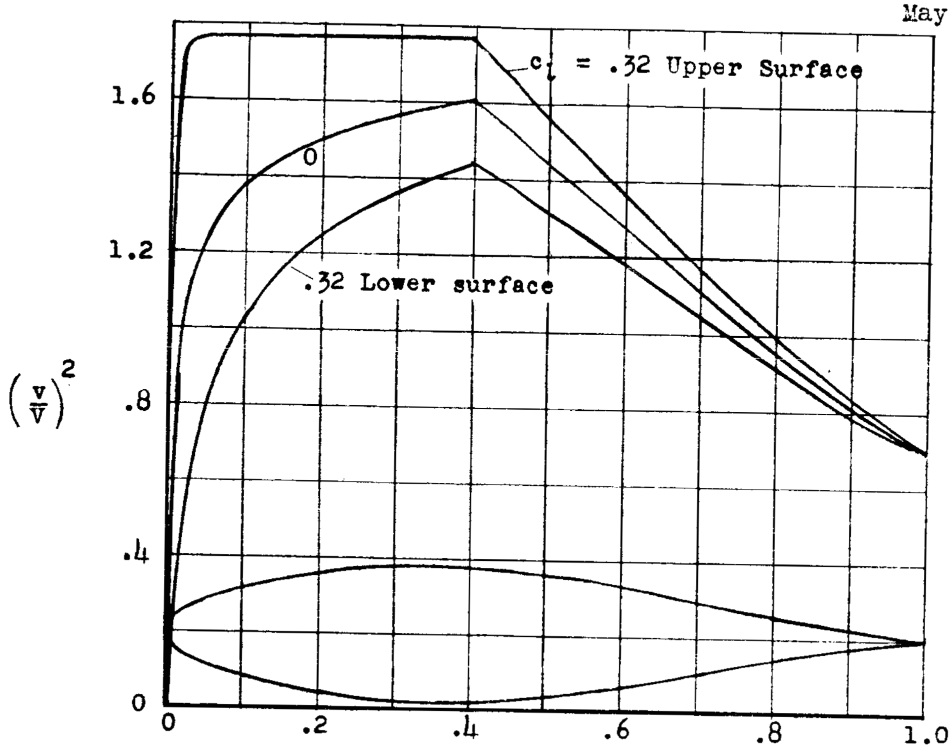
5c

May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.646
.5	1.428	.546	.739	1.360
.75	1.720	.705	.840	1.269
1.25	2.177	.862	.920	1.128
2.5	3.005	1.079	1.039	.904
5.0	4.186	1.244	1.115	.669
7.5	5.076	1.327	1.152	.558
10	5.803	1.380	1.175	.486
15	6.942	1.450	1.204	.391
20	7.782	1.497	1.224	.331
25	8.391	1.535	1.239	.288
30	8.789	1.562	1.250	.255
35	8.979	1.585	1.259	.228
40	8.952	1.600	1.265	.200
45	8.630	1.518	1.232	.177
50	8.114	1.436	1.198	.154
55	7.445	1.354	1.164	.134
60	6.658	1.272	1.128	.117
65	5.782	1.190	1.091	.102
70	4.842	1.109	1.053	.088
75	3.866	1.028	1.014	.074
80	2.888	.952	.976	.063
85	1.951	.879	.937	.051
90	1.101	.812	.901	.039
95	.400	.747	.864	.027
100	0	.695	.834	0
L. E. radius: 2.208 percent c				

NACA 64_3-018 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

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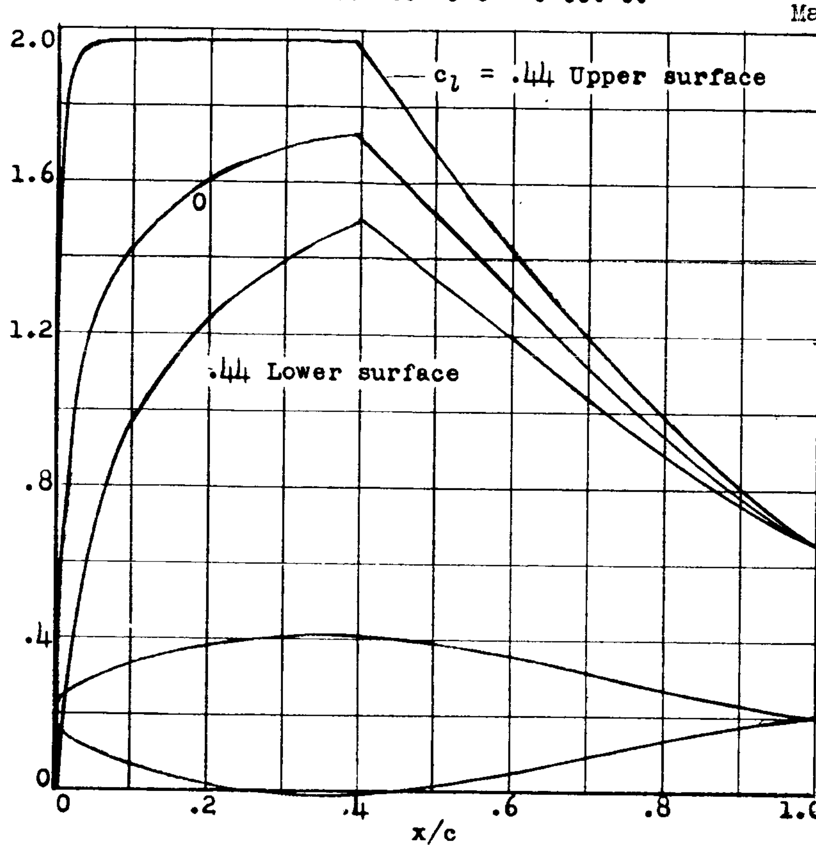
May 16, 1944

62



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.458
.5	1.646	.462	.680	1.274
.75	1.985	.603	.776	1.203
1.25	2.517	.759	.871	1.084
2.5	3.485	1.010	1.005	.878
5.0	4.871	1.248	1.117	.665
7.5	5.915	1.358	1.165	.557
10	6.769	1.431	1.196	.486
15	8.108	1.527	1.236	.395
20	9.095	1.593	1.262	.335
25	9.807	1.654	1.281	.293
30	10.269	1.681	1.297	.259
35	10.481	1.712	1.308	.232
40	10.431	1.709	1.307	.202
45	10.030	1.607	1.268	.178
50	9.404	1.507	1.228	.155
55	8.607	1.406	1.186	.134
60	7.678	1.307	1.143	.116
65	6.649	1.209	1.099	.099
70	5.549	1.112	1.055	.084
75	4.416	1.020	1.010	.071
80	3.287	.932	.965	.059
85	2.213	.851	.923	.047
90	1.245	.778	.882	.036
95	.449	.711	.844	.022
100	0	.653	.808	0

L. E. radius: 2.884 percent c

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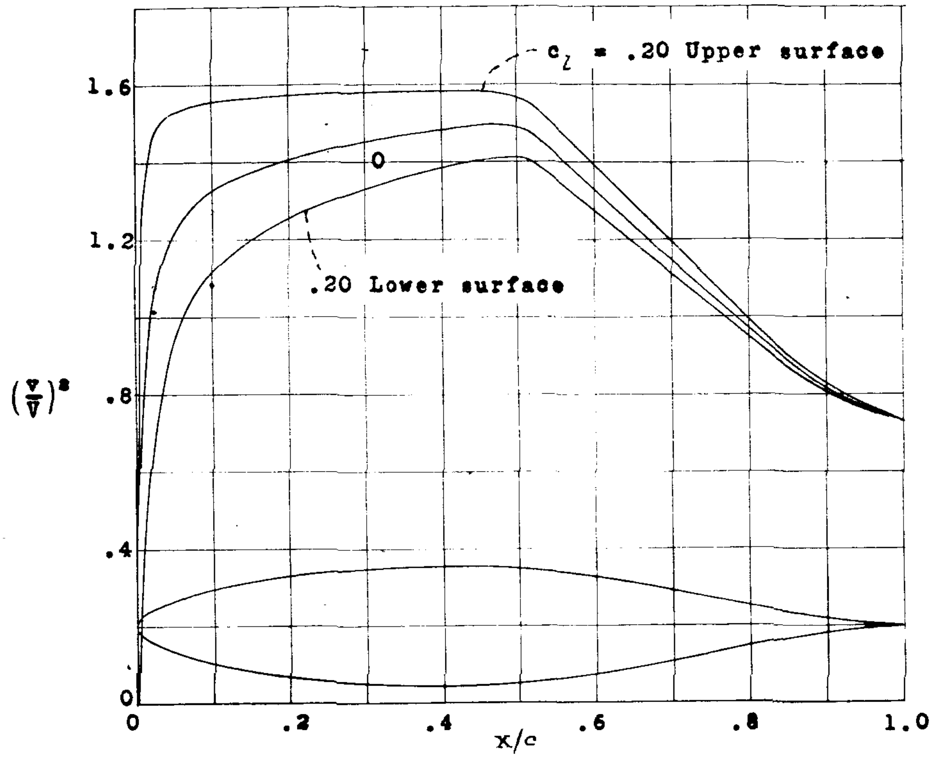
NACA 64_4-021 basic thickness form

ACR by Messrs. Jacobs. Abbott. and Davidson

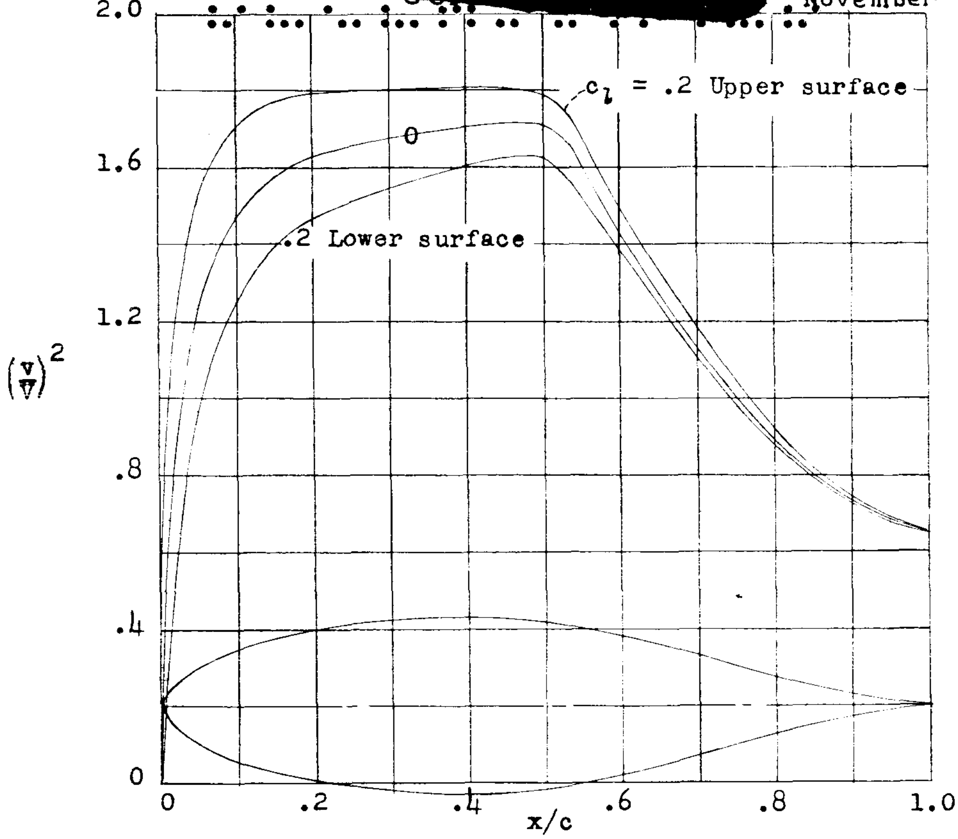


x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.950
.5	1.202	.560	.748	1.650
.75	1.423	.690	.831	1.500
1.25	1.796	.842	.918	1.275
2.5	2.507	1.068	1.033	.920
5.0	3.543	1.217	1.103	.680
7.5	4.316	1.287	1.134	.545
10	4.954	1.328	1.152	.480
15	5.958	1.379	1.174	.390
20	6.701	1.409	1.187	.325
25	7.252	1.433	1.197	.285
30	7.645	1.453	1.205	.255
35	7.892	1.469	1.212	.225
40	7.995	1.484	1.218	.200
45	7.938	1.497	1.224	.180
50	7.672	1.491	1.221	.160
55	7.184	1.421	1.192	.140
60	6.495	1.328	1.152	.125
65	5.647	1.235	1.111	.110
70	4.713	1.147	1.071	.095
75	3.738	1.056	1.028	.080
80	2.759	.970	.985	.066
85	1.817	.886	.941	.050
90	.982	.816	.903	.040
95	.340	.769	.877	.025
100	0	.733	.856	0
L. E. radius: 1.704 percent c				

NACA 65,2-016 basic thickness form

COPY NO. 92

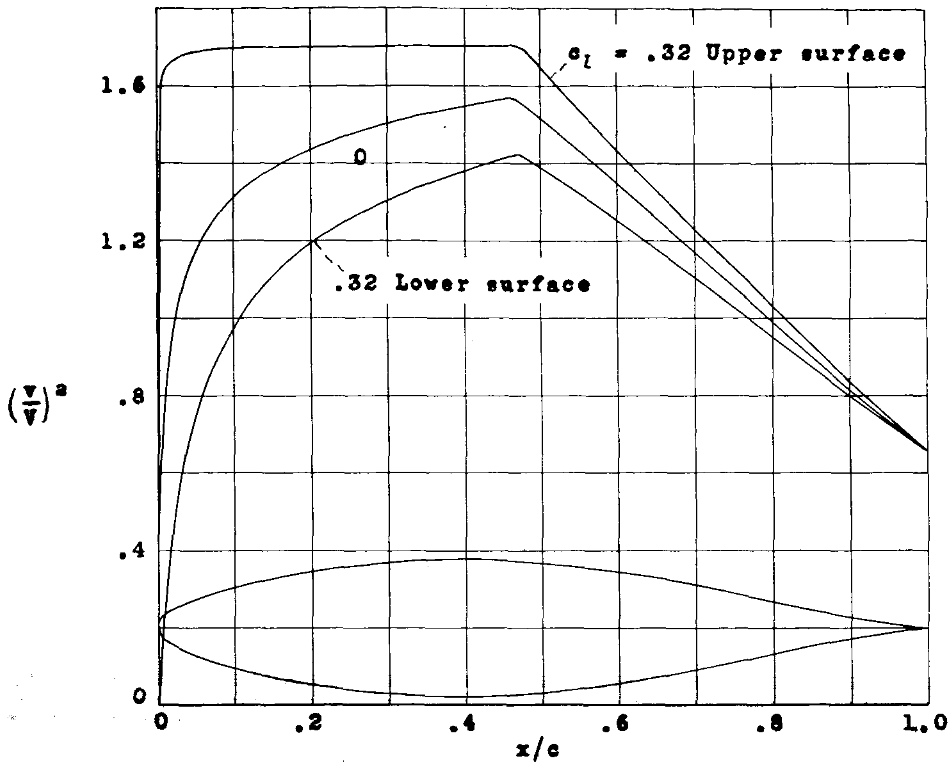
[redacted] November 5, 1942



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.414
.5	1.664	.400	.632	1.161
.75	2.040	.500	.707	1.084
1.25	2.628	.682	.826	.967
2.5	3.715	.943	.971	.811
5.0	5.300	1.232	1.110	.633
7.5	6.478	1.375	1.173	.539
10	7.433	1.467	1.211	.479
15	8.889	1.577	1.256	.380
20	9.917	1.628	1.276	.324
25	10.648	1.655	1.286	.281
30	11.142	1.677	1.295	.247
35	11.423	1.694	1.302	.220
40	11.499	1.708	1.307	.198
45	11.361	1.716	1.310	.178
50	10.949	1.712	1.308	.161
55	10.179	1.606	1.267	.147
60	9.108	1.428	1.195	.110
65	7.848	1.274	1.129	.096
70	6.461	1.135	1.065	.093
75	5.015	1.003	1.001	.080
80	3.618	.893	.945	.053
85	2.345	.803	.896	.035
90	1.258	.732	.856	.022
95	.439	.682	.826	.018
100	0	.651	.807	0

L. E. radius: 2.955 percent c

NACA 65,2-023 basic thickness form



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.750
.5	1.324	.650	.806	1.387
.75	1.599	.750	.866	1.268
1.25	2.004	.872	.934	1.108
2.5	2.728	1.020	1.010	.890
5.0	3.651	1.179	1.086	.677
7.5	4.701	1.263	1.124	.568
10	5.424	1.320	1.149	.489
15	6.568	1.393	1.180	.395
20	7.434	1.439	1.200	.334
25	8.093	1.473	1.214	.292
30	8.568	1.502	1.226	.260
35	8.868	1.526	1.235	.232
40	8.990	1.546	1.243	.209
45	8.916	1.562	1.250	.186
50	8.593	1.513	1.230	.165
55	8.045	1.433	1.197	.142
60	7.317	1.348	1.161	.123
65	6.450	1.258	1.122	.107
70	5.486	1.169	1.081	.093
75	4.456	1.079	1.039	.080
80	3.390	.992	.996	.066
85	2.325	.905	.951	.054
90	1.324	.818	.904	.040
95	.492	.738	.859	.024
100	0	.658	.811	0
L. E. radius: 1.92 percent c				

NACA 65,3-018 basic thickness form

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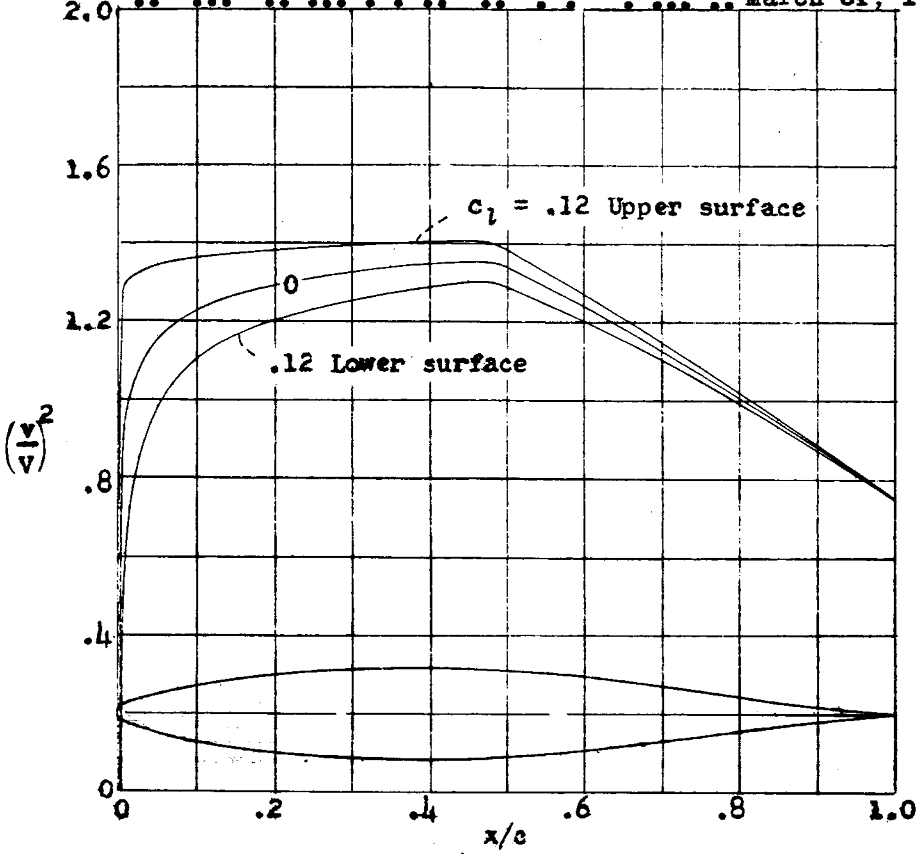
March 31, 1943



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.444
.5	.923	.848	.921	1.776
.75	1.109	.935	.967	1.465
1.25	1.387	1.000	1.000	1.200
2.5	1.875	1.082	1.040	.931
5.0	2.606	1.162	1.078	.702
7.5	3.172	1.201	1.096	.568
10	3.647	1.232	1.110	.480
15	4.402	1.268	1.126	.389
20	4.975	1.295	1.138	.326
25	5.406	1.316	1.147	.282
30	5.716	1.332	1.154	.251
35	5.912	1.343	1.159	.223
40	5.997	1.350	1.162	.204
45	5.949	1.357	1.165	.188
50	5.757	1.343	1.159	.169
55	5.412	1.295	1.138	.145
60	4.943	1.243	1.115	.127
65	4.381	1.188	1.090	.111
70	3.743	1.134	1.065	.094
75	3.059	1.073	1.036	.074
80	2.345	1.010	1.005	.062
85	1.630	.949	.974	.049
90	.947	.884	.940	.038
95	.356	.819	.905	.025
100	0	.748	.865	0

L. E. radius: 1.000 percent c

NACA 65_1-012 basic thickness form

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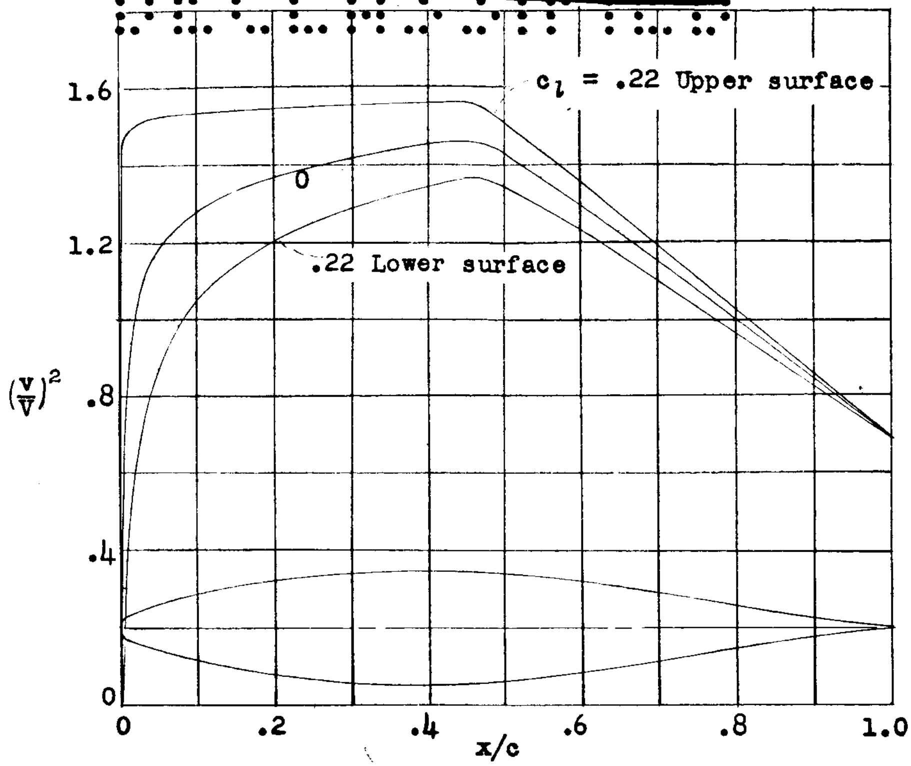

x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.038
.5	1.124	.654	.809	1.729
.75	1.356	.817	.904	1.390
1.25	1.702	.939	.969	1.156
2.5	2.324	1.063	1.031	.920
5.0	3.245	1.184	1.088	.682
7.5	3.959	1.241	1.114	.563
10	4.555	1.281	1.132	.487
15	5.504	1.336	1.156	.393
20	6.223	1.374	1.172	.334
25	6.764	1.397	1.182	.290
30	7.152	1.418	1.191	.255
35	7.396	1.438	1.199	.227
40	7.498	1.452	1.205	.203
45	7.427	1.464	1.210	.184
50	7.168	1.433	1.197	.160
55	6.720	1.369	1.170	.143
60	6.118	1.297	1.139	.127
65	5.403	1.228	1.108	.109
70	4.600	1.151	1.073	.096
75	3.744	1.077	1.038	.078
80	2.858	1.002	1.001	.068
85	1.977	.924	.961	.052
90	1.144	.846	.920	.038
95	.428	.773	.879	.026
100	0	.697	.835	0

L. E. radius: 1.505 percent c

NACA 65_2-015 basic thickness form

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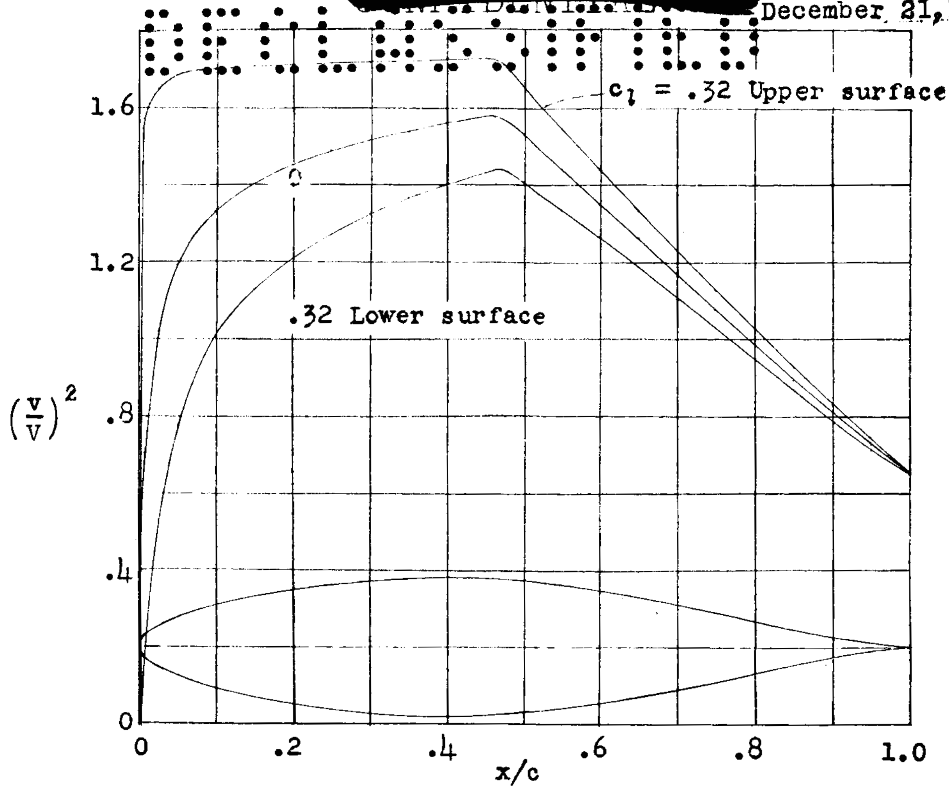
7b

[redacted] December 21, 1942



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.746
.5	1.337	.625	.791	1.437
.75	1.608	.702	.838	1.302
1.25	2.014	.817	.904	1.123
2.5	2.751	1.020	1.010	.858
5.0	3.866	1.192	1.092	.650
7.5	4.733	1.275	1.129	.542
10	5.457	1.329	1.153	.474
15	6.606	1.402	1.184	.385
20	7.476	1.452	1.205	.327
25	8.129	1.488	1.220	.285
30	8.595	1.515	1.231	.251
35	8.886	1.539	1.241	.225
40	8.999	1.561	1.249	.203
45	8.901	1.578	1.256	.182
50	8.568	1.526	1.235	.157
55	8.008	1.440	1.200	.137
60	7.267	1.353	1.163	.118
65	6.395	1.262	1.123	.104
70	5.426	1.170	1.082	.087
75	4.396	1.076	1.037	.074
80	3.338	.985	.992	.062
85	2.295	.896	.947	.050
90	1.319	.813	.902	.039
95	.490	.730	.854	.026
100	0	.657	.811	0

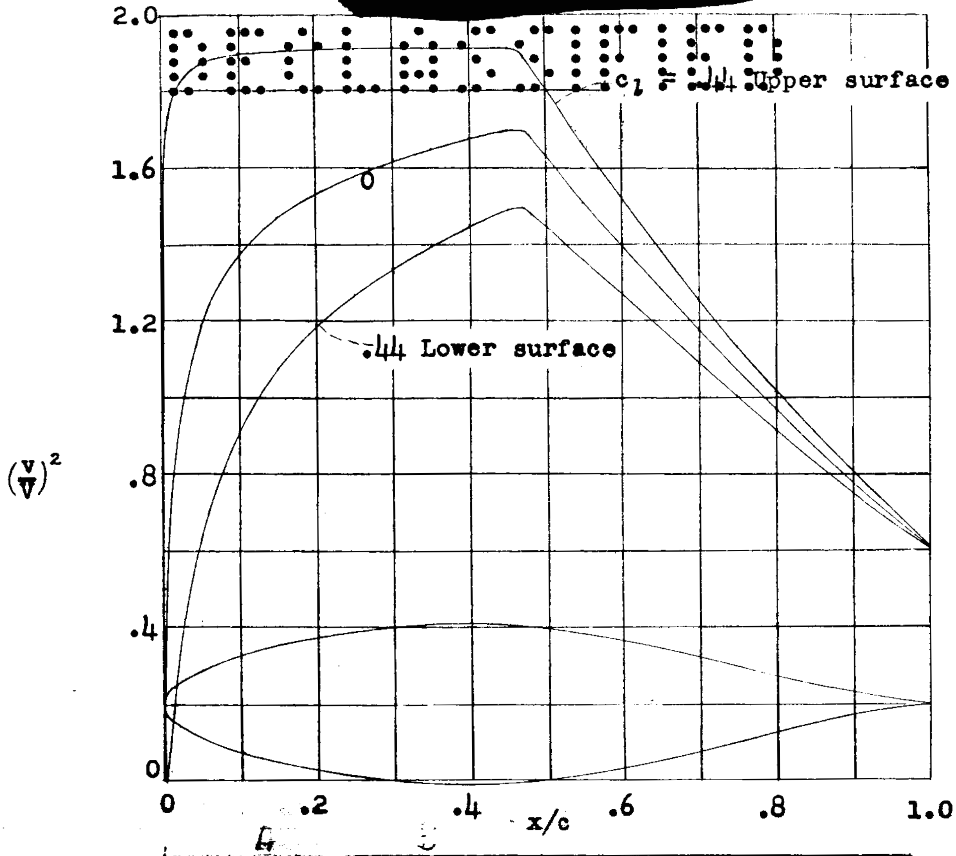
L. E. radius: 1.96 percent c

NACA 65_3-018 basic thickness form

COPY NO. 62

[redacted]

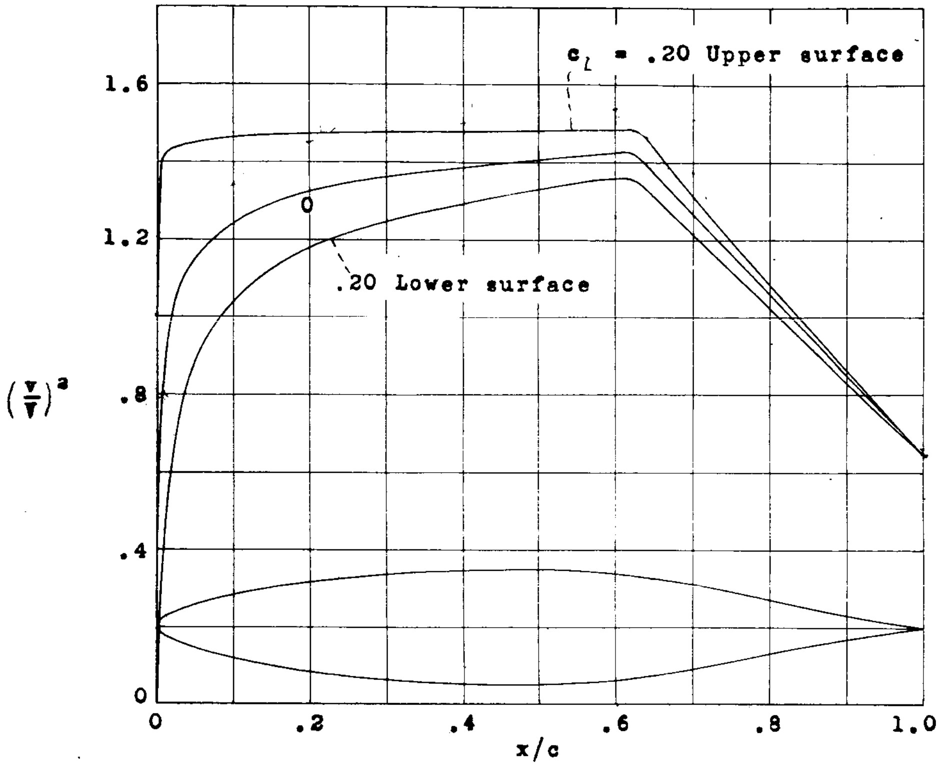
7c
December
21,1942



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.531
.5	1.522	.514	.717	1.333
.75	1.838	.607	.779	1.215
1.25	2.301	.740	.860	1.062
2.5	3.154	.960	.980	.838
5.0	4.472	1.186	1.089	.649
7.5	5.498	1.293	1.137	.544
10	6.352	1.371	1.171	.478
15	7.700	1.469	1.212	.388
20	8.720	1.533	1.238	.330
25	9.487	1.580	1.257	.289
30	10.036	1.621	1.273	.255
35	10.375	1.654	1.286	.229
40	10.499	1.680	1.296	.206
45	10.366	1.700	1.304	.184
50	9.952	1.633	1.278	.158
55	9.277	1.508	1.228	.139
60	8.390	1.397	1.182	.120
65	7.360	1.286	1.134	.101
70	6.224	1.177	1.085	.087
75	5.024	1.073	1.036	.073
80	3.800	.970	.985	.058
85	2.598	.872	.934	.047
90	1.484	.778	.882	.035
95	.546	.694	.833	.020
100	0	.616	.785	0

