NACA TN 4322

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE 4322

ORDINATES AND THEORETICAL PRESSURE-DISTRIBUTION DATA FOR NACA 6- AND 6A-SERIES AIRFOIL SECTIONS WITH THICKNESSES FROM 2 TO 21 AND FROM 2 TO 15 PERCENT CHORD, RESPECTIVELY

By Elizabeth W. Patterson and Albert L. Braslow

Langley Aeronautical Laboratory
Langley Field, Va.

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SUMMARY

Basic thickness forms of the NACA 63-, 64-, 65-series and NACA 63A-, 64A-, 65A-series airfoil sections are tabulated for thicknesses of 2, 3, 4, and 5 percent chord. Also presented for these thin airfoil sections are theoretical values of pressures and velocity ratios required to obtain theoretical airfoil pressure distributions. In addition, for each family of airfoil sections, cross plots are presented from which ordinates and pressure distributions can be easily obtained for airfoil sections of thicknesses intermediate to those presented in this report, in NACA Report 824 (from 6 to 21 percent chord for the NACA 6-series), and in NACA Report 903 (from 6 to 15 percent chord for the NACA 6A-series).

INTRODUCTION

In order to minimize the wave drag of supersonic aircraft, the wings and tail surfaces are designed with the use of airfoil sections thinner than 6 percent chord. Ordinates for only a few of these thin airfoils are published and these are not conveniently located in a single report. This report will supplement the information presented in references 1 and 2 and provide the ordinates of additional airfoil sections useful in design of supersonic aircraft.

The information presented in this report includes tabulated ordinates for symmetrical NACA 6- and 6A-series airfoil sections with thicknesses of 2, 3, 4, and 5 percent chord and a simplified method of obtaining ordinates for any thickness intermediate to published values from 2 to 21 percent chord for NACA 63-, 64-, and 65-series and from 2 to 15 percent chord for NACA 63A-, 64A-, and 65A-series airfoil sections. In addition, a simplified procedure is presented for obtaining the pressure distributions about airfoil sections of intermediate thicknesses.

SYMBOLS

c	chord of airfoil
t	maximum thickness of airfoil
V_∞	free-stream velocity
V	local velocity at any point on airfoil surface
ΔV	increment of local velocity
ΔV_a	increment of local velocity caused by additional type of load distribution
x	distance along chord from leading edge
y	distance perpendicular to chord

DISCUSSION

The basic thickness forms for the NACA 63-, 64-, 65-series and NACA 63A-, 64A-, 65A-series airfoil sections with thicknesses of 2, 3, 4, and 5 percent chord are presented in the tables of figures 1 to 24. For the 6A-series airfoil sections, where a trailing-edge radius is specified, an ordinate is presented for the 100-percent-chord station to serve as a guide in fairing the rear portion of the airfoil. The theoretical methods of references 1 and 2 were used to derive the 2-percent-thick airfoil sections of the NACA 63-, 64-, 65-series and the NACA 63A-, 64A-, 65A-series families, respectively. Although not exactly correct, ordinates for thickness ratios intermediate to those presented in references 1 and 2 and in the present report can be obtained for all practical purposes by the following method which was used to obtain the ordinates for the 3-, 4-, and 5-percent-thick airfoil sections tabulated herein. For each family of airfoils, the ratio obtained by dividing the ordinate y at each chordwise station by the maximum thickness t is plotted against the airfoil maximum thickness in percent airfoil chord as presented in figures 25 to 30. From these cross plots, the ratio y/t at each chordwise station can be obtained at the desired value of maximum thickness. Values of the ratio of the leading-edge radius to the maximum thickness squared as a function of maximum thickness t are presented for the NACA 6-series and 6A-series airfoil sections in figures 31 and 32, respectively. Addition of a cambered mean line to the basic thickness form is accomplished with the use of the mean-line data of references 1 and 2.

The theoretical pressure distributions, indicated by $(V/V_\infty)^2$, for each of the symmetrical airfoil sections presented are also tabulated in figures 1 to 24. In order to obtain the theoretical pressure distributions for these airfoil sections at angles of attack and/or with cambered mean lines, the procedure described in reference 1 can be used. In this method of calculating the pressure distributions, the velocity distribution about an airfoil section is considered to be composed of the following three separate and independent components:

(1) The distribution corresponding to the velocity distribution over the basic thickness form at zero angle of attack (V/V_∞)

(2) The distribution corresponding to the design load distribution of the mean line $(\Delta V/V_\infty)$

(3) The distribution corresponding to the additional load distribution associated with angle of attack $(\Delta V_a/V_\infty)$

Values of the velocity-increment ratio $\Delta V/V_\infty$ are presented in references 1 and 2 and values of the velocity ratio V/V_∞ and the velocity-increment ratio $\Delta V_a/V_\infty$ are tabulated in figures 1 to 24. For each family of airfoil sections, values of $(V/V_\infty)^2$ and $\Delta V_a/V_\infty$ for intermediate thicknesses can be obtained from figures 33 to 44. In these figures, $(V/V_\infty)^2$ and $\Delta V_a/V_\infty$ are plotted as a function of the maximum airfoil thickness t in percent chord for each chordwise station.

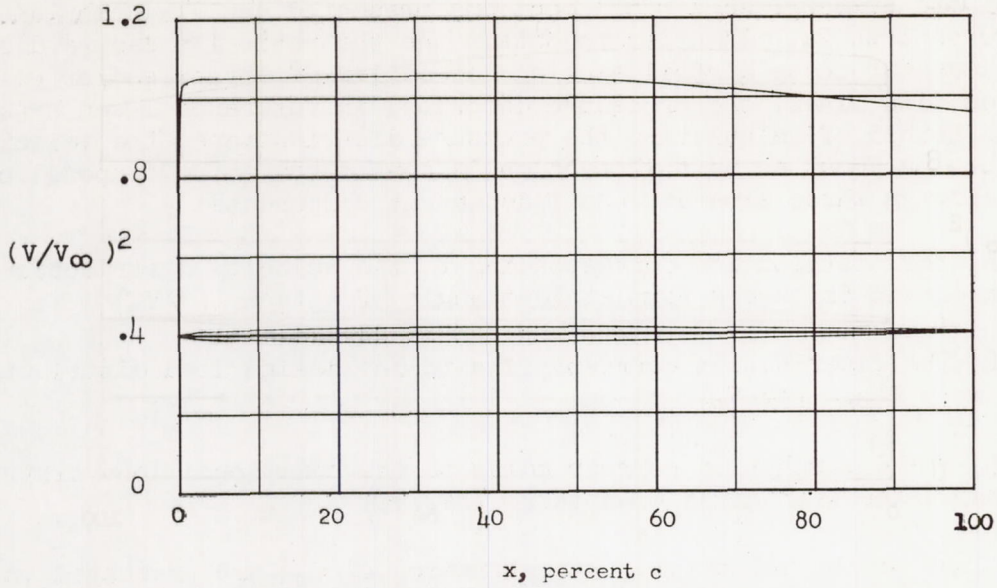
Careful comparison of the ordinates and pressure ratios tabulated in references 1 and 2 with the faired cross plots of figures 25 to 44 shows some discrepancies. Although these discrepancies are small enough to be disregarded for all practical purposes, the values obtained from the faired cross plots are preferred for design considerations.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., August 25, 1958.

REFERENCES

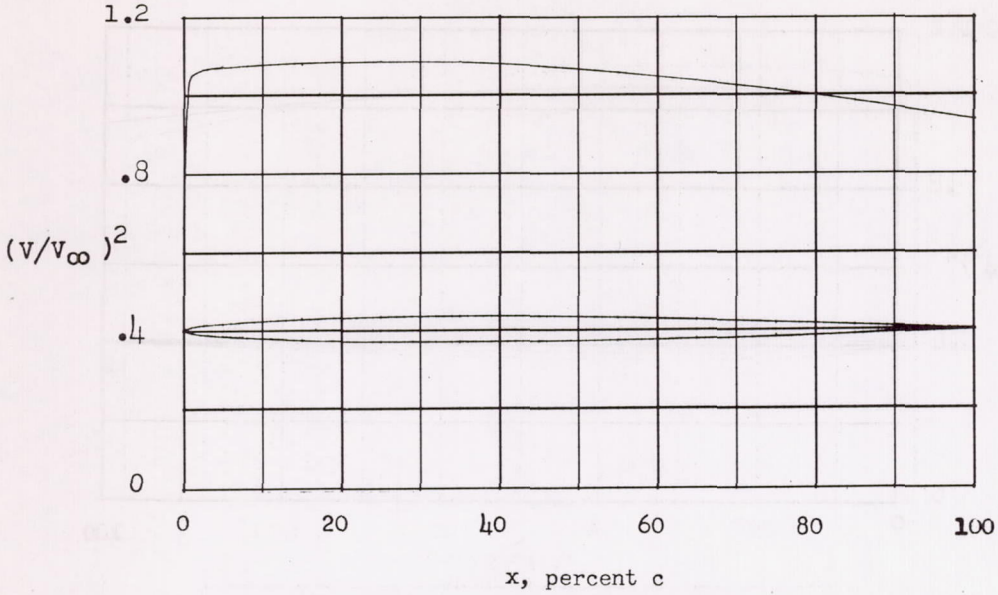
1. Abbott, Ira H., Von Doenhoff, Albert E., and Stivers, Louis S., Jr.: Summary of Airfoil Data. NACA Rep. 824, 1945. (Formerly NACA WR L-560.)

2. Loftin, Laurence K., Jr.: Theoretical and Experimental Data for a Number of NACA 6A-Series Airfoil Sections. NACA Rep. 903, 1948. (Supersedes NACA TN 1368.)



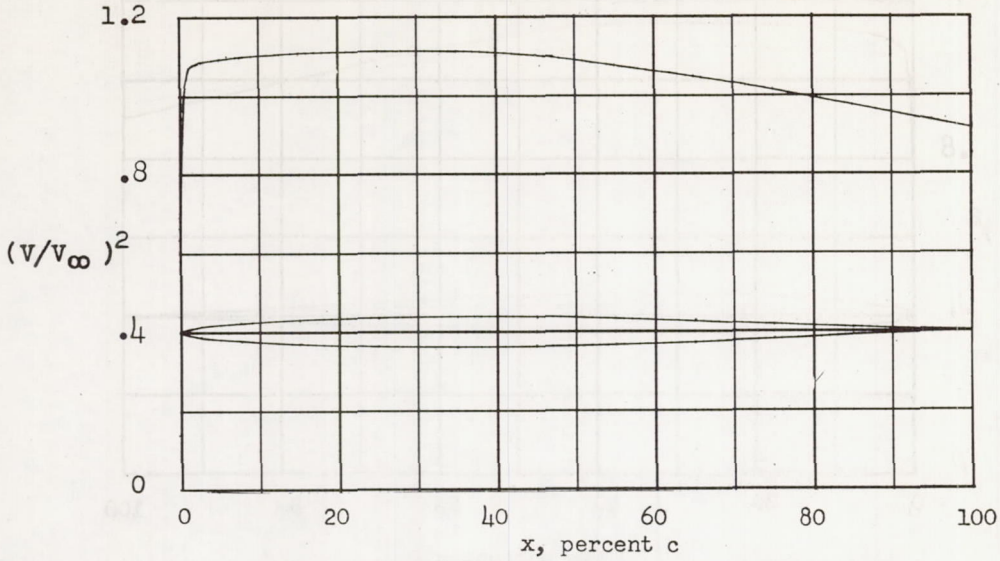
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	14.164
.5	.158	1.028	1.014	2.262
.75	.198	1.032	1.016	1.740
1.25	.254	1.037	1.018	1.353
2.5	.352	1.045	1.022	.998
5.0	.489	1.049	1.024	.703
7.5	.590	1.050	1.025	.558
10	.671	1.051	1.025	.480
15	.796	1.052	1.026	.380
20	.885	1.053	1.026	.320
25	.946	1.054	1.027	.277
30	.983	1.055	1.027	.245
35	.999	1.055	1.027	.218
40	.993	1.053	1.026	.195
45	.965	1.050	1.025	.175
50	.916	1.045	1.022	.158
55	.850	1.039	1.019	.143
60	.769	1.033	1.016	.128
65	.676	1.025	1.012	.115
70	.573	1.018	1.009	.102
75	.463	1.009	1.004	.090
80	.350	.999	.999	.077
85	.239	.989	.994	.065
90	.136	.979	.989	.050
95	.051	.969	.984	.035
100	0	.958	.979	0
L.E. radius: 0.045 percent c				

Figure 1.- NACA 63-002 basic thickness form.



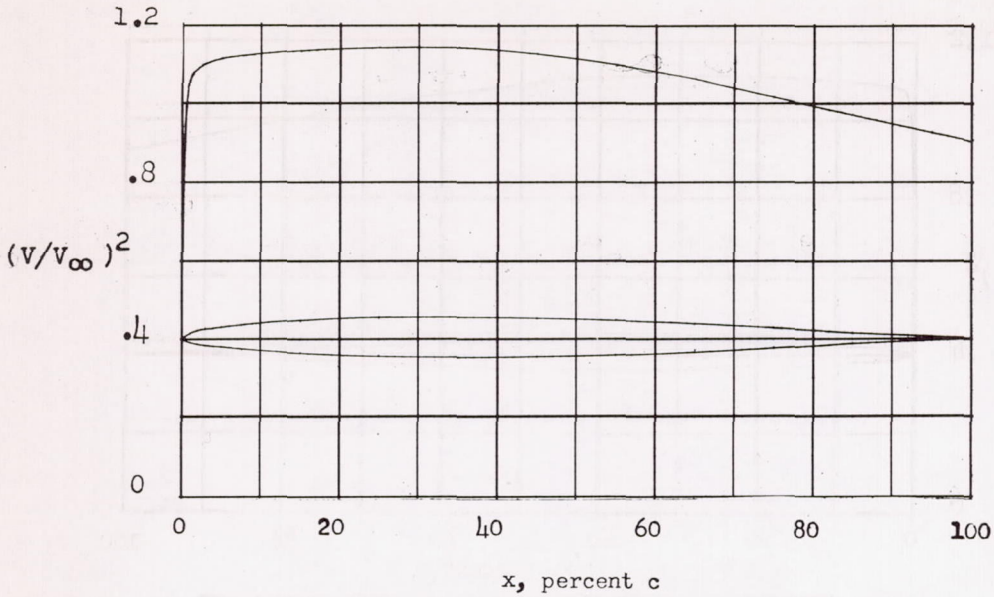
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	9.083
.5	.243	1.022	1.011	2.247
.75	.300	1.042	1.021	1.770
1.25	.383	1.054	1.027	1.377
2.5	.528	1.065	1.032	.995
5.0	.732	1.071	1.035	.700
7.5	.884	1.074	1.036	.559
10	1.006	1.076	1.037	.481
15	1.193	1.079	1.039	.382
20	1.327	1.081	1.040	.321
25	1.420	1.083	1.041	.278
30	1.476	1.084	1.041	.245
35	1.499	1.082	1.040	.218
40	1.489	1.080	1.039	.195
45	1.445	1.074	1.036	.175
50	1.371	1.068	1.033	.158
55	1.271	1.058	1.029	.142
60	1.149	1.049	1.024	.127
65	1.008	1.037	1.018	.114
70	.853	1.025	1.012	.100
75	.688	1.012	1.006	.088
80	.520	.998	.999	.076
85	.354	.983	.991	.064
90	.201	.968	.984	.049
95	.074	.954	.977	.034
100	0	.939	.969	0
L.E. radius: 0.072 percent c				

Figure 2.- NACA 63-003 basic thickness form.