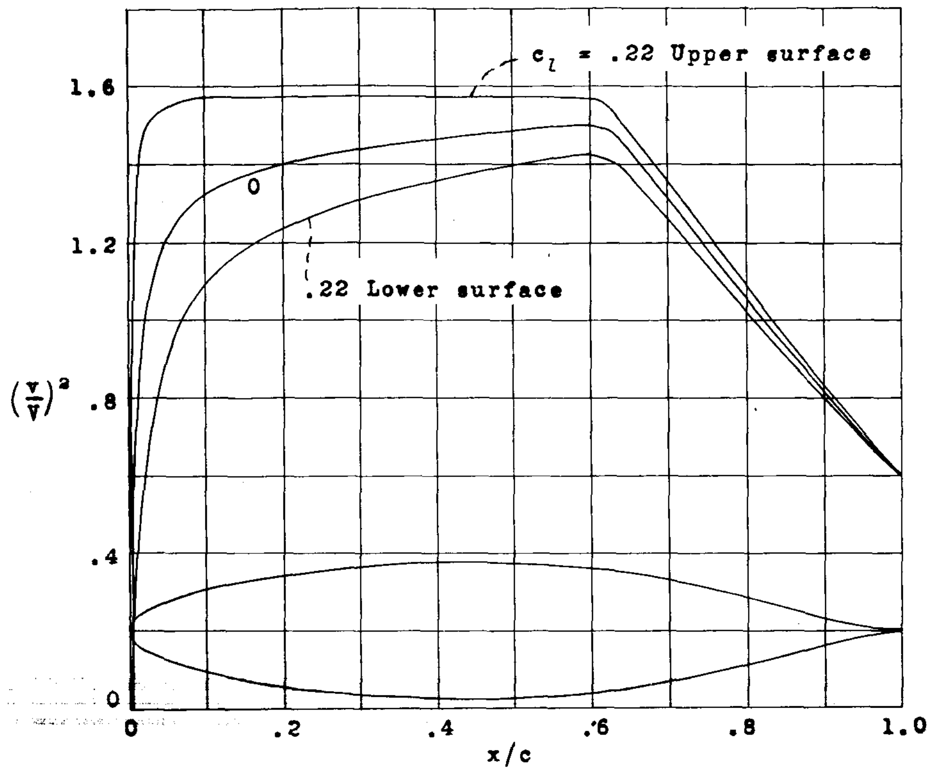
L. E. radius: 2.50 percent c

NACA 65_4-021 basic thickness form



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.085
.5	1.110	.700	.837	1.703
.75	1.329	.870	.933	1.382
1.25	1.645	.940	.970	1.156
2.5	2.229	1.048	1.024	.898
5.0	3.086	1.154	1.074	.655
7.5	3.757	1.210	1.100	.547
10	4.337	1.244	1.115	.473
15	5.255	1.290	1.136	.382
20	5.964	1.323	1.150	.323
25	6.516	1.342	1.158	.283
30	6.933	1.359	1.166	.248
35	7.230	1.374	1.172	.222
40	7.415	1.387	1.178	.199
45	7.495	1.397	1.182	.179
50	7.460	1.407	1.186	.161
55	7.294	1.415	1.190	.145
60	6.961	1.421	1.192	.131
65	6.405	1.372	1.171	.122
70	5.597	1.267	1.126	.102
75	4.652	1.162	1.078	.080
80	3.616	1.057	1.028	.066
85	2.545	.953	.976	.050
90	1.488	.848	.921	.037
95	.560	.743	.862	.025
100	0	.640	.800	0
L. E. radius: 1.384 percent c				

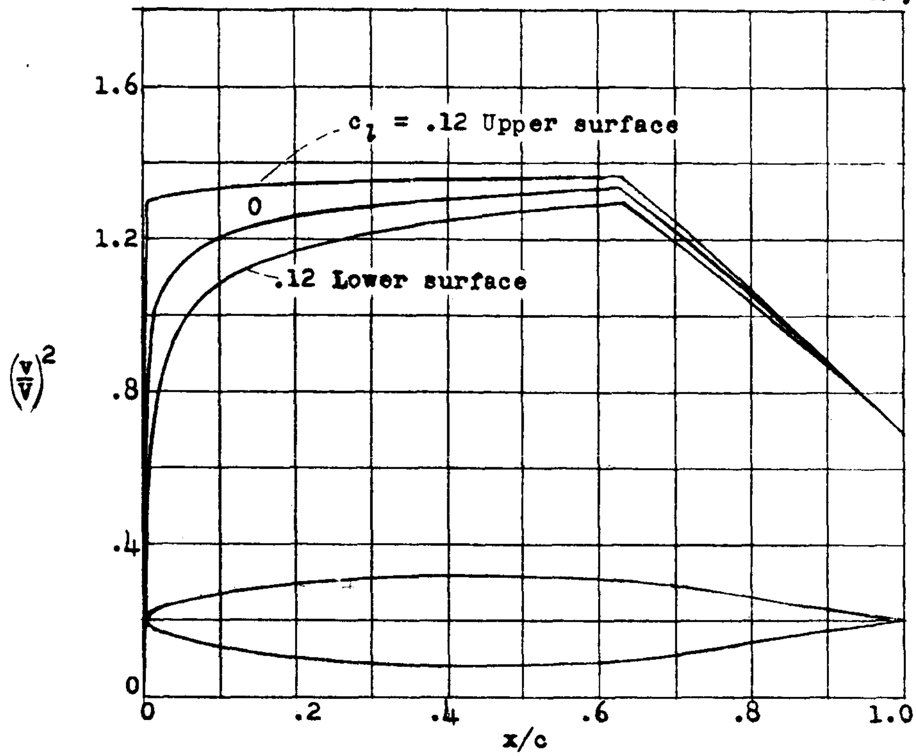
NACA 66,2-015 basic thickness form



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.659
.5	1.438	.590	.768	1.317
.75	1.730	.740	.860	1.209
1.25	2.180	.918	.958	1.091
2.5	2.938	1.084	1.041	.867
5.0	3.984	1.217	1.103	.665
7.5	4.804	1.285	1.134	.544
10	5.486	1.325	1.151	.469
15	6.541	1.373	1.172	.379
20	7.342	1.401	1.184	.323
25	7.957	1.422	1.192	.282
30	8.419	1.440	1.200	.251
35	8.741	1.456	1.207	.224
40	8.933	1.468	1.212	.201
45	8.998	1.478	1.216	.181
50	8.934	1.488	1.220	.162
55	8.719	1.497	1.224	.146
60	8.316	1.502	1.226	.134
65	7.629	1.442	1.201	.102
70	6.657	1.314	1.146	.089
75	5.523	1.185	1.089	.078
80	4.296	1.059	1.029	.064
85	3.027	.936	.967	.052
90	1.789	.817	.904	.041
95	.672	.700	.837	.027
100	0	.594	.771	0

L.E. radius: 2.30 percent c

NACA 66,2-018 basic thickness form



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.569
.5	.906	.800	.894	1.847
.75	1.087	.915	.957	1.575
1.25	1.358	.980	.990	1.237
2.5	1.808	1.073	1.036	.913
5	2.496	1.138	1.067	.674
7.5	3.037	1.177	1.085	.549
10	3.496	1.204	1.097	.473
15	4.234	1.237	1.112	.380
20	4.801	1.259	1.122	.323
25	5.238	1.275	1.129	.280
30	5.568	1.287	1.134	.246
35	5.803	1.297	1.139	.221
40	5.947	1.303	1.142	.197
45	6.000	1.311	1.145	.176
50	5.965	1.318	1.148	.162
55	5.836	1.323	1.150	.147
60	5.588	1.331	1.154	.132
65	5.139	1.302	1.141	.113
70	4.515	1.221	1.105	.098
75	3.767	1.139	1.067	.084
80	2.944	1.053	1.026	.069
85	2.083	.968	.984	.053
90	1.234	.879	.938	.040
95	.474	.788	.888	.031
100	0	.687	.829	0
L. E. radius: 0.952 percent c				

[redacted]

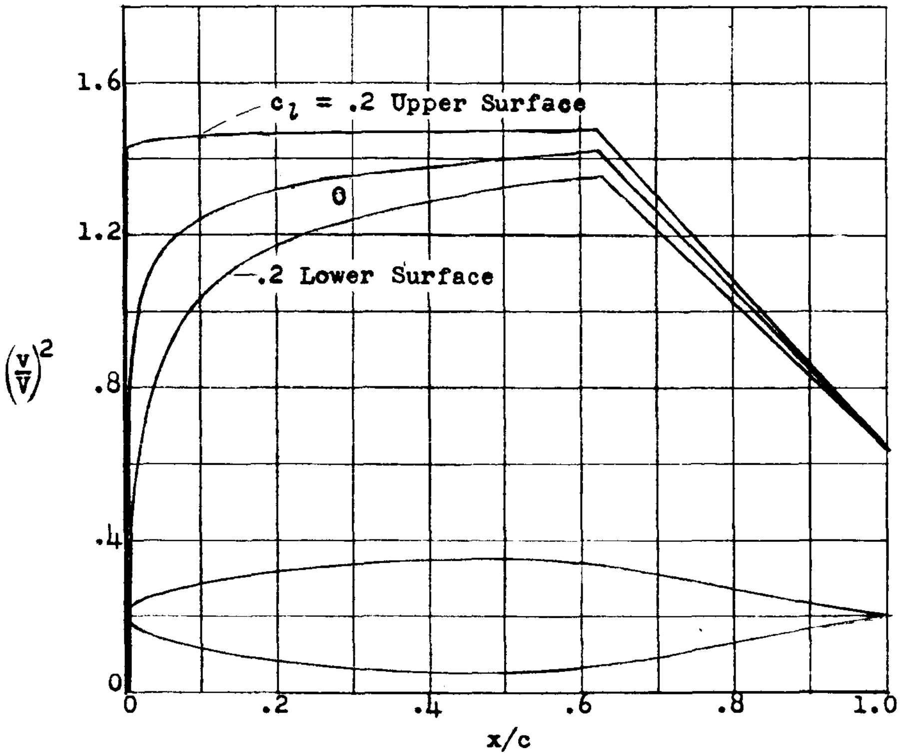
NACA 66_1-012 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

NACA [redacted] COPY NO. 62

9b

May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.139
.5	1.122	.760	.872	1.652
.75	1.343	.840	.916	1.431
1.25	1.675	.929	.964	1.172
2.5	2.235	1.055	1.027	.895
5	3.100	1.163	1.078	.663
7.5	3.781	1.208	1.099	.547
10	4.358	1.242	1.114	.473
15	5.286	1.288	1.134	.381
20	5.995	1.317	1.148	.322
25	6.543	1.340	1.158	.280
30	6.956	1.356	1.164	.248
35	7.250	1.370	1.170	.222
40	7.430	1.380	1.175	.200
45	7.495	1.391	1.179	.180
50	7.450	1.401	1.184	.163
55	7.283	1.411	1.188	.146
60	6.959	1.420	1.192	.131
65	6.372	1.367	1.169	.113
70	5.576	1.260	1.122	.096
75	4.632	1.156	1.075	.080
80	3.598	1.053	1.026	.065
85	2.530	.949	.974	.051
90	1.489	.847	.920	.039
95	.566	.744	.863	.025
100	0	.639	.799	0

L. E. radius: 1.435 percent c

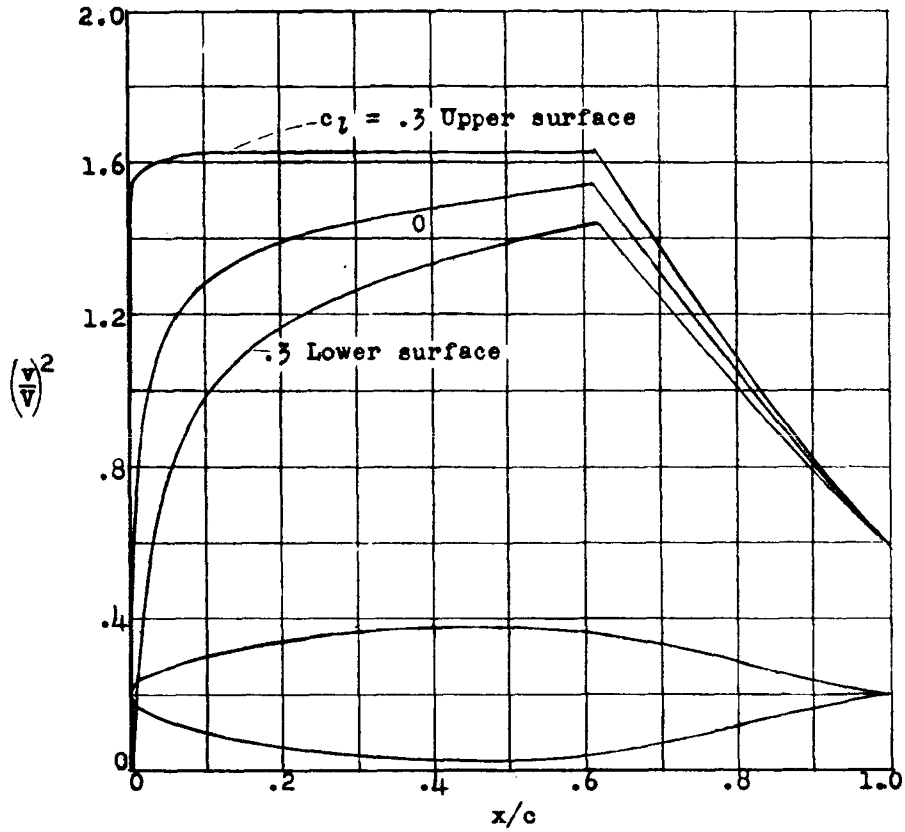
NACA 66_2-015 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

NACA [redacted] COPY NO. 82

9c

May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.773
.5	1.323	.650	.806	1.456
.75	1.571	.735	.857	1.312
1.25	1.952	.850	.897	1.121
2.5	2.646	1.005	1.002	.858
5	3.690	1.154	1.074	.649
7.5	4.513	1.234	1.111	.545
10	5.210	1.285	1.134	.472
15	6.333	1.350	1.162	.381
20	7.188	1.393	1.180	.323
25	7.848	1.423	1.193	.282
30	8.346	1.445	1.202	.250
35	8.701	1.464	1.210	.223
40	8.918	1.481	1.217	.201
45	8.998	1.496	1.223	.181
50	8.942	1.509	1.228	.163
55	8.733	1.522	1.234	.147
60	8.323	1.534	1.238	.131
65	7.580	1.438	1.199	.114
70	6.597	1.302	1.141	.095
75	5.451	1.172	1.083	.077
80	4.206	1.045	1.022	.061
85	2.934	.922	.950	.048
90	1.714	.803	.896	.037
95	.646	.692	.832	.022
100	0	.587	.766	0

L. E. radius: 1.955 percent c

NACA 66_3-018 basic thickness form

ACR by Messrs. Jacobs, Abbott, and Davidson

[redacted]

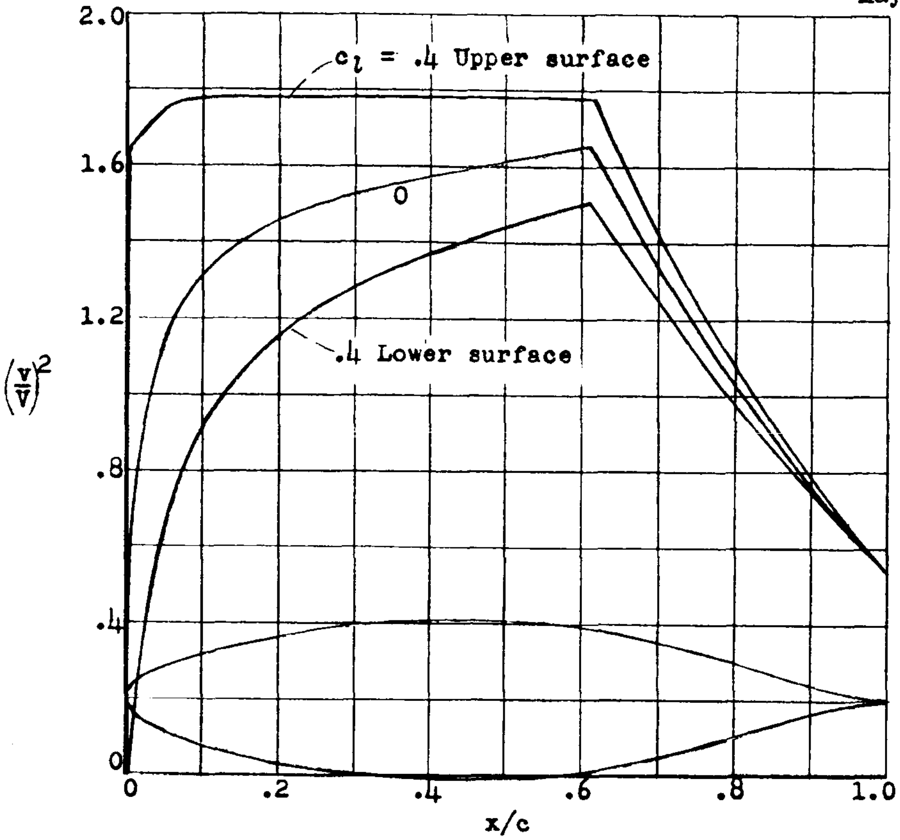
NACA

DECLASSIFIED [redacted]

COPY NO. 62

9d

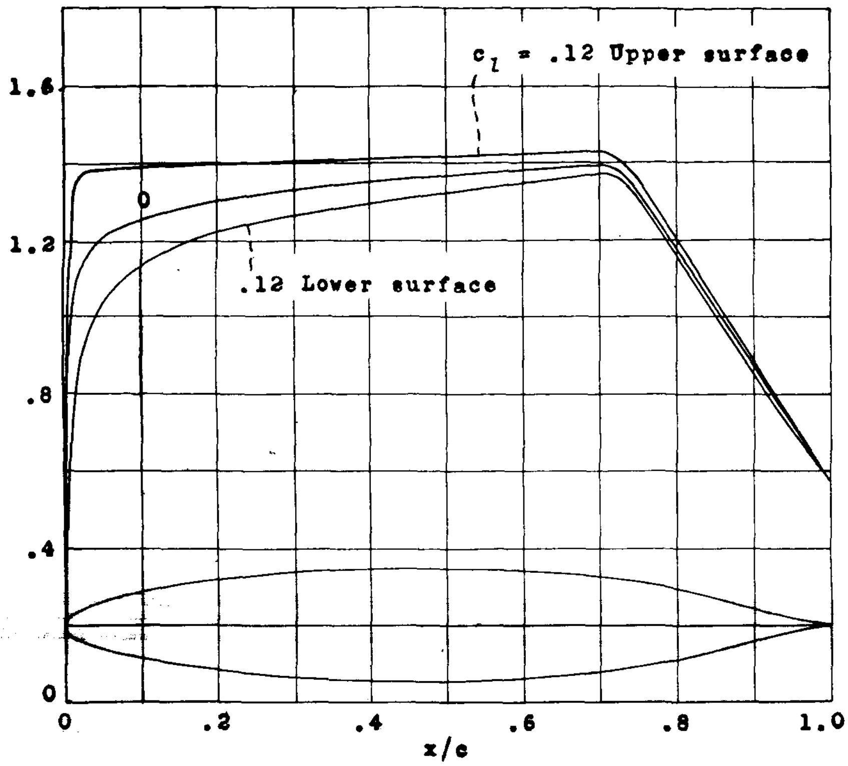
May 16, 1944



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	1.547
.5	1.525	.580	.761	1.314
.75	1.804	.635	.797	1.218
1.25	2.240	.755	.869	1.054
2.5	3.045	.952	.976	.828
5	4.269	1.143	1.069	.635
7.5	5.233	1.246	1.116	.542
10	6.052	1.318	1.148	.472
15	7.369	1.405	1.185	.381
20	8.376	1.459	1.208	.324
25	9.153	1.499	1.224	.283
30	9.738	1.528	1.236	.251
35	10.154	1.551	1.245	.224
40	10.407	1.574	1.255	.202
45	10.500	1.594	1.263	.183
50	10.434	1.611	1.269	.165
55	10.186	1.629	1.276	.148
60	9.692	1.648	1.284	.132
65	8.793	1.508	1.228	.114
70	7.610	1.335	1.155	.093
75	6.251	1.176	1.084	.073
80	4.796	1.031	1.015	.058
85	3.324	.891	.944	.046
90	1.924	.763	.873	.034
95	.717	.648	.805	.020
100	0	.539	.734	0
L. E. radius: 2.550 percent c				

NACA 66_4-021 basic thickness form

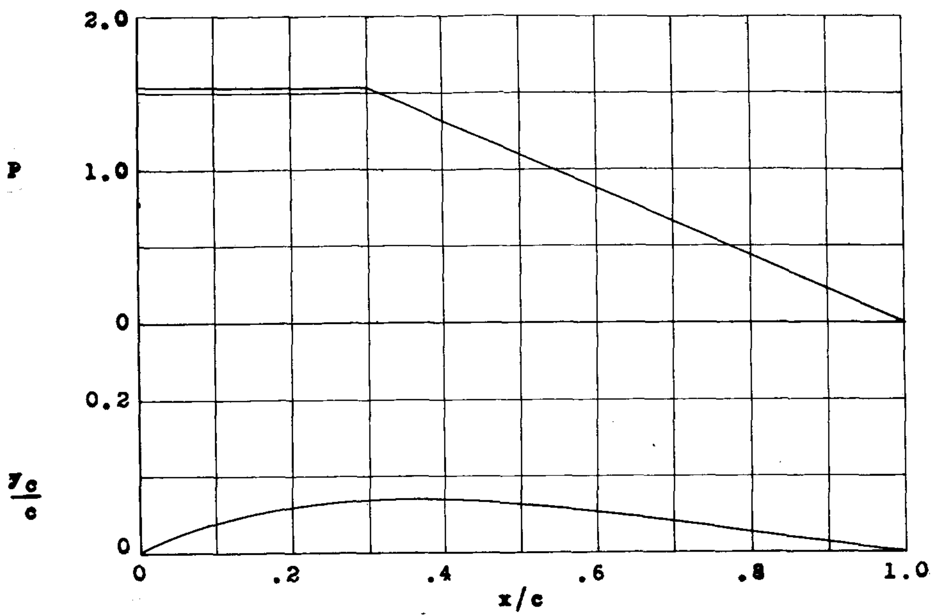
ACR by Messrs. Jacobs, Abbott, and Davidson



x (percent c)	y (percent c)	$(v/V)^2$	v/V	$\Delta v_a/V$
0	0	0	0	2.042
.5	1.167	.650	.806	1.560
.75	1.394	.970	.985	1.370
1.25	1.764	1.059	1.029	1.152
2.5	2.395	1.140	1.068	.906
5.0	3.245	1.209	1.100	.667
7.5	3.900	1.239	1.113	.548
10	4.433	1.259	1.122	.470
15	5.283	1.285	1.134	.370
20	5.940	1.304	1.142	.312
25	6.454	1.318	1.148	.276
30	6.854	1.330	1.153	.248
35	7.155	1.341	1.158	.221
40	7.359	1.351	1.162	.201
45	7.475	1.360	1.166	.180
50	7.497	1.368	1.170	.160
55	7.421	1.375	1.173	.142
60	7.231	1.381	1.175	.124
65	6.905	1.388	1.178	.111
70	6.402	1.390	1.179	.108
75	5.621	1.321	1.149	.094
80	4.540	1.176	1.084	.071
85	3.327	1.018	1.009	.060
90	2.021	.864	.930	.045
95	.788	.712	.844	.025
100	0	.570	.755	0
L. E. radius: 1.523 percent c				

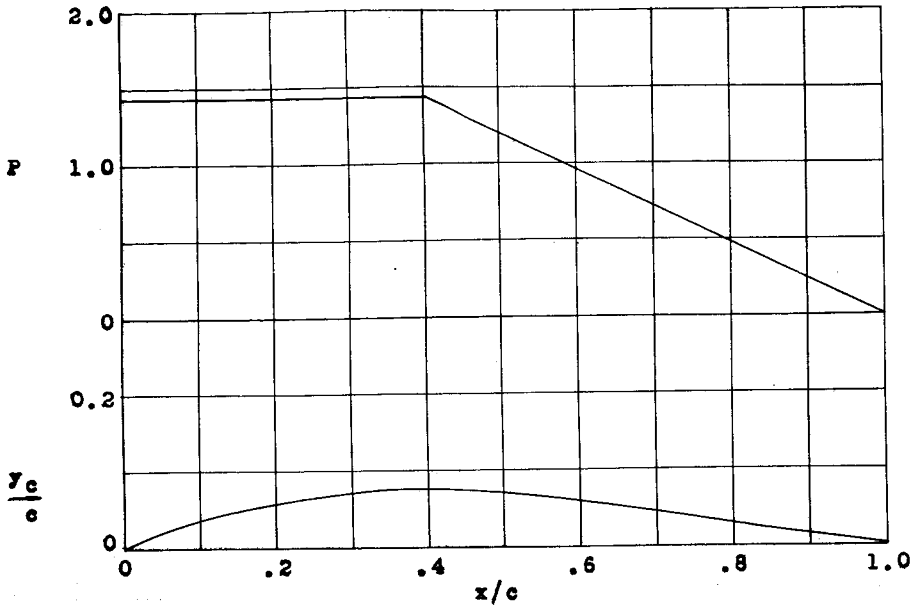
NACA 67,1-015 basic thickness form

II. - MEAN LINES



$c_{l_i} = 1.0$	$\alpha_i = 3.84^\circ$	$c_{m_{c/4}} = -0.106$		
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	--------	-----	-----------
.5	.390	0.65540		
.75	.545	.60525		
1.25	.835	.54160		
2.5	1.450	.45405		
5.0	2.455	.36350		
7.5	3.295	.30785	1.538	0.385
10	4.010	.26625		
15	5.170	.20250		
20	6.050	.15070		
25	6.685	.10280		
30	7.070	.04835		
35	7.175	-.00205	1.429	.357
40	7.075	-.03710	1.319	.330
45	6.815	-.06495	1.209	.302
50	6.435	-.08745	1.099	.275
55	5.950	-.10570	.989	.247
60	5.385	-.12015	.879	.220
65	4.755	-.13120	.769	.192
70	4.080	-.13900	.659	.165
75	3.370	-.14365	.549	.137
80	2.645	-.14500	.440	.110
85	1.925	-.14280	.330	.082
90	1.225	-.13640	.220	.055
95	.570	-.12430	.110	.028
100	0	-.09905	0	0

Mean line a = 0.3



$c_{l_i} = 1.0$	$\alpha_i = 3.47^\circ$	$c_{m_{c/4}} = -0.121$		
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	--------	-------	----------
.5	.365	0.61755		
.75	.515	.57105		
1.25	.785	.51210		
2.5	1.365	.43105		
5.0	2.330	.34760		
7.5	3.135	.29670		
10	3.825	.25890	1.429	0.357
15	4.970	.20185		
20	5.860	.15680		
25	6.545	.11730		
30	7.035	.07985		
35	7.340	.04135		
40	7.440	-.00725		
45	7.275	-.05325	1.310	.327
50	6.930	-.08385	1.190	.298
55	6.450	-.10735	1.071	.268
60	5.860	-.12570	.952	.238
65	5.200	-.13965	.833	.208
70	4.475	-.14965	.714	.179
75	3.705	-.15590	.595	.149
80	2.920	-.15840	.476	.119
85	2.130	-.15685	.357	.089
90	1.360	-.15065	.238	.060
95	.635	-.13820	.119	.030
100	0	-.11140	0	0

Mean line a = 0.4

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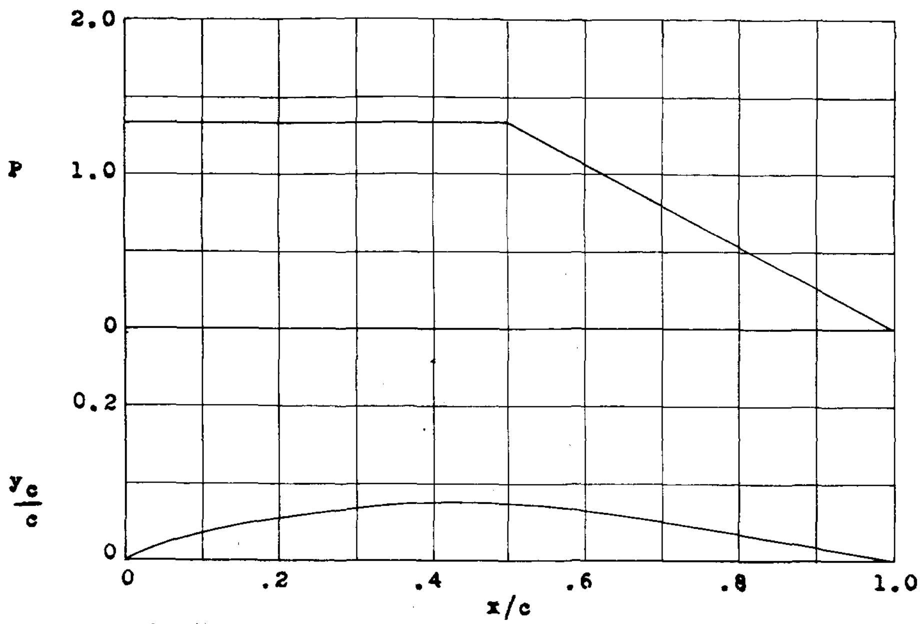
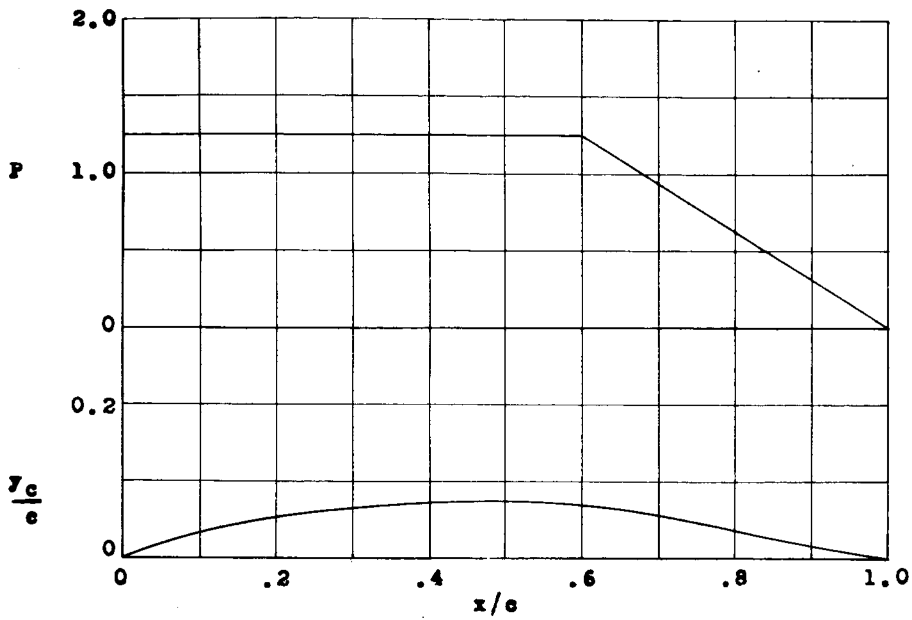


$c_{l_i} = 1.0$	$\alpha_i = 3.04^\circ$		$c_{m_{c/4}} = -0.139$	
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	--------	--------	----------
.5	.345	0.58195		
.75	.485	.53855		
1.25	.735	.48360		
2.5	1.295	.40815		
5.0	2.205	.33070		
7.5	2.970	.28365		
10	3.630	.24890		
15	4.740	.19690	1.333	0.333
20	5.620	.15650		
25	6.310	.12180		
30	6.840	.09000		
35	7.215	.05930		
40	7.430	.02800		
45	7.490	-.00630		
50	7.350	-.05305		
55	6.965	-.09765	1.200	.300
60	6.405	-.12550	1.067	.267
65	5.725	-.14570	.933	.233
70	4.955	-.16015	.800	.200
75	4.130	-.16960	.667	.167
80	3.265	-.17435	.533	.133
85	2.395	-.17415	.400	.100
90	1.535	-.16850	.267	.067
95	.720	-.15565	.133	.033
100	0	-.12660	0	0

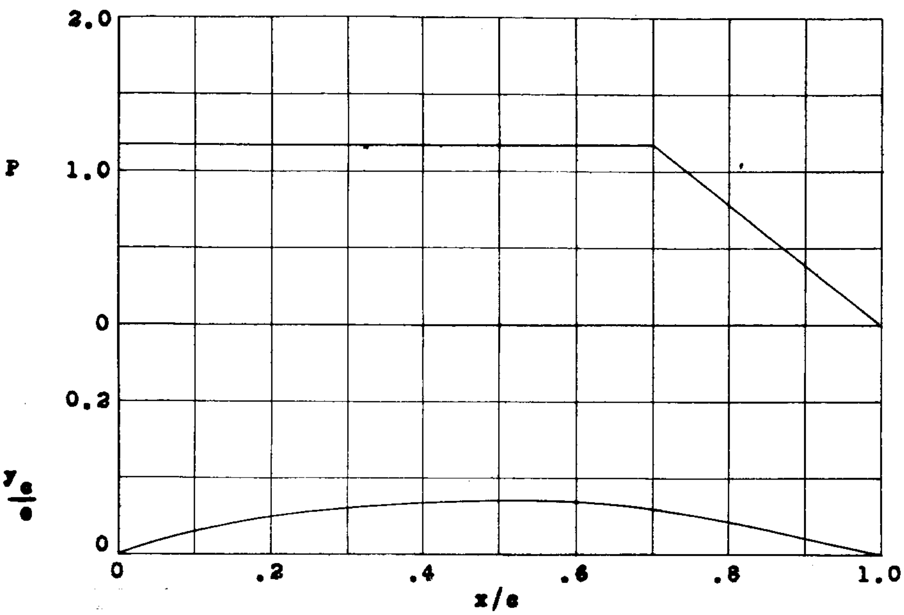
Mean line $a = 0.5$



$c_{l_i} = 1.0$ $\alpha_i = 2.58^{\circ}$ $c_{m_{c/4}} = -0.158$

x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	-------	-----	--------
.5	.325	0.54825		
.75	.455	.50760		
1.25	.695	.45615		
2.5	1.220	.38555		
5.0	2.080	.31325		
7.5	2.805	.26950		
10	3.435	.23730		
15	4.495	.18935		
20	5.345	.15250	1.250	0.312
25	6.035	.12125		
30	6.570	.09310		
35	6.965	.06660		
40	7.235	.04060		
45	7.370	.01405		
50	7.370	-.01435		
55	7.220	-.04700		
60	6.880	-.09470		
65	6.275	-.14015	1.094	.273
70	5.505	-.16595	.938	.234
75	4.630	-.18270	.781	.195
80	3.695	-.19225	.625	.156
85	2.720	-.19515	.469	.117
90	1.755	-.19095	.312	.078
95	.825	-.17790	.156	.039
100	0	-.14550	0	0