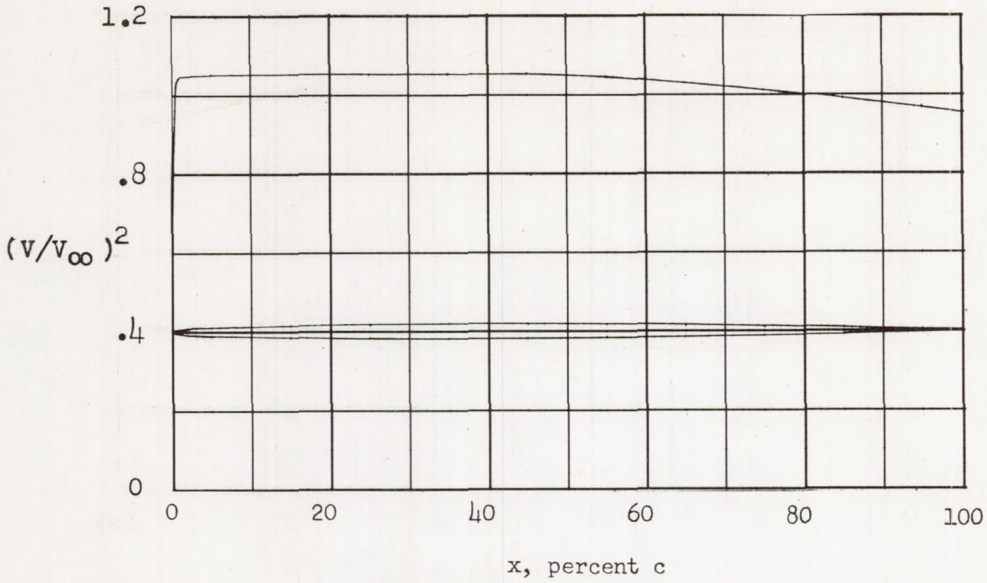
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	6.711
.5	.330	1.010	1.005	2.212
.75	.404	1.049	1.024	1.789
1.25	.513	1.068	1.033	1.395
2.5	.705	1.082	1.040	.991
5.0	.976	1.091	1.045	.696
7.5	1.178	1.097	1.047	.560
10	1.341	1.100	1.049	.482
15	1.590	1.106	1.052	.383
20	1.770	1.109	1.053	.321
25	1.894	1.112	1.055	.278
30	1.969	1.114	1.055	.245
35	2.000	1.111	1.054	.218
40	1.984	1.108	1.053	.195
45	1.924	1.100	1.049	.175
50	1.824	1.091	1.045	.158
55	1.689	1.078	1.038	.142
60	1.525	1.065	1.032	.127
65	1.336	1.049	1.024	.113
70	1.129	1.033	1.016	.100
75	.910	1.015	1.007	.087
80	.686	.997	.998	.075
85	.466	.978	.989	.063
90	.263	.958	.979	.048
95	.096	.939	.969	.033
100	0	.921	.960	0
L.E. radius: 0.128 percent c				

Figure 3.- NACA 63-004 basic thickness form.



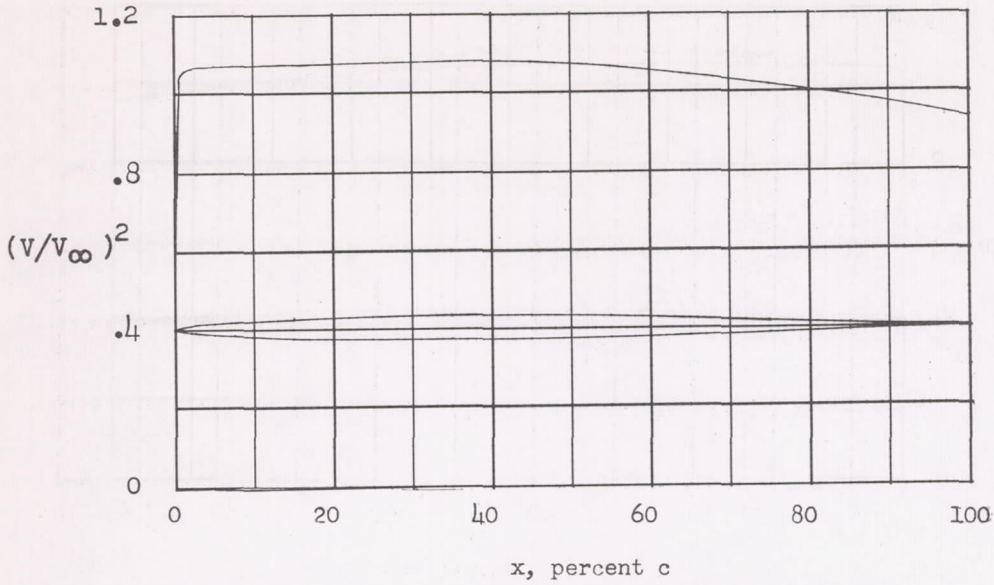
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.353
.5	.417	.994	.997	2.169
.75	.506	1.052	1.026	1.799
1.25	.642	1.077	1.038	1.403
2.5	.881	1.098	1.048	.987
5.0	1.220	1.111	1.054	.694
7.5	1.472	1.120	1.058	.561
10	1.676	1.124	1.060	.483
15	1.988	1.133	1.064	.383
20	2.213	1.137	1.066	.322
25	2.368	1.141	1.068	.279
30	2.462	1.143	1.069	.245
35	2.500	1.141	1.068	.218
40	2.478	1.136	1.066	.195
45	2.401	1.126	1.061	.175
50	2.274	1.114	1.055	.158
55	2.104	1.097	1.047	.141
60	1.897	1.080	1.039	.126
65	1.661	1.061	1.030	.112
70	1.401	1.040	1.020	.099
75	1.128	1.018	1.009	.086
80	.849	.995	.997	.074
85	.576	.972	.986	.061
90	.324	.947	.973	.047
95	.118	.924	.961	.032
100	0	.902	.950	0
L.E. radius: 0.200 percent c				

Figure 4.- NACA 63-005 basic thickness form.



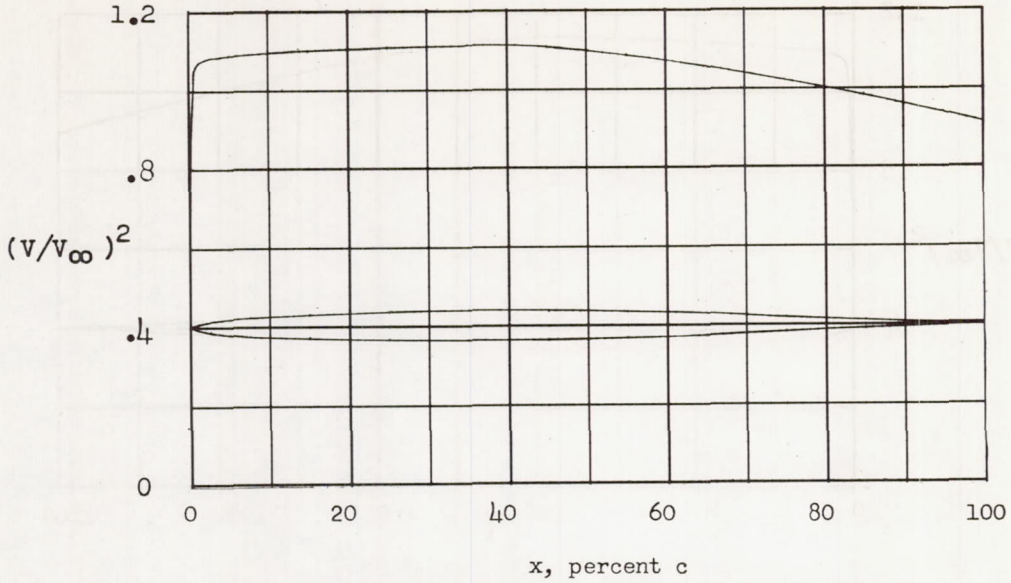
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	14.451
.5	.149	1.021	1.010	2.210
.75	.188	1.033	1.016	1.860
1.25	.246	1.042	1.021	1.465
2.5	.344	1.045	1.022	.998
5.0	.480	1.048	1.024	.697
7.5	.575	1.049	1.024	.562
10	.654	1.049	1.024	.478
15	.775	1.050	1.025	.380
20	.863	1.051	1.025	.320
25	.928	1.051	1.025	.277
30	.971	1.052	1.026	.245
35	.995	1.053	1.026	.218
40	.999	1.054	1.027	.196
45	.976	1.052	1.026	.178
50	.931	1.048	1.024	.158
55	.867	1.042	1.021	.142
60	.790	1.036	1.018	.128
65	.699	1.028	1.014	.115
70	.597	1.020	1.010	.102
75	.487	1.011	1.005	.089
80	.372	1.002	1.001	.078
85	.258	.992	.996	.065
90	.150	.983	.991	.052
95	.058	.970	.985	.035
100	0	.955	.977	0
L.E. radius: 0.028 percent c				

Figure 5.- NACA 64-002 basic thickness form.



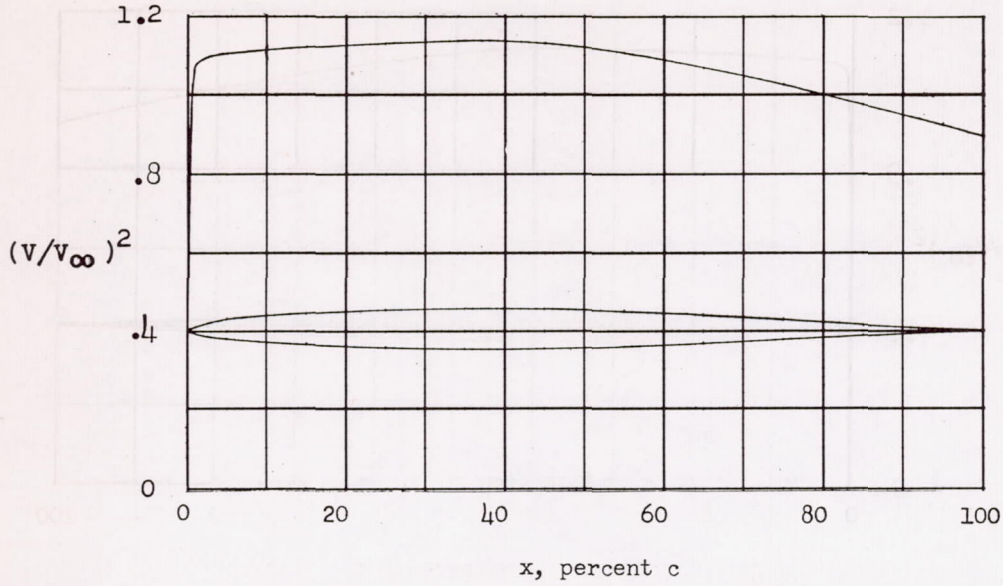
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	9.750
.5	.235	1.028	1.014	2.223
.75	.288	1.051	1.025	1.860
1.25	.372	1.058	1.029	1.465
2.5	.515	1.063	1.031	.995
5.0	.712	1.066	1.032	.696
7.5	.856	1.068	1.033	.561
10	.973	1.070	1.034	.478
15	1.156	1.072	1.035	.381
20	1.291	1.075	1.037	.320
25	1.389	1.077	1.038	.278
30	1.455	1.079	1.039	.245
35	1.491	1.080	1.039	.218
40	1.499	1.081	1.040	.197
45	1.463	1.078	1.038	.178
50	1.395	1.071	1.035	.158
55	1.298	1.063	1.031	.142
60	1.180	1.053	1.026	.128
65	1.043	1.041	1.020	.114
70	.889	1.030	1.015	.101
75	.724	1.015	1.007	.088
80	.553	1.002	1.001	.076
85	.382	.987	.993	.063
90	.221	.972	.986	.050
95	.084	.953	.976	.034
100	0	.935	.967	0
L.E. radius: 0.062 percent c				

Figure 6.- NACA 64-003 basic thickness form.



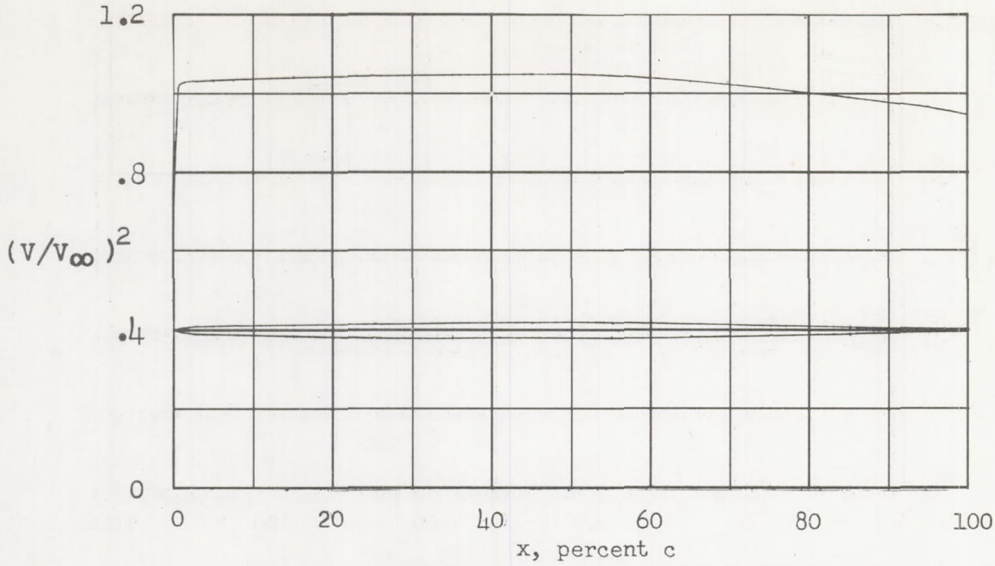
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	7.070
.5	.322	1.029	1.014	2.225
.75	.391	1.060	1.030	1.844
1.25	.500	1.070	1.034	1.456
2.5	.685	1.079	1.039	.992
5.0	.943	1.084	1.041	.695
7.5	1.134	1.088	1.043	.561
10	1.290	1.091	1.045	.478
15	1.536	1.097	1.047	.382
20	1.717	1.101	1.049	.320
25	1.849	1.104	1.051	.278
30	1.938	1.107	1.052	.245
35	1.987	1.109	1.053	.218
40	1.997	1.112	1.055	.197
45	1.950	1.104	1.051	.177
50	1.857	1.095	1.046	.158
55	1.726	1.083	1.041	.142
60	1.567	1.069	1.034	.128
65	1.382	1.054	1.027	.114
70	1.177	1.039	1.019	.100
75	.957	1.020	1.010	.087
80	.729	1.002	1.001	.075
85	.503	.981	.990	.062
90	.290	.960	.980	.059
95	.110	.937	.968	.033
100	0	.915	.957	0
L.E. radius: 0.110 percent c				

Figure 7.- NACA 64-004 basic thickness form.



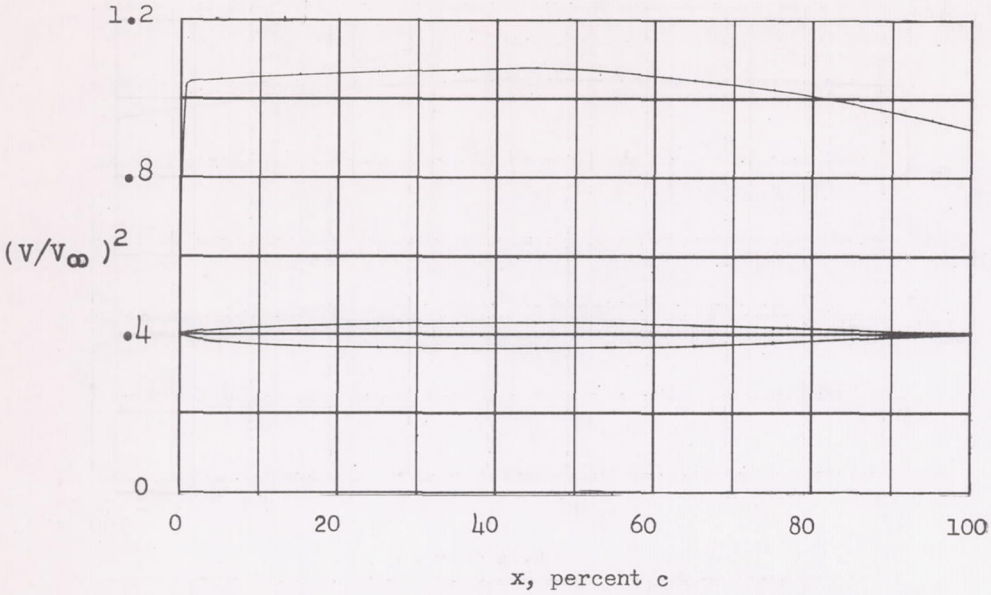
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.550
.5	.408	1.021	1.010	2.213
.75	.494	1.063	1.031	1.817
1.25	.627	1.079	1.039	1.440
2.5	.854	1.094	1.046	.987
5.0	1.173	1.101	1.049	.693
7.5	1.412	1.107	1.052	.560
10	1.608	1.112	1.055	.479
15	1.916	1.121	1.059	.383
20	2.143	1.127	1.062	.321
25	2.310	1.132	1.064	.279
30	2.421	1.136	1.066	.245
35	2.483	1.138	1.067	.219
40	2.496	1.141	1.068	.198
45	2.435	1.132	1.064	.177
50	2.316	1.119	1.058	.158
55	2.152	1.104	1.051	.142
60	1.950	1.086	1.042	.127
65	1.717	1.067	1.033	.113
70	1.460	1.047	1.023	.099
75	1.186	1.023	1.011	.086
80	.902	1.001	1.001	.074
85	.621	.975	.987	.061
90	.357	.949	.974	.048
95	.134	.922	.960	.032
100	0	.895	.946	0
L.E. radius: 0.173 percent c				

Figure 8.- NACA 64-005 basic thickness form.