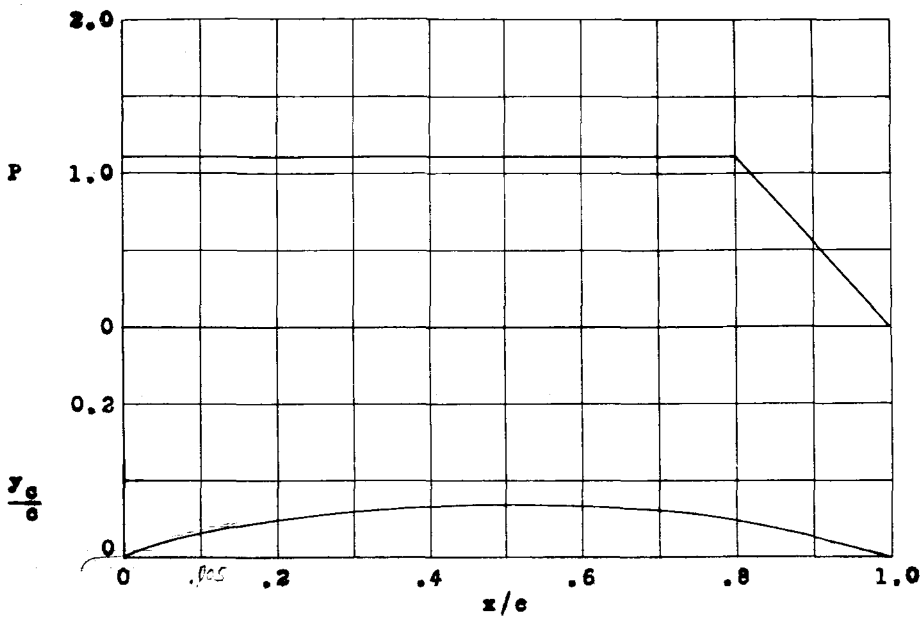
Mean line a = 0.6



$c_{l_i} = 1.0$ $\alpha_i = 2.09^\circ$ $c_{m_{c/4}} = -0.179$

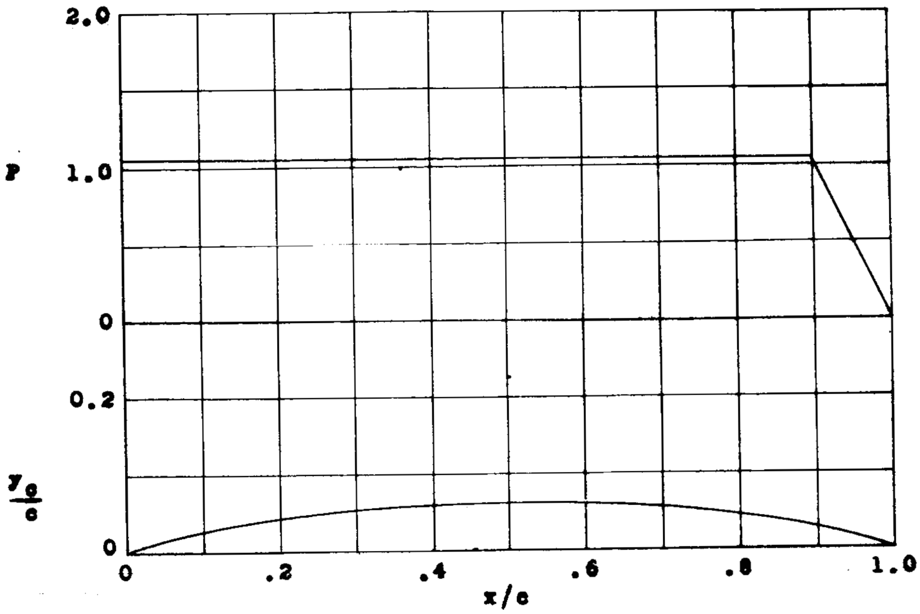
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	————	————	————
.5	.305	0.51620		
.75	.425	.47795		
1.25	.655	.42960		
2.5	1.160	.36325		
5.0	1.955	.29545		
7.5	2.645	.25450		
10	3.240	.22445		
15	4.245	.17995		
20	5.060	.14595		
25	5.715	.11740	1.176	0.294
30	6.240	.09200		
35	6.635	.06840		
40	6.925	.04570		
45	7.095	.02315		
50	7.155	0		
55	7.090	−.02455		
60	6.900	−.05185		
65	6.565	−.08475		
70	6.030	−.13650		
75	5.205	−.18510	.980	.245
80	4.215	−.20855	.784	.196
85	3.140	−.21955	.588	.147
90	2.035	−.21960	.392	.098
95	.965	−.20725	.196	.049
100	0	−.16985	0	0

Mean line a = 0.7



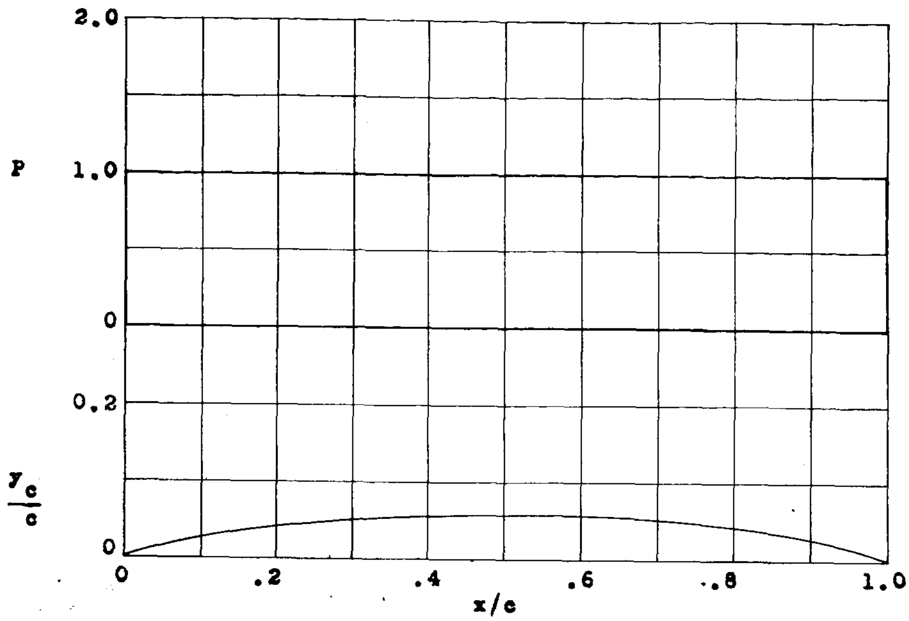
$c_{l_i} = 1.0$ $\alpha_i = 1.54^\circ$ $c_{m_{c/4}} = -0.202$				
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	———	———	———
.5	.290	0.48540	1.111	0.278
.75	.405	.44930		
1.25	.615	.40365		
2.5	1.075	.34115		
5.0	1.835	.27730		
7.5	2.480	.23875		
10	3.030	.21080		
15	3.990	.16880		
20	4.740	.13740		
25	5.370	.11100		
30	5.865	.08765		
35	6.260	.06630		
40	6.530	.04590		
45	6.715	.01910		
50	6.785	.00620		
55	6.765	−.01430		
60	6.645	−.03605		
65	6.420	−.06005		
70	6.040	−.08780		
75	5.500	−.12300		
80	4.770	−.18405		
85	3.760	−.23920	.833	.208
90	2.430	−.25595	.556	.139
95	1.100	−.24905	.278	.069
100	0	−.20380	0	0

Mean line a = 0.8



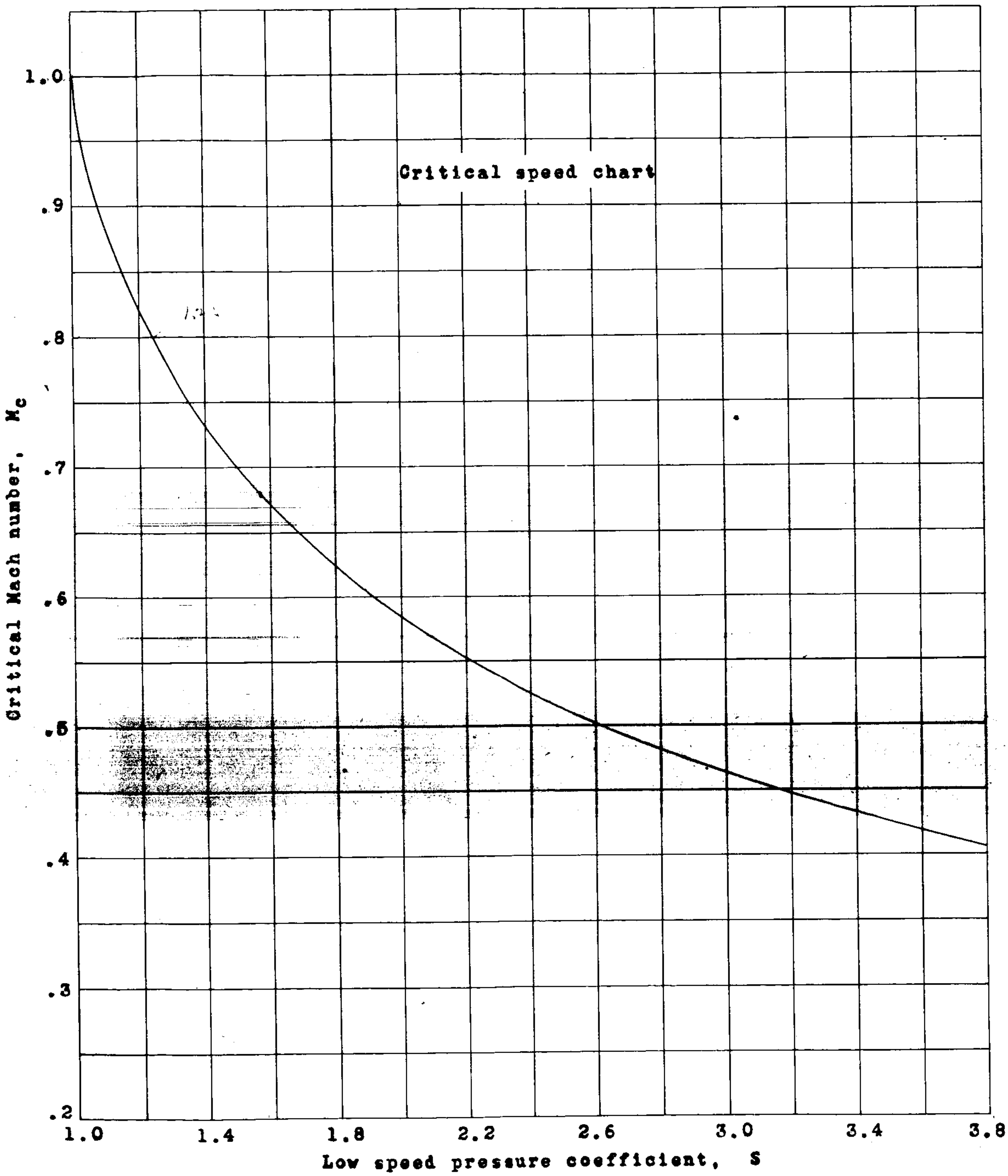
$c_{l_i} = 1.0$	$\alpha_i = 0.91^\circ$	$c_{m_{c/4}} = -0.225$		
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0			
.5				
.75				
1.25	.575	0.37730		
2.5	1.010	.31810		
5.0	1.720	.25775		
7.5	2.320	.22145		
10	2.840	.19490		
15	3.705	.15590		
20	4.410	.12640		
25	4.980	.10190		
30	5.430	.08045		
35	5.785	.06080	1.053	0.263
40	6.045	.04230		
45				
50	6.290	.00675		
55				
60	6.175	-.02970		
65				
70	5.680	-.07105		
75				
80	4.710	-.12605		
85	3.985	-.16725		
90	2.980	-.25200		
95	1.495	-.31460	.526	.132
100	0	-.26085	0	0

Mean line a = 0.9



$c_{l_i} = 1.0$	$\alpha_i = 0°$	$c_{m_{c/4}} = -0.250$		
x (percent c)	y_c (percent c)	dy_c/dx	P	$\Delta u/V = P/4$
0	0	———	———	———
.5	.250	0.42120	1.000	0.250
.75	.350	.38875		
1.25	.535	.34770		
2.5	.930	.29155		
5.0	1.580	.23430		
7.5	2.120	.19995		
10	2.585	.17485		
15	3.365	.13805		
20	3.980	.11030		
25	4.475	.08745		
30	4.860	.06745		
35	5.150	.04925		
40	5.355	.03225		
45	5.475	.01595		
50	5.515	0		
55	5.475	-.01595		
60	5.355	-.03225		
65	5.150	-.04925		
70	4.860	-.06745		
75	4.475	-.08745		
80	3.980	-.11030		
85	3.365	-.13805		
90	2.585	-.17485		
95	1.580	-.23430		
100	0	———	———	———

Mean line a = 1.0



Curve calqulated from equations (8) and (62) of article entitled "Compressibility Effects in Aerodynamics" by Th. von Karmán in the Journal of Aeronautical Science, vol. 8, no. 9, July 1941, pp. 337-356 (reference 5 in the report).

III. - AIRFOIL SECTION CHARTS

(a) Nonroutine tests

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[redacted]

December 21, 1942

NACA 63(420)-422 and NACA 63(420)-517.- The addition of the number 20 enclosed in parenthesis with the low-drag-range index for the section designation in charts NACA 63(420)-422 and NACA 63(420)-517 indicates that these sections were obtained by scaling the ordinates of the NACA 63,4-020 basic section. Thus, the section designation NACA 63(420)-517 may be interpreted as follows: The NACA 63,4-517 airfoil derived from the NACA 63,4-020 basic section. The altered thickness of the derived section leads, as one would expect, to a change in the low-drag range of the derived section as compared with that of the basic section. The 4 indicating the low-drag range in the original designation is replaced by (420) indicating that the low-drag range was ±0.4 when the thickness was 20 percent. The parenthesis is employed to emphasize the fact that the low-drag range index does not apply to the altered airfoil. For the example mentioned, NACA 63(420)-517, the theoretical low-drag range is probably less than ±0.3.

This extension to the numbering system will be generally employed henceforth to designate such altered airfoils.

NACA 65_2-415, 65_3-418, and 65_4-421.- Three charts are being included (December 1942) to represent a family of NACA 65-series airfoils of varying thickness. Data on the basic thickness forms NACA 65_2-015, 65_3-018, and 65_4-021 are also given (pp. 7a, 7b, and 7c, respectively). These represent related thickness forms largely based on the older form NACA 65,3-018, but the NACA 65_3-018 section differs slightly from the older airfoil. Members of the thickness series are therefore distinguished by the use of the subscript numerals.

Copy No. 62

[redacted]

August 22, 1942

<u>NACA 65,2-215, a = 0.5 (approx.)</u>.- The results presented in the chart NACA 65,2-215, a = 0.5 (approx.) were obtained from tests of a section of a wing defined by straight-line fairing between root and tip. The section tested was taken close to the section NACA 65,2-215, a = 0.5 and closely approximates this section. The section was tested before installation of lift-measuring equipment, and the lift data presented were obtained by integration of pressure distributions to obtain normal- and chord-force components. The maximum lift coefficients presented may be low because of difficulty experienced in the early tests in properly sealing the gaps between the model ends and the tunnel walls.

<u>NACA 65,2-215, a = 0.5 (approx.), with 0.21c plain flap</u>.- The effects of a 0.21c plain flap, or aileron, on the characteristics of the approximate NACA 65,2-215, a = 0.5, section are shown by the chart NACA 65,2-215, a = 0.5 (approx.), with 0.21c plain flap. The flap, or aileron, was hinged at the lower surface. This model was tested before installation of lift-measuring apparatus, and normal-force coefficients obtained from integration of pressure distributions are presented instead of lift coefficients for all conditions except flap neutral at a Reynolds number of 6.7×10^6. For this one condition, lift coefficients are presented as obtained from integration of pressure distributions to obtain both normal- and chord-force components. The maximum lift or normal-force coefficients presented may be too low because of imperfectly sealed gaps between the model ends and the tunnel walls.

The drag-coefficient curve presented was obtained with the flap, or aileron, slot sealed with modeling clay at the upper surface. With the slot open, a check made between $c_l = 0.1$ and $c_l = 0.7$ showed little deviation from the curve presented.

<u>NACA 65(216)-222 (approx.)</u>.- The results presented in the chart NACA 65(216)-222 (approx.) were obtained from routine tests of a section of a wing defined by straight-line fairing between root and tip. The section tested was outboard from an NACA 65(216)-222 root section and resembles the NACA 65(216)-222 section. The root section was obtained by thickening the basic NACA 65,2-016 section and is a rather extreme example of such change in thickness.

 Copy No. 62

[redacted]

November 5, 1942

<u>NACA 65(223)-422, a = 1.0 (approx.)</u>.- The chart of the NACA 65(223)-422, a = 1.0 (approx.) gives the test results of a wing root section which was slightly modified. The "(approx.)" in the airfoil designation, NACA 65(223)-422, a = 1.0 (approx.), refers to a small thickening near the trailing edge of the NACA 65(223)-422, a = 1.0, airfoil.

<u>NACA 65,3-018</u>.- The results originally presented in the chart NACA 65,3-018 (test: TDT 100) have been replaced by the chart NACA 65,3-018 (test: TDT 159, 212, and 214). The effects of model inaccuracies have thus been removed so that the chart now gives standard test results.

<u>NACA 66,2-118 with 0.25c slotted flap</u>.- The chart NACA 66,2-118 with 0.25c slotted flap presents characteristics of a 0.25c slotted flap, which otherwise is similar to the flap of chart NACA 66,2-216, a = 0.6, with 0.30c slotted flap. The flap movement was such as to keep the slot closed when the flap was extended and deflected up to an angle of a little more than 15°. No attempt was made to keep the slot sealed at these low deflections, and there was undoubtedly some slight leakage through the slot. Only two drag points are available with the flap deflected 15° and the resulting gap in the lower surface blocked with modeling-clay dams to prevent spanwise movement of the low-energy air in the gap. The drag curve for this condition was estimated from more nearly complete data available without dams and with the gap entirely filled with modeling clay. Filling the gap failed to improve the drag characteristics.

<u>NACA 66,2-216 with 0.25c plain flap</u>.- The chart NACA 66,2-216 with 0.25c plain flap shows the section characteristics for this combination. The flap, or aileron, was hinged at the lower surface.

NACA 66,2-216, a = 0.6, with 0.17c plain flap.- The chart NACA 66,2-216, a = 0.6, with 0.17c plain flap presents the section characteristics for this combination of airfoil and flap. This flap, or aileron, was hinged on the airfoil mean line and was tested with a rubber seal to prevent flow through the slot. There is reason to believe, however, that some leakage occurred across the seal. This test with flap deflected was made previous to test TDT 40; therefore, the maximum lift coefficients may be too low because of leakage between the model ends and the tunnel walls. The data presented for the plain airfoil were obtained later, and the lift data may be too high by as much as 0.05, as discussed in the report under Tests and Results. These considerations explain the failure of the data to show a proper variation of maximum lift with flap deflection.

NACA 66,2-216, a = 0.6, with 0.20c split flap.- The effects of a 0.20c split flap on the characteristics of a low-drag airfoil are shown in the chart NACA 66,2-216, a = 0.6, with 0.20c split flap. The data presented for flap deflections of 30°, 45°, and 60° were obtained before installation of lift-measuring equipment. For these deflections normal-force coefficients obtained from pressure distributions are presented instead of lift coefficients. It is thought that the maximum normal-force coefficients presented for these flap deflections may be low because of difficulty experienced in the early tests in properly sealing the gaps between the model ends and the tunnel walls. The data for the plain airfoil and for the airfoil with flap deflected 15° were obtained later from routine tests of a new model.

NACA 66,2-216, a = 0.6, with 0.25c hinged slotted flap.- The chart NACA 66,2-216, a = 0.6, with 0.25c hinged slotted flap presents the characteristics of the slotted-flap combination shown in more detail in the accompanying figure. This flap is designed to deflect by rotation about a fixed hinge point. The tests of this combination were routine; however, insufficient data are available to show a reliable drag curve for the flap-retracted condition. Three drag points for this condition are plotted. The gap on the lower surface with flap retracted allows a possible spanwise movement of low-energy air into or away from the wake-survey position. This spanwise movement of air was prevented by dams of modeling clay placed in the gap on each side of the survey plane.

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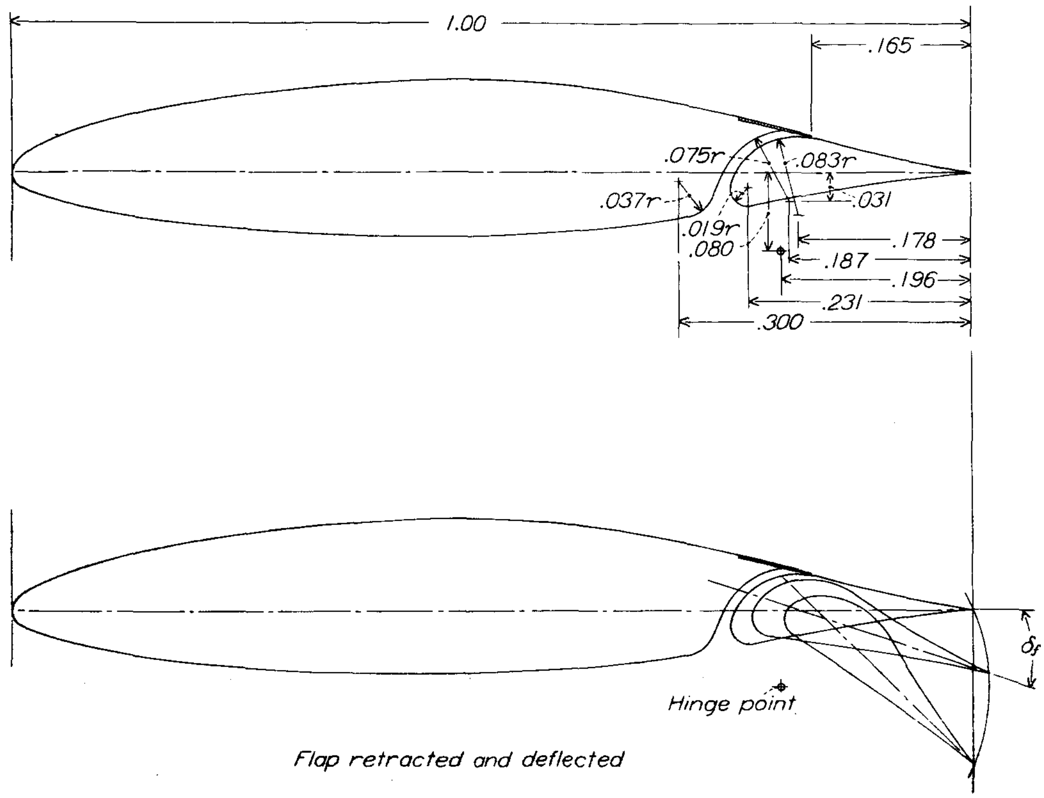
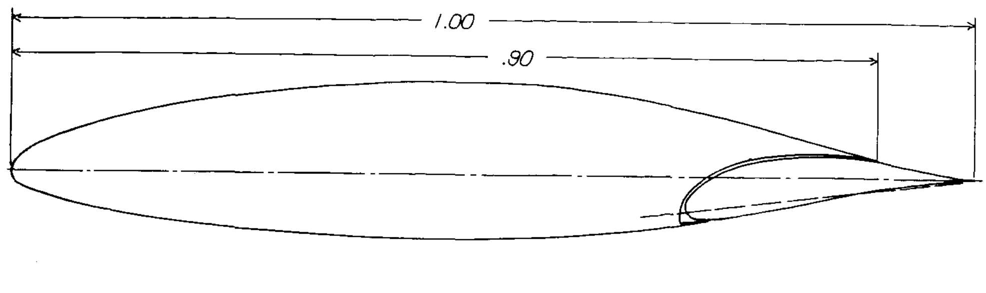
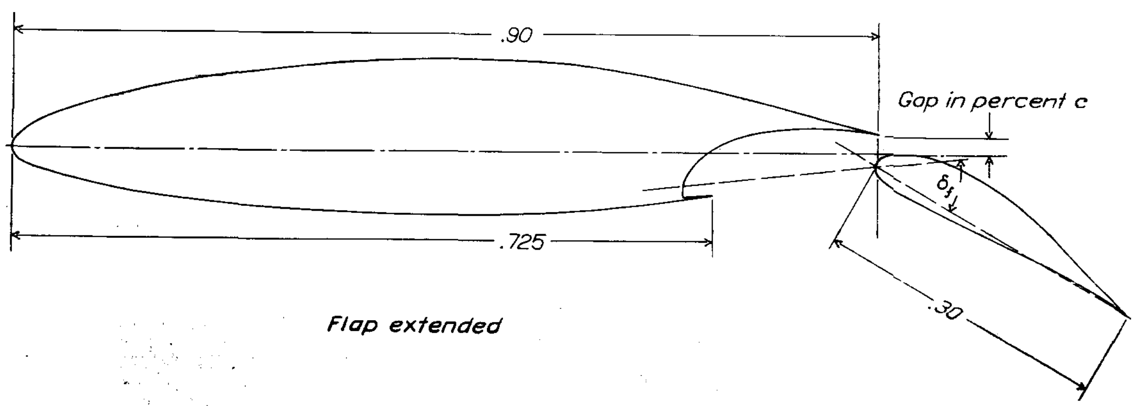


NACA 66,2-216, a = 0.6, with 0.25c hinged slotted flap.

NACA 66,2-216, a = 0.6, with 0.30c slotted flap.- The chart NACA 66,2-216, a = 0.6, with 0.30c slotted flap shows the characteristics of the slotted-flap combination shown in more detail in the accompanying figure. Normal-force coefficients obtained from integration of pressure-distribution diagrams are shown instead of lift coefficients except in the case of the plain-airfoil data shown for comparison. The flap is in the fully extended position for all deflections for which data are presented. Conditions in which the flap was partially deflected indicated very favorable drag characteristics, especially for the case in which the flap was deflected and extended, as with the 0.25c slotted flap, in such a manner as not to open the slot until a deflection of the order of 15° was reached. These data are not presented because the absence of dams made them of doubtful accuracy.



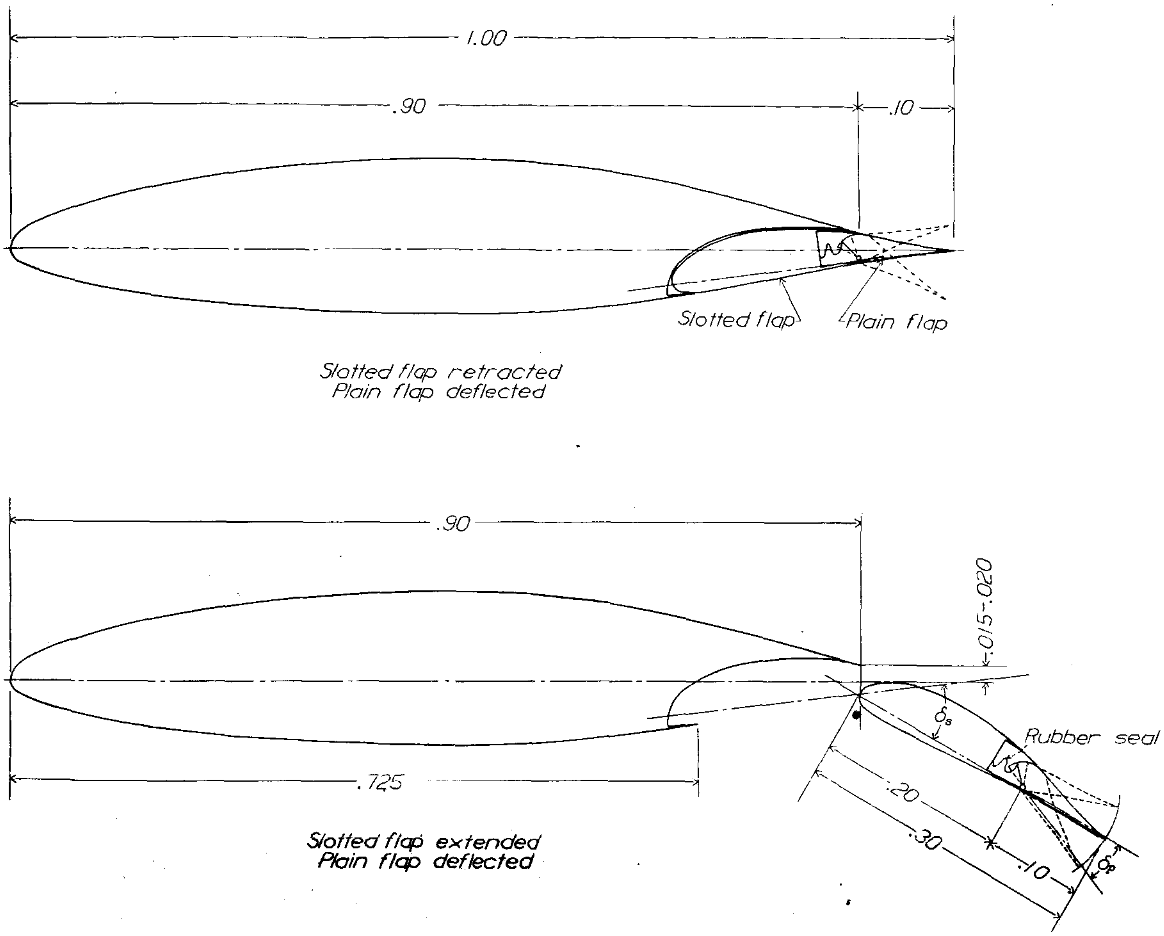
Flap retracted



Flap extended

NACA 66,2-216, a = 0.6, with 0.30c slotted flap

NACA 66,2-216, a = 0.6, with 0.30c slotted and 0.10c plain flap.- The chart NACA 66,2-216, a = 0.6, with 0.30c slotted and 0.10c plain flap presents the characteristics of the combination shown in greater detail in the accompanying figure. This combination is similar to that shown in chart NACA 66,2-216, a = 0.6, with 0.30c slotted flap, except for the addition of a 0.10c plain flap, which forms the rear portion of the slotted flap. The plain flap is hinged on the lower surface and is operable with the slotted flap either retracted or deflected. The plain-flap slot contained a rubber seal to prevent flows through the slot. Maximum lift data from the earlier test, TDT 32, may be too low because of leakage at the airfoil ends and the lift data for the plain airfoil, test TDT 90, may be too high because of the change in lift tares.



Slotted flap retracted
Plain flap deflected

Slotted flap extended
Plain flap deflected

NACA 66,2-216, a = 0.6, with 0.30c slotted and 0.10c plain flap.

NACA 66,2x-415, a = 0.6.- The "x" in the section designation of the airfoil presented in chart NACA 66,2x-415, a = 0.6 indicates that the model tested was built before the derivation of the section was finally judged satisfactory and that the section does not exactly correspond to the final NACA 66,2-415, a = 0.6 section. The lift results presented were obtained from pressure distributions to avoid error from the change in lift tares.

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National Advisory Committee for Aeronautics,
Langley Field, Va.

(b) Charts

Charts not mentioned under the preceding heading (Nonroutine tests) present standard routine test results as described in the report text. Pitching-moment data from tests subsequent to TDT 208 are obtained from the moment balance installed during May 1942.

Charts with the addition of data from tests with a standard roughness.- Most of the low-drag airfoils first investigated were of conservative design and, though the leading edge might become very rough, no very serious separation difficulties should arise in operation with these airfoils. The thickness, the camber, and the position of minimum pressure for these airfoils were so chosen that there would be a conservative pressure recovery over the rearward part of the upper surface. For these conservative airfoils the recovery could be made without marked separation, even in the presence of a boundary layer excessively thickened by premature transition and roughness near the leading edge. Hence, when the conservative low-drag airfoils and conventional airfoils were similarly roughened, it was expected that their drag coefficients would be in the same range.

In some recent applications conservative sections have been increased in thickness (by the application of a factor to the basic section ordinates) to the point that their relation to the conservative range has become, at least, doubtful. The range of conservative airfoil design, as contrasted with the critical range determined by the choice of thickness, camber, and minimum pressure, is discussed in general terms in this report under the section entitled "Description of Airfoils."

Some of these airfoils, considered doubtfully conservative with respect to separation, were tested after the application of a standard roughness to the leading edge. A standard roughness is defined in the NACA Confidential Bulletin by the authors of the present paper, issued in June 1942 and entitled "Investigation of Extreme Leading-Edge Roughness on Thick Low-Drag Airfoils to Indicate Those Critical to Separation." Excerpts from this Bulletin follow:

[redacted]

"It was desired to choose an extreme rough condition as a standard roughness to be applied to the leading edge of the various airfoils and at the same time one that would not alter the contour of the section. The standard roughness might thus simulate an extremely rough condition that might result from mud or rough ice on the leading edge of the airfoil but, of course, could not represent thick ice accumulations of the worst type, which would seriously alter the airfoil contour.

"With such considerations in view, a standard roughness consisting of carborundum particles thinly applied over the leading-edge part of the airfoil was adopted. A microscopic examination of the particles used showed them to be shaped like lumps of coal and to have crosswise dimensions near 0.010 inch and seldom greater than 0.015 inch. The particles were applied to one surface of Scotch tape; the tape was, in turn, attached to the leading edge of the airfoil. The use of Scotch tape in applying the roughness permitted its quick removal for the comparative tests of the smooth airfoil. The carborundum particles were retained on the Scotch tape by a thin coat of shellac allowed to become tacky before the application of the particles. The tape and roughness extended around the leading edge of the airfoil section for a total surface length of $3\frac{13}{16}$ inches, equally disposed above and below the leading edge. The carborundum was so thinly spread on this surface that 5 to 10 percent of the area was actually covered by carborundum grains. The airfoil models were of 2-foot chord and 3-foot span; the roughness strip was extended across the entire span from wall to wall in the tunnel.

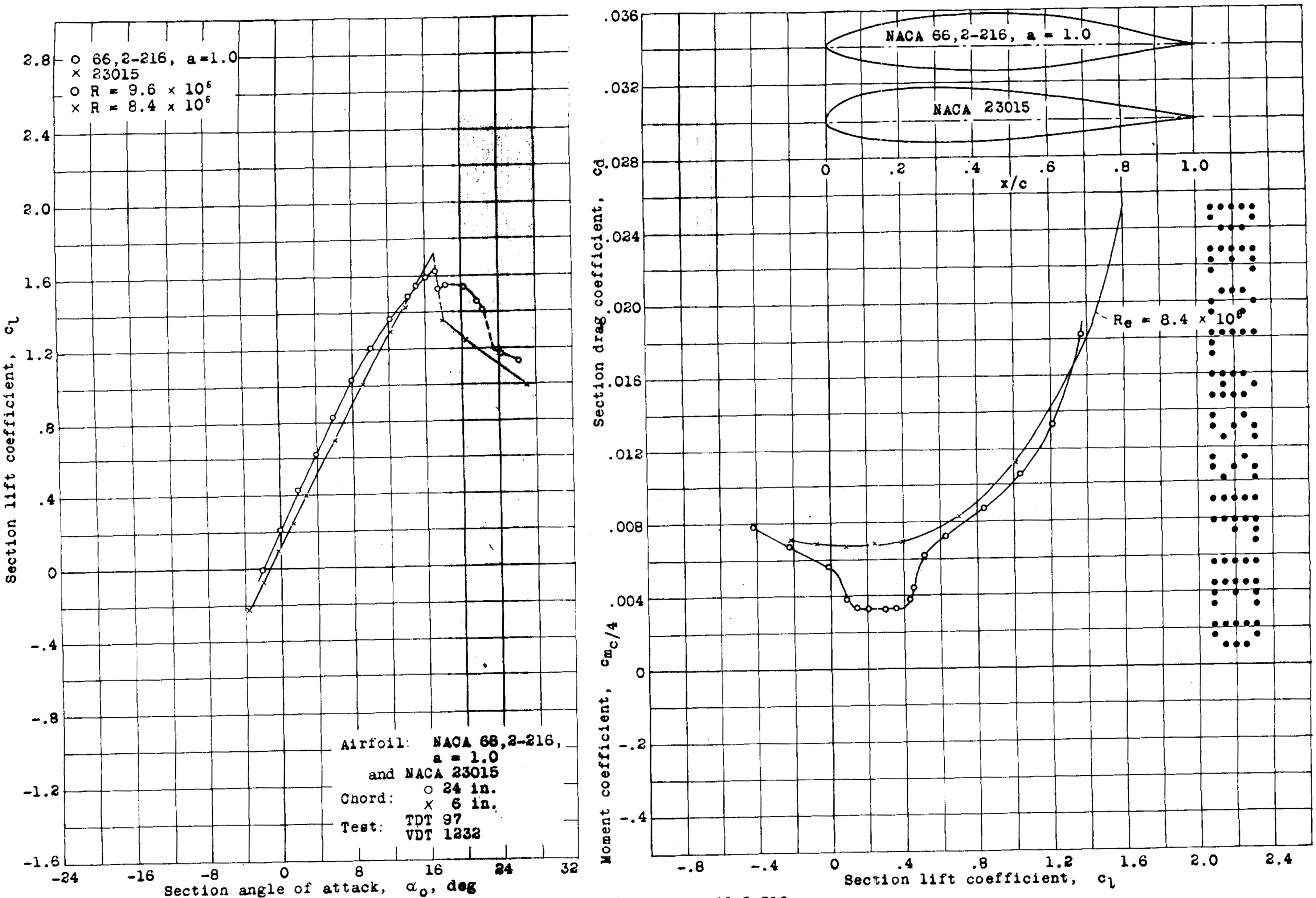
"For the full-scale wing at a Reynolds number corresponding to that of these model tests, the corresponding roughness is geometrically similar to that on the model. The roughness may thus be considered to be something like particles of sand somewhat less than 1/16 inch across adhering to the leading edge of a wing of 100-inch chord. Such roughness conditions, of course, cannot be considered typical but it was hoped that the comparative results of the same roughness on various wings would be of value as representing a standard roughness condition, extreme, but of a type not markedly altering the original airfoil contour."