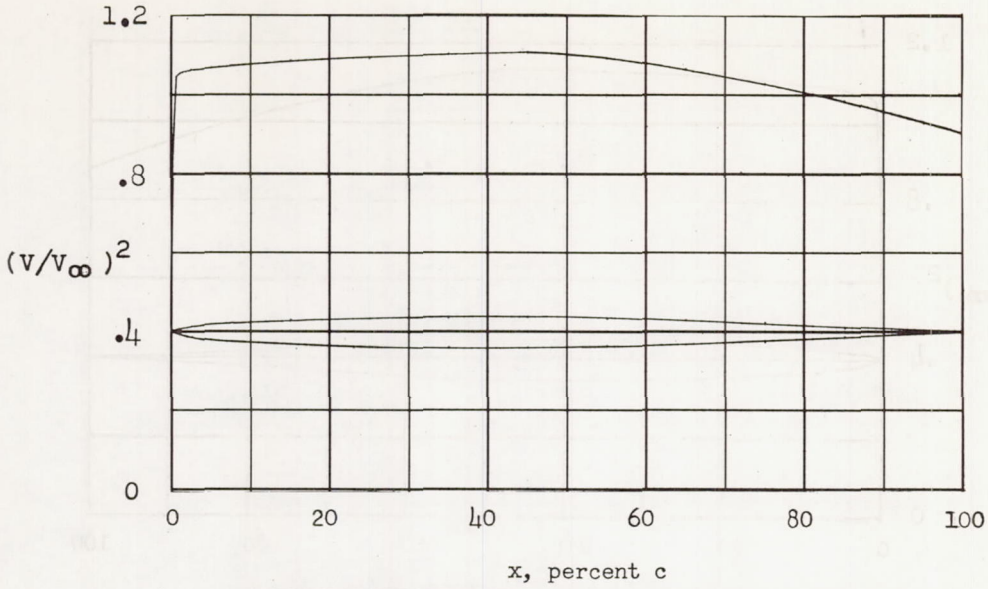
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	15.947
.5	.139	1.017	1.008	2.220
.75	.165	1.025	1.012	1.780
1.25	.211	1.030	1.015	1.401
2.5	.307	1.035	1.017	.994
5.0	.430	1.037	1.018	.692
7.5	.522	1.038	1.019	.563
10	.600	1.040	1.020	.478
15	.724	1.042	1.021	.381
20	.818	1.045	1.022	.321
25	.890	1.047	1.023	.277
30	.943	1.049	1.024	.245
35	.979	1.050	1.025	.218
40	.997	1.052	1.026	.196
45	.997	1.054	1.027	.177
50	.974	1.053	1.026	.159
55	.926	1.048	1.024	.144
60	.856	1.042	1.021	.130
65	.768	1.035	1.017	.116
70	.668	1.027	1.013	.103
75	.556	1.017	1.008	.090
80	.435	1.007	1.003	.078
85	.308	.995	.997	.065
90	.183	.983	.991	.052
95	.072	.967	.983	.035
100	0	.948	.974	0
L.E. radius: 0.027 percent c				

Figure 9.- NACA 65-002 basic thickness form.



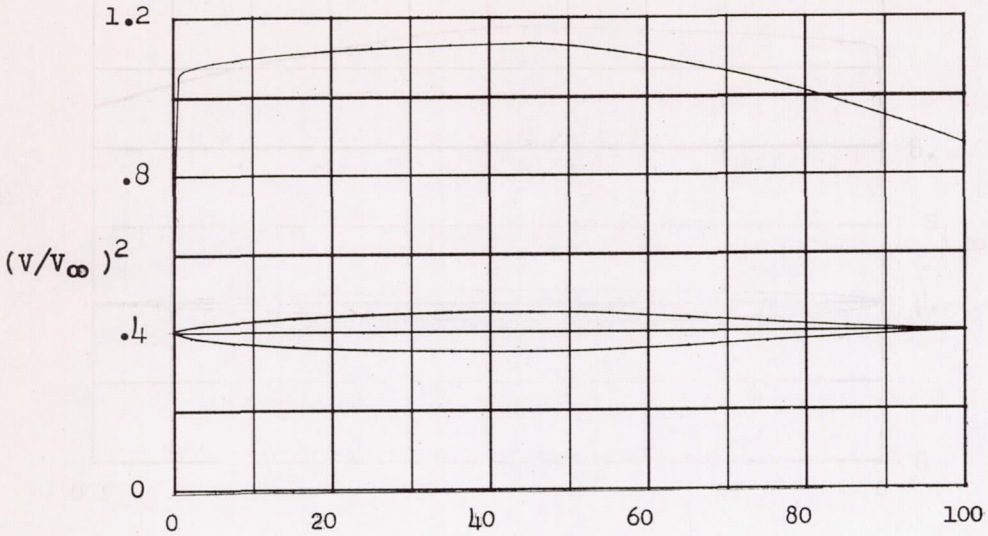
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	9.980
.5	.220	1.033	1.016	2.210
.75	.264	1.042	1.021	1.793
1.25	.334	1.047	1.024	1.406
2.5	.469	1.051	1.025	.987
5.0	.649	1.055	1.027	.693
7.5	.788	1.057	1.028	.562
10	.905	1.060	1.030	.478
15	1.091	1.065	1.032	.381
20	1.233	1.068	1.033	.321
25	1.341	1.072	1.035	.278
30	1.420	1.074	1.036	.245
35	1.472	1.076	1.037	.218
40	1.498	1.079	1.039	.196
45	1.495	1.081	1.040	.177
50	1.458	1.080	1.039	.159
55	1.383	1.072	1.035	.144
60	1.276	1.063	1.031	.130
65	1.144	1.051	1.025	.116
70	.991	1.039	1.019	.102
75	.822	1.024	1.012	.089
80	.641	1.009	1.004	.076
85	.453	.992	.996	.064
90	.269	.973	.986	.050
95	.105	.949	.974	.034
100	0	.925	.962	0
L.E. radius: 0.061 percent c				

Figure 10.- NACA 65-003 basic thickness form.



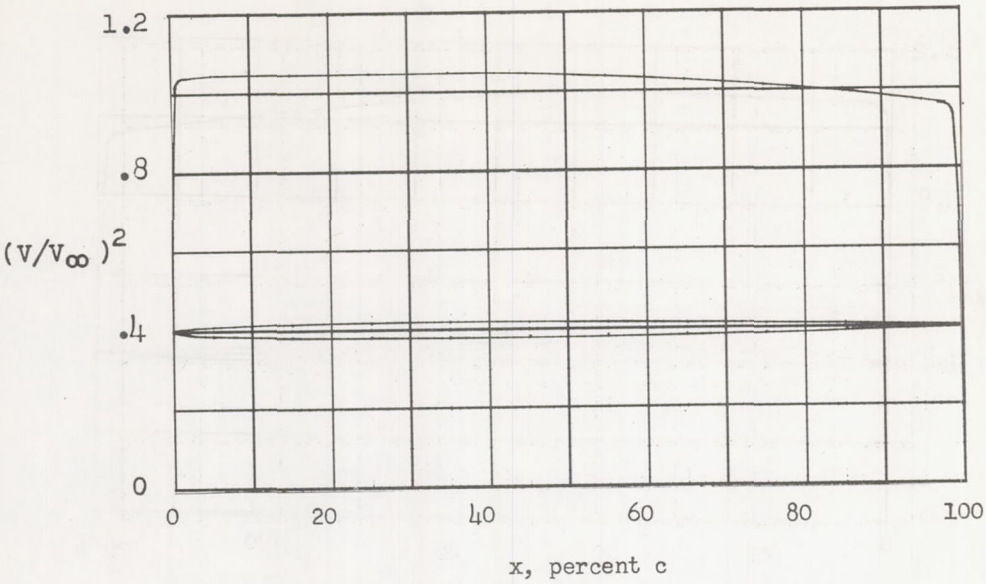
x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	7.180
.5	.307	1.046	1.023	2.188
.75	.370	1.054	1.027	1.800
1.25	.465	1.059	1.029	1.407
2.5	.632	1.064	1.032	.978
5.0	.870	1.071	1.035	.695
7.5	1.055	1.076	1.037	.561
10	1.212	1.081	1.040	.478
15	1.460	1.089	1.044	.381
20	1.650	1.093	1.045	.321
25	1.793	1.097	1.047	.279
30	1.897	1.100	1.049	.246
35	1.965	1.103	1.050	.219
40	1.998	1.106	1.052	.196
45	1.991	1.109	1.053	.178
50	1.940	1.108	1.053	.160
55	1.838	1.097	1.047	.144
60	1.693	1.083	1.041	.129
65	1.515	1.068	1.033	.115
70	1.309	1.051	1.025	.101
75	1.083	1.031	1.015	.088
80	.842	1.011	1.005	.075
85	.593	.989	.994	.063
90	.351	.964	.982	.049
95	.136	.933	.966	.033
100	0	.902	.950	0
L.E. radius: 0.109 percent c				

Figure 11.- NACA 65-004 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.720
.5	.394	1.051	1.025	2.152
.75	.475	1.060	1.030	1.800
1.25	.594	1.064	1.032	1.402
2.5	.795	1.074	1.036	.973
5.0	1.090	1.087	1.043	.695
7.5	1.322	1.094	1.046	.560
10	1.518	1.100	1.049	.478
15	1.828	1.111	1.054	.381
20	2.066	1.118	1.057	.321
25	2.245	1.123	1.060	.279
30	2.375	1.127	1.062	.246
35	2.459	1.131	1.063	.219
40	2.498	1.134	1.065	.197
45	2.487	1.137	1.066	.178
50	2.420	1.136	1.066	.160
55	2.290	1.120	1.058	.144
60	2.106	1.103	1.050	.129
65	1.881	1.084	1.041	.114
70	1.623	1.062	1.031	.100
75	1.339	1.038	1.019	.087
80	1.038	1.012	1.006	.074
85	.729	.985	.992	.062
90	.430	.954	.977	.048
95	.165	.917	.958	.033
100	0	.880	.938	0
L.E. radius: 0.170 percent c				

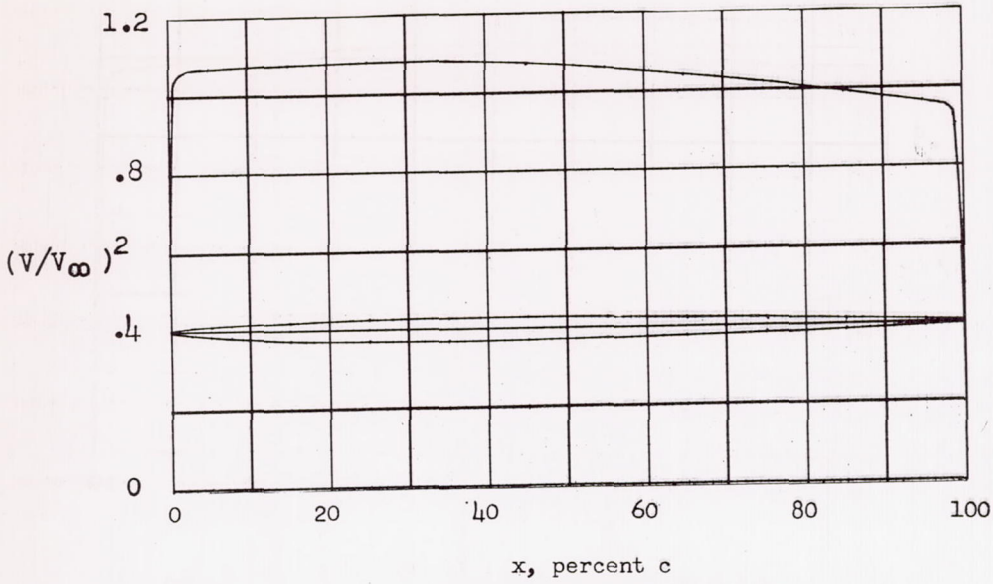
Figure 12.- NACA 65-005 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	14.296
.5	.159	1.018	1.009	2.210
.75	.196	1.034	1.017	1.830
1.25	.251	1.041	1.020	1.450
2.5	.350	1.044	1.022	.995
5.0	.486	1.048	1.024	.697
7.5	.587	1.049	1.024	.558
10	.668	1.050	1.025	.481
15	.790	1.051	1.025	.381
20	.877	1.052	1.026	.319
25	.938	1.052	1.026	.277
30	.977	1.053	1.026	.243
35	.996	1.053	1.026	.217
40	.995	1.052	1.026	.196
45	.974	1.048	1.024	.176
50	.936	1.045	1.022	.158
55	.880	1.040	1.020	.142
60	.808	1.035	1.017	.128
65	.724	1.029	1.014	.115
70	.630	1.022	1.011	.102
75	.528	1.014	1.007	.090
80	.424	1.007	1.003	.078
85	.319	.998	.999	.065
90	.214	.988	.994	.052
95	.109	.976	.988	.035
100	.005	0	0	0

L.E. radius: 0.030 percent c
T.E. radius: 0.005 percent c

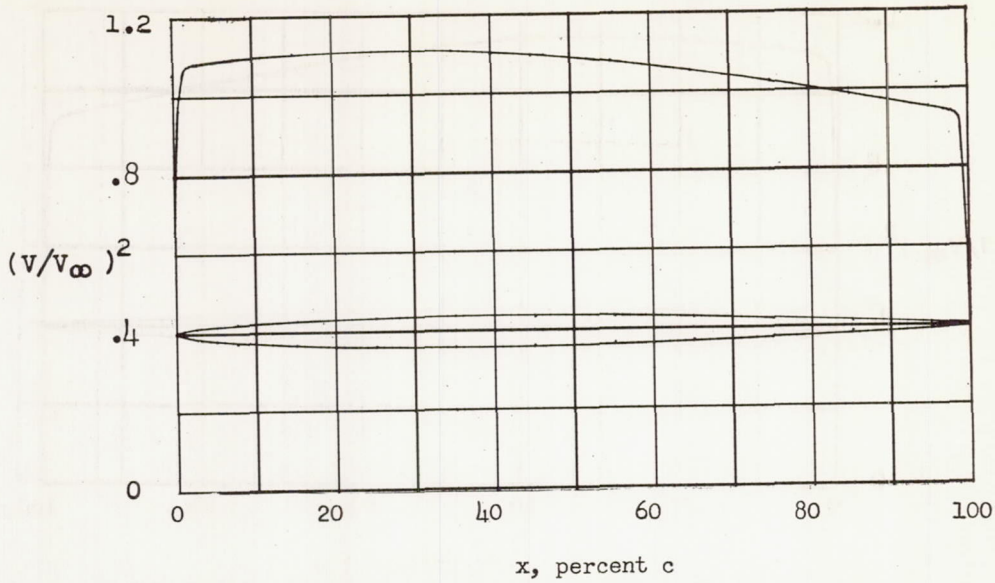
Figure 13.- NACA 63A002 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	9.320
.5	.242	.993	.996	2.198
.75	.295	1.048	1.024	1.828
1.25	.377	1.057	1.028	1.435
2.5	.524	1.064	1.032	.990
5.0	.727	1.070	1.034	.697
7.5	.878	1.072	1.035	.560
10	.999	1.075	1.037	.482
15	1.183	1.078	1.038	.382
20	1.315	1.080	1.039	.319
25	1.408	1.082	1.040	.277
30	1.467	1.084	1.041	.243
35	1.495	1.082	1.040	.217
40	1.493	1.079	1.039	.195
45	1.461	1.074	1.036	.175
50	1.400	1.068	1.033	.158
55	1.316	1.061	1.030	.142
60	1.209	1.051	1.025	.127
65	1.083	1.041	1.020	.114
70	.940	1.030	1.015	.101
75	.788	1.020	1.010	.089
80	.633	1.008	1.004	.076
85	.476	.995	.997	.064
90	.319	.982	.991	.051
95	.163	.967	.983	.034
100	.007	0	0	0