DECL[redacted]D August 22, 1942

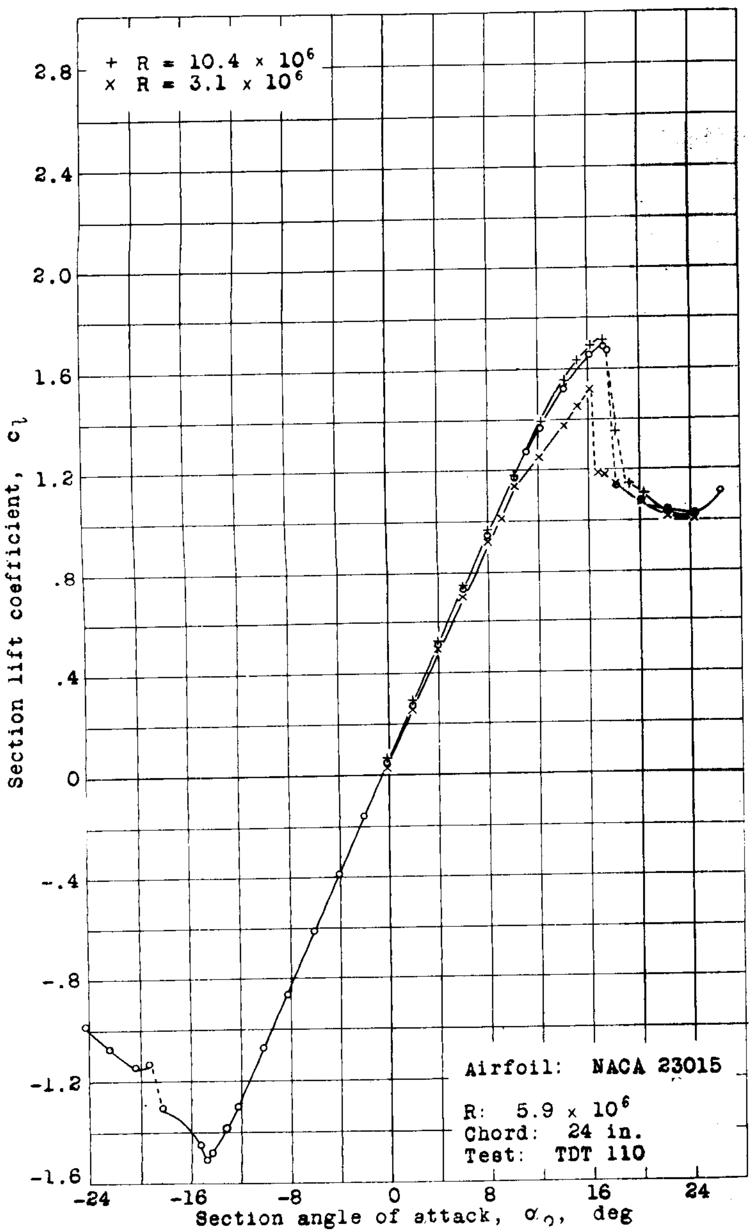
The important roughness data are presented herein as polar curves for each airfoil plotted to a smaller than standard scale (drag coefficient only) on the left-hand part of the standard chart. Such polar curves are presented for both the airfoil smooth and for the airfoil with a standard roughness, and a lift curve for the airfoil with standard roughness is also shown for comparison. These additional curves are shown as thin solid lines without test points, to differentiate them from the other curves.

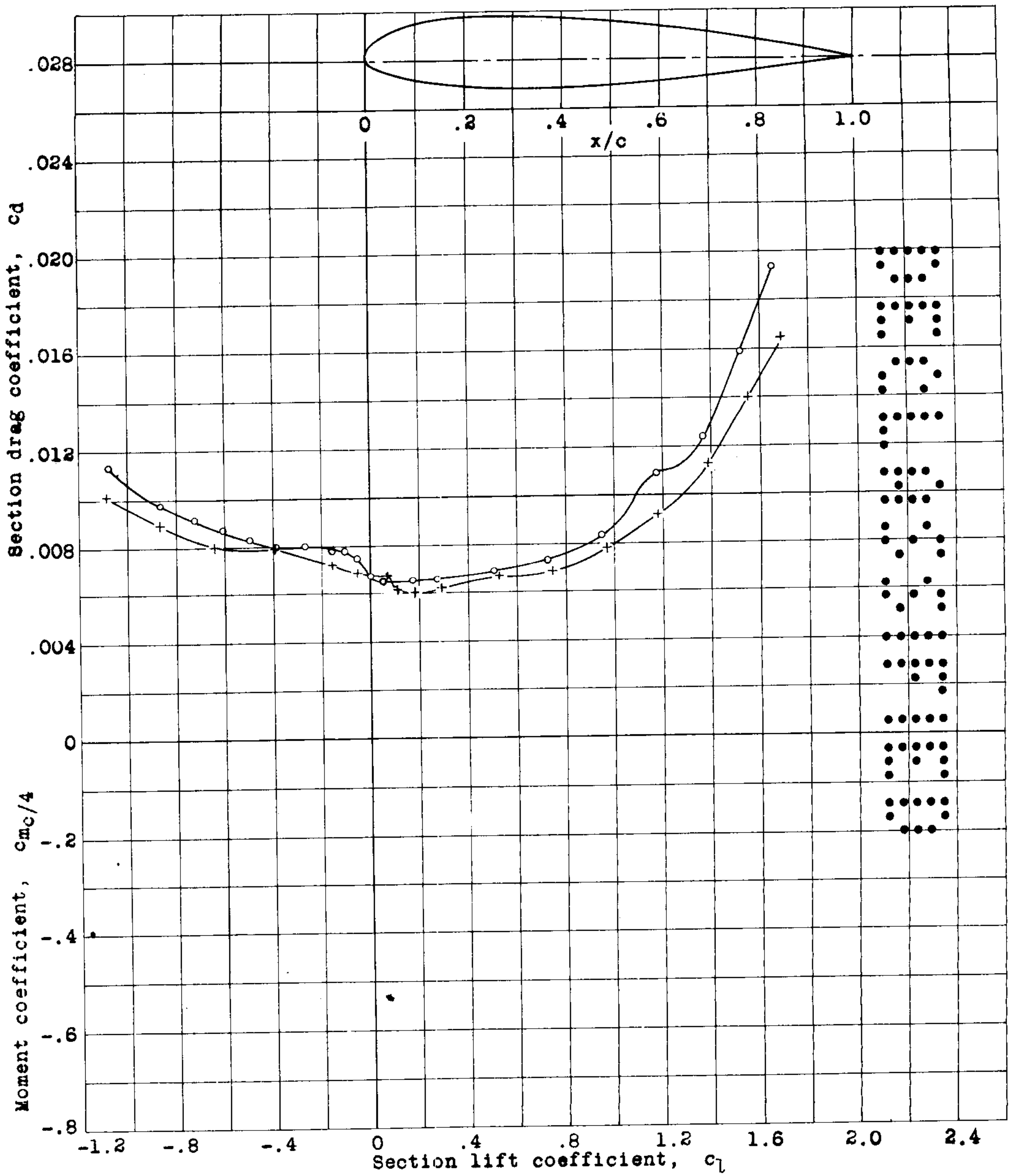
The chart for the NACA 65,3-418 low-drag airfoil gives the characteristics of a low-drag airfoil considered to be of the conservative type while the chart for the NACA 65(216)-222 (approx.) gives the characteristics of a low-drag airfoil considered to be unconservative.

A conventional airfoil, the NACA 23021 with roughness, is used as a basis for comparison as to whether a low-drag airfoil with roughness is to be considered of the conservative or nonconservative type.

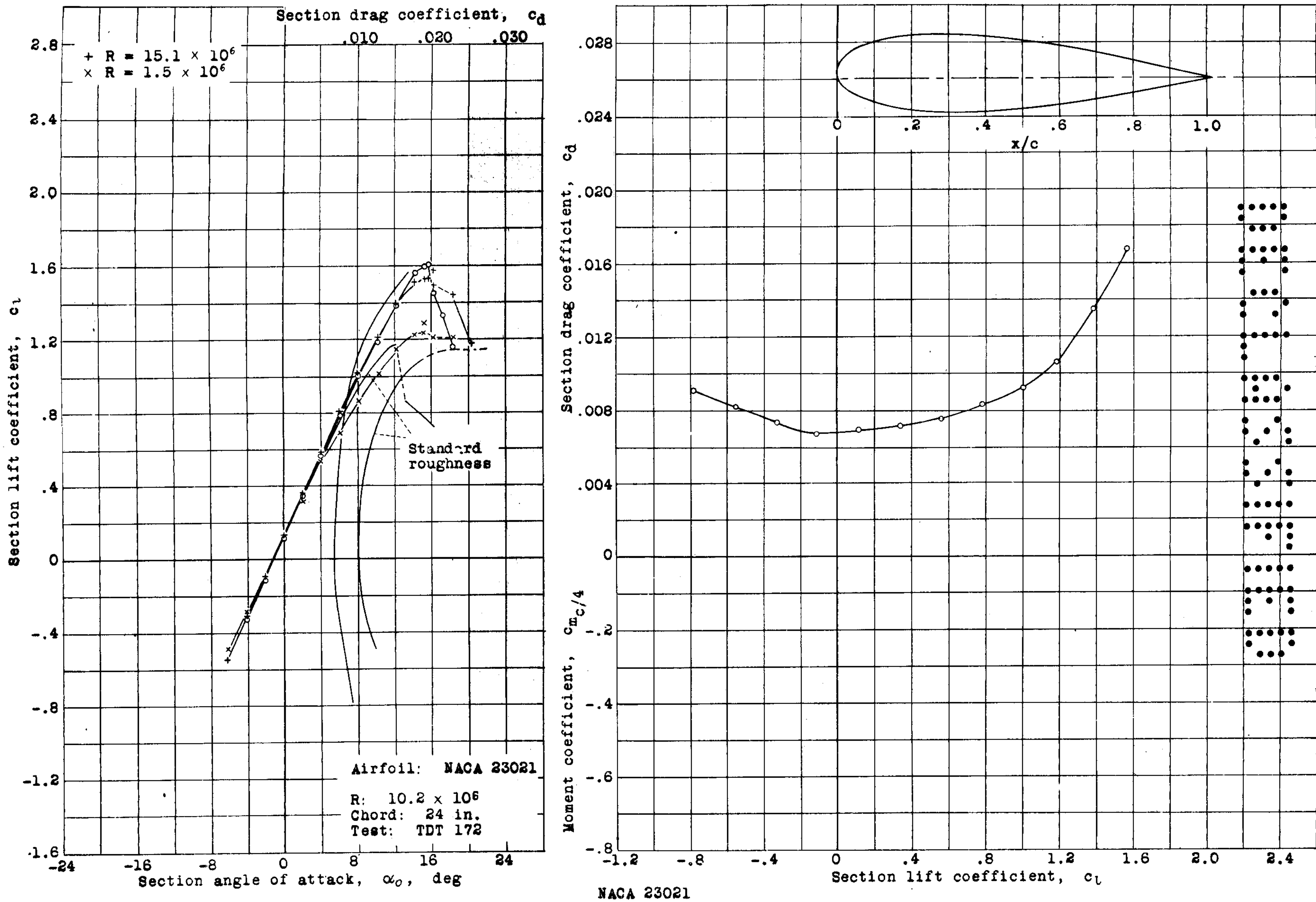


NACA 23015 and NACA 66,2-216


+ R = 10.4 × 10^6
× R = 3.1 × 10^6
Section lift coefficient, c_l
Section angle of attack, α_0, deg
Airfoil: NACA 23015
R: 5.9 × 10^6
Chord: 24 in.
Test: TDT 110


x/c
Section drag coefficient, c_d
Moment coefficient, $c_{m_{c/4}}$
Section lift coefficient, c_l

NACA 23015



NACA 23021

August 22, 1942

33a

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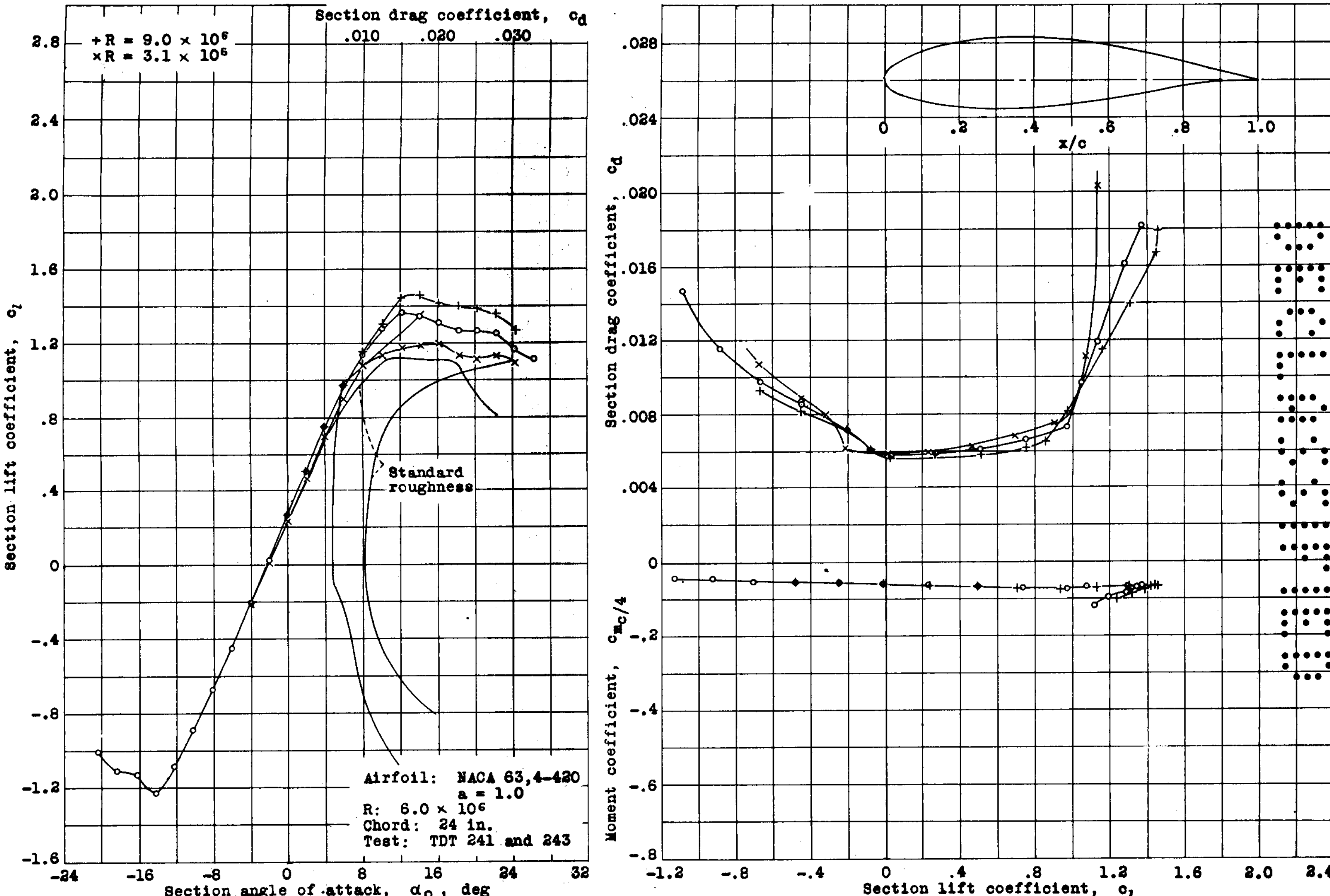

NACA 63,4-420

August 22, 1943

33b

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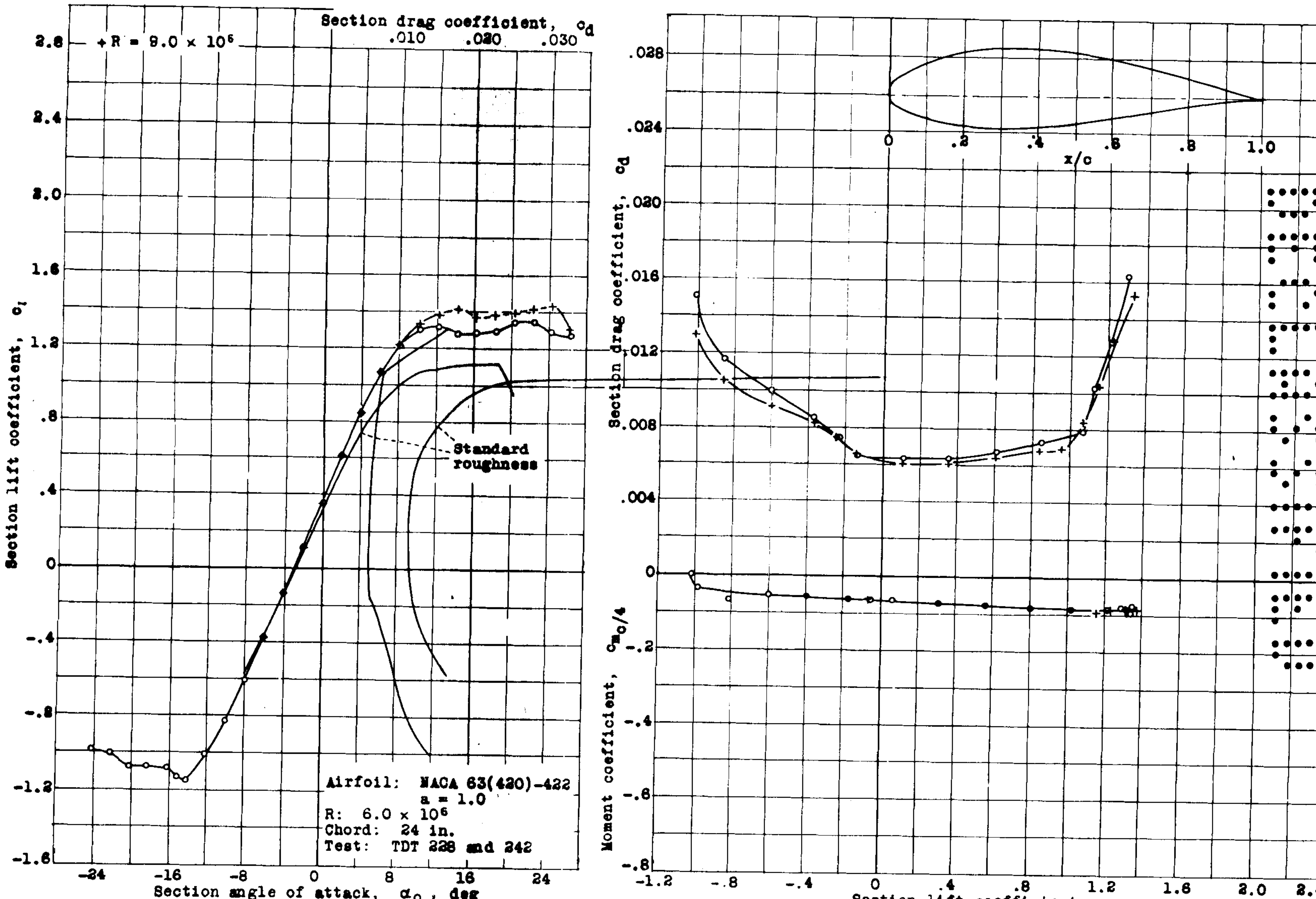
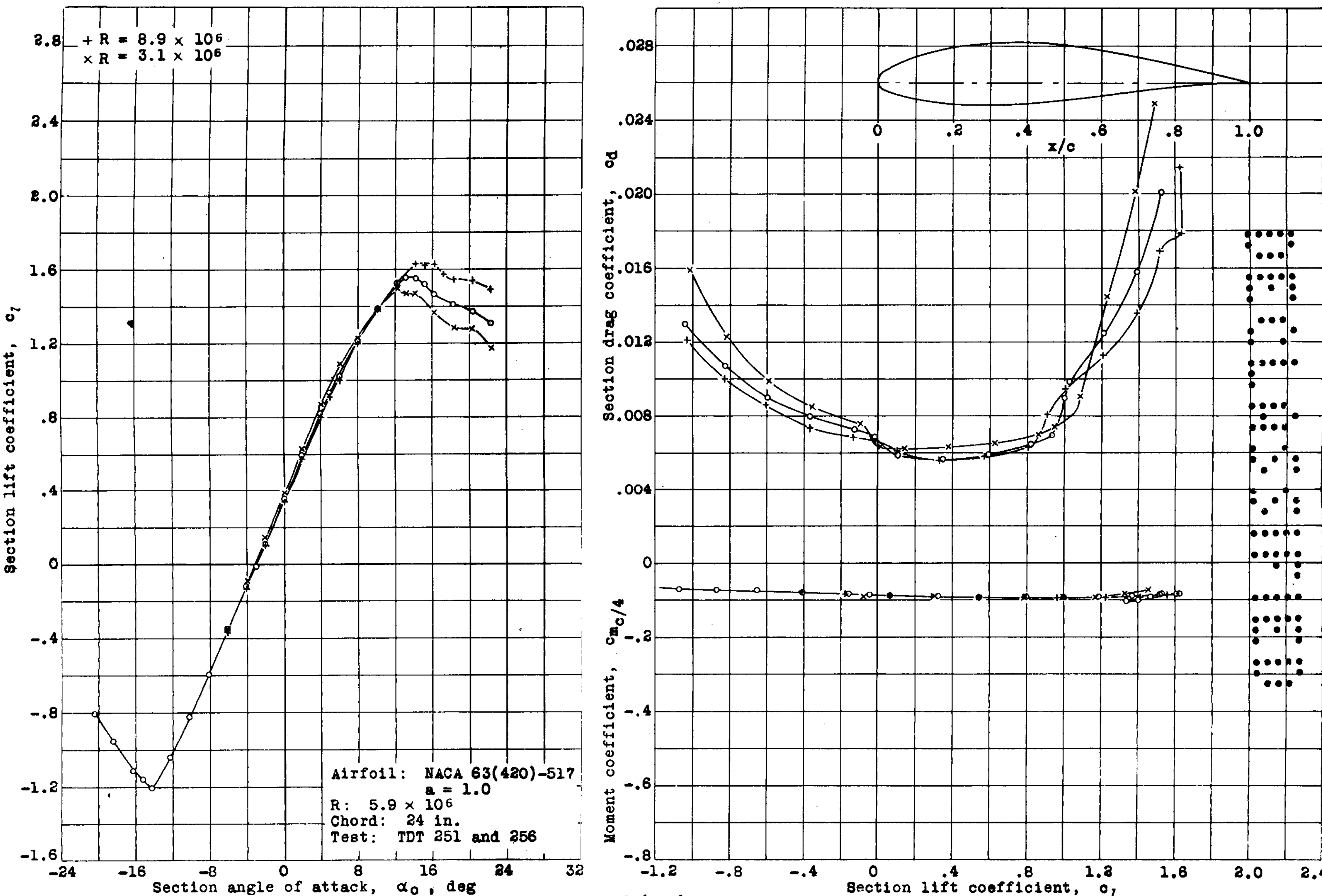


NACA 63(420)-422

November 5, 1948

33c

COPY NO. 62

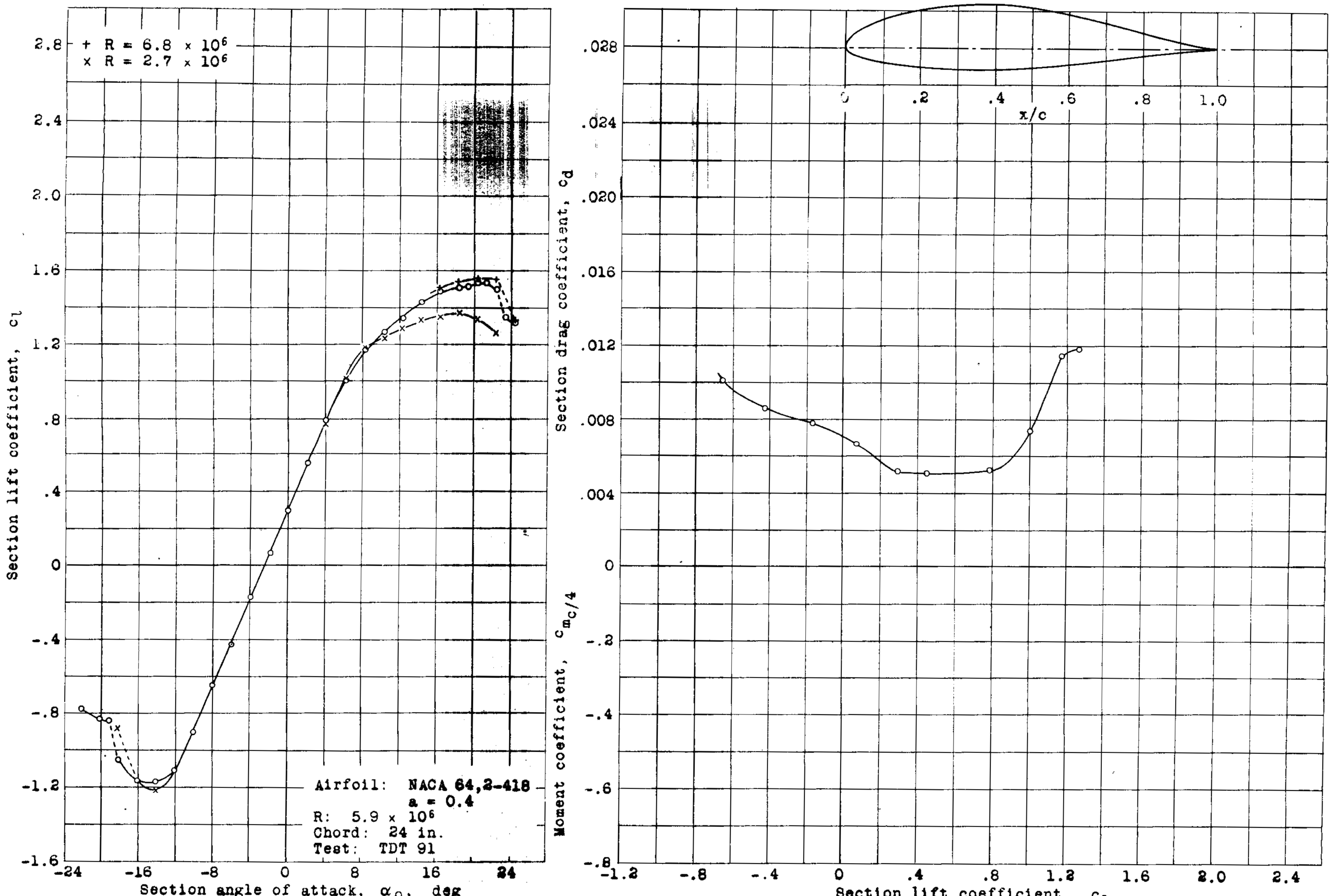


NACA 63(420)-517

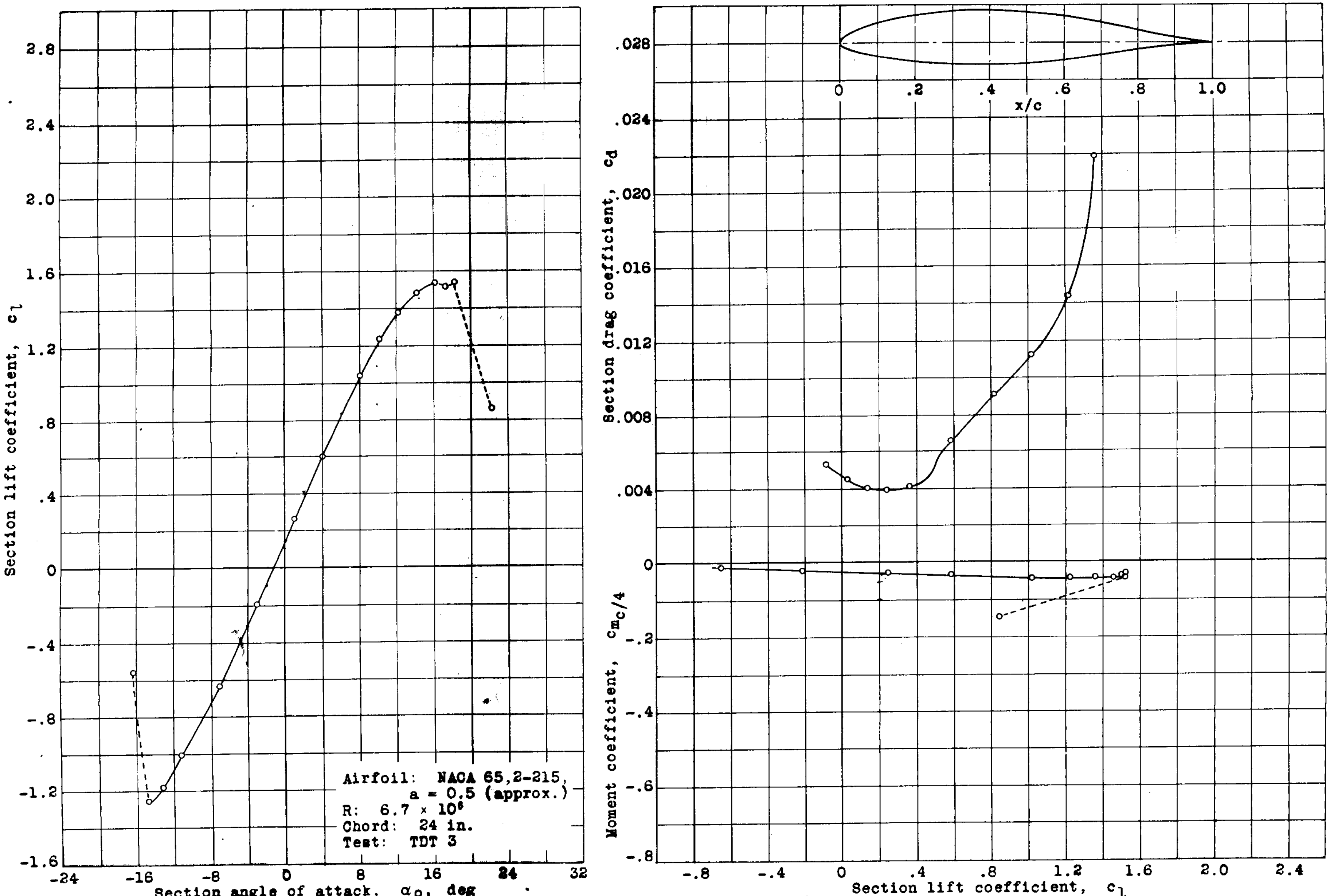
August 22, 1942

33d

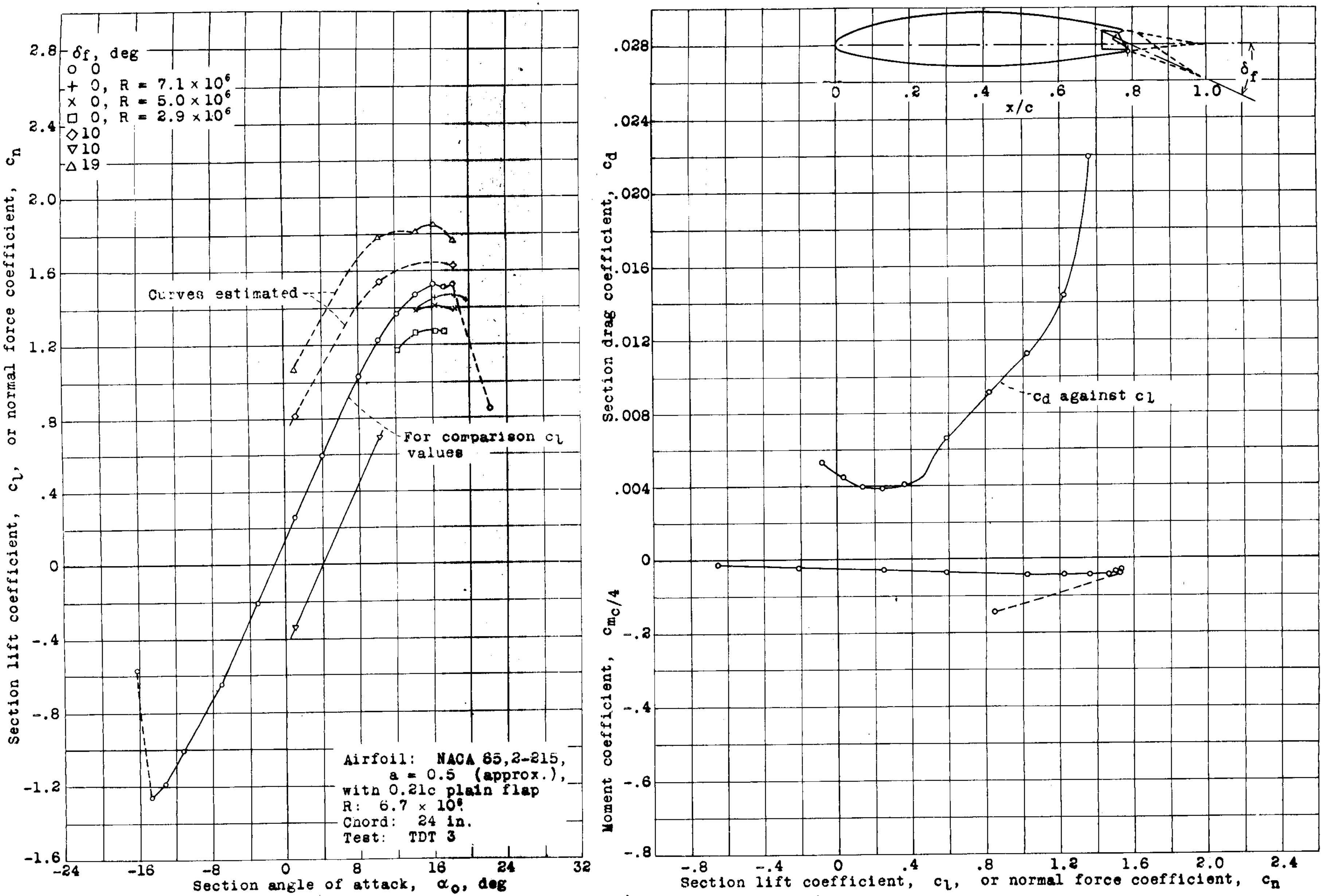
Copy No. 62



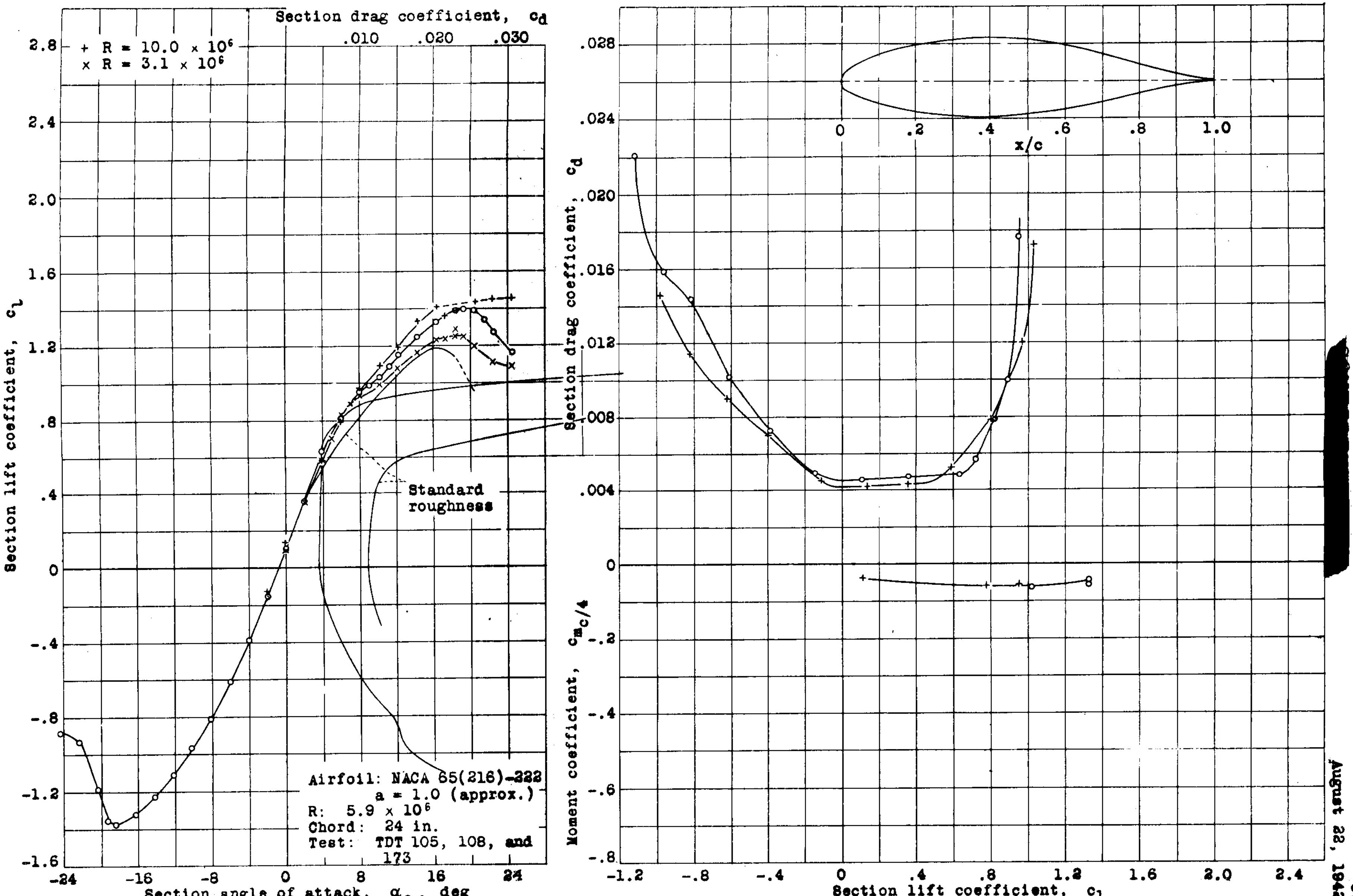
NACA 64,2-418, a = 0.4



NACA 65,2-215, a = 0.5 (approx.)