L.E. radius: 0.067 percent c
T.E. radius: 0.008 percent c

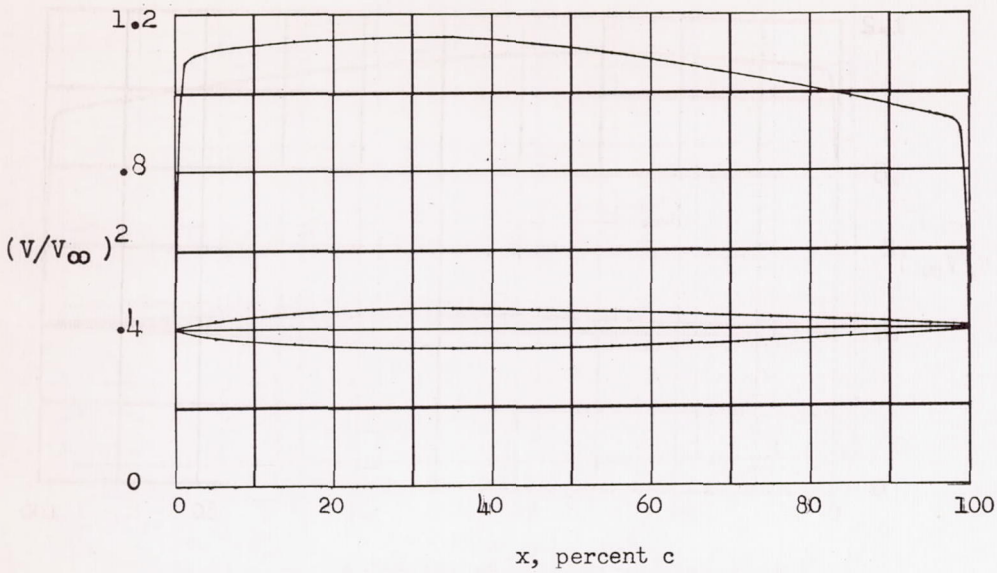
Figure 14.- NACA 63A003 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	6.770
.5	.326	.967	.983	2.170
.75	.396	1.058	1.029	1.812
1.25	.503	1.071	1.035	1.418
2.5	.698	1.082	1.040	.985
5.0	.967	1.092	1.045	.696
7.5	1.167	1.095	1.046	.561
10	1.328	1.100	1.049	.484
15	1.576	1.105	1.051	.382
20	1.753	1.108	1.053	.320
25	1.878	1.111	1.054	.277
30	1.958	1.114	1.055	.244
35	1.995	1.111	1.054	.217
40	1.991	1.106	1.052	.194
45	1.946	1.098	1.048	.175
50	1.864	1.090	1.044	.158
55	1.750	1.080	1.039	.141
60	1.607	1.067	1.033	.126
65	1.439	1.054	1.027	.113
70	1.249	1.040	1.020	.100
75	1.046	1.026	1.013	.088
80	.840	1.009	1.004	.075
85	.632	.992	.996	.063
90	.424	.976	.988	.049
95	.217	.958	.979	.034
100	.009	0	0	0

L.E. radius: 0.118 percent c
T.E. radius: 0.010 percent c

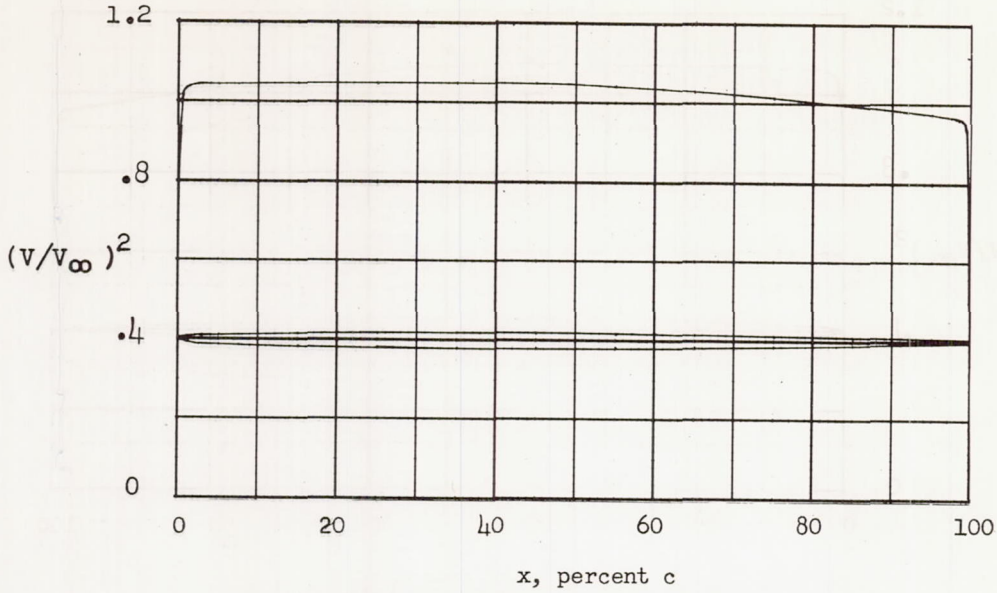
Figure 15.- NACA 63A004 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.420
.5	.412	.940	.970	2.131
.75	.496	1.063	1.031	1.786
1.25	.628	1.080	1.039	1.400
2.5	.871	1.098	1.048	.980
5.0	1.207	1.113	1.055	.695
7.5	1.456	1.118	1.057	.562
10	1.658	1.124	1.060	.484
15	1.968	1.132	1.064	.382
20	2.191	1.137	1.066	.320
25	2.348	1.140	1.068	.278
30	2.450	1.142	1.070	.244
35	2.496	1.140	1.068	.217
40	2.488	1.132	1.064	.194
45	2.430	1.123	1.060	.174
50	2.327	1.114	1.055	.157
55	2.183	1.100	1.049	.140
60	2.003	1.084	1.041	.126
65	1.792	1.067	1.033	.112
70	1.555	1.048	1.024	.099
75	1.302	1.031	1.015	.086
80	1.045	1.010	1.005	.074
85	.786	.989	.994	.062
90	.528	.970	.985	.048
95	.270	.948	.974	.033
100	.012	0	0	0

L.E. radius: 0.185 percent c
T.E. radius: 0.013 percent c

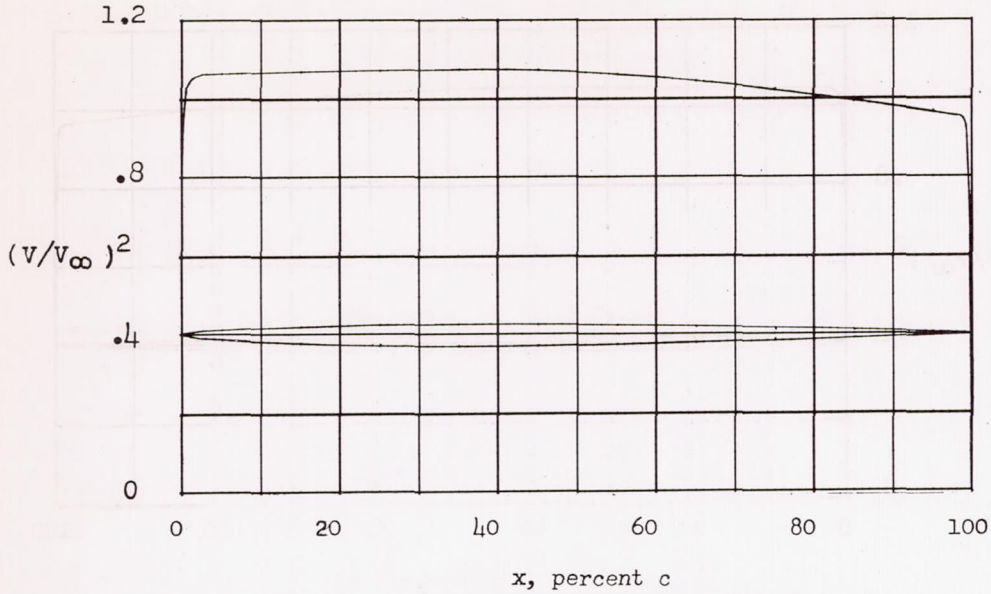
Figure 16.- NACA 63A005 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	14.738
.5	.153	1.020	1.010	2.240
.75	.191	1.033	1.016	1.850
1.25	.245	1.040	1.020	1.470
2.5	.341	1.043	1.021	.992
5.0	.473	1.045	1.022	.698
7.5	.571	1.046	1.023	.558
10	.650	1.047	1.023	.481
15	.769	1.048	1.024	.381
20	.856	1.049	1.024	.319
25	.921	1.050	1.025	.277
30	.967	1.051	1.025	.244
35	.993	1.052	1.026	.218
40	1.000	1.052	1.026	.194
45	.987	1.051	1.025	.176
50	.950	1.047	1.023	.159
55	.895	1.042	1.021	.143
60	.825	1.036	1.018	.129
65	.744	1.029	1.014	.116
70	.652	1.023	1.011	.102
75	.550	1.016	1.008	.090
80	.442	1.008	1.004	.078
85	.332	.999	.999	.065
90	.223	.989	.994	.052
95	.113	.978	.989	.034
100	.004	0	0	0

L.E. radius: 0.028 percent c
T.E. radius: 0.005 percent c

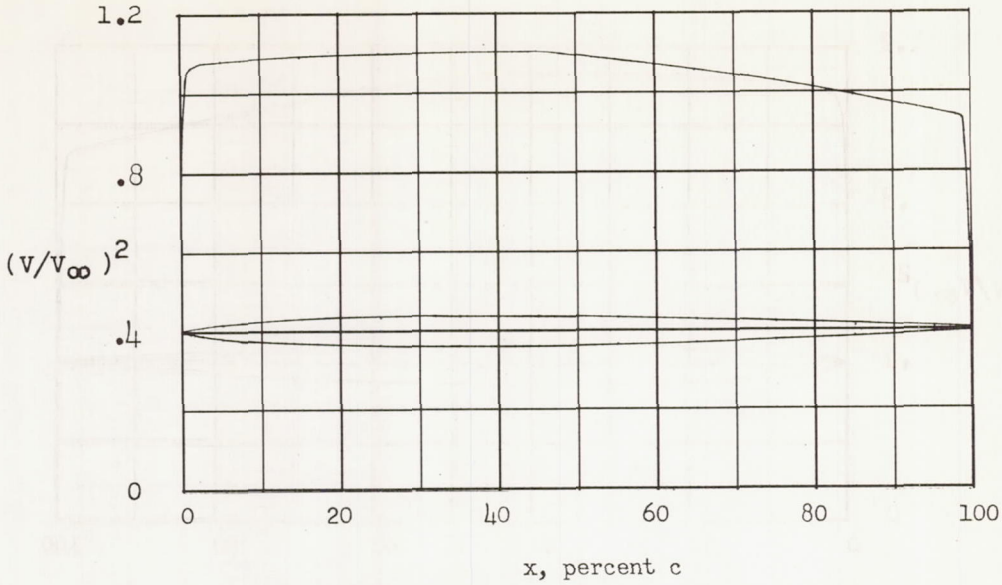
Figure 17.- NACA 64A002 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	9.500
.5	.235	1.030	1.015	2.228
.75	.289	1.046	1.023	1.850
1.25	.369	1.055	1.027	1.467
2.5	.510	1.062	1.031	.990
5.0	.706	1.064	1.032	.697
7.5	.851	1.066	1.032	.560
10	.969	1.068	1.033	.481
15	1.148	1.071	1.035	.381
20	1.282	1.073	1.036	.320
25	1.380	1.075	1.037	.278
30	1.449	1.078	1.038	.244
35	1.489	1.079	1.039	.218
40	1.500	1.080	1.039	.195
45	1.478	1.078	1.038	.176
50	1.421	1.070	1.034	.159
55	1.337	1.062	1.031	.142
60	1.232	1.054	1.027	.128
65	1.110	1.044	1.022	.115
70	.971	1.034	1.017	.101
75	.818	1.023	1.011	.089
80	.657	1.010	1.005	.077
85	.494	.997	.998	.064
90	.331	.982	.991	.051
95	.169	.967	.983	.034
100	.007	0	0	0

L.E. radius: 0.062 percent c
T.E. radius: 0.008 percent c

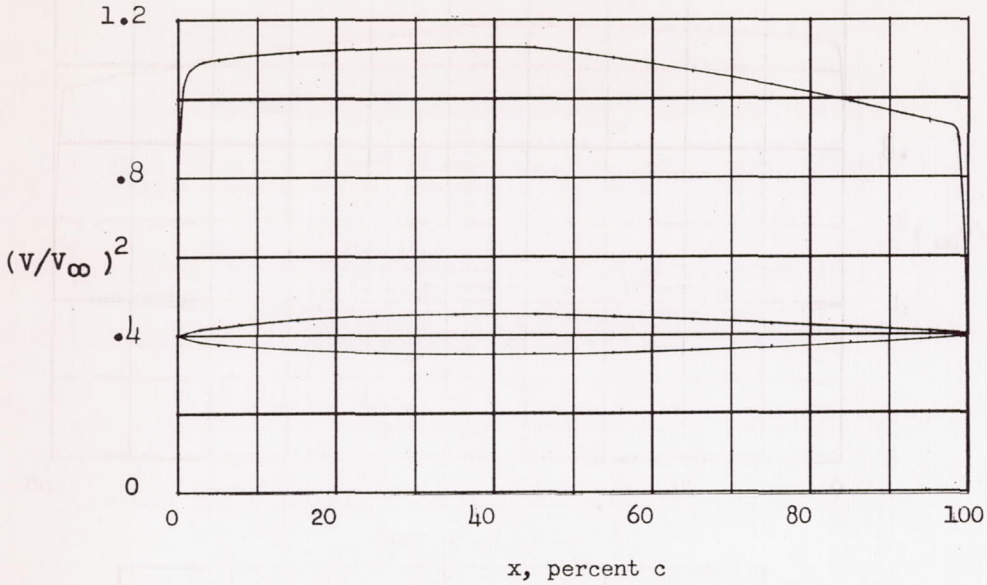
Figure 18.- NACA 64A003 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	6.920
.5	.318	1.035	1.017	2.199
.75	.388	1.052	1.026	1.845
1.25	.492	1.066	1.032	1.459
2.5	.679	1.079	1.039	.985
5.0	.937	1.082	1.040	.696
7.5	1.129	1.086	1.042	.562
10	1.286	1.089	1.044	.481
15	1.526	1.094	1.046	.381
20	1.706	1.098	1.048	.320
25	1.839	1.101	1.049	.278
30	1.931	1.104	1.051	.245
35	1.985	1.106	1.052	.219
40	2.000	1.108	1.053	.196
45	1.967	1.105	1.051	.176
50	1.890	1.094	1.046	.158
55	1.778	1.083	1.041	.142
60	1.637	1.071	1.035	.128
65	1.472	1.059	1.029	.114
70	1.286	1.045	1.022	.100
75	1.082	1.030	1.015	.088
80	.868	1.013	1.006	.076
85	.652	.995	.997	.063
90	.438	.976	.988	.050
95	.223	.958	.979	.033
100	.009	0	0	0