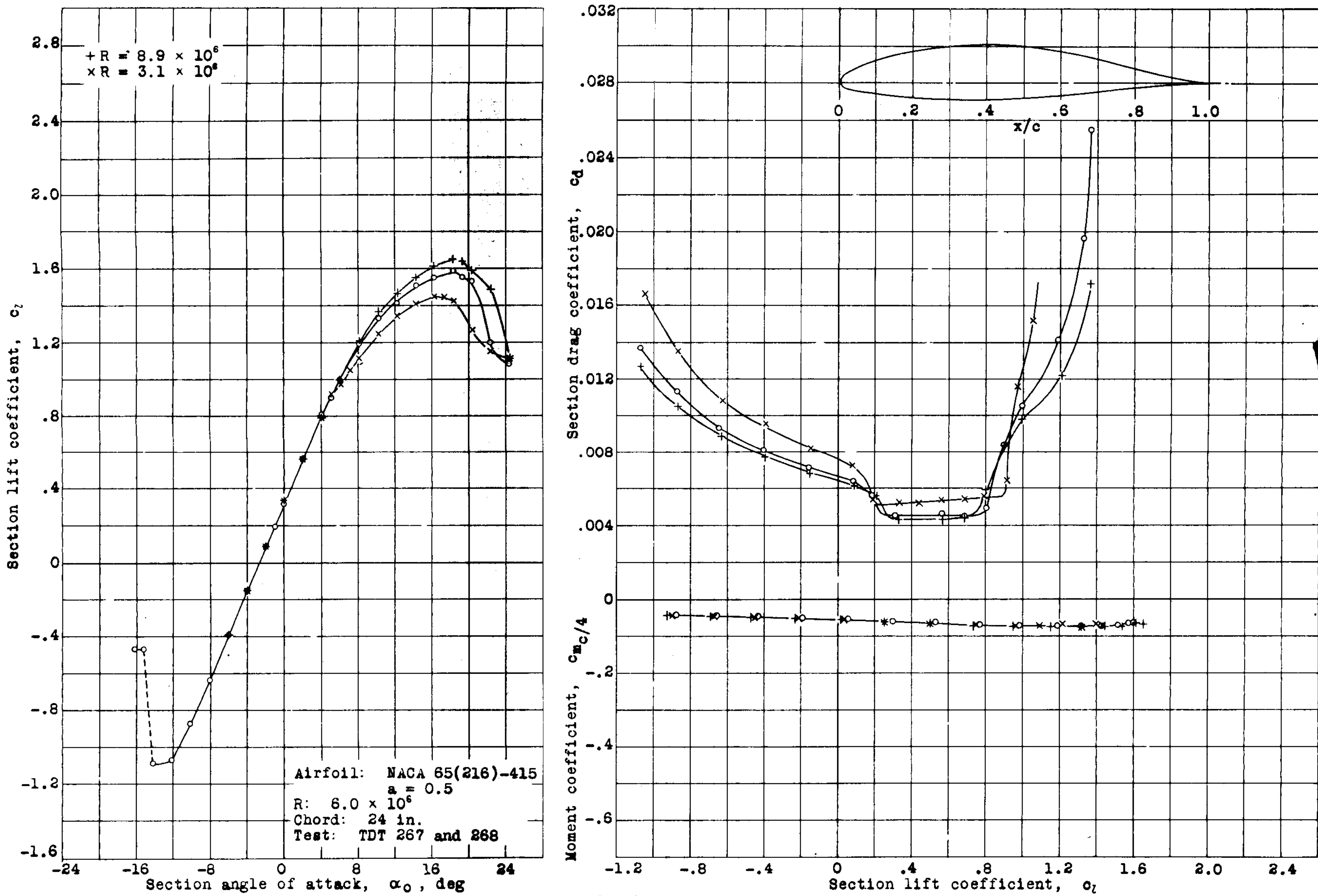
NACA 65,2-215, a = 0.5 (approx.), with 0.21c plain flap



NACA 65(216)-222 (approx.)

August 22, 1942

Copy No. 62



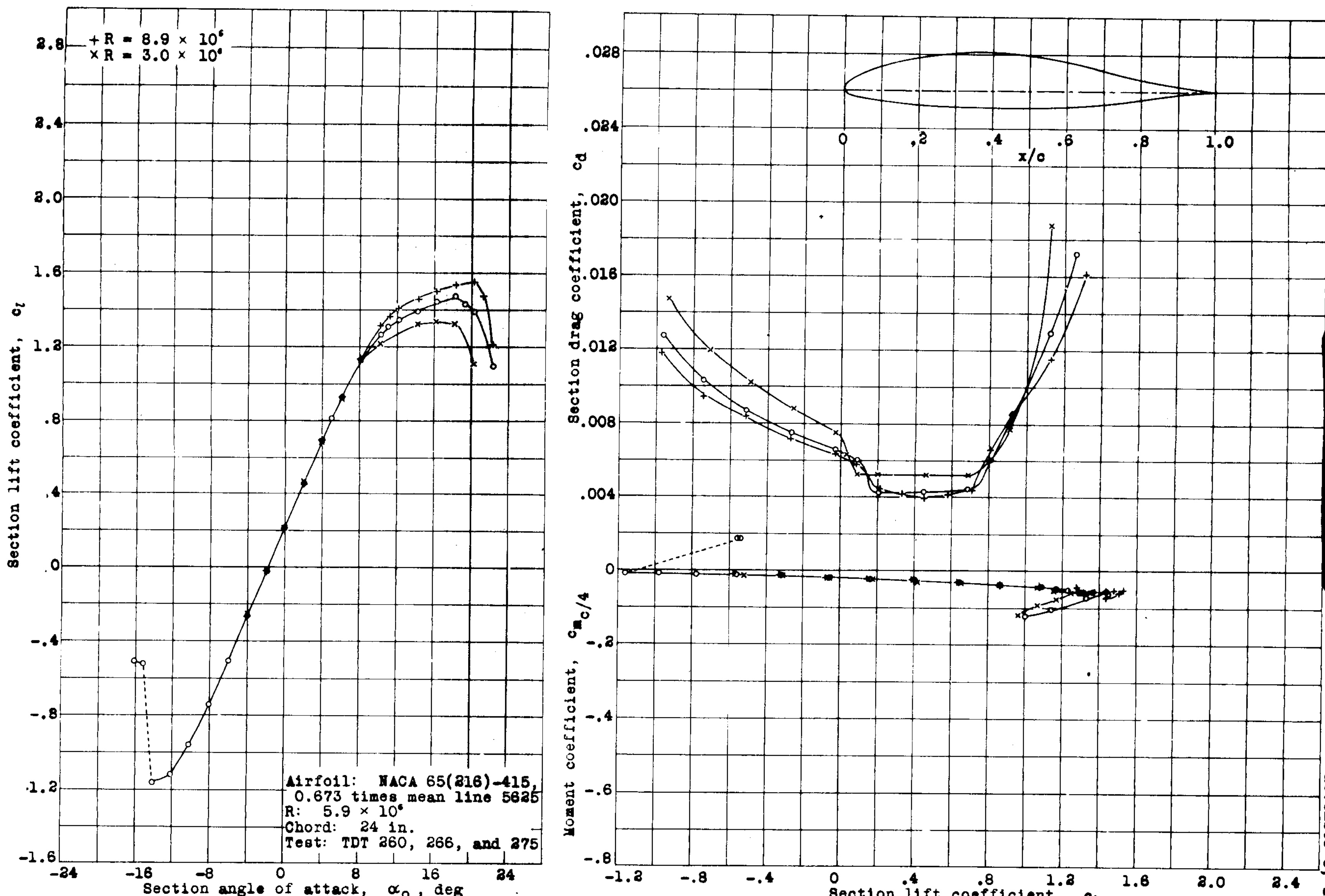
NACA 65(216)-415, a = 0.5

[redacted]

November 5, 1942

38

COPY NO. 62



NACA 65(216)-415, 0.673 times mean line 5625

November 5, 1942

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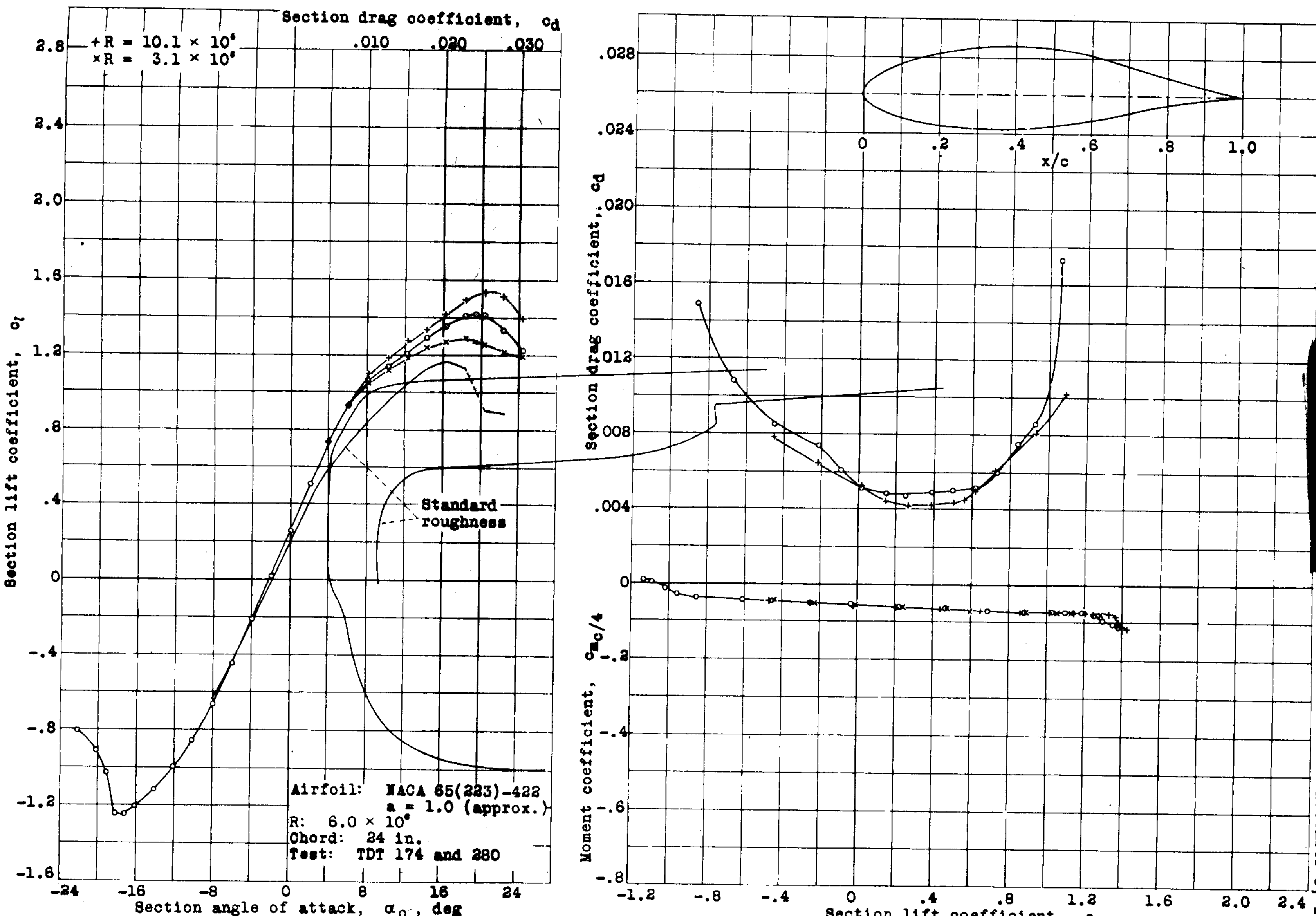
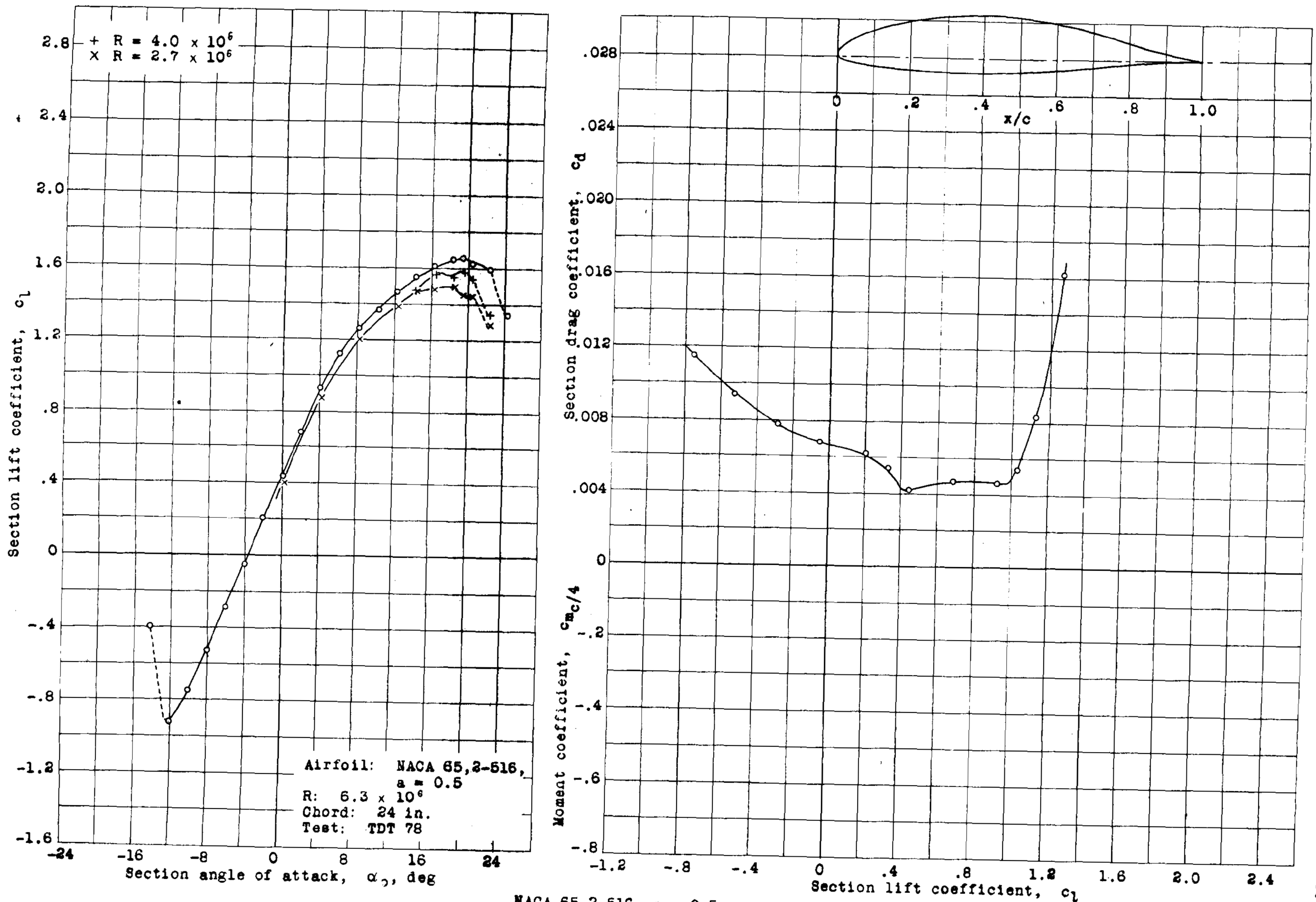


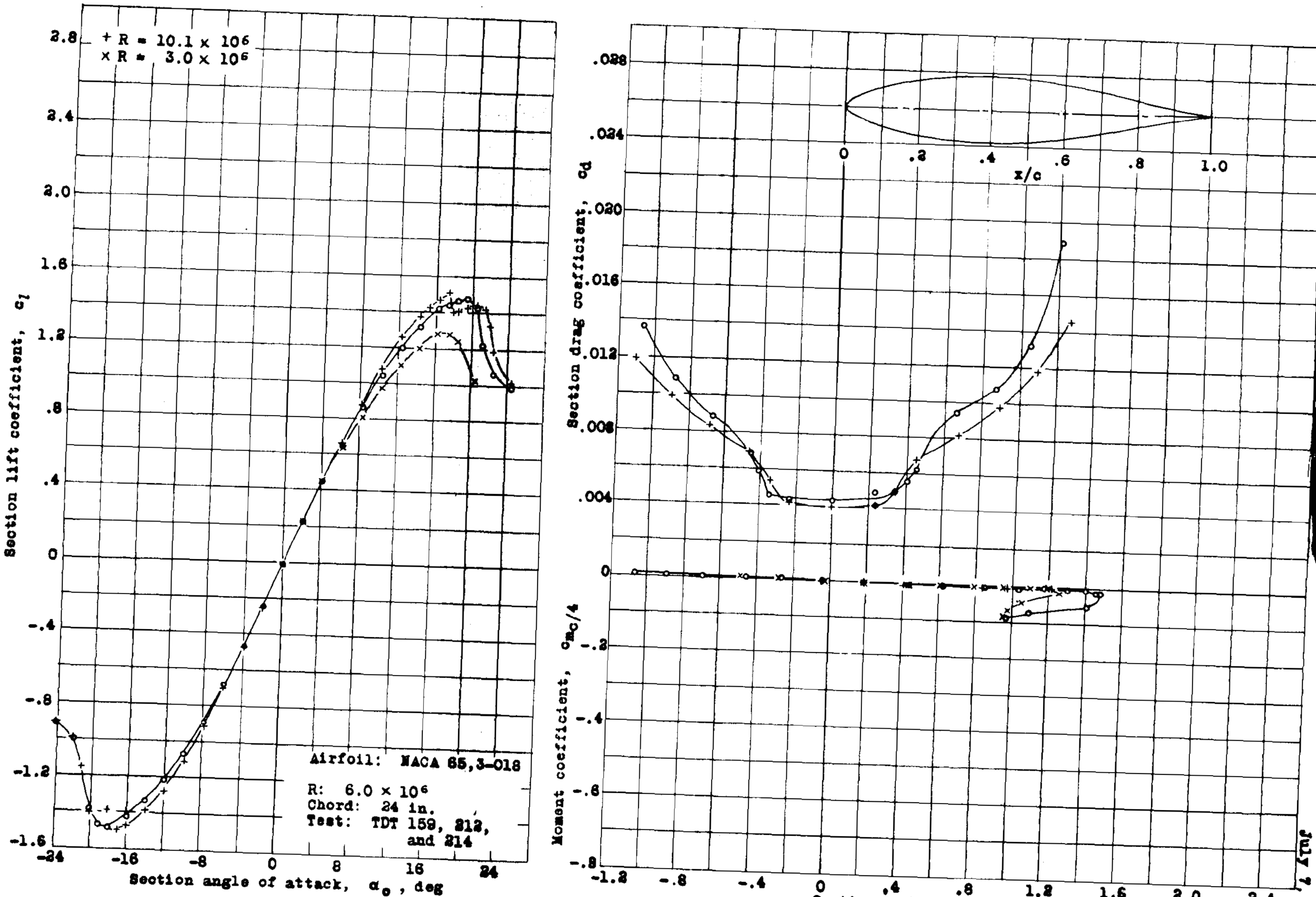
NACA 65(223)-422 (approx.)

November 5, 1942

COPY NO. 62



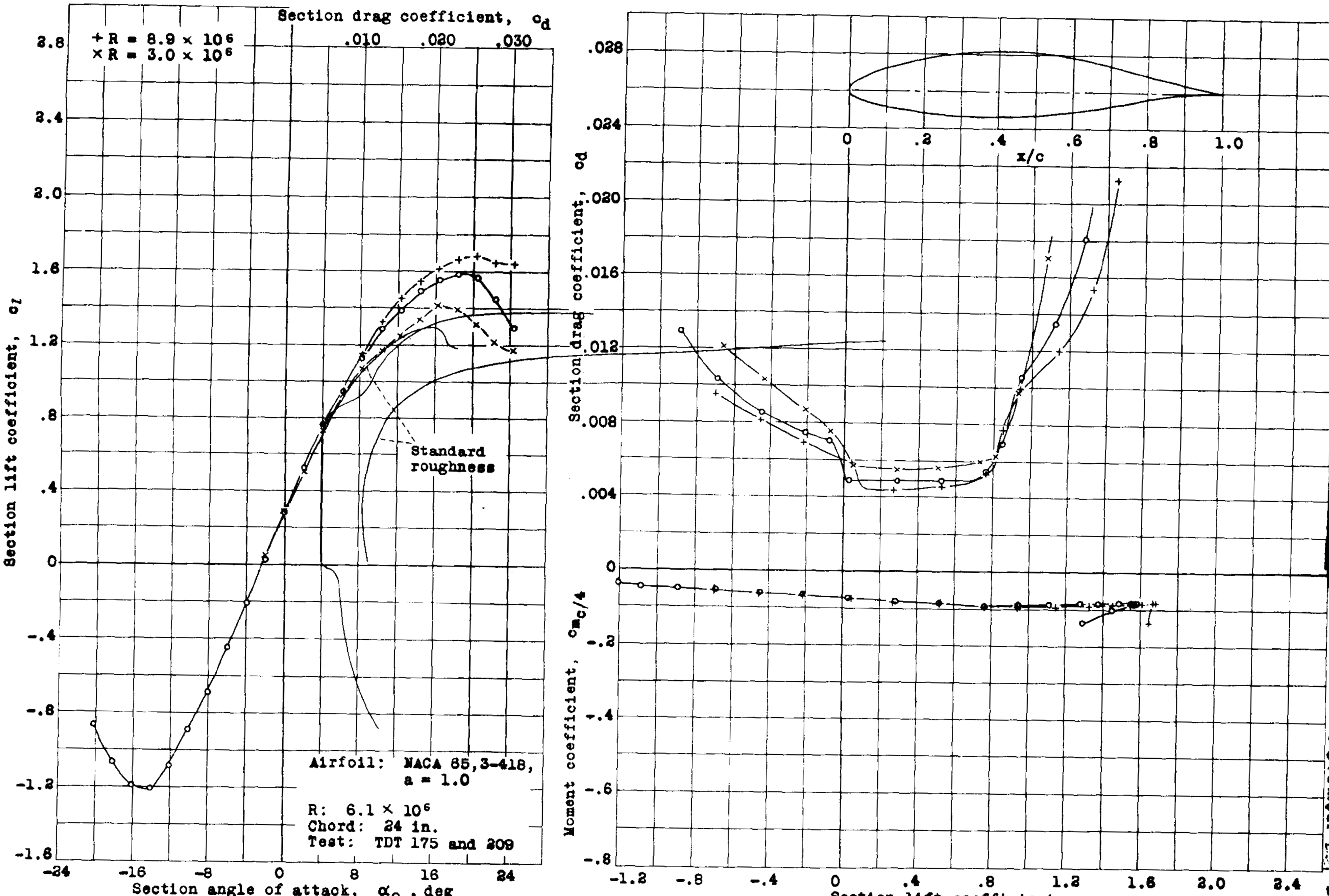
NACA 65,2-516, a = 0.5



NACA 65,3-018

July 7, 1942

Copy No. 62.

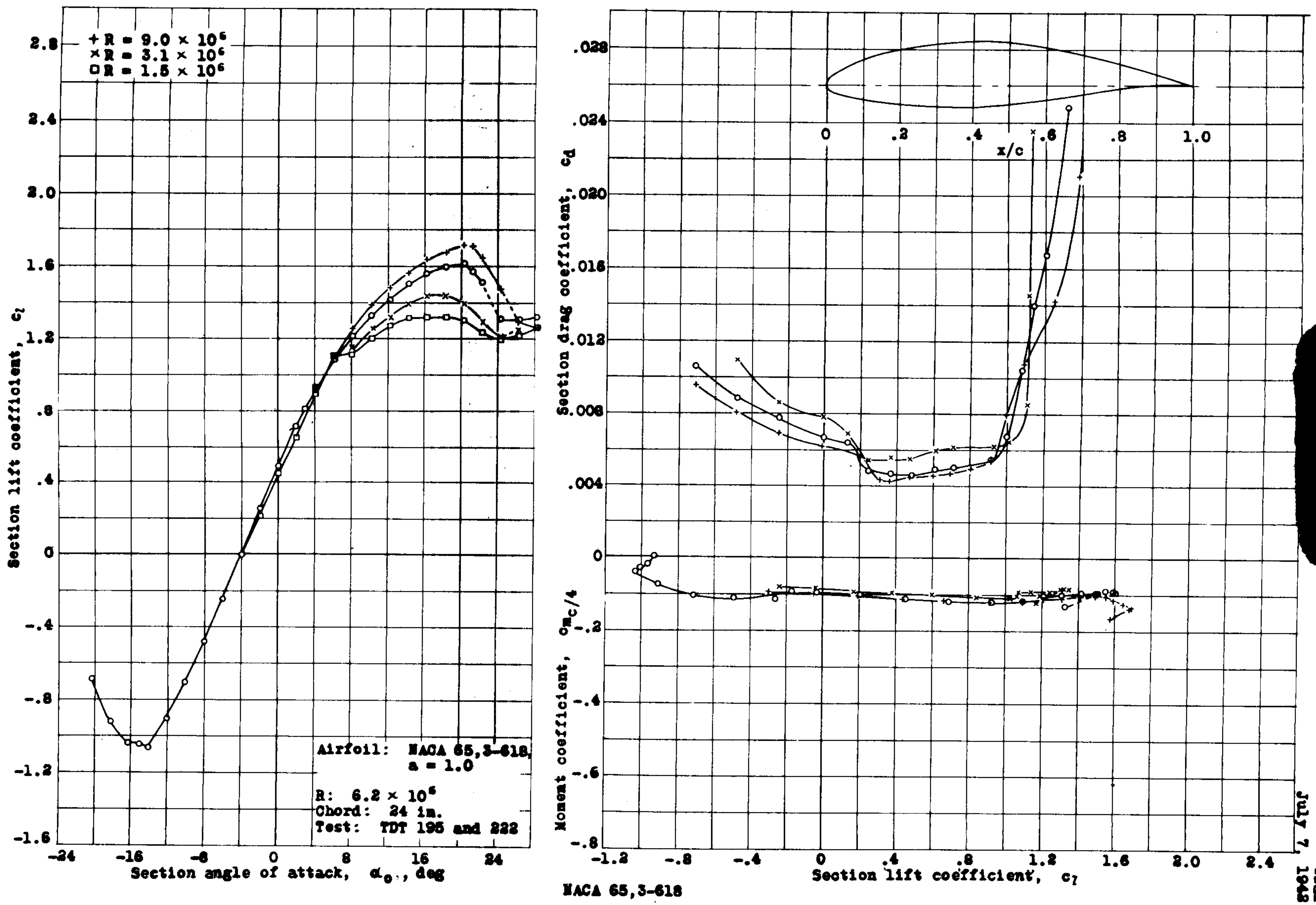


NACA 65,3-418

November 25, 1942

41a

COPY NO. 62



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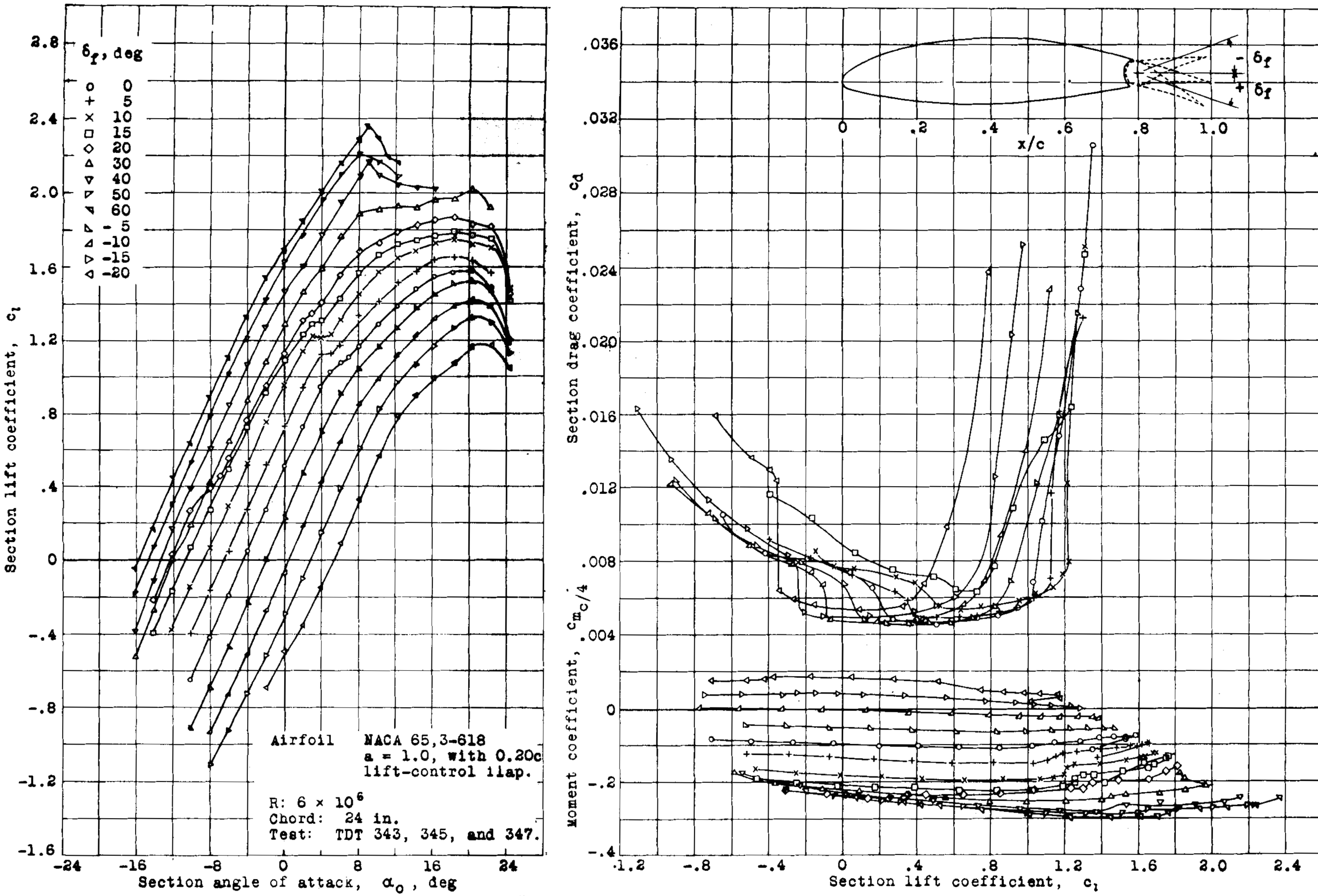
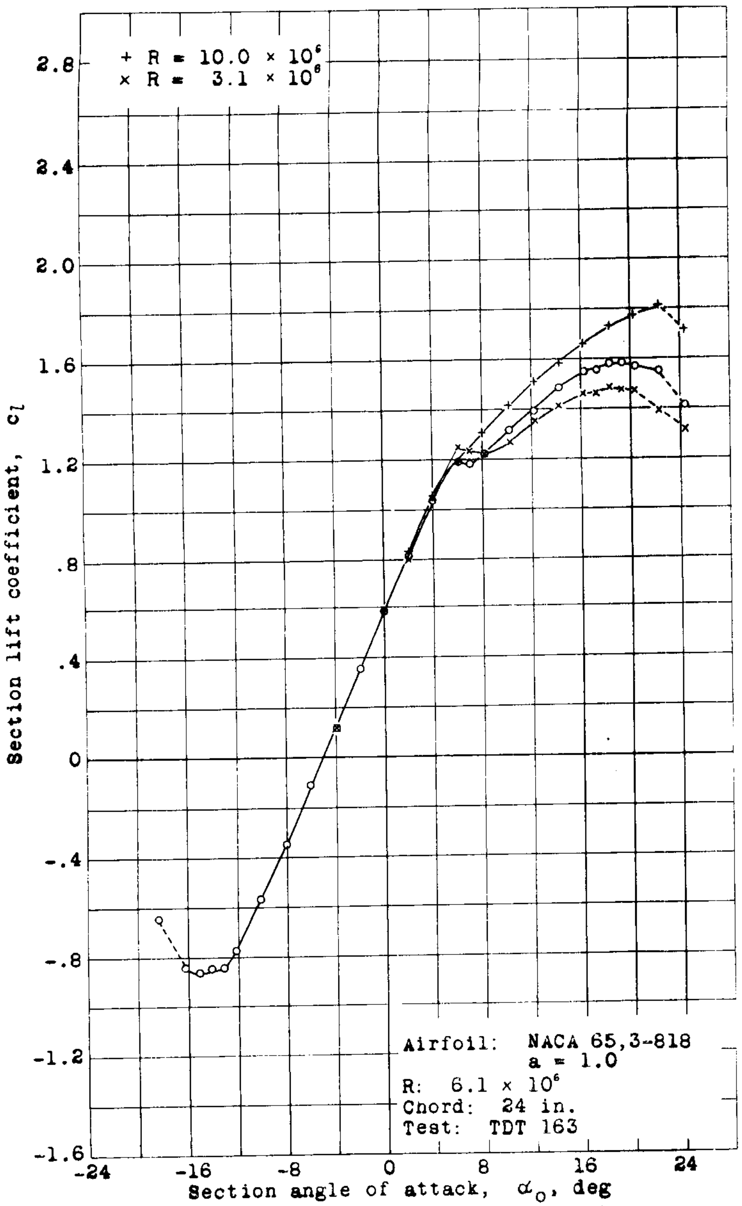
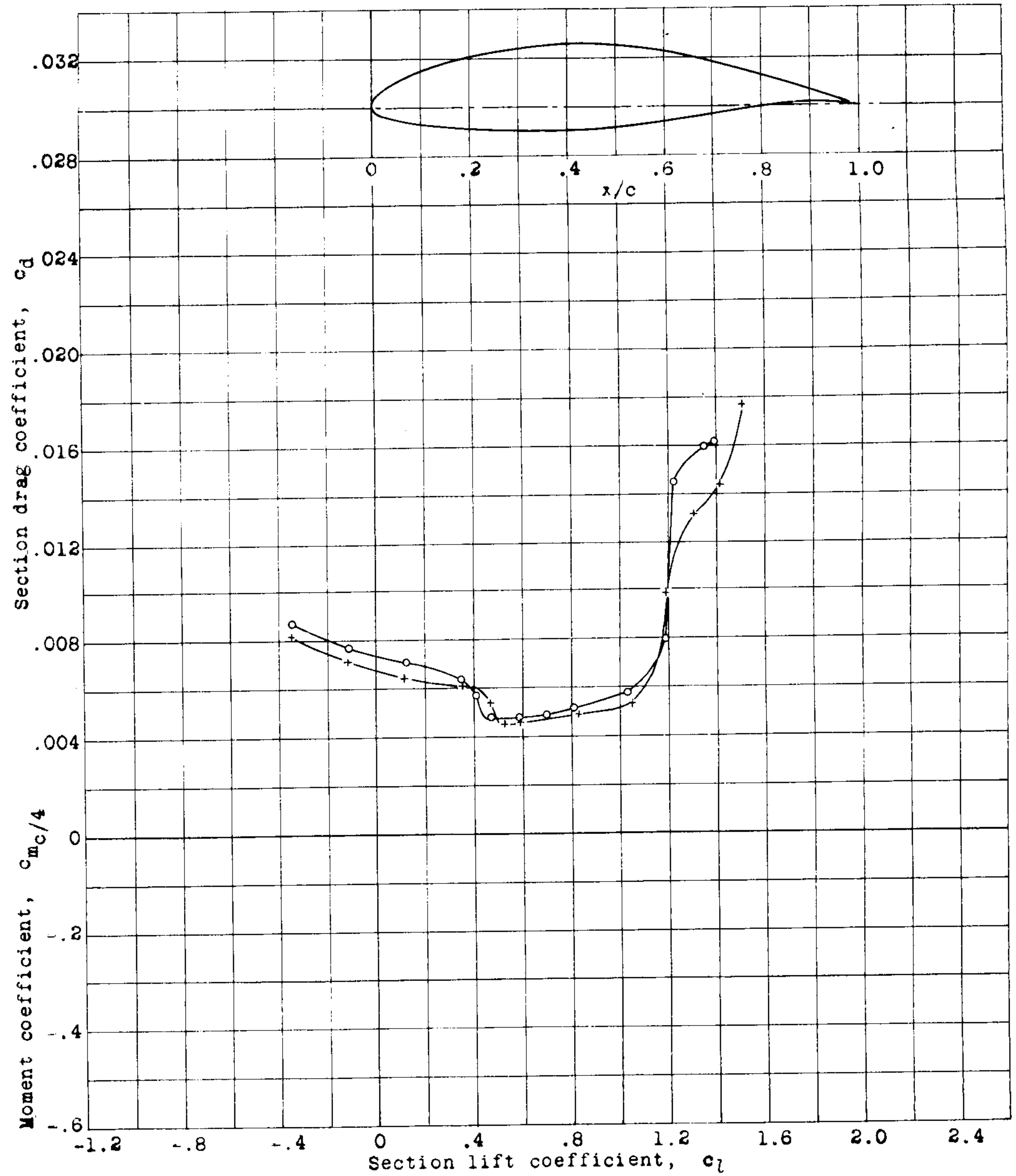


A.C.R. by Messrs. Jacobs, Abbott, and Davidson

NACA 65,3-618 airfoil with 0.20c lift-control flap.

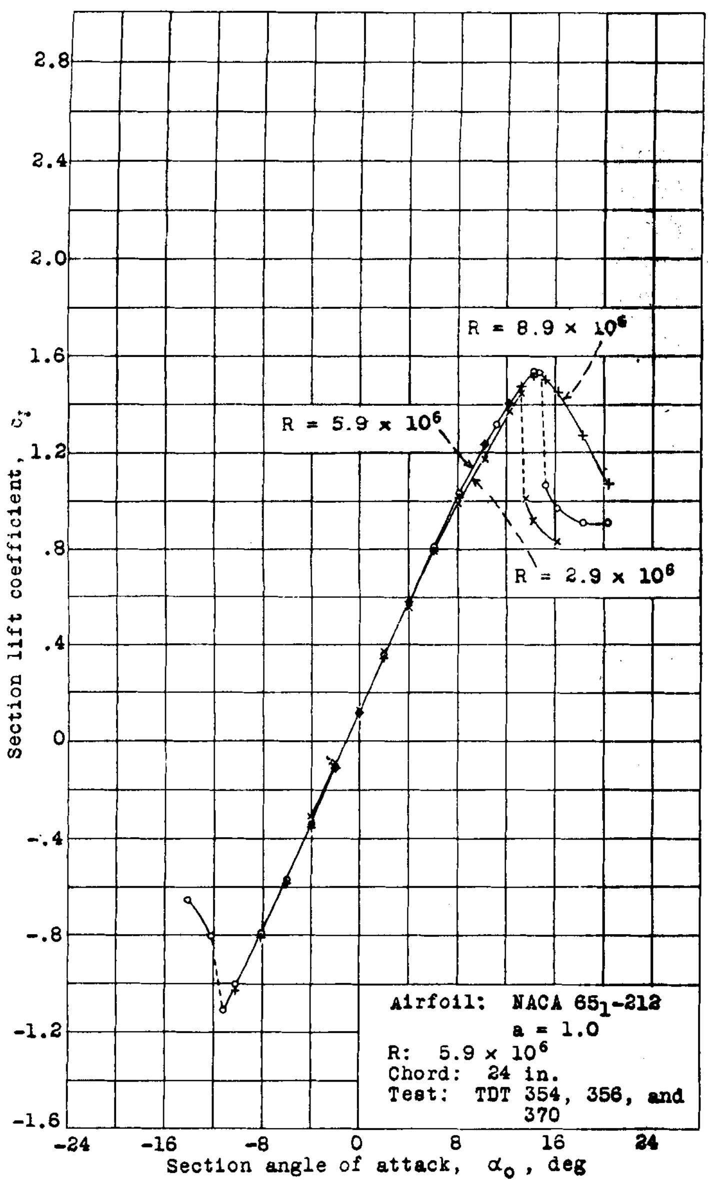


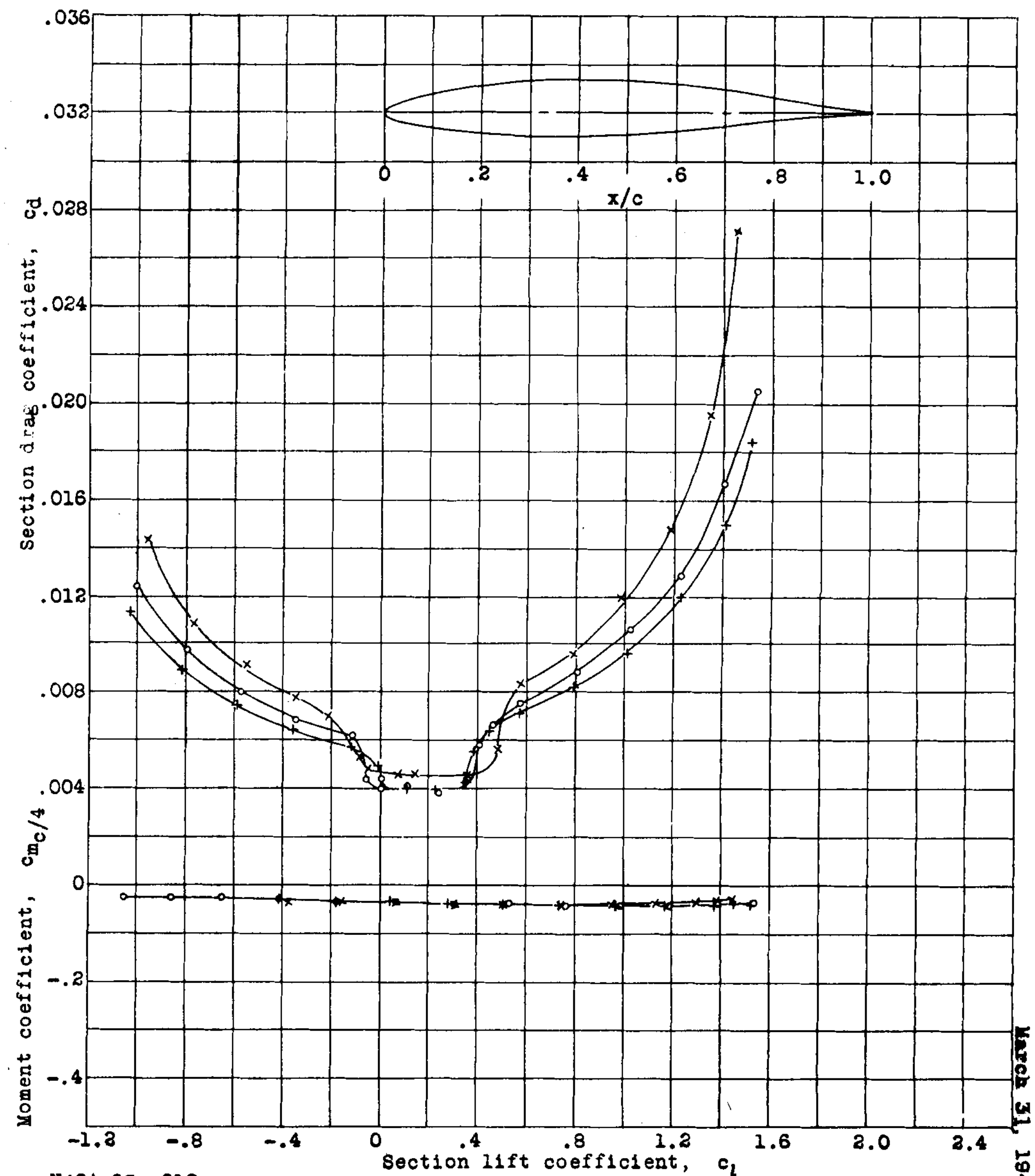


NACA 65,3-818

[redacted]

Copy No. 62





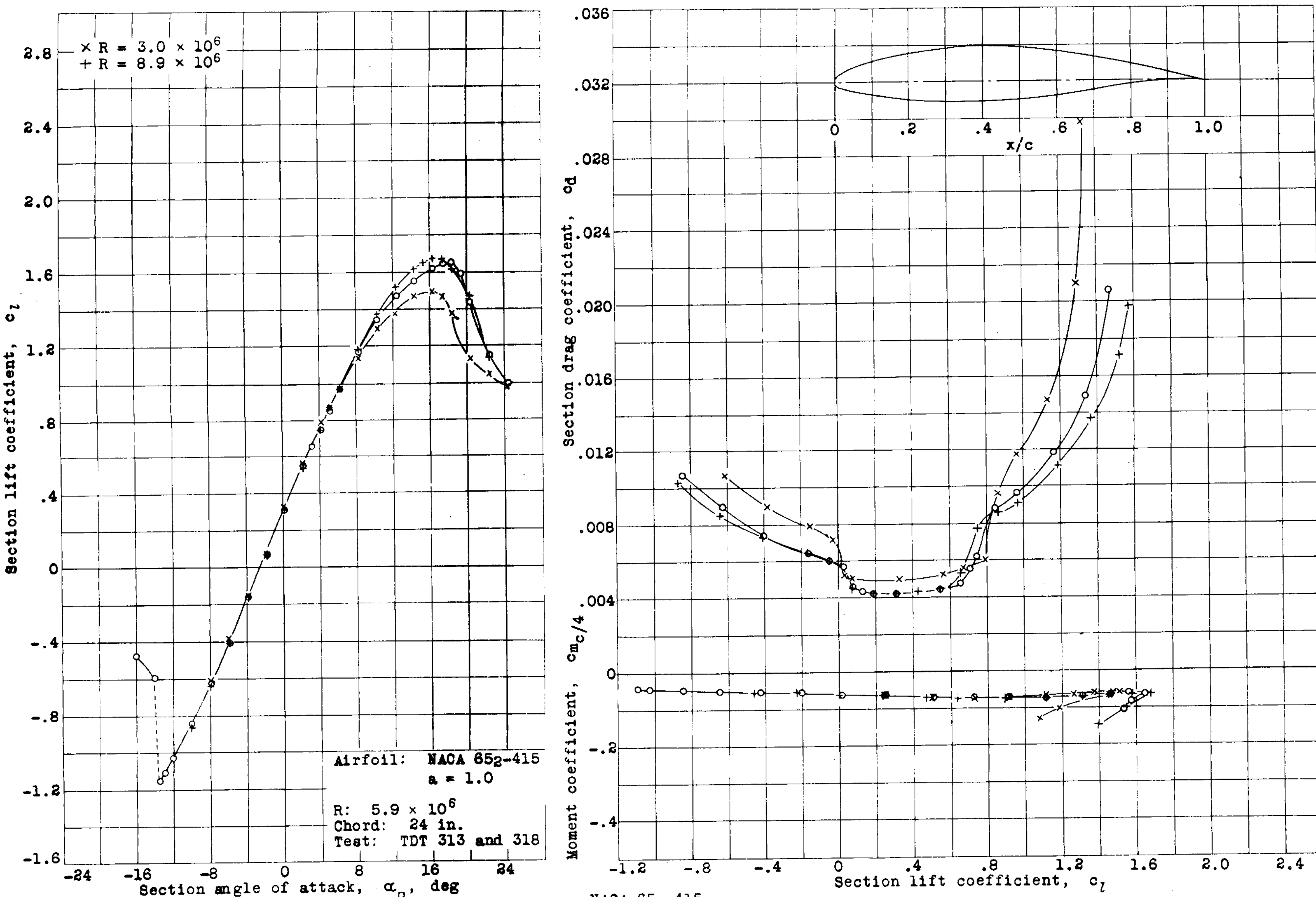
NACA 65_1-212

NACA

COPY NO. 62

March 31, 1943

41b1



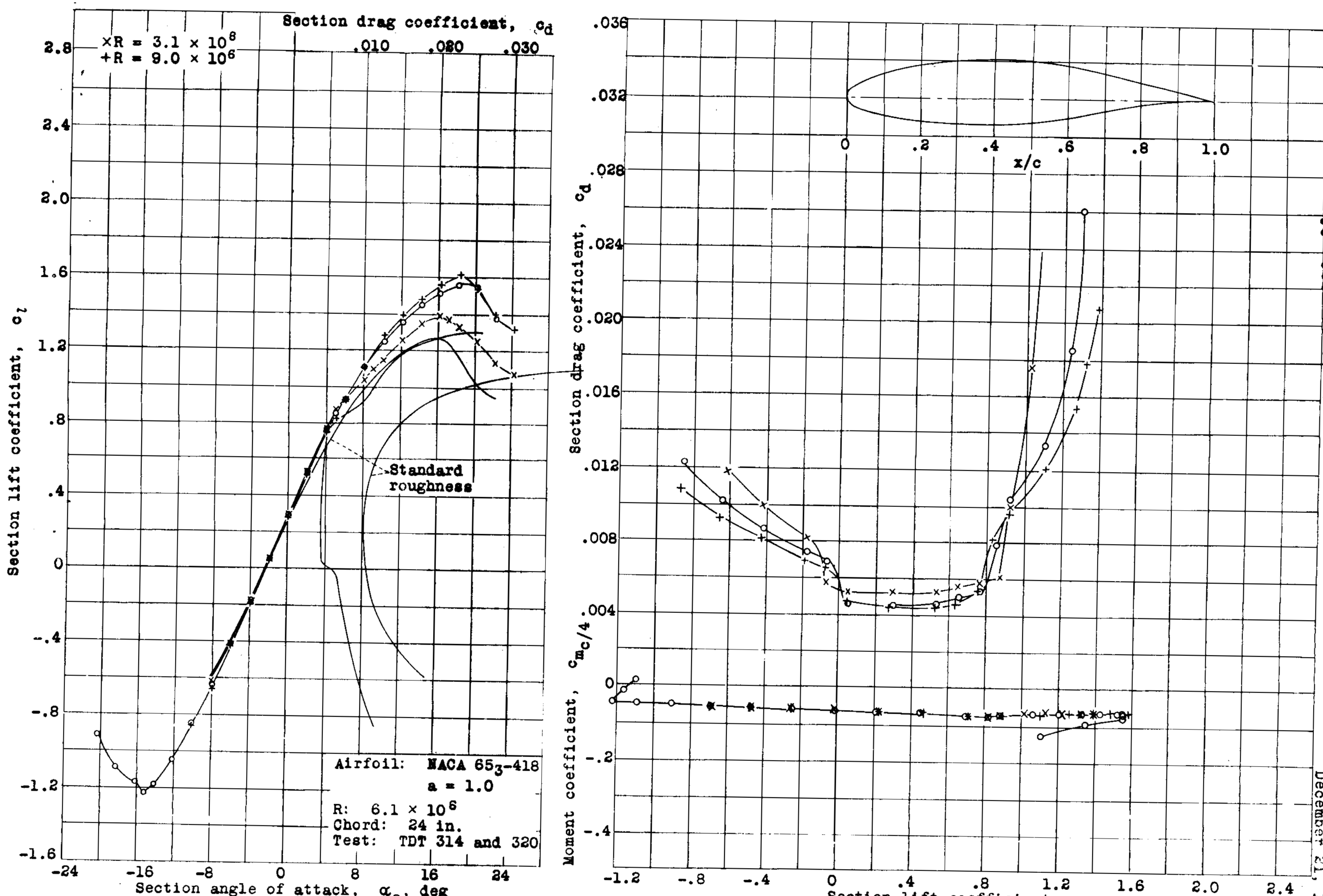
NACA 65_2-415

December 21, 1942

41c

COPY NO. 62

[redacted]

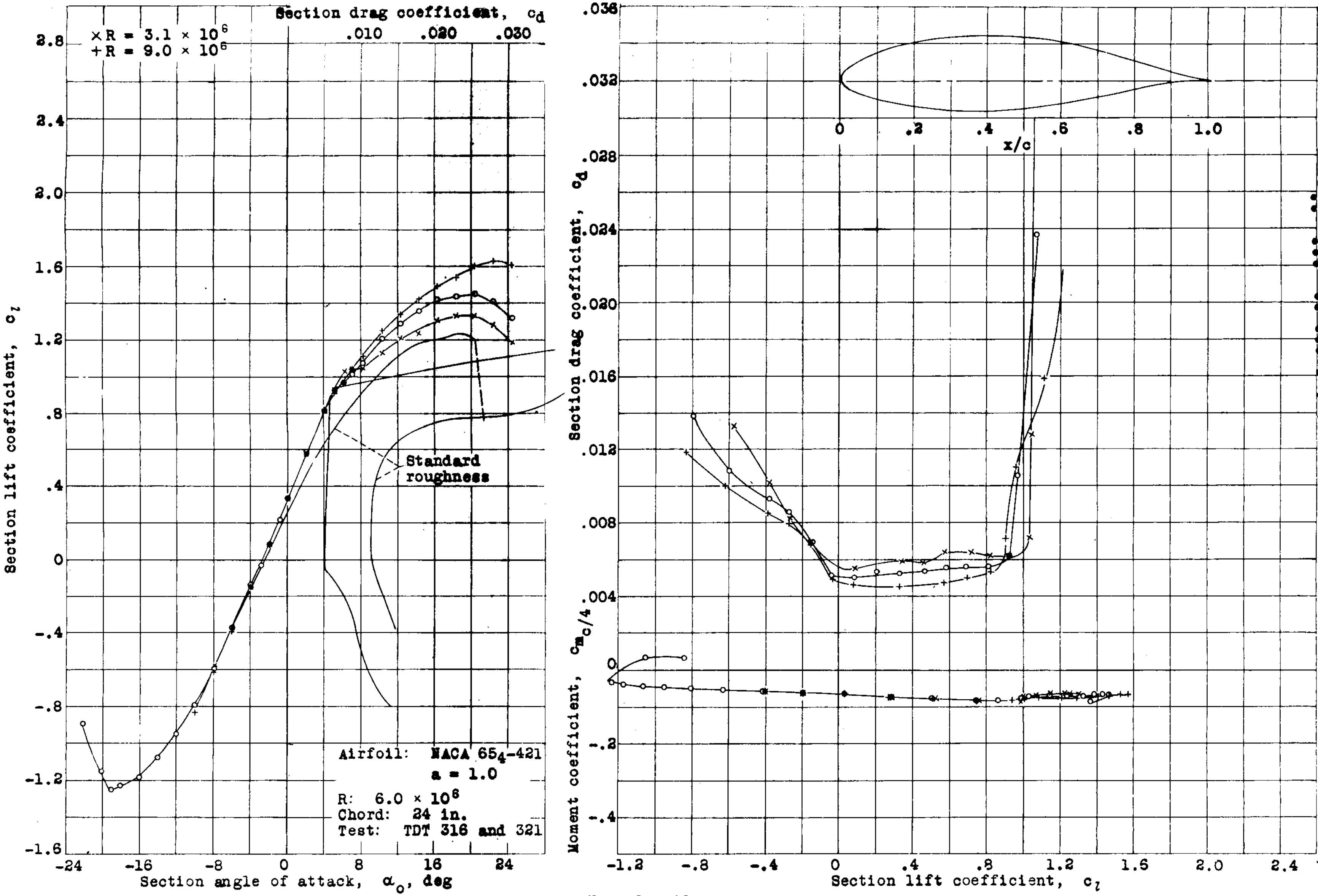


NACA 65_3-418

December 21, 1942

41d

COPY NO. 62

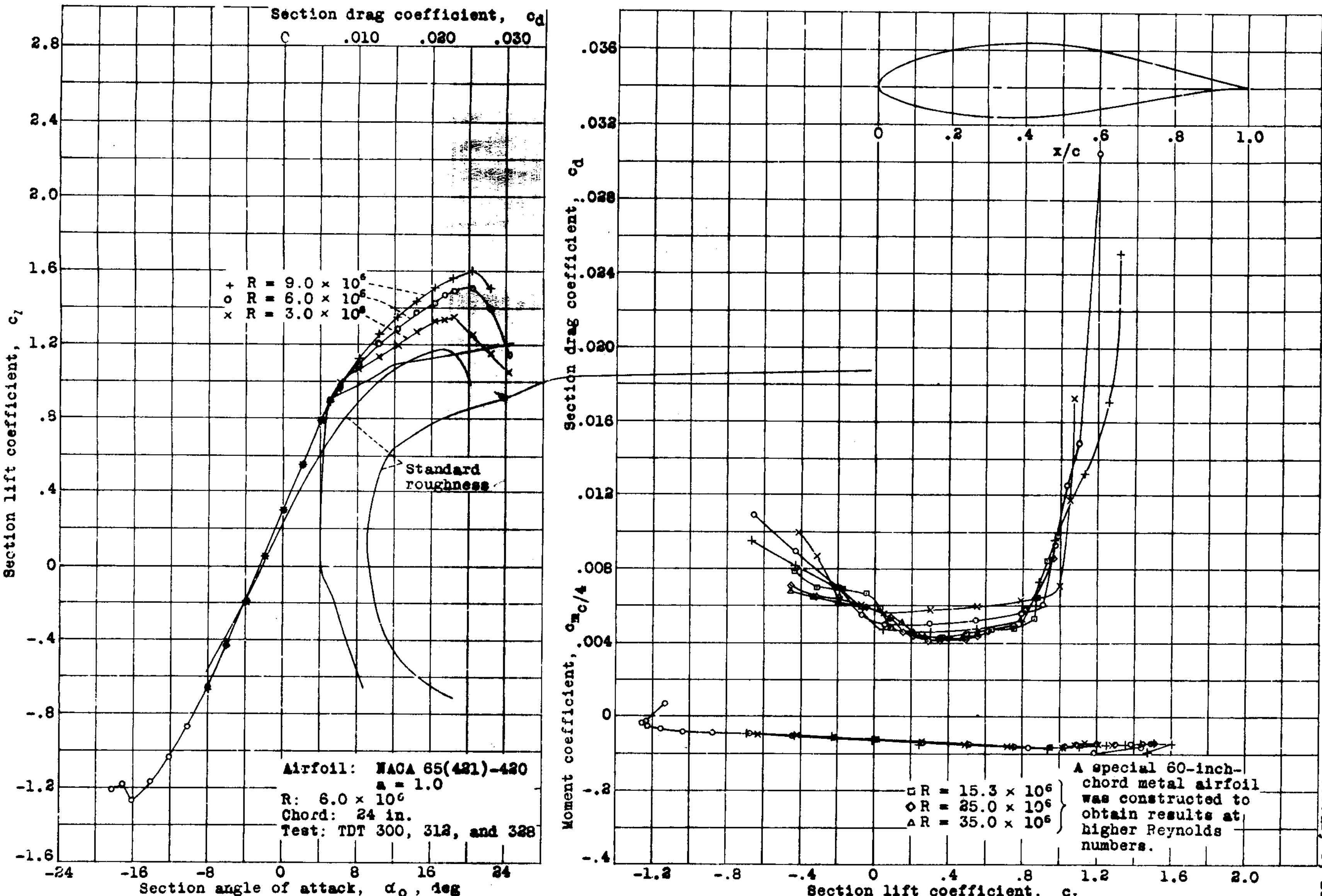


NACA 65_4-421

December 21, 1942

41e

COPY NO. 82



NACA 65(421)-420

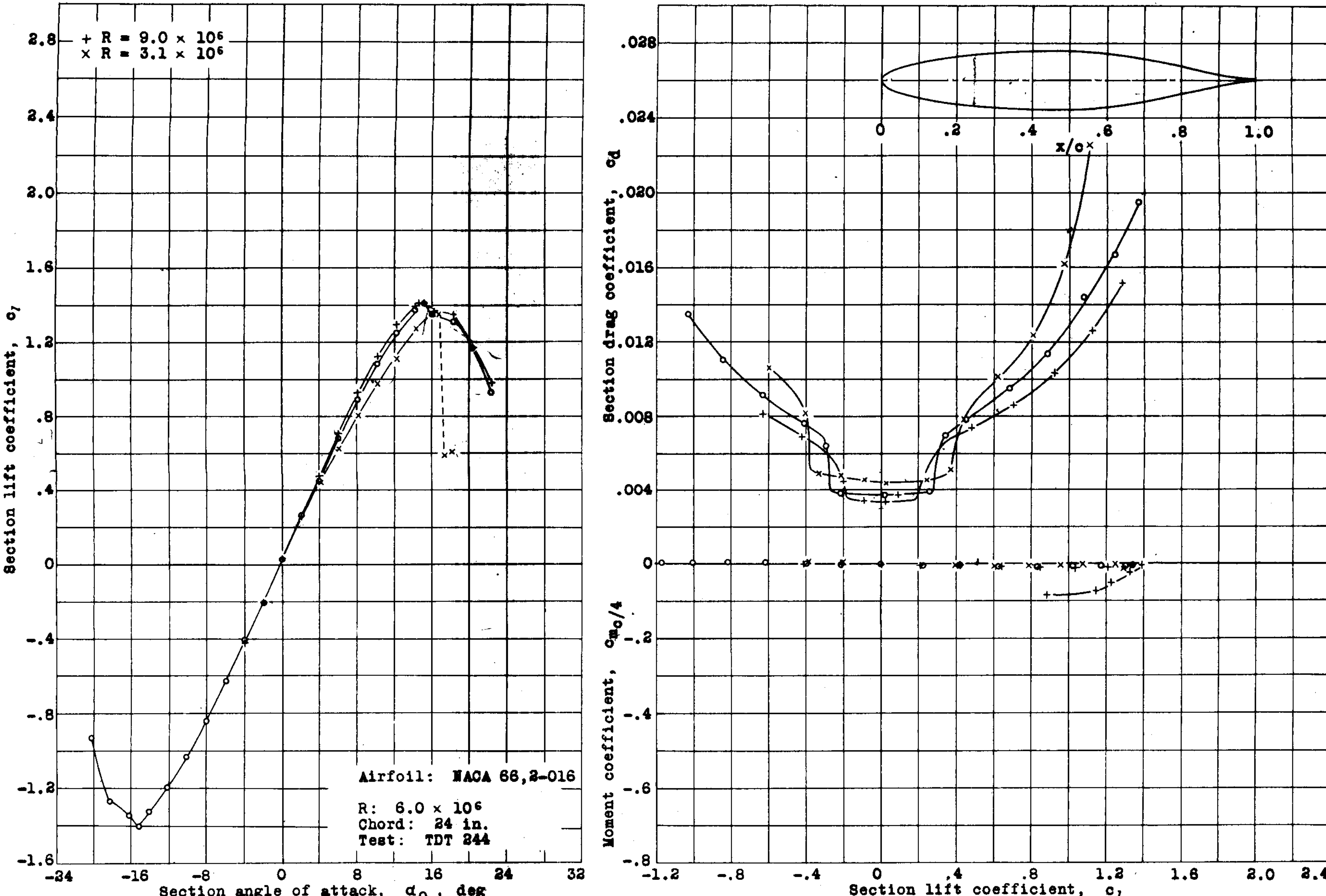
A.C.R. by Messrs. Jacobs, Abbott, and Davidson

NACA February 3, 1943

41f

[redacted]