L.E. radius: 0.110 percent c
T.E. radius: 0.010 percent c

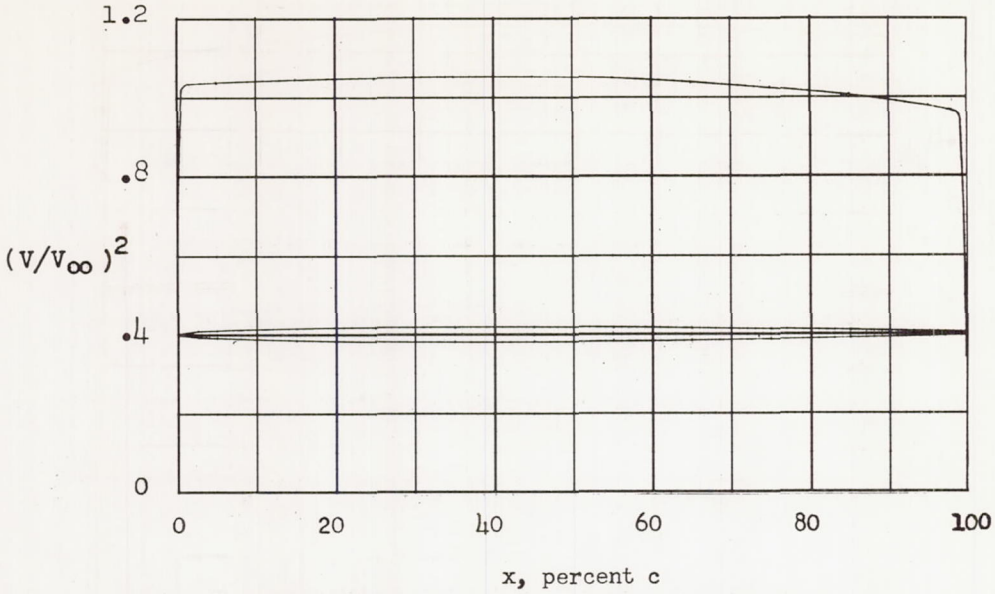
Figure 19.- NACA 64A004 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.570
.5	.402	1.032	1.016	2.156
.75	.487	1.053	1.026	1.831
1.25	.616	1.074	1.036	1.445
2.5	.848	1.093	1.045	.982
5.0	1.167	1.100	1.049	.695
7.5	1.406	1.106	1.052	.563
10	1.602	1.111	1.054	.481
15	1.904	1.117	1.057	.381
20	2.131	1.123	1.060	.321
25	2.297	1.127	1.062	.278
30	2.413	1.131	1.063	.245
35	2.481	1.133	1.064	.219
40	2.500	1.136	1.066	.197
45	2.456	1.131	1.063	.176
50	2.358	1.118	1.057	.158
55	2.216	1.104	1.051	.141
60	2.038	1.089	1.044	.127
65	1.831	1.073	1.036	.113
70	1.597	1.055	1.027	.099
75	1.343	1.036	1.018	.087
80	1.077	1.015	1.007	.075
85	.811	.994	.997	.062
90	.544	.970	.985	.048
95	.278	.946	.973	.032
100	.011	0	0	0

L.E. radius: 0.173 percent c
T.E. radius: 0.0125 percent c

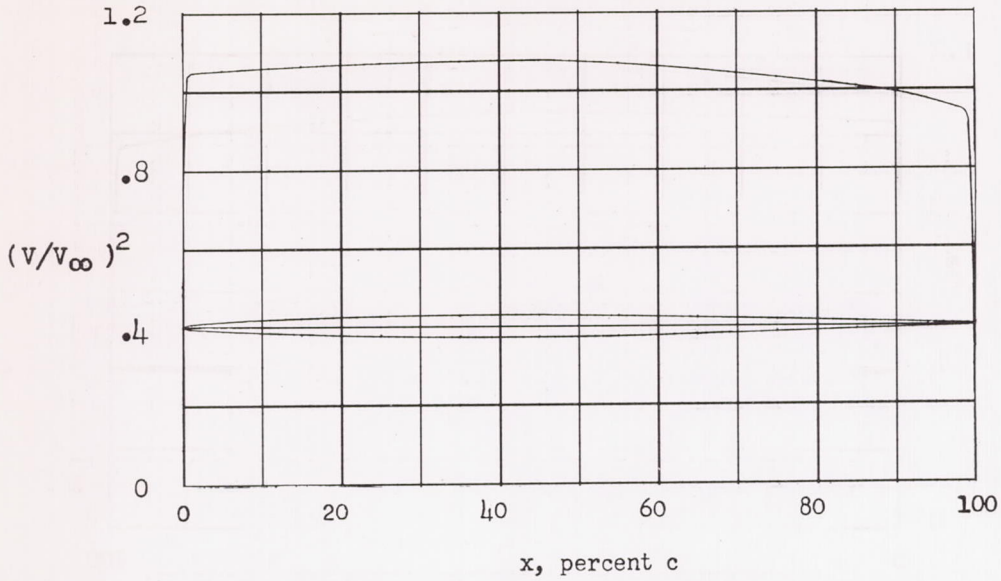
Figure 20.- NACA 64A005 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	16.145
.5	.140	1.017	1.008	2.220
.75	.168	1.027	1.013	1.810
1.25	.214	1.032	1.016	1.400
2.5	.312	1.035	1.017	.980
5.0	.436	1.038	1.019	.692
7.5	.527	1.039	1.019	.563
10	.603	1.040	1.020	.479
15	.724	1.042	1.021	.380
20	.818	1.044	1.022	.320
25	.890	1.046	1.023	.277
30	.944	1.048	1.024	.245
35	.980	1.050	1.025	.218
40	.999	1.051	1.025	.196
45	.999	1.052	1.026	.178
50	.980	1.051	1.025	.160
55	.938	1.047	1.023	.144
60	.876	1.041	1.020	.129
65	.799	1.035	1.017	.116
70	.707	1.028	1.014	.103
75	.603	1.021	1.010	.090
80	.489	1.013	1.006	.078
85	.368	1.003	1.001	.065
90	.247	.991	.995	.051
95	.126	.977	.988	.034
100	.004	0	0	0

L.E. radius: 0.026 percent c
T.E. radius: 0.0045 percent c

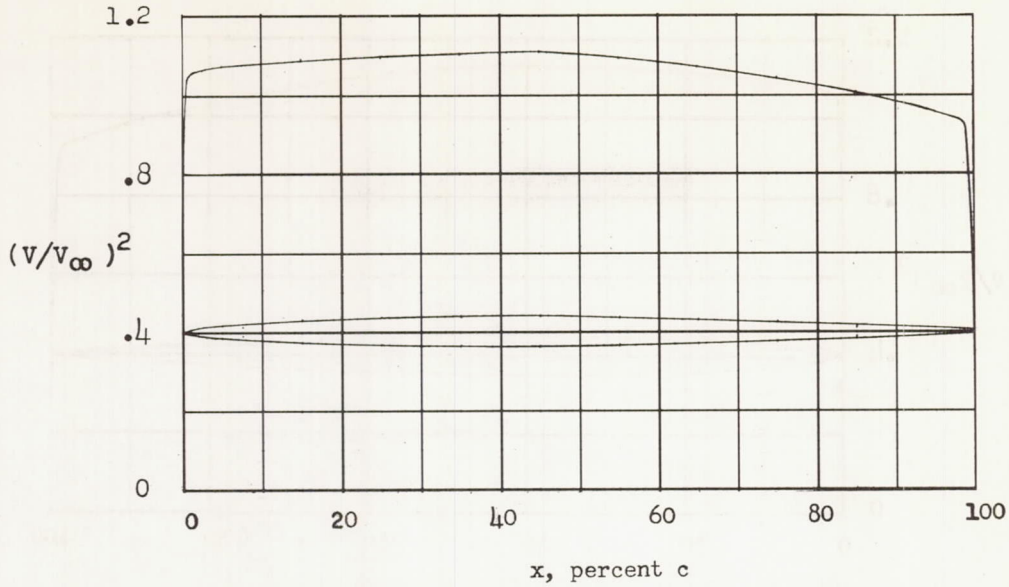
Figure 21.- NACA 65A002 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	10.081
.5	.223	1.030	1.016	2.220
.75	.269	1.043	1.021	1.812
1.25	.342	1.046	1.023	1.395
2.5	.479	1.049	1.024	.978
5.0	.656	1.055	1.027	.691
7.5	.793	1.058	1.029	.563
10	.908	1.060	1.030	.480
15	1.091	1.064	1.032	.381
20	1.231	1.068	1.033	.321
25	1.339	1.071	1.035	.277
30	1.418	1.073	1.036	.245
35	1.471	1.076	1.037	.218
40	1.498	1.078	1.038	.197
45	1.498	1.079	1.039	.178
50	1.467	1.076	1.037	.160
55	1.404	1.070	1.034	.144
60	1.310	1.062	1.031	.129
65	1.193	1.053	1.026	.115
70	1.056	1.042	1.021	.102
75	.901	1.032	1.016	.090
80	.729	1.018	1.009	.078
85	.550	1.003	1.001	.064
90	.369	.988	.994	.050
95	.188	.968	.984	.034
100	.007	0	0	0

L.E. radius: 0.058 percent c
T.E. radius: 0.007 percent c

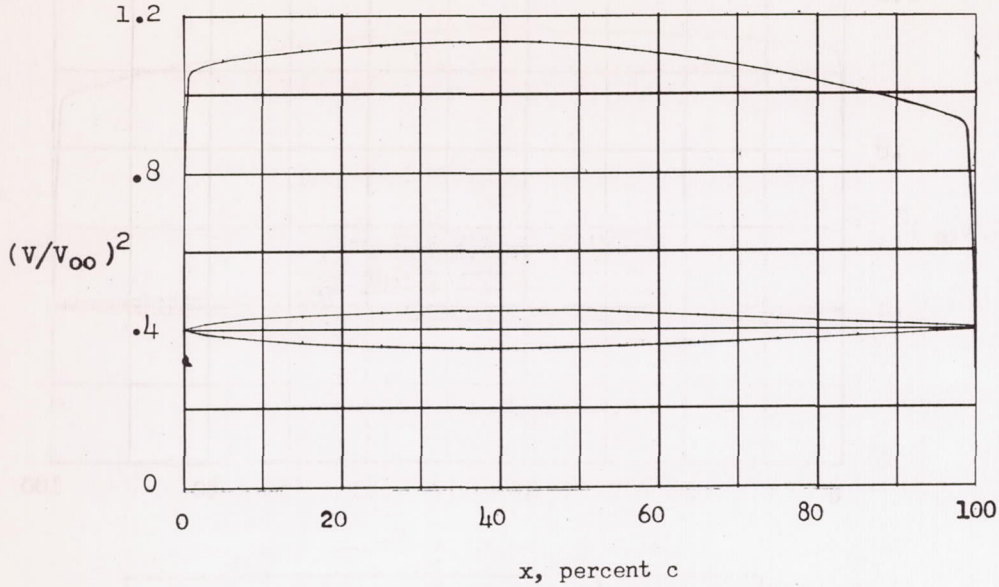
Figure 22.- NACA 65A003 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	7.337
.5	.304	1.038	1.019	2.210
.75	.368	1.050	1.025	1.805
1.25	.469	1.055	1.027	1.389
2.5	.647	1.061	1.030	.974
5.0	.875	1.071	1.035	.690
7.5	1.059	1.076	1.037	.563
10	1.213	1.080	1.039	.480
15	1.459	1.087	1.043	.381
20	1.645	1.091	1.045	.322
25	1.788	1.095	1.046	.277
30	1.892	1.098	1.048	.245
35	1.962	1.101	1.049	.218
40	1.997	1.104	1.051	.198
45	1.996	1.105	1.051	.178
50	1.954	1.101	1.049	.161
55	1.868	1.092	1.045	.144
60	1.743	1.081	1.040	.128
65	1.586	1.070	1.034	.114
70	1.402	1.056	1.028	.101
75	1.195	1.041	1.020	.089
80	.967	1.023	1.011	.077
85	.729	1.003	1.001	.063
90	.490	.983	.991	.049
95	.250	.958	.979	.034
100	.009	0	0	0

L.E. radius: 0.102 percent c
T.E. radius: 0.010 percent c

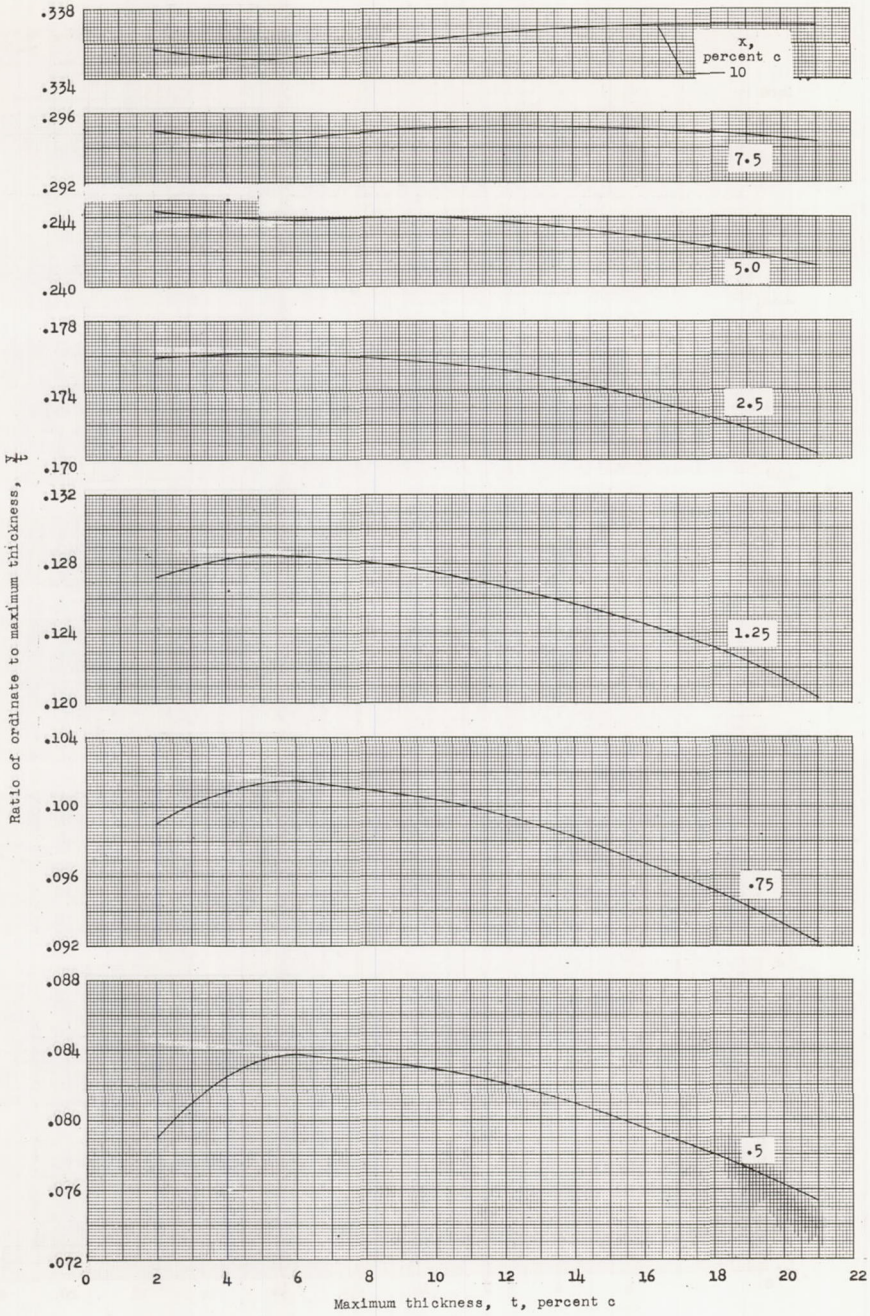
Figure 23.- NACA 65A004 basic thickness form.



x, percent c	y, percent c	$(V/V_\infty)^2$	V/V_∞	$\Delta V_a/V_\infty$
0	0	0	0	5.831
.5	.385	1.041	1.020	2.190
.75	.467	1.050	1.025	1.789
1.25	.595	1.060	1.030	1.379
2.5	.815	1.072	1.035	.970
5.0	1.094	1.087	1.043	.689
7.5	1.326	1.094	1.046	.562
10	1.519	1.099	1.048	.480
15	1.826	1.109	1.053	.382
20	2.059	1.115	1.056	.323
25	2.237	1.120	1.058	.278
30	2.367	1.123	1.060	.246
35	2.453	1.127	1.062	.218
40	2.496	1.130	1.063	.198
45	2.494	1.132	1.064	.178
50	2.440	1.128	1.062	.161
55	2.331	1.116	1.056	.144
60	2.173	1.102	1.050	.128
65	1.976	1.088	1.043	.113
70	1.746	1.069	1.034	.100
75	1.487	1.050	1.025	.088
80	1.203	1.028	1.014	.076
85	.907	1.003	1.001	.062
90	.609	.978	.989	.048
95	.310	.947	.973	.034
100	.011	0	0	0