COPY NO. 62

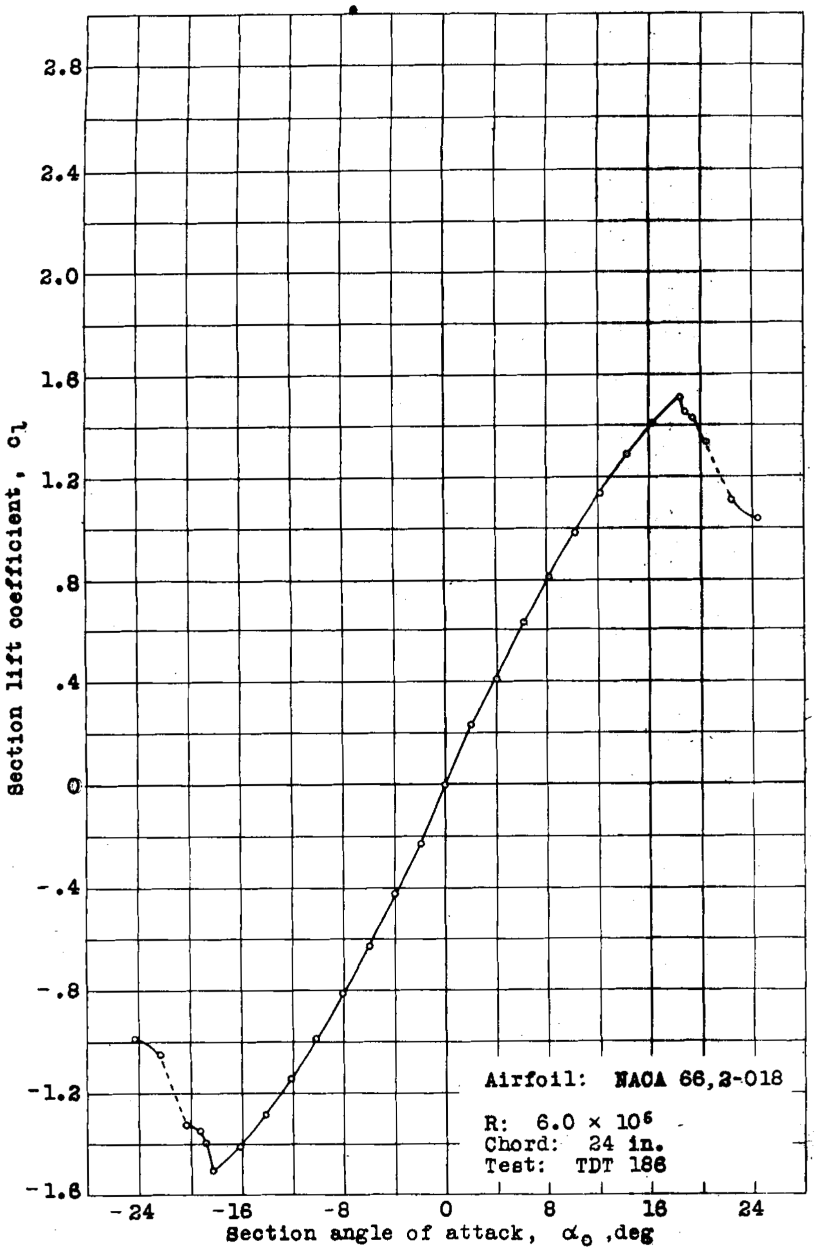


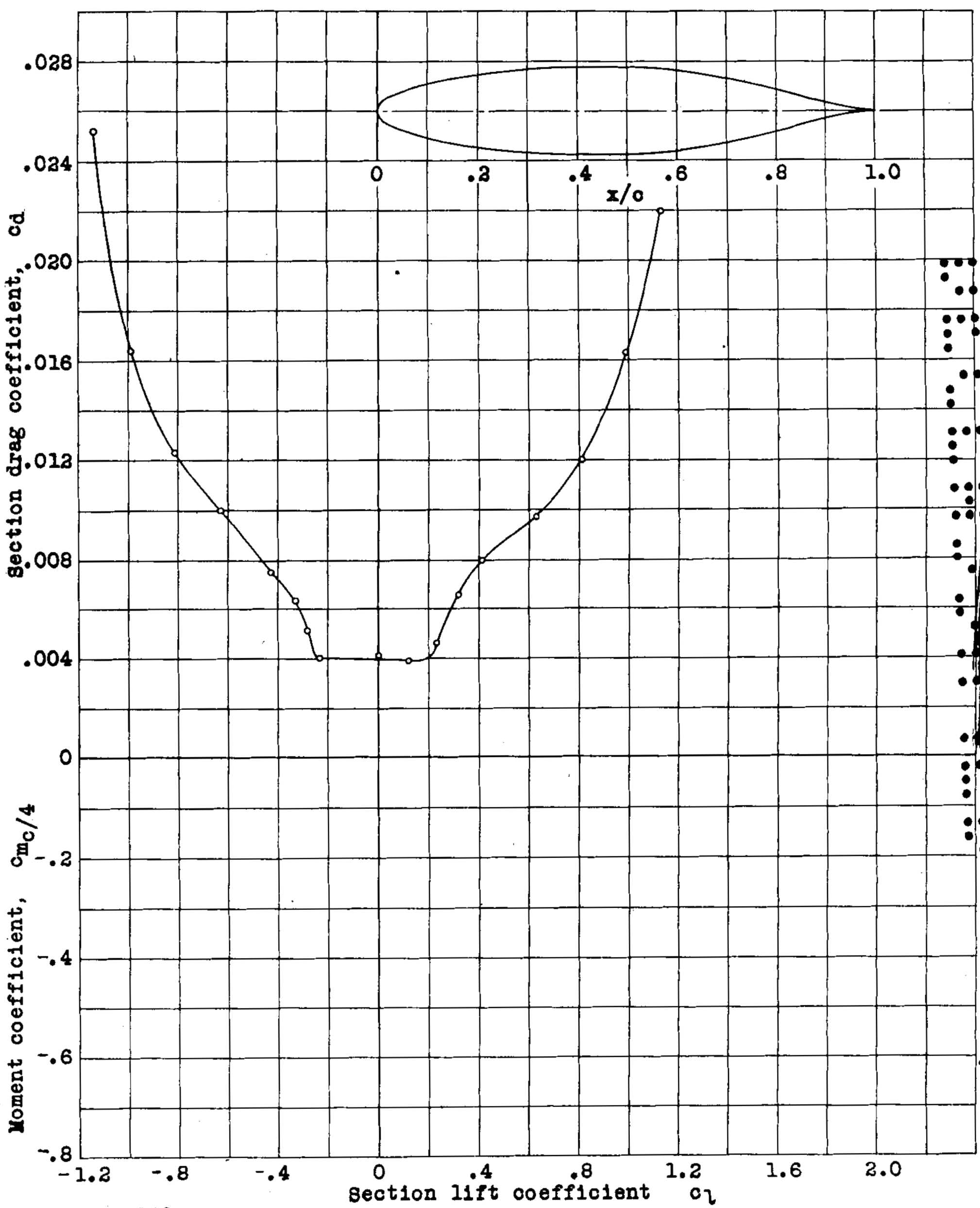
NACA 66,2-016

August 22, 1942

418

Copy No. 62



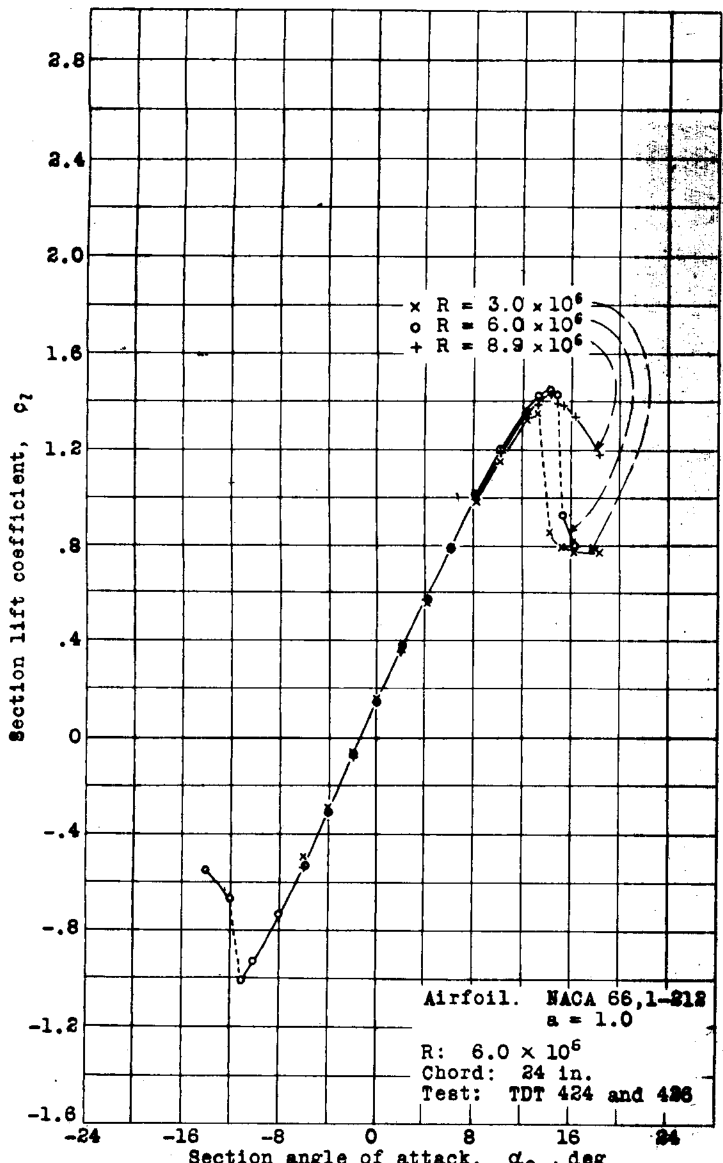


NACA 66,2-018

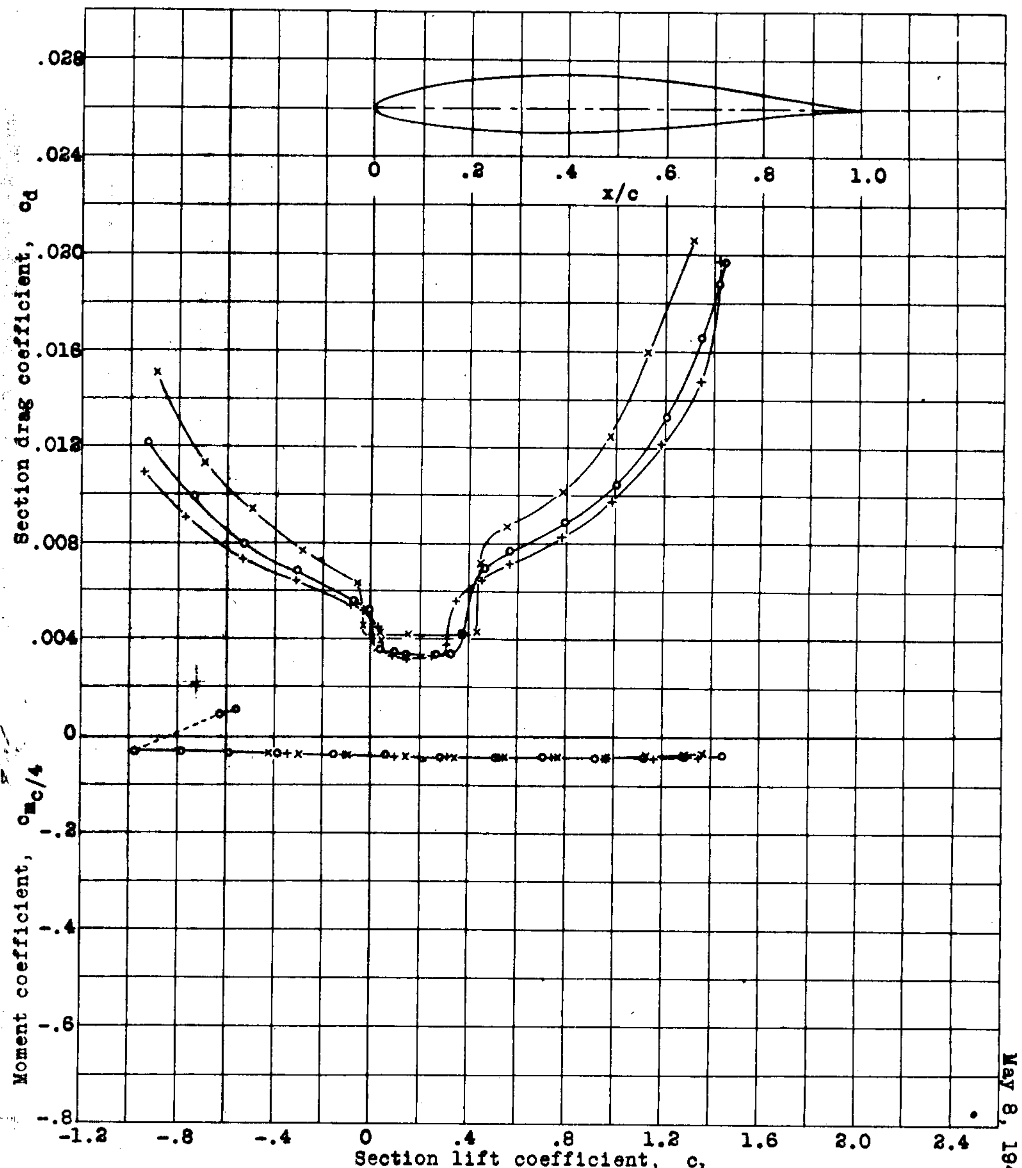
Copy No. 62

Apr. 30 1942

41h



A.C.R. by Messrs. Jacobs, Abbott, and Davidson



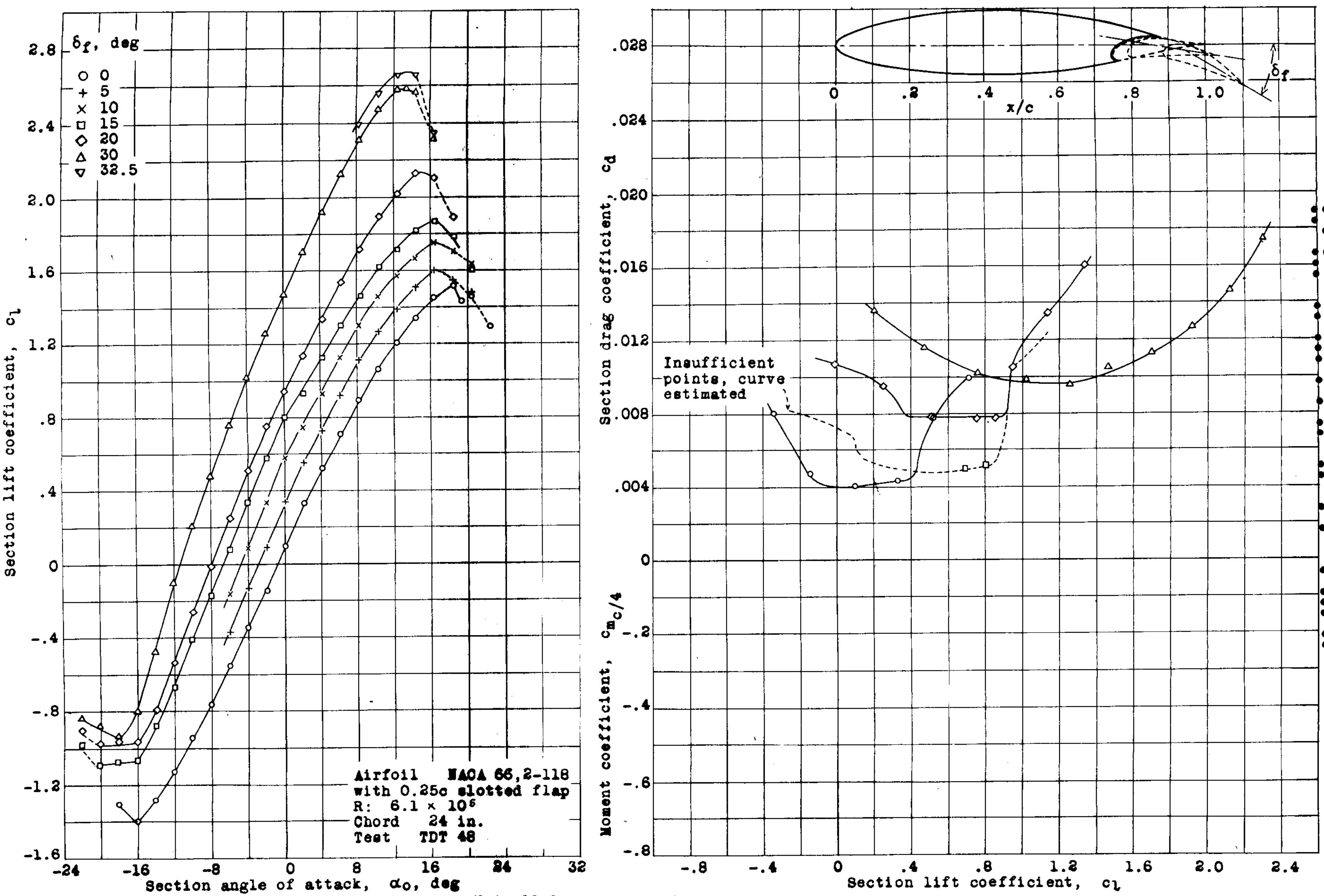
NACA 66,1-212

[redacted]

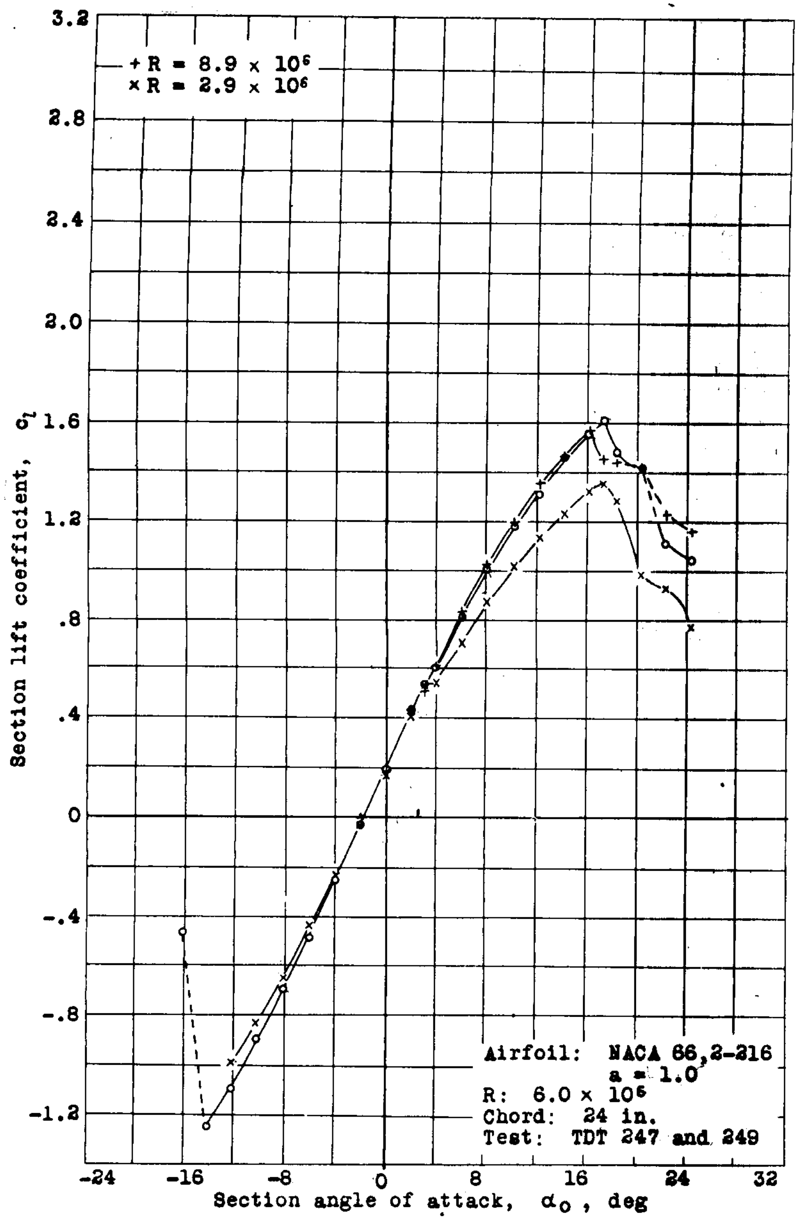
COPY NO. 62

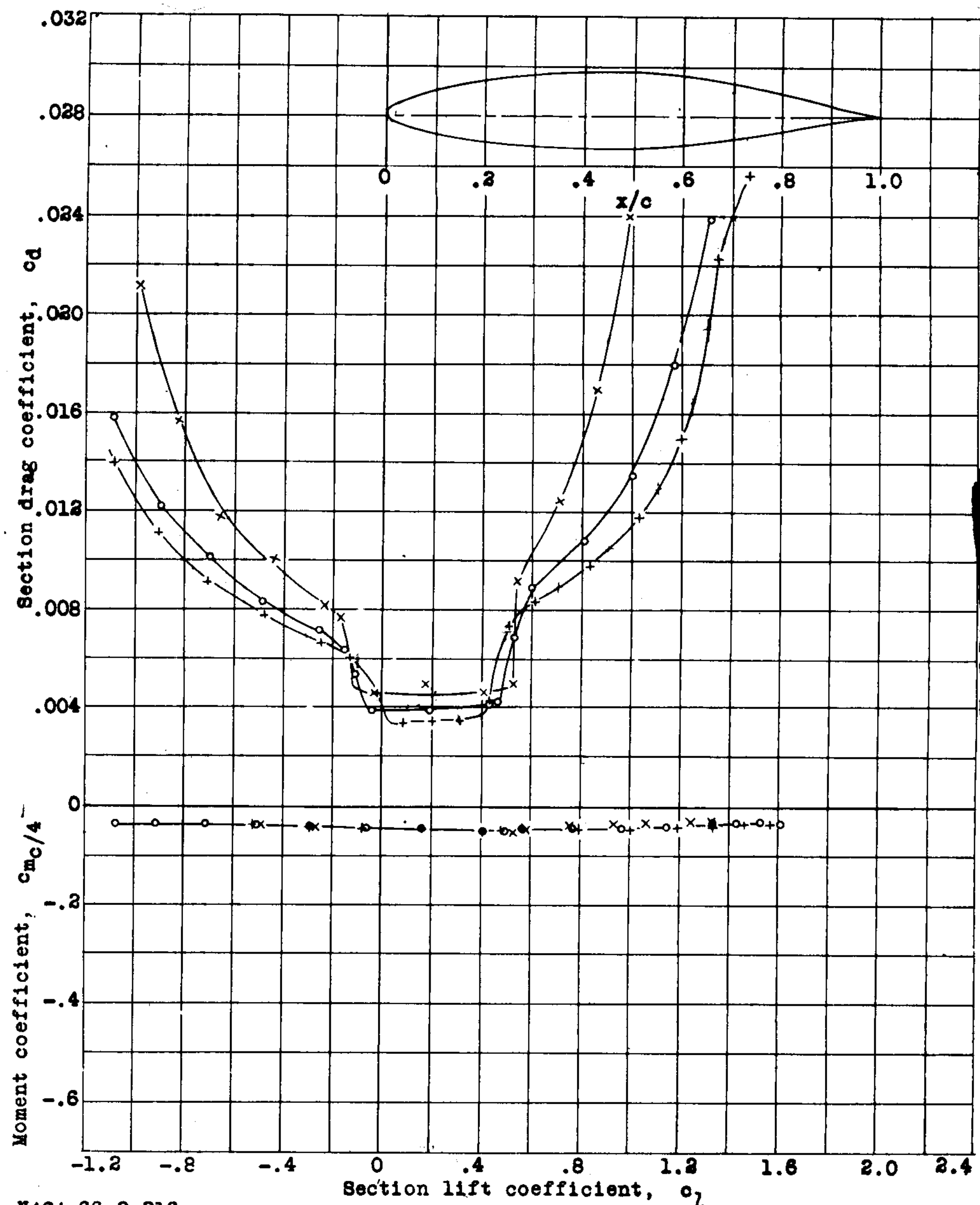
May 8, 1943

4121



NACA 66,2-118 with 0.25c slotted flap



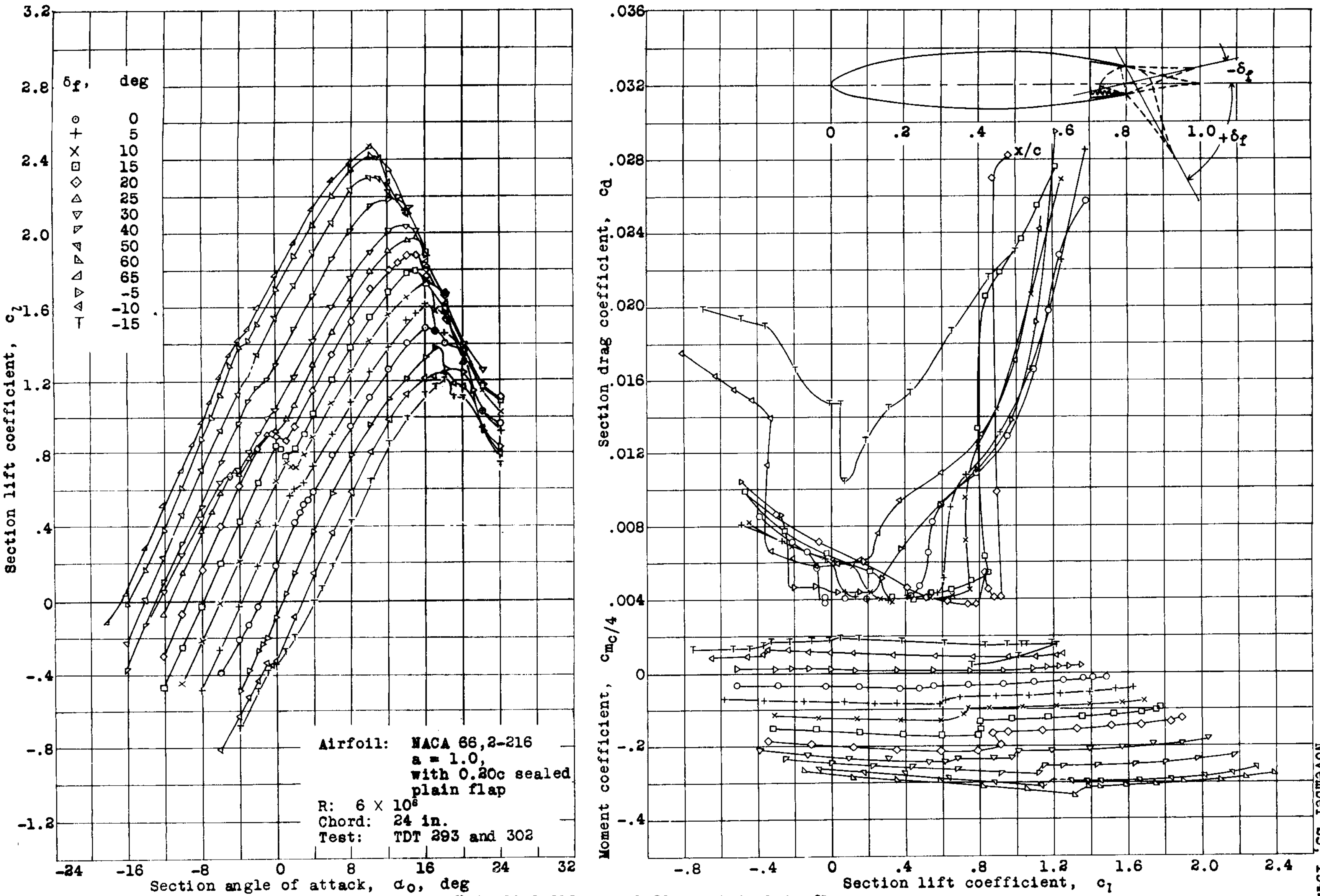


NACA 66,2-216

August 22, 1942

43

Copy No. 62



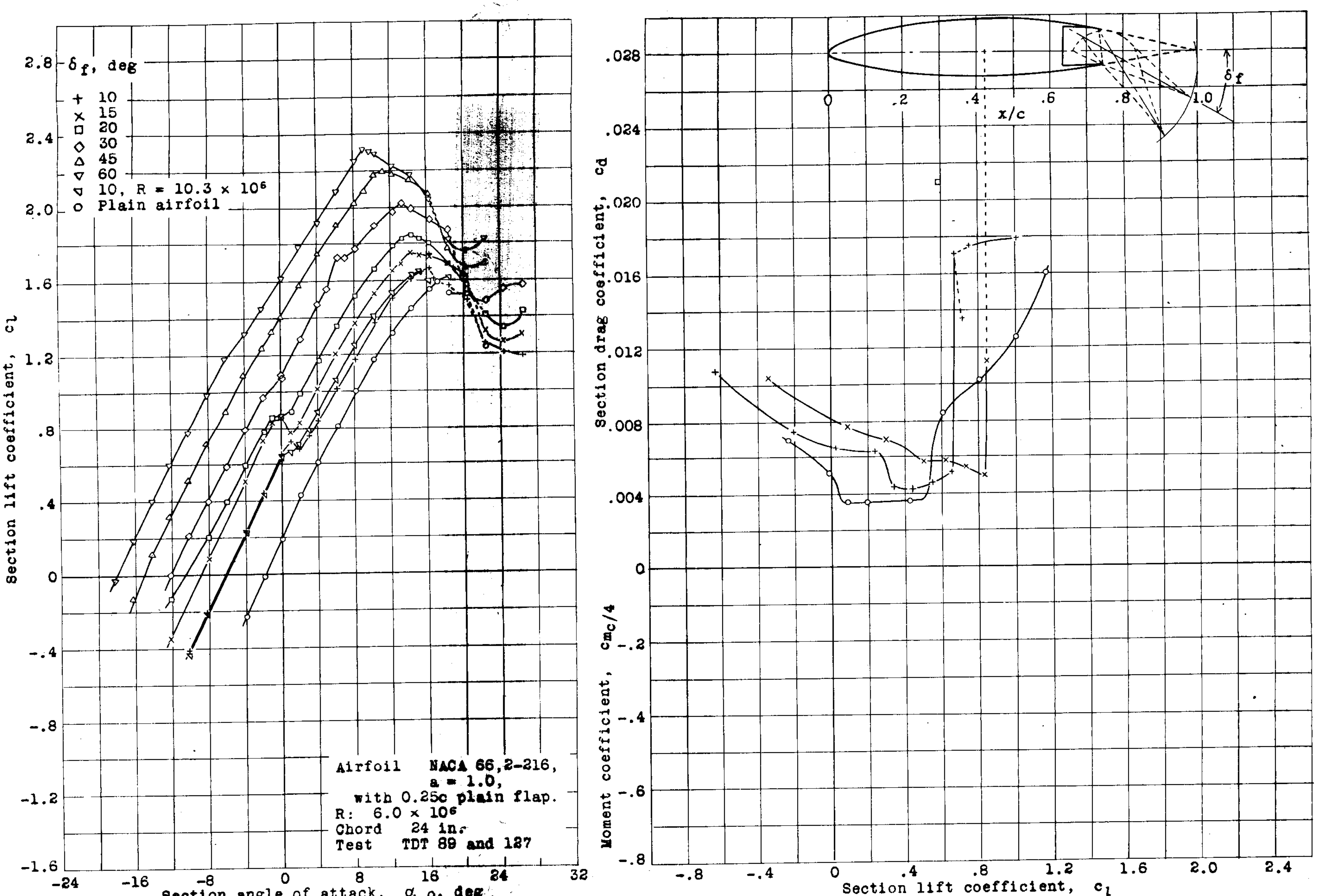
NACA 66,2-216 with 0.20c sealed plain flap

November 25, 1942

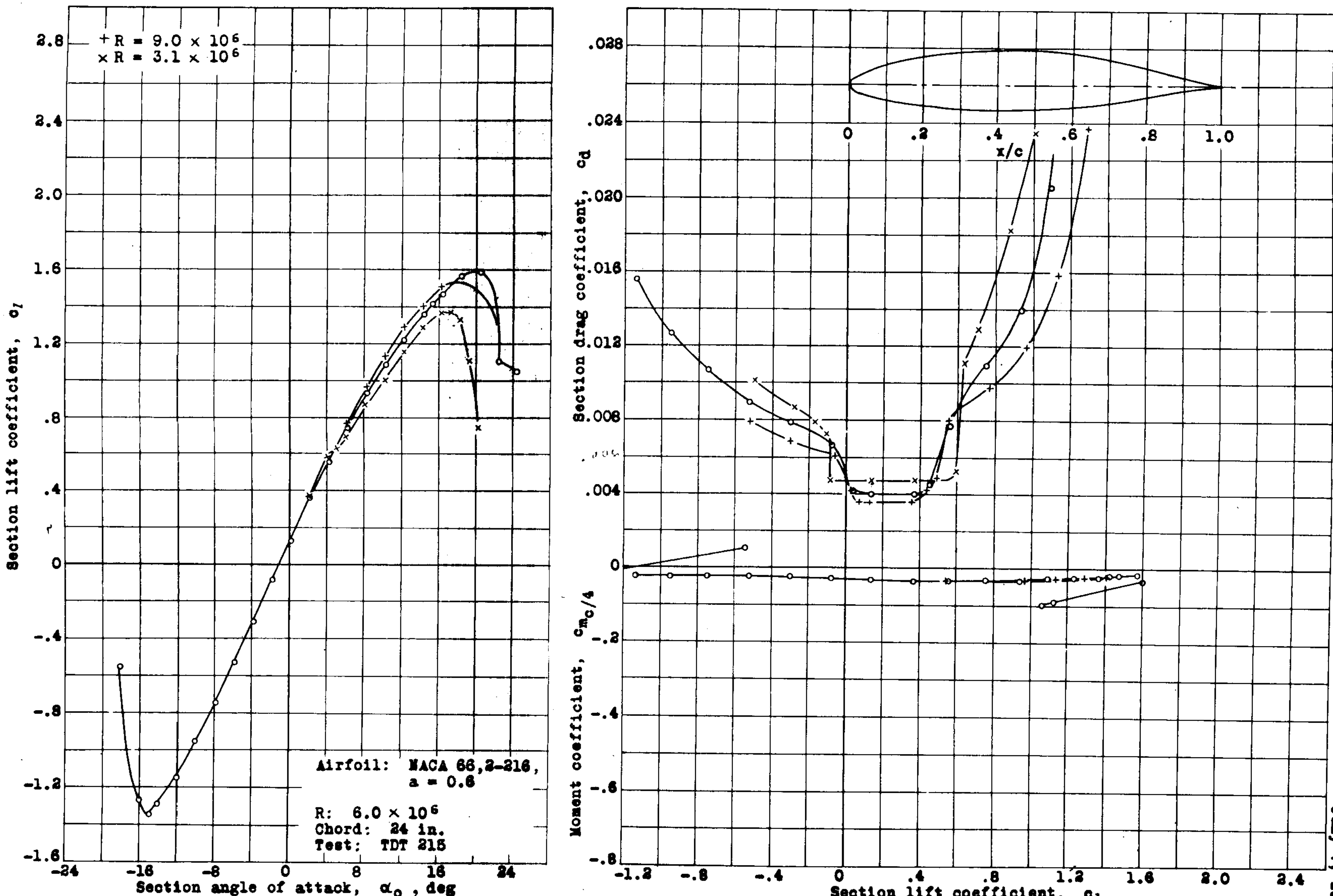
COPY NO. 62

43a

[redacted]



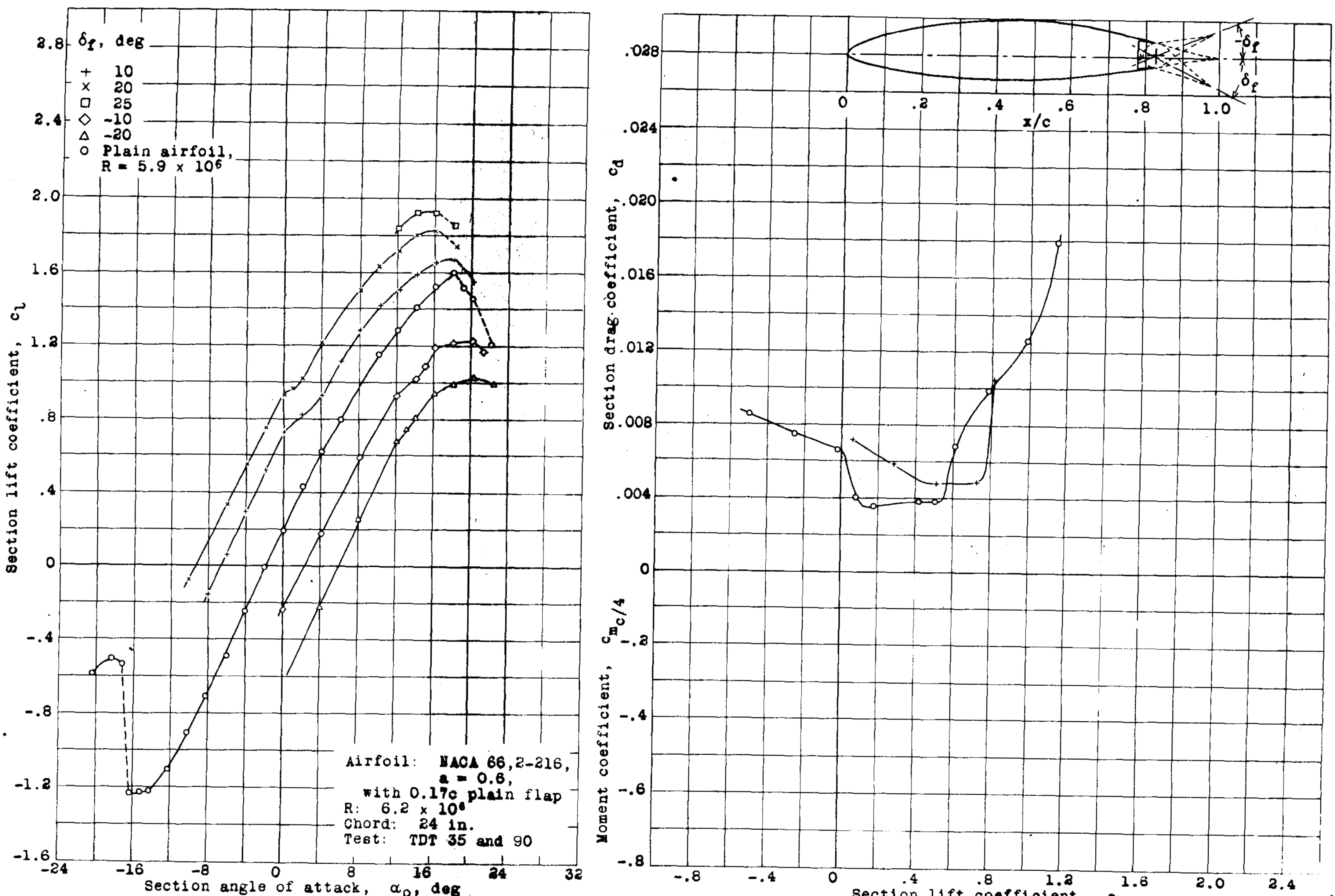
NACA 66,2-216 with 0.25c plain flap



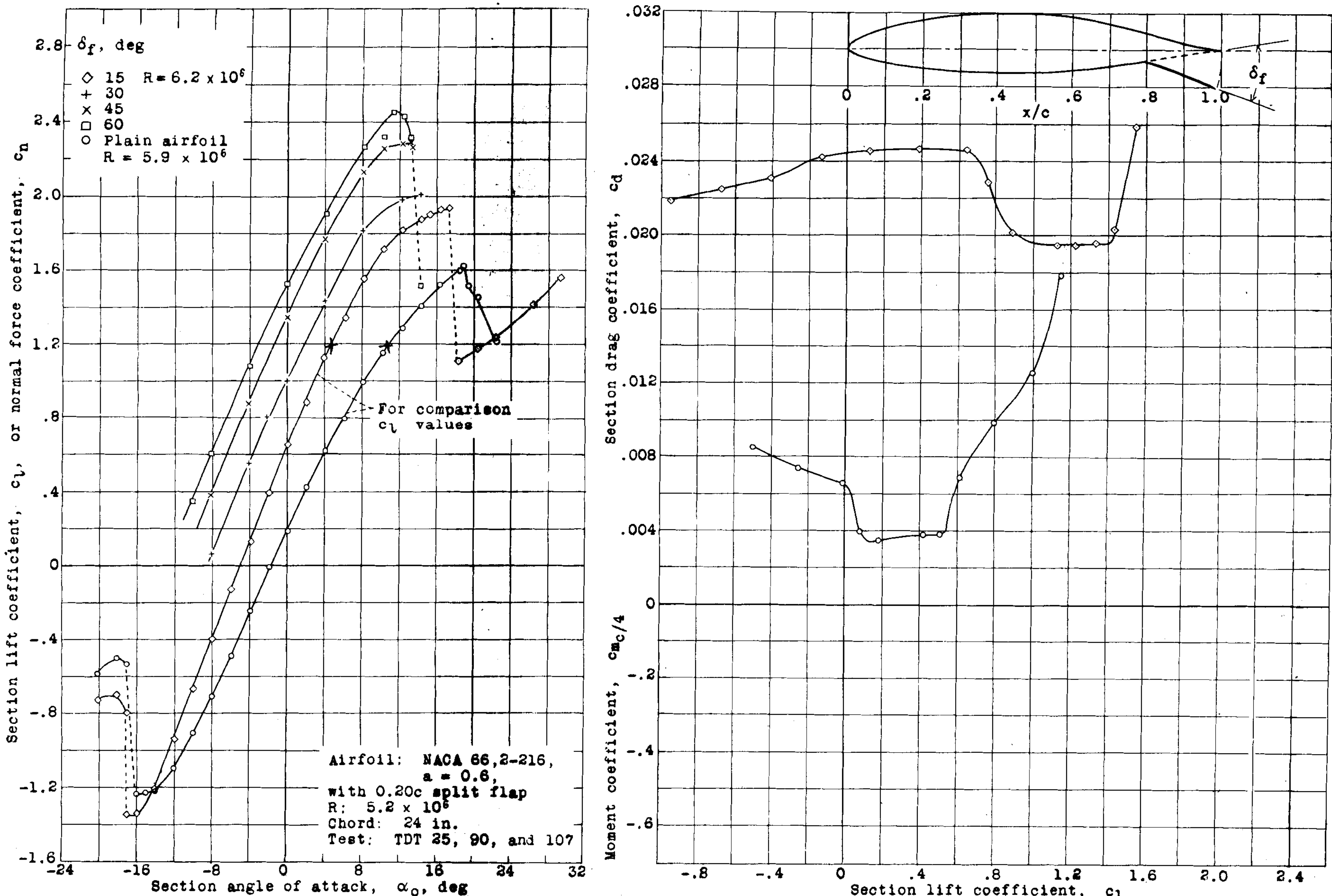
NACA 66,2-216, a = 0.6

July 7, 1943
45

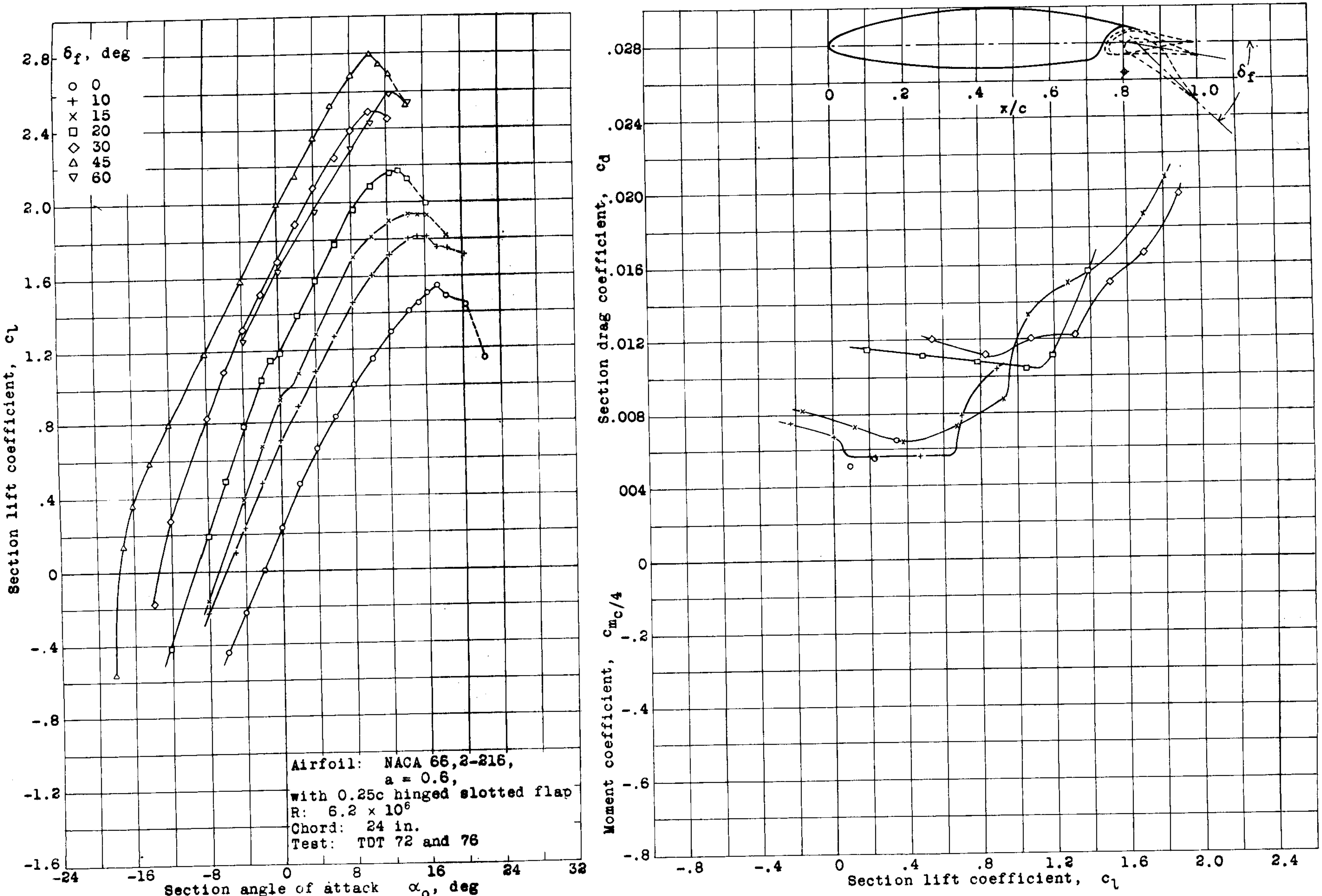
Copy No. 62.



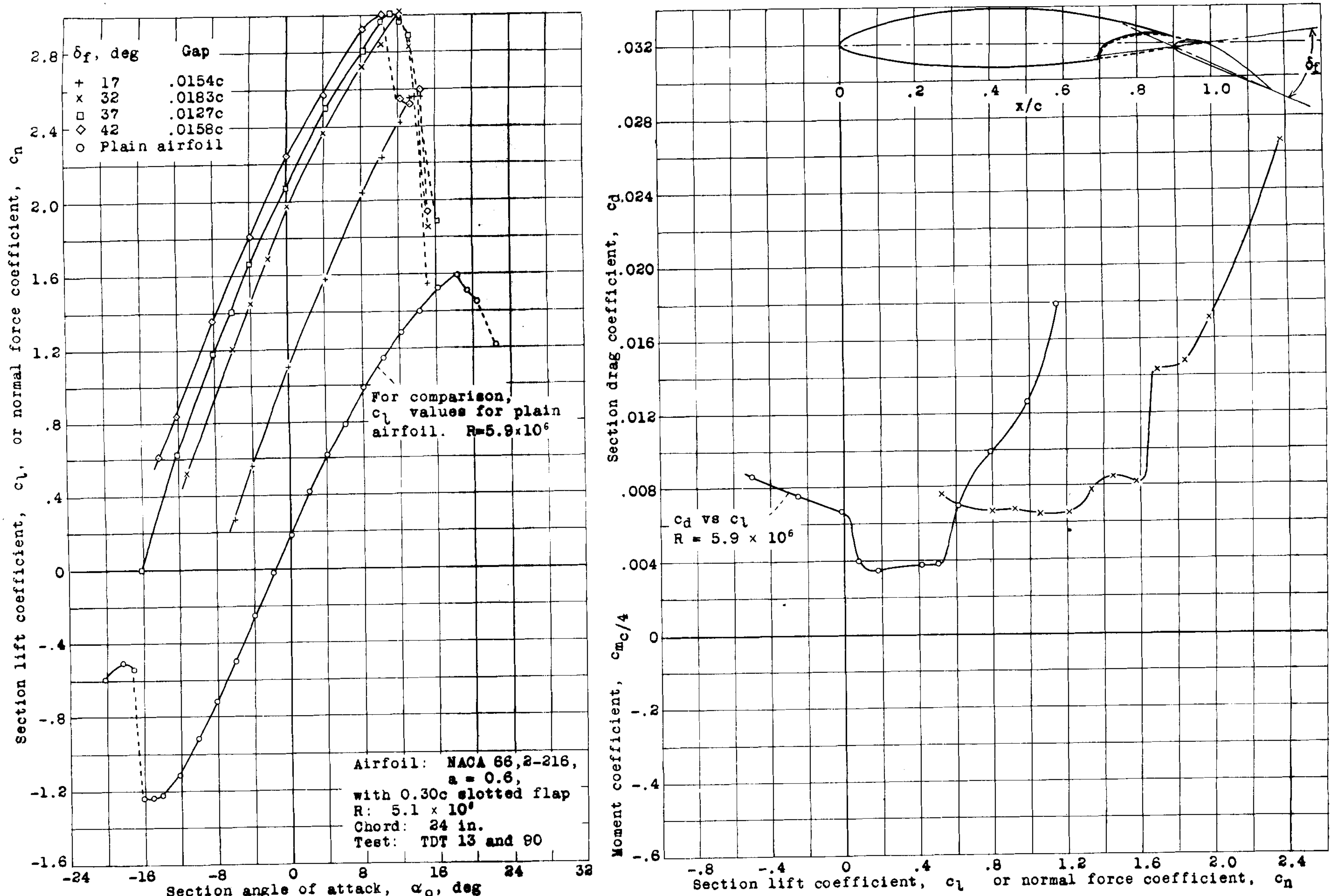
NACA 66,2-216, a = 0.6, with 0.17c plain flap



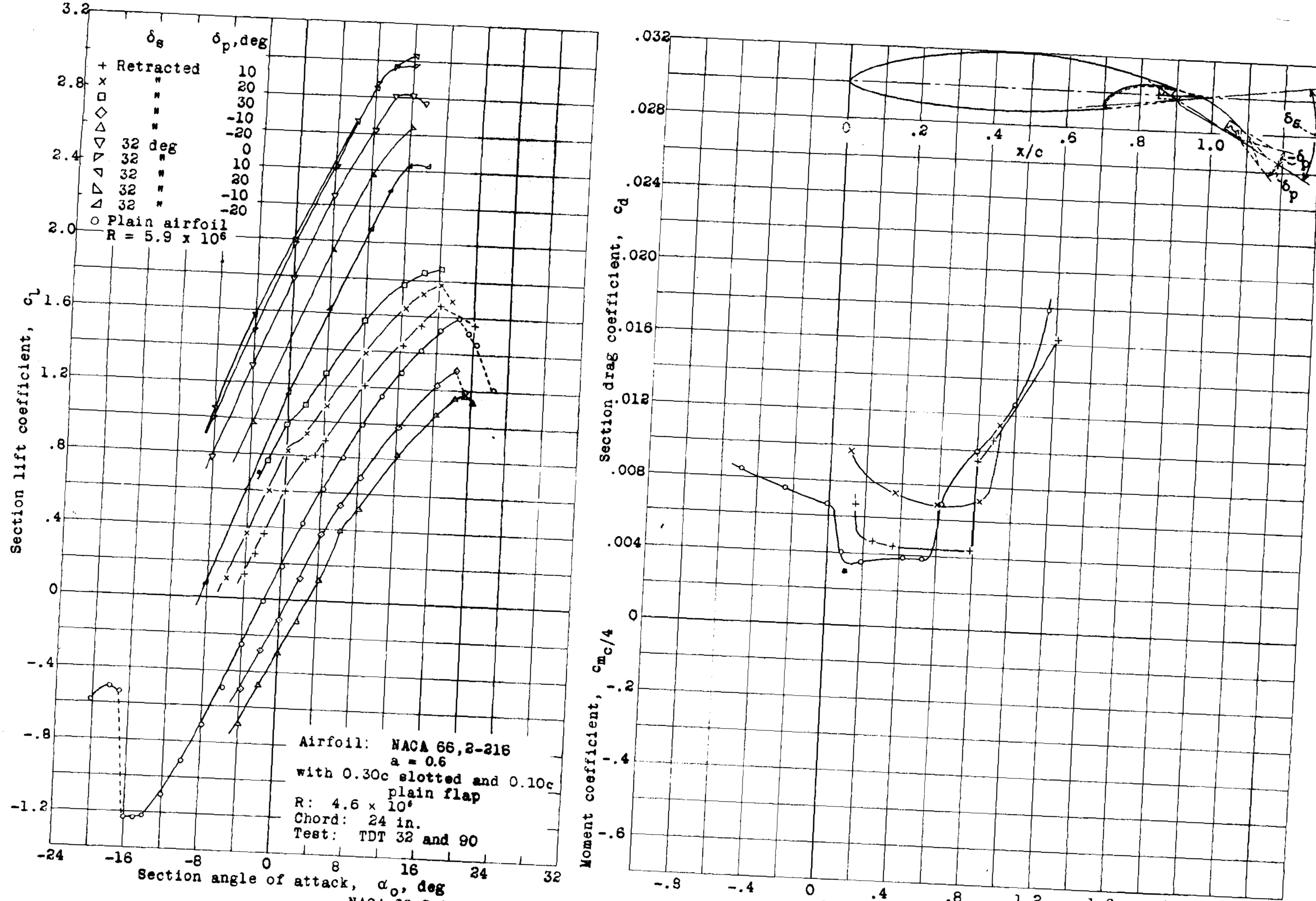
NACA 66,2-216, a = 0.6, with 0.20c split flap



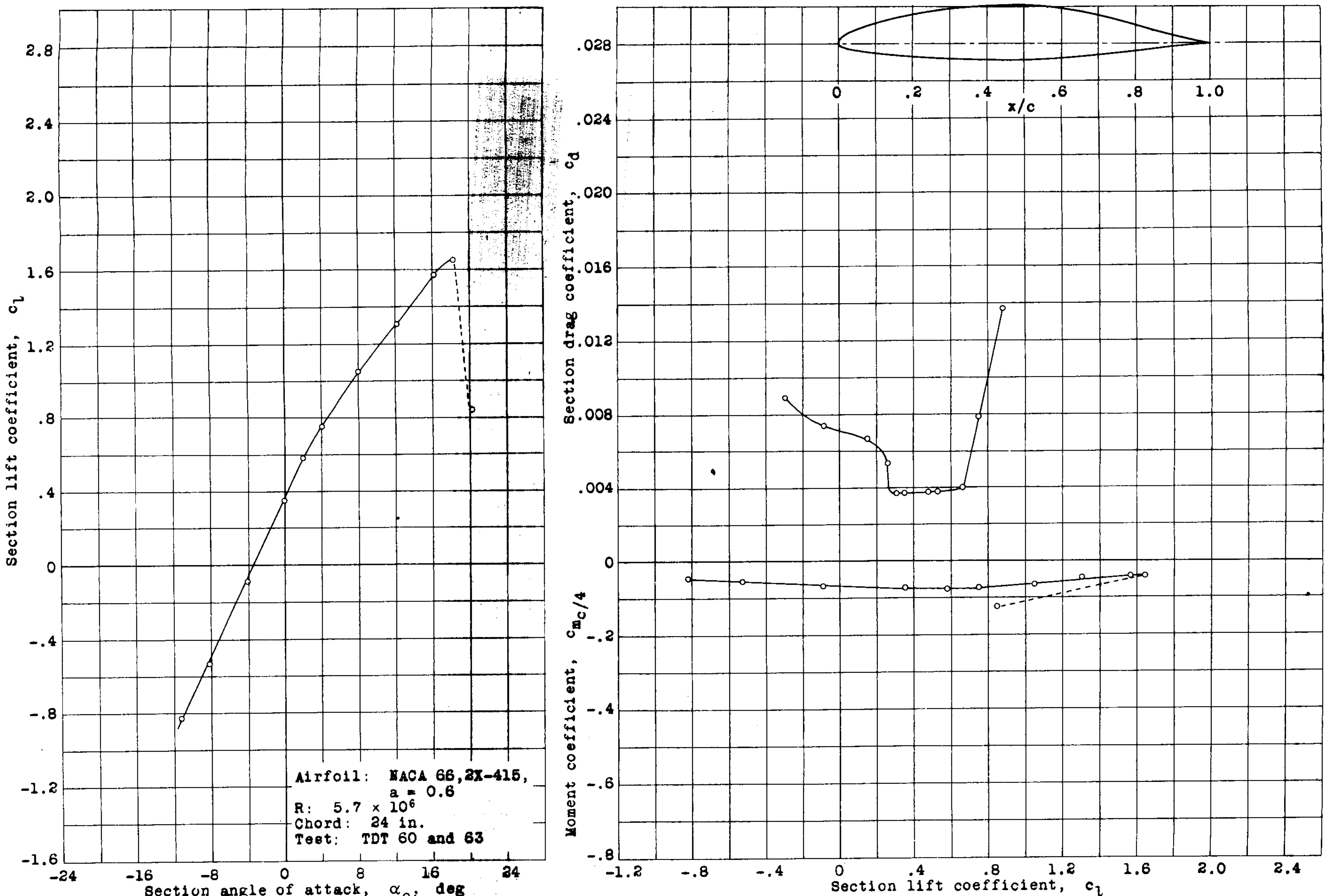
NACA 66,2-216, a = 0.6, a = 0.6, with 0.25c hinged slotted flap



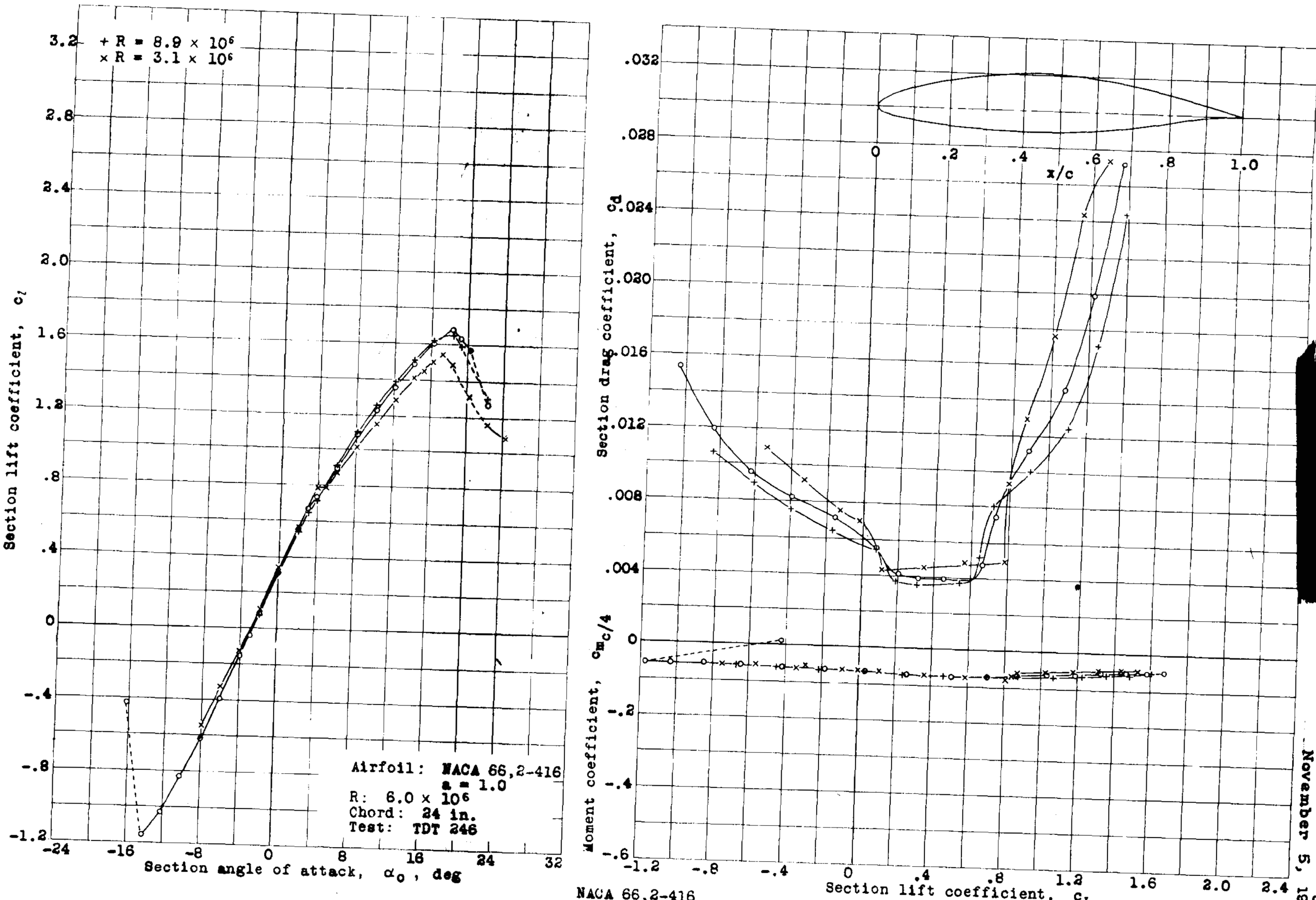
NACA 66,2-216, a = 0.6, with 0.30c slotted flap



NACA 66,2-216, a = 0.6, with 0.30c slotted and 0.10c plain flap



NACA 66,2X-415, a = 0.6

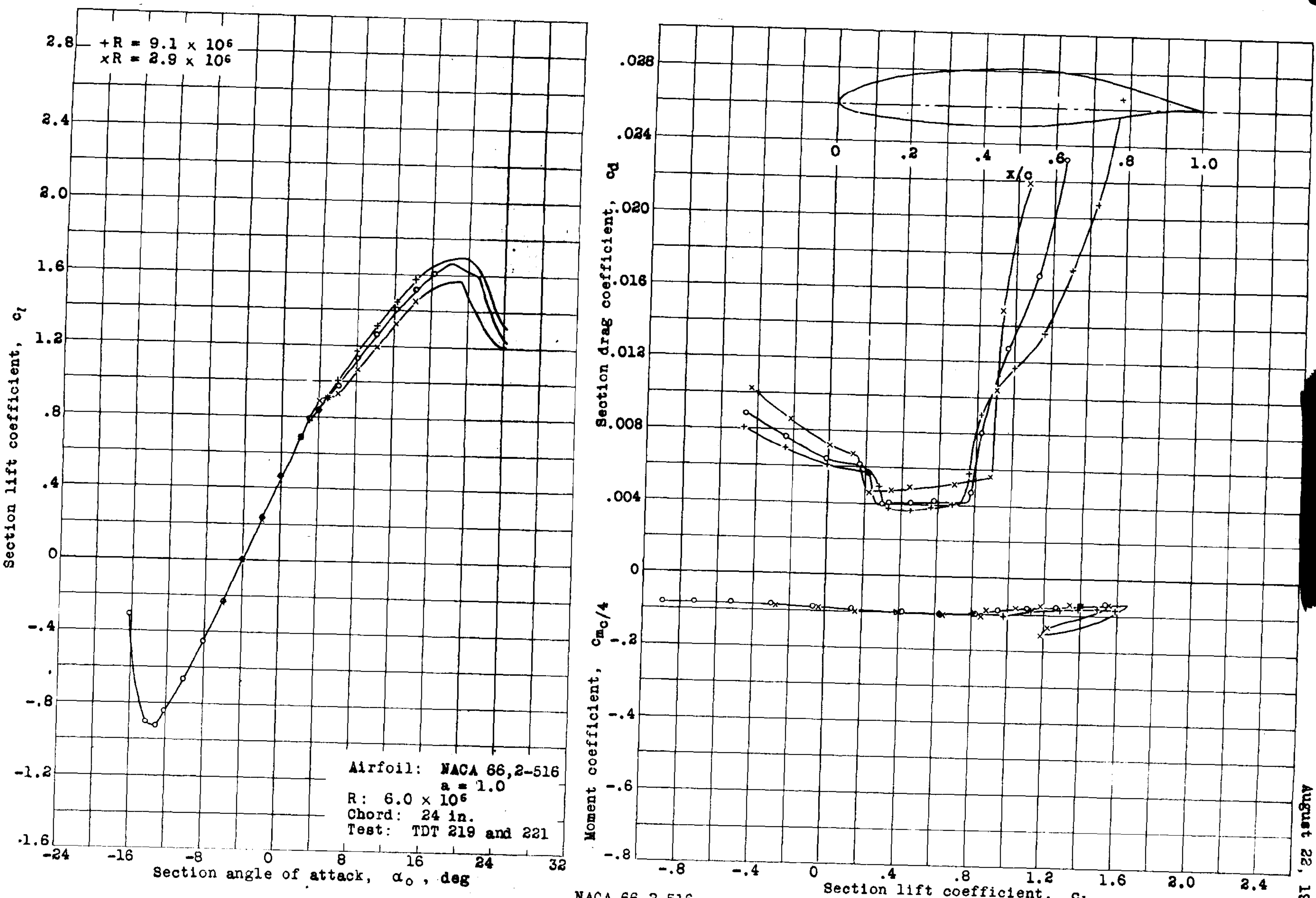


NACA 66,2-416

November 5, 1942

51a

COPY NO. 62

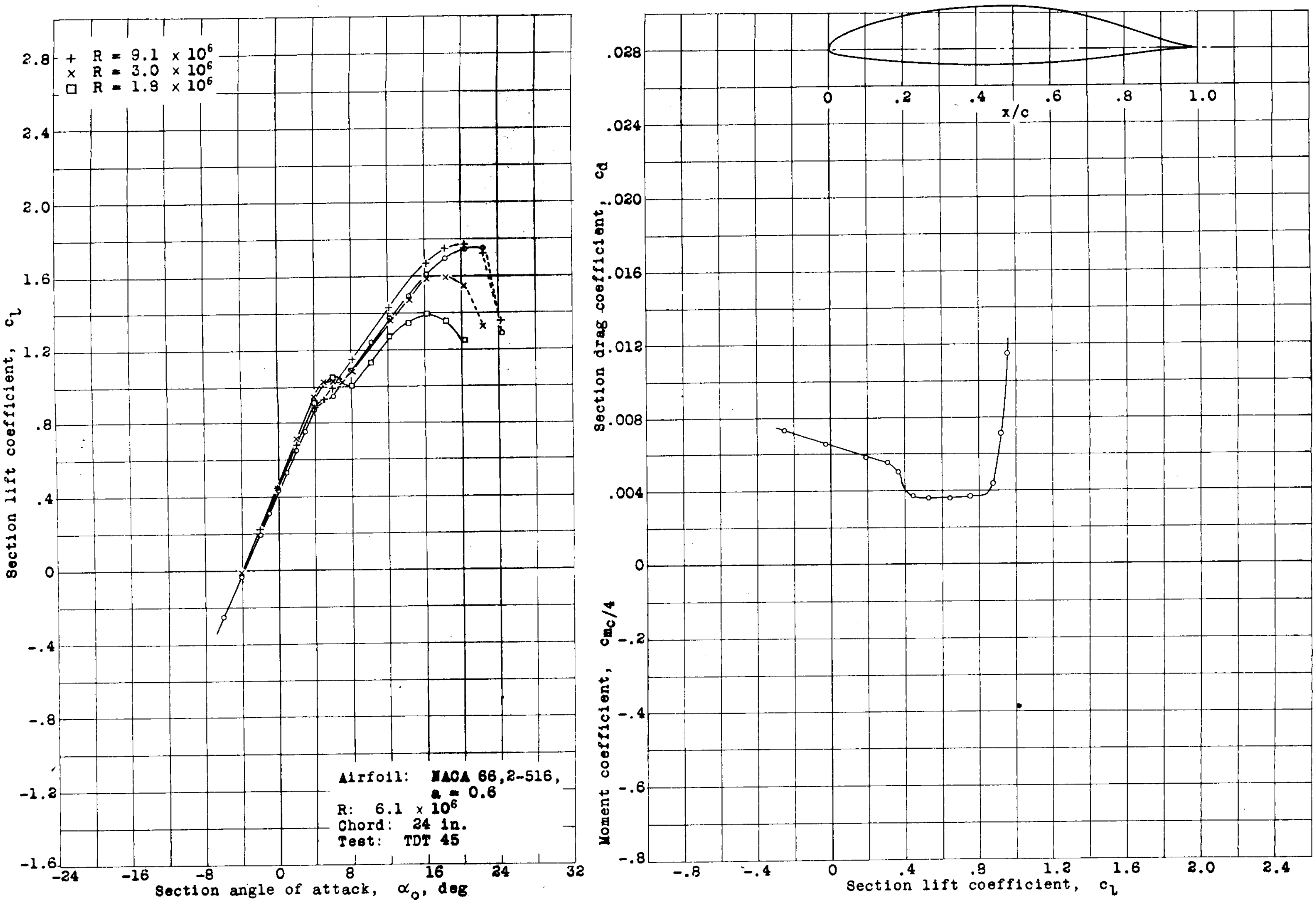


NACA 66,2-516

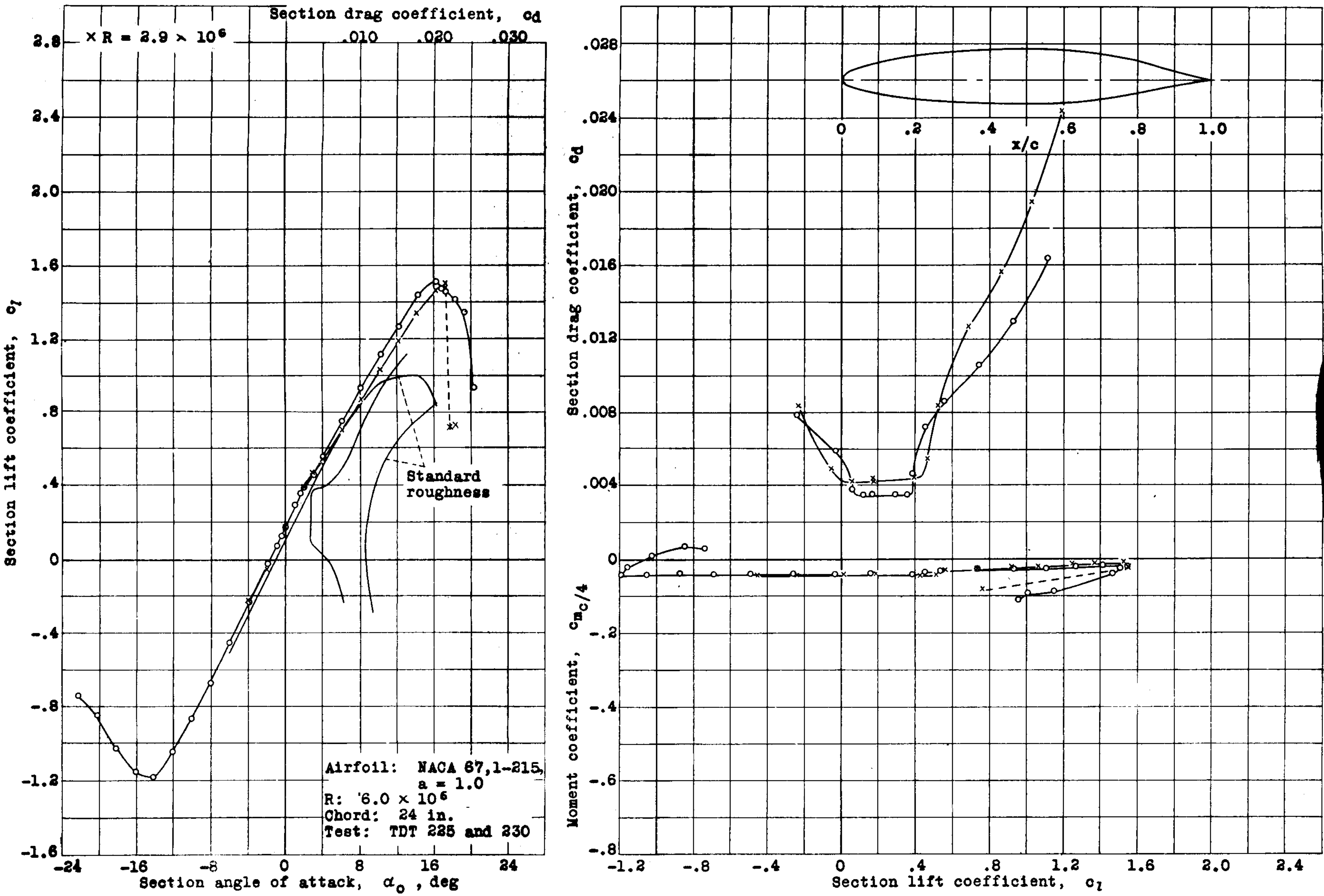
[redacted]

August 22, 1942 52

Copy No. 62



NACA 66,2-516, a = 0.6



NACA 67,1-215

August 22, 1942

54

Copy No. 62