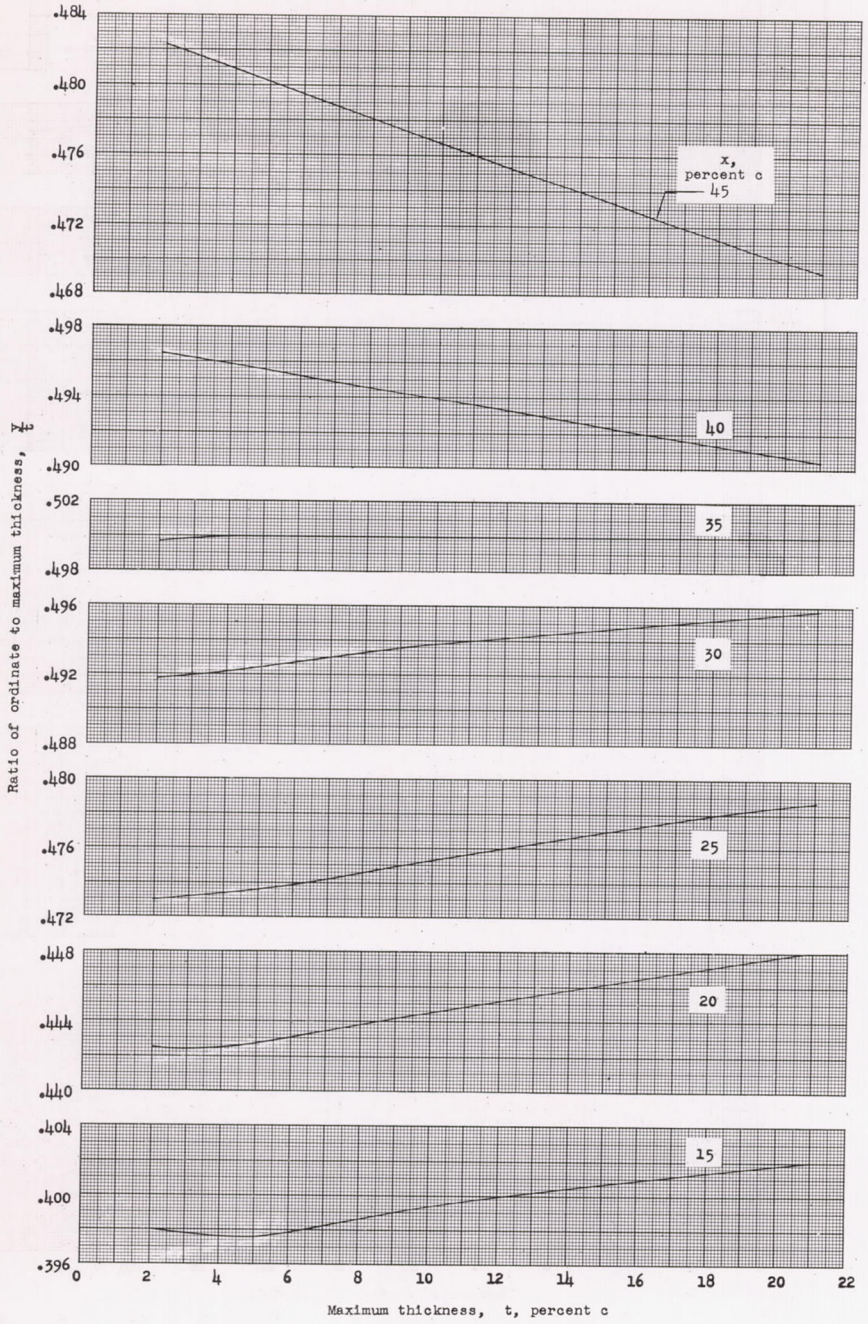
L.E. radius: 0.150 percent c
T.E. radius: 0.0125 percent c

Figure 24.- NACA 65A005 basic thickness form.



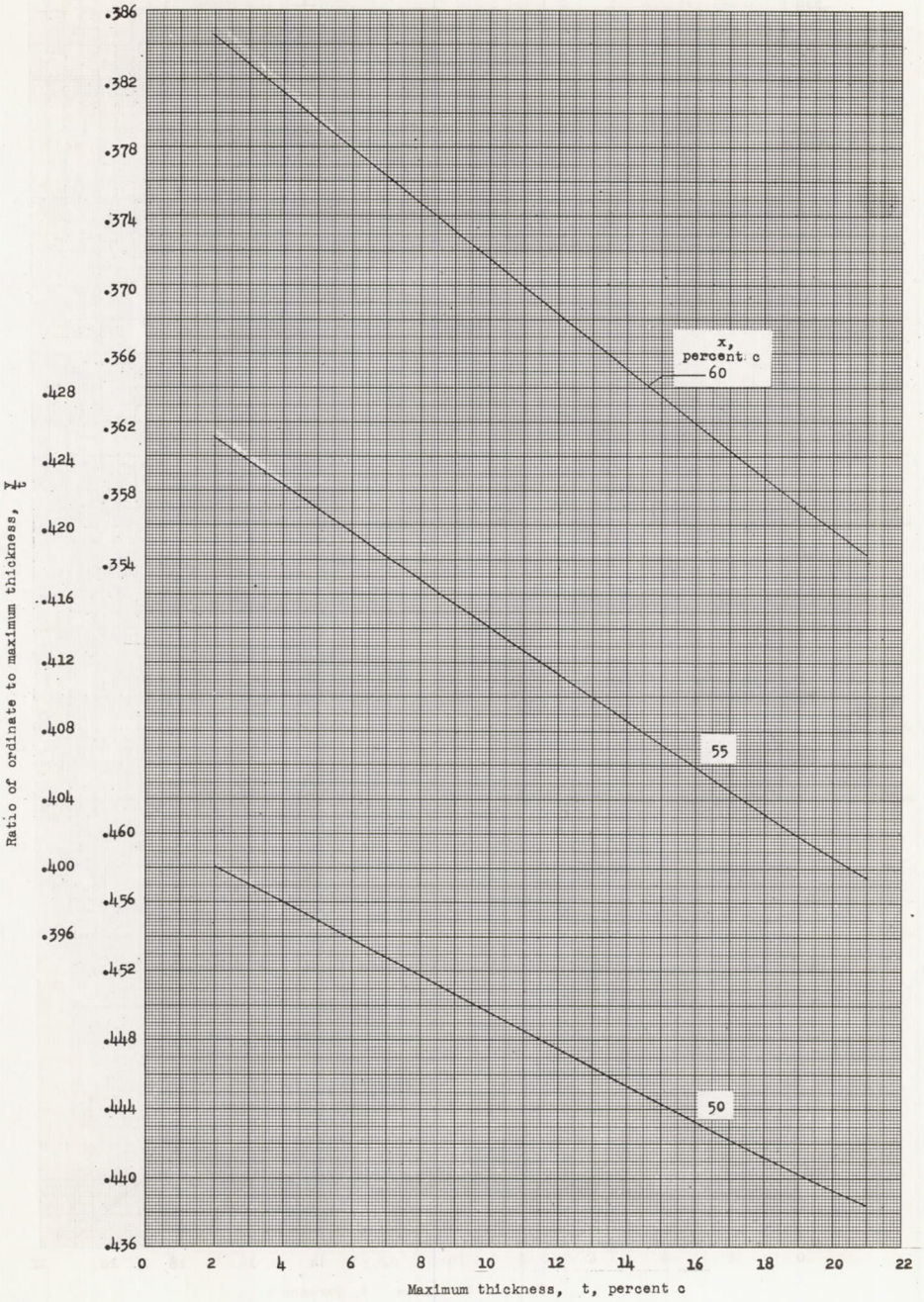
(a) x = 0.5 to 10 percent c.

Figure 25.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 63-series airfoil sections.



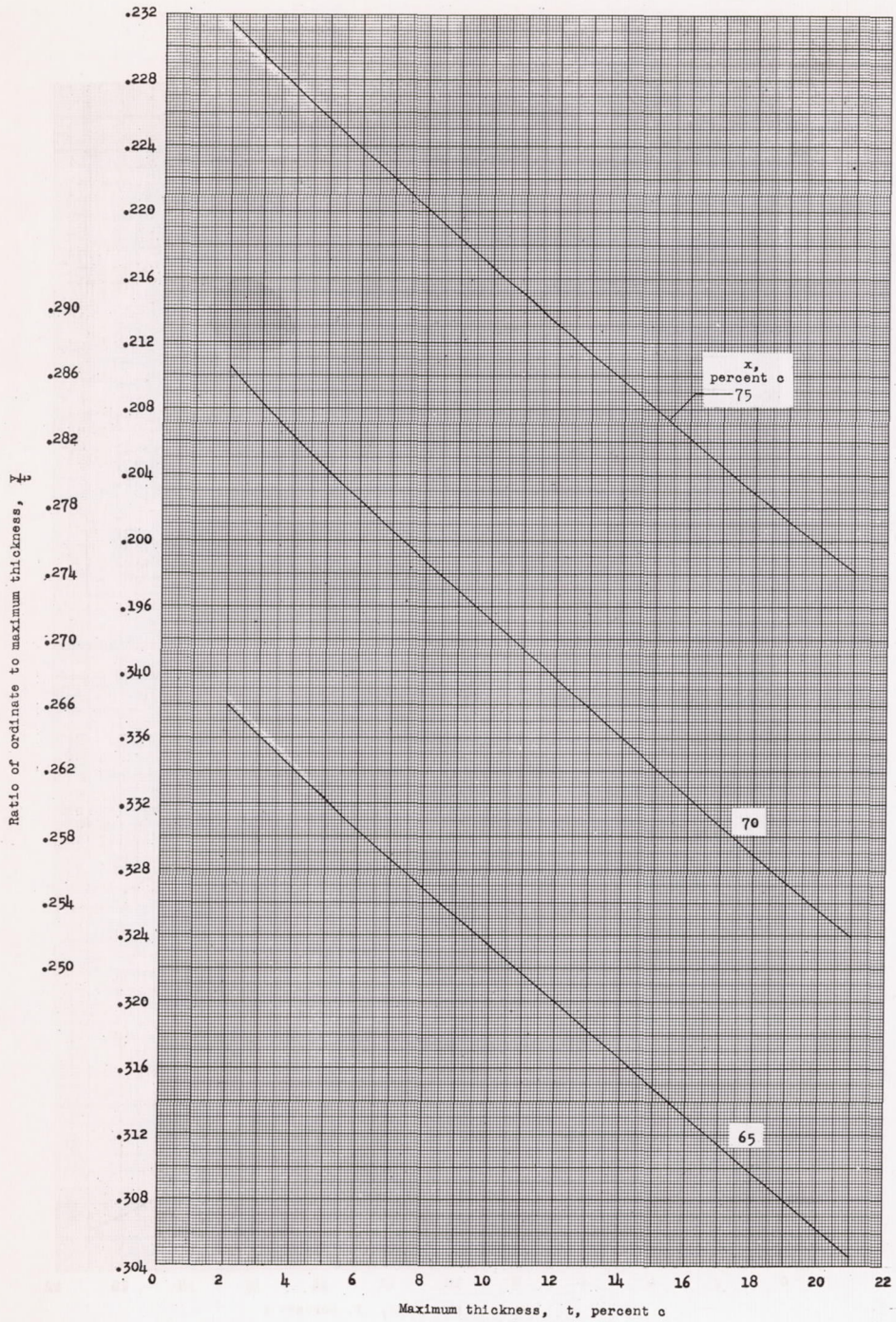
(b) x = 15 to 45 percent c.

Figure 25.- Continued.



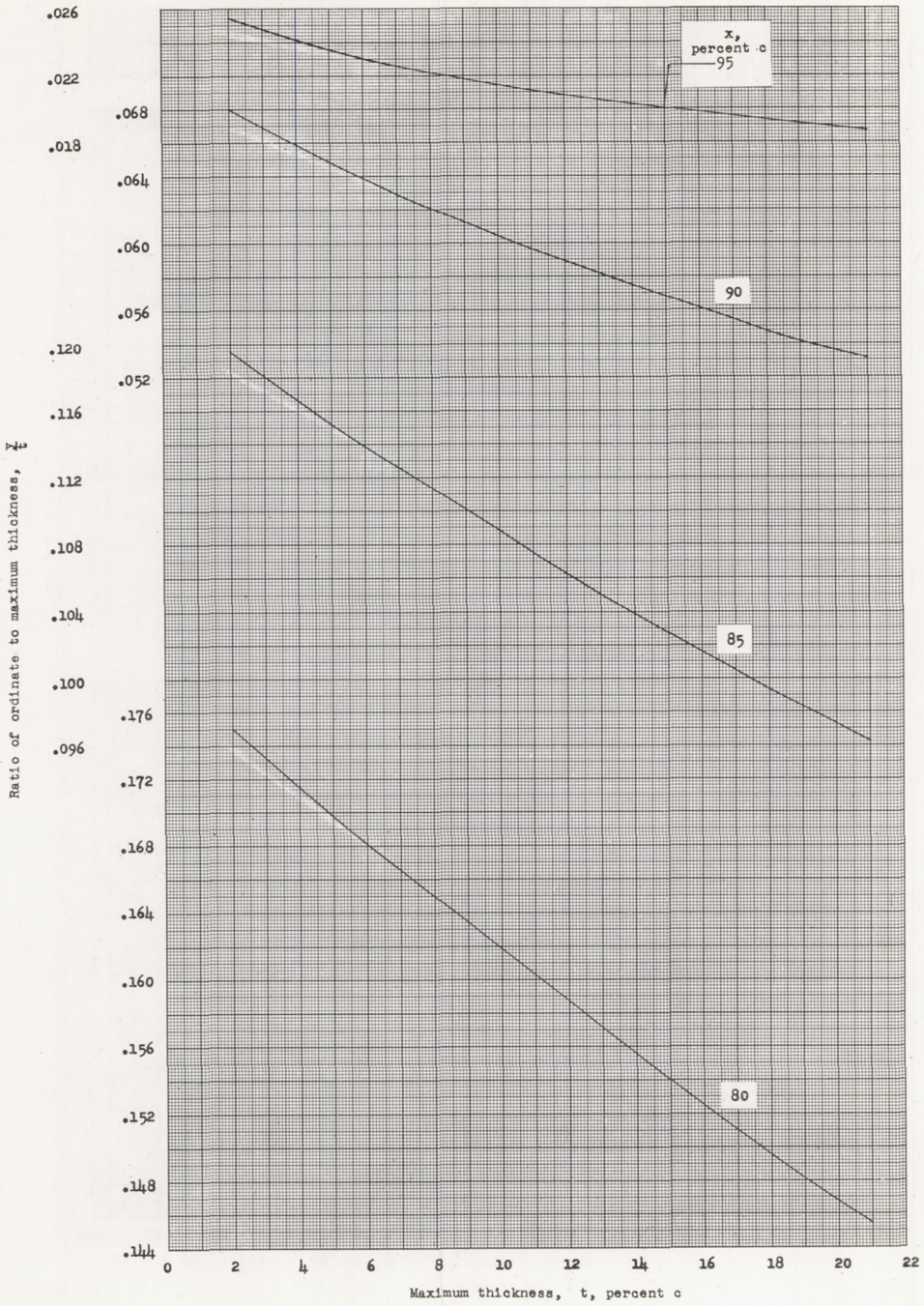
(c) x = 50 to 60 percent c.

Figure 25.- Continued.



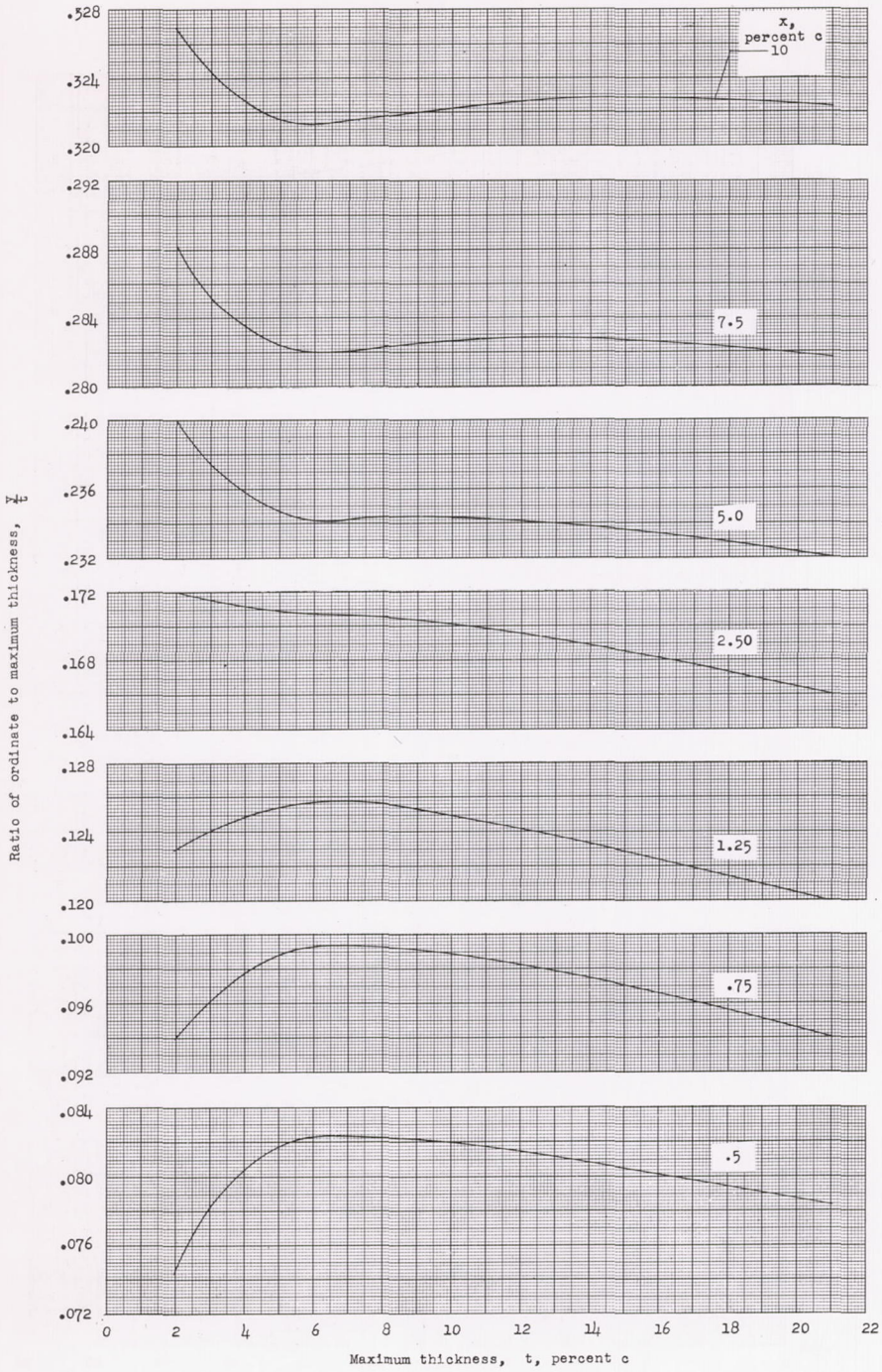
(d) x = 65 to 75 percent c.

Figure 25.- Continued.



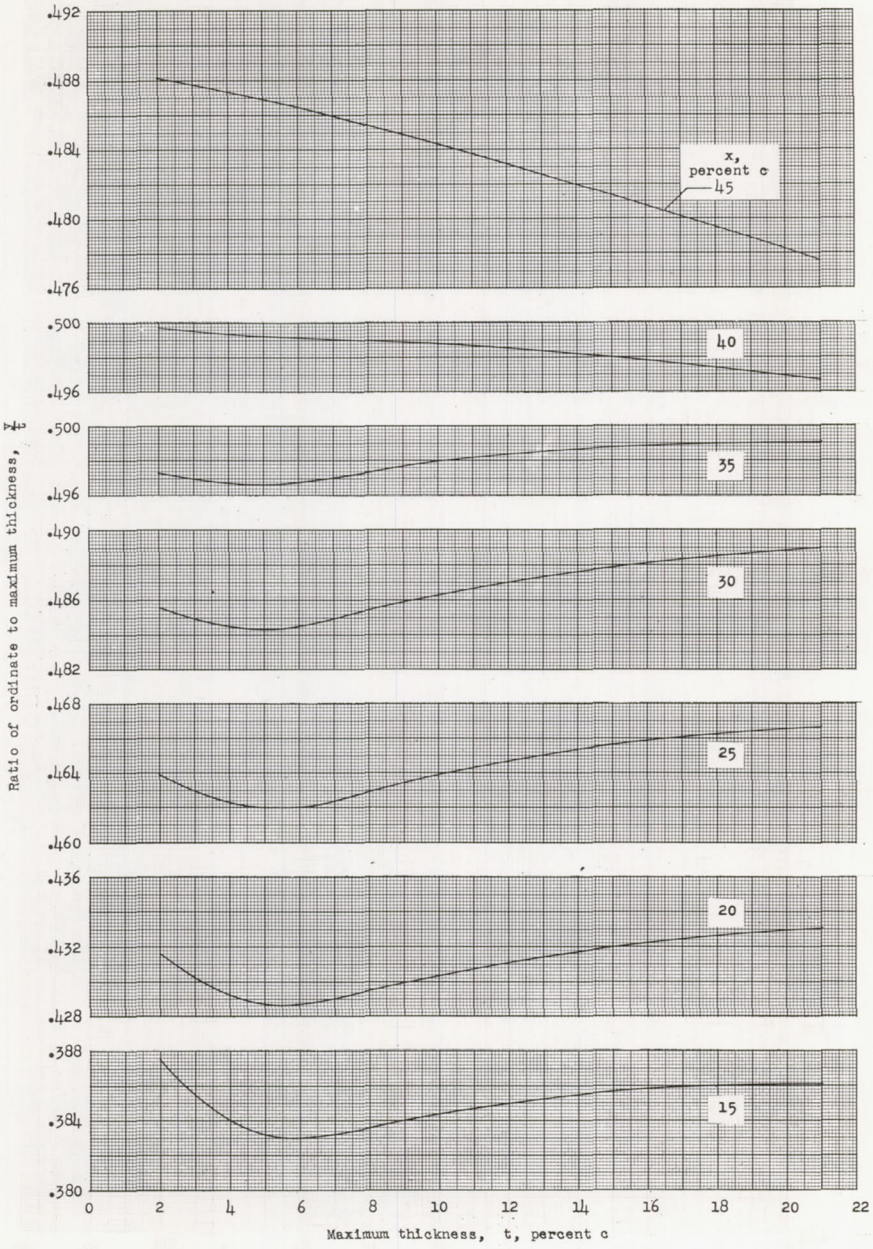
(e) x = 80 to 95 percent c.

Figure 25.- Concluded.



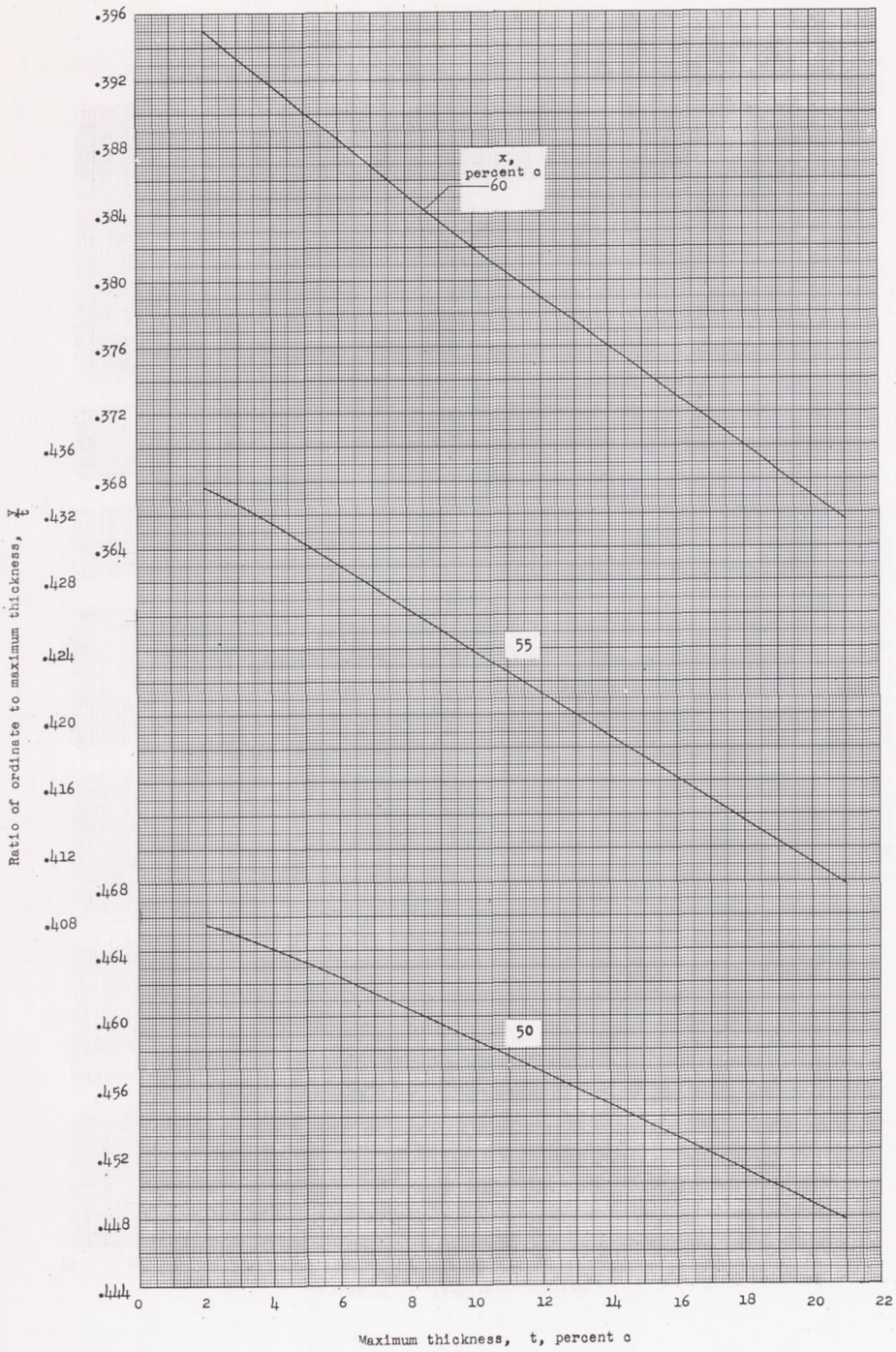
(a) x = 0.5 to 10 percent c.

Figure 26.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 64-series airfoil sections.



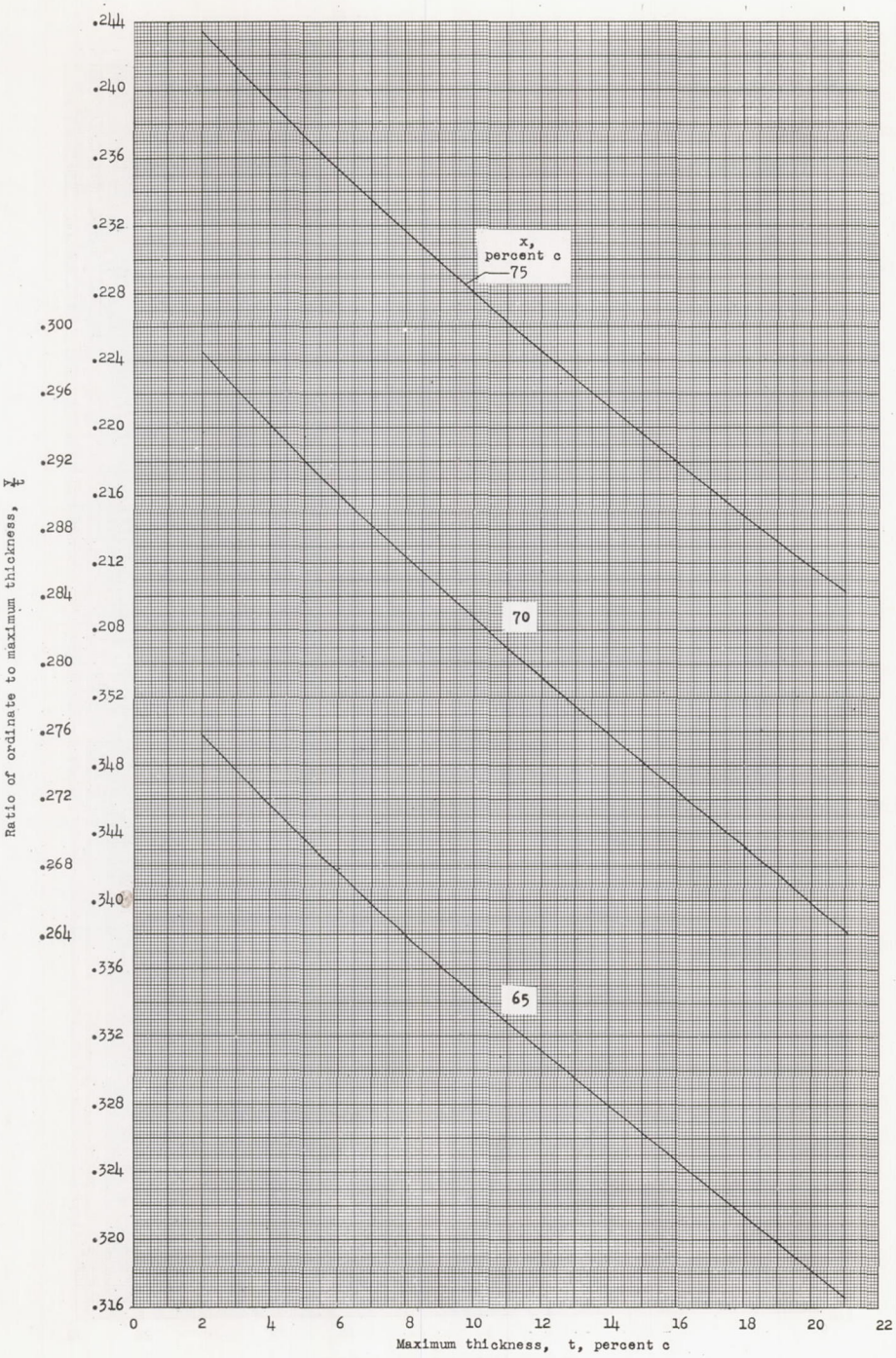
(b) x = 15 to 45 percent c.

Figure 26.- Continued.



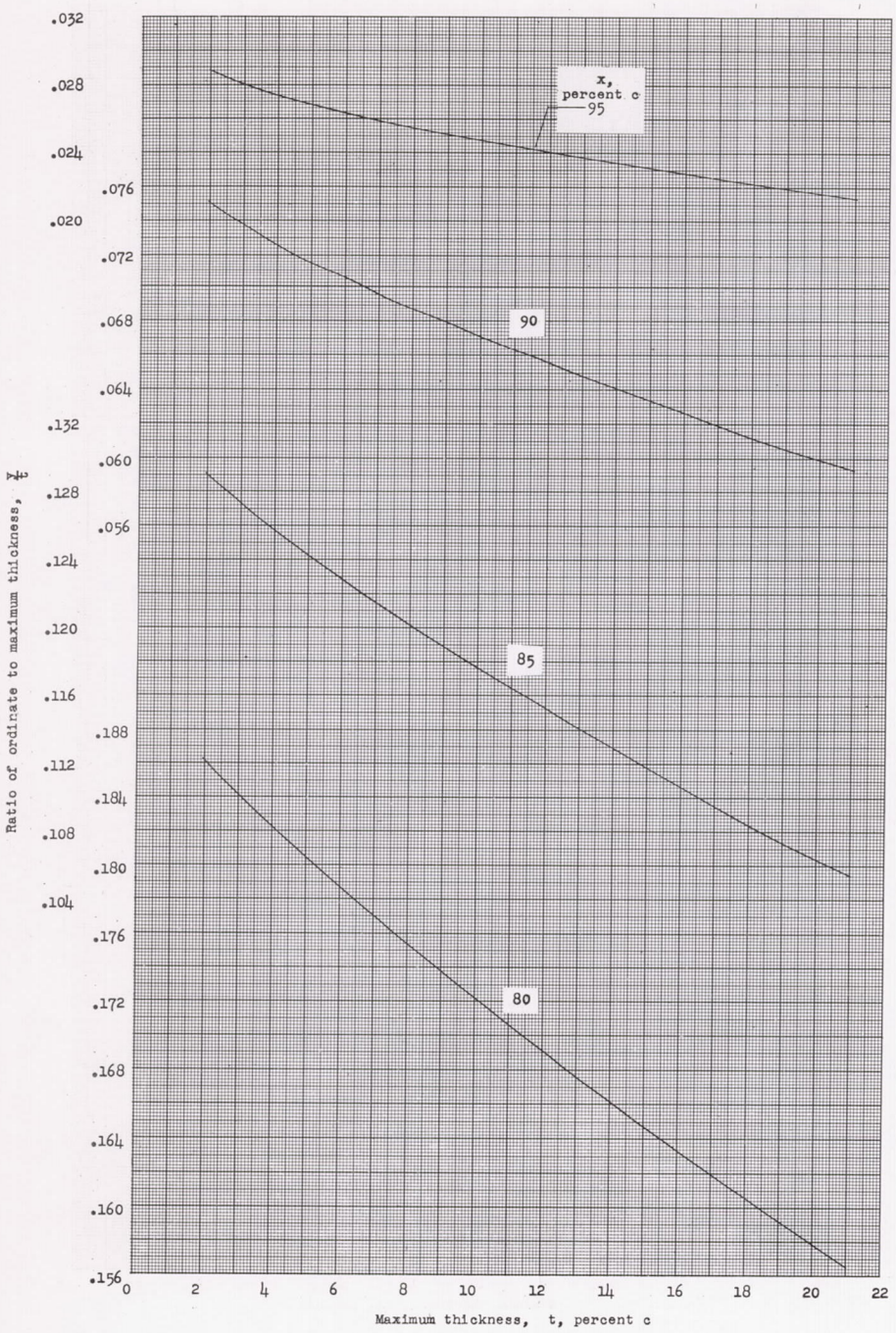
(c) x = 50 to 60 percent c.

Figure 26.- Continued.



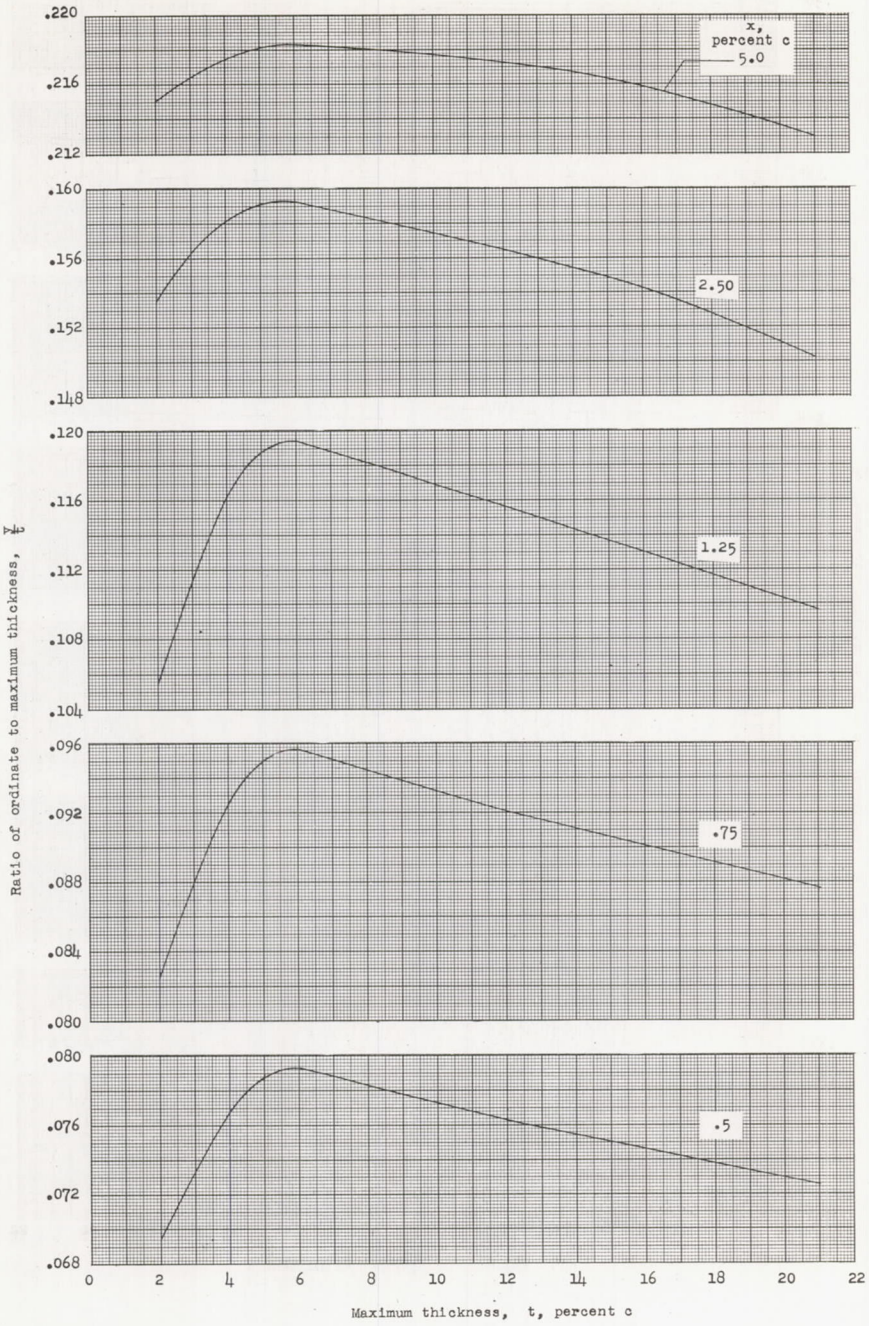
(d) x = 65 to 75 percent c.

Figure 26.- Continued.



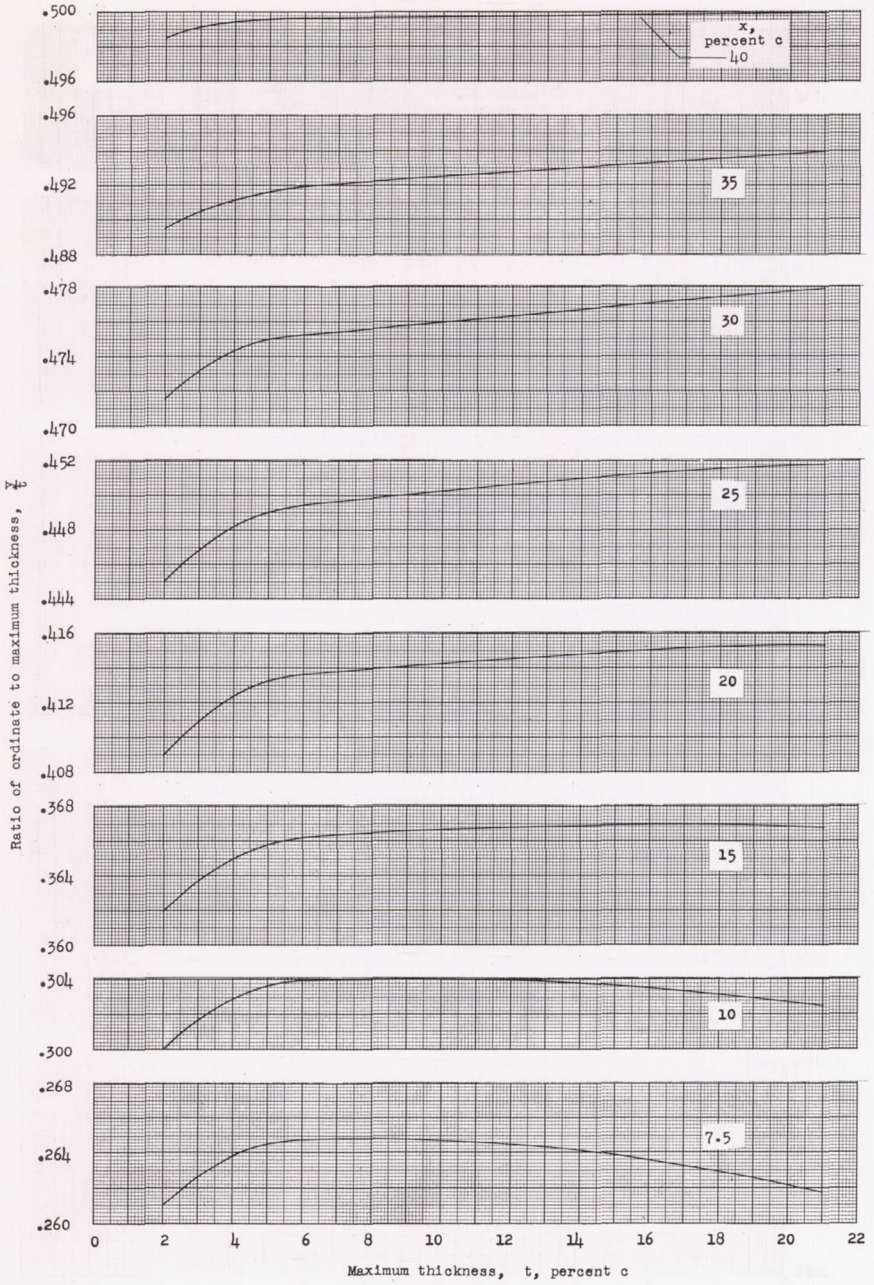
(e) x = 80 to 95 percent c.

Figure 26.- Concluded.



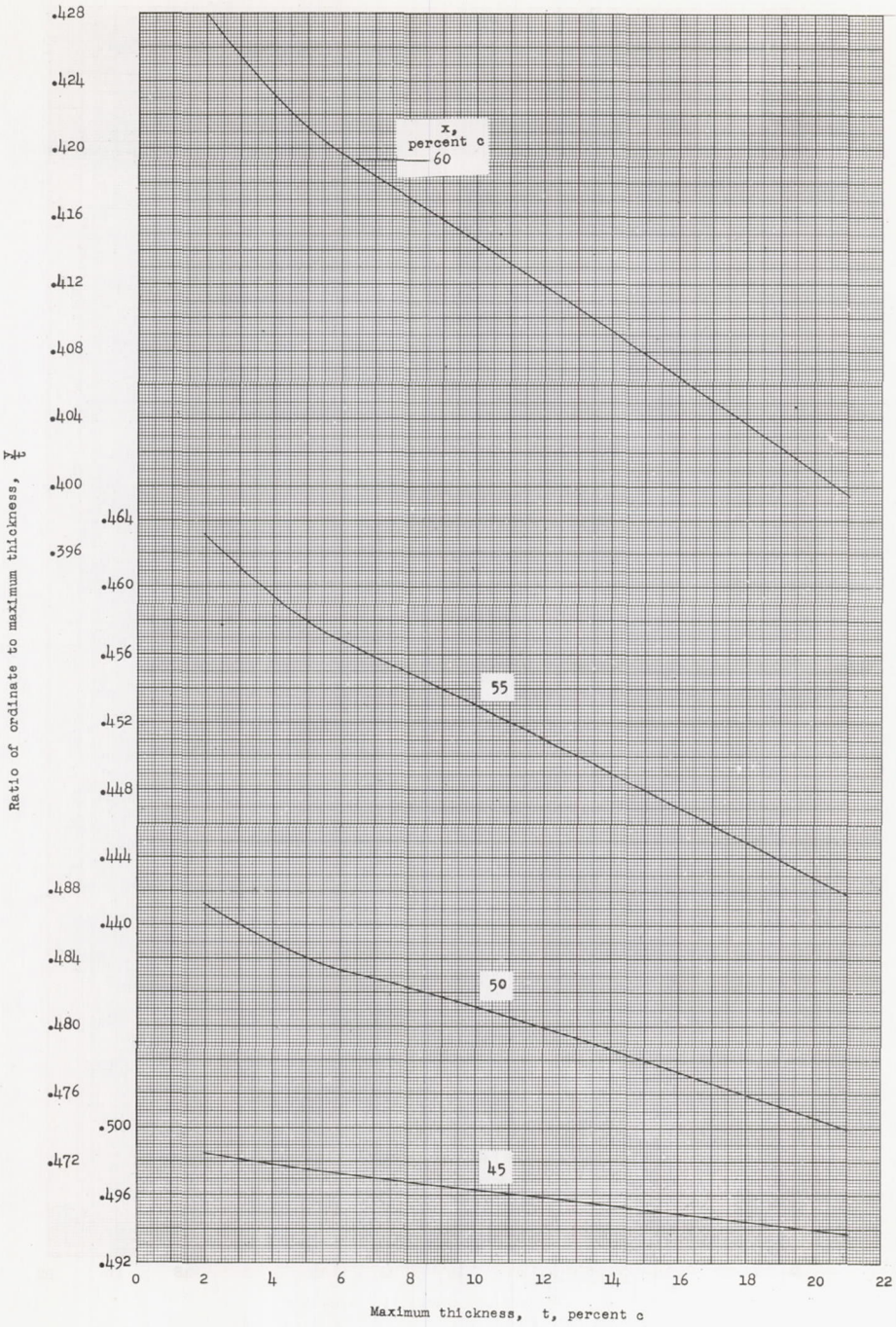
(a) x = 0.5 to 5.0 percent c.

Figure 27.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 65-series airfoil sections.



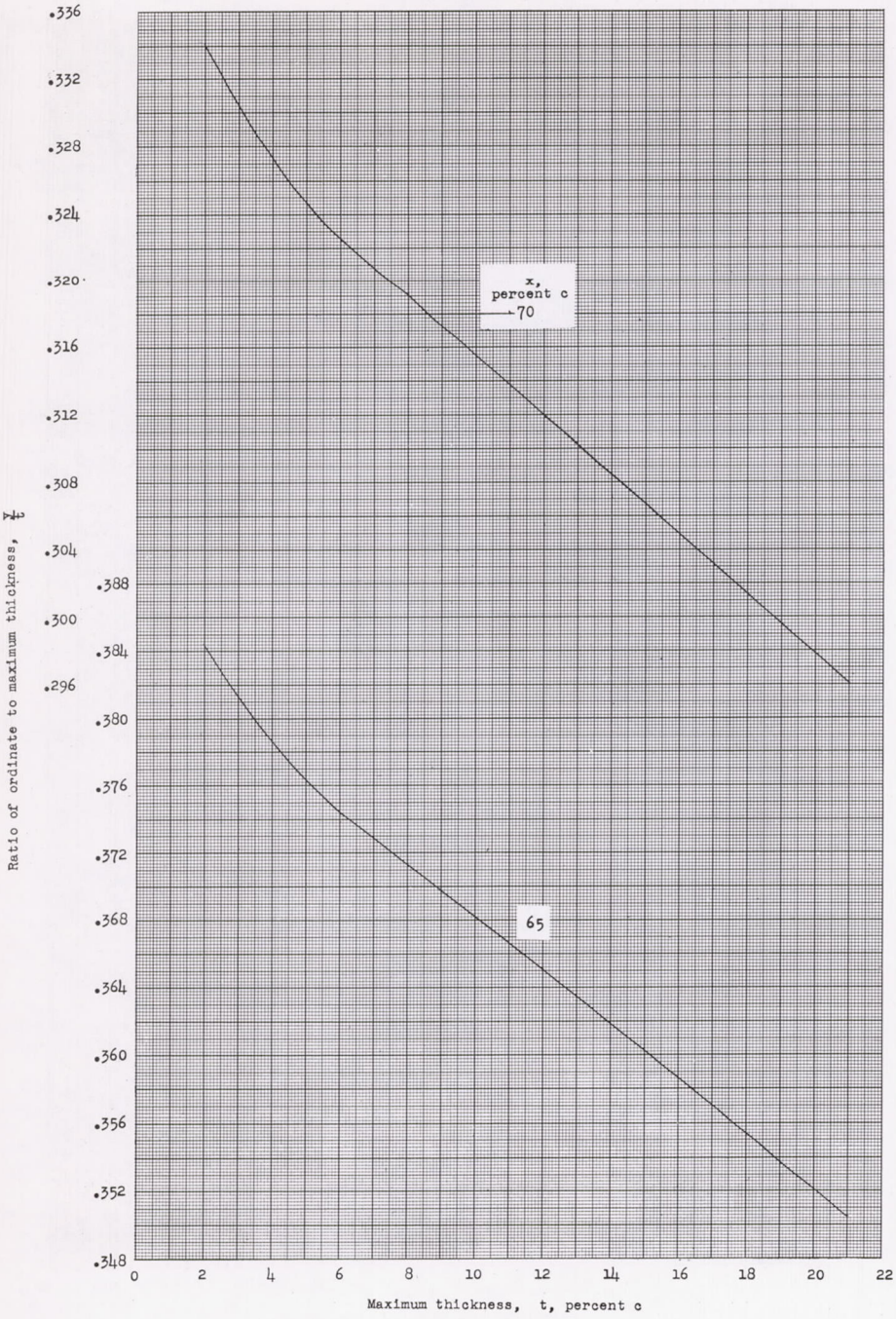
(b) x = 7.5 to 40 percent c.

Figure 27.- Continued.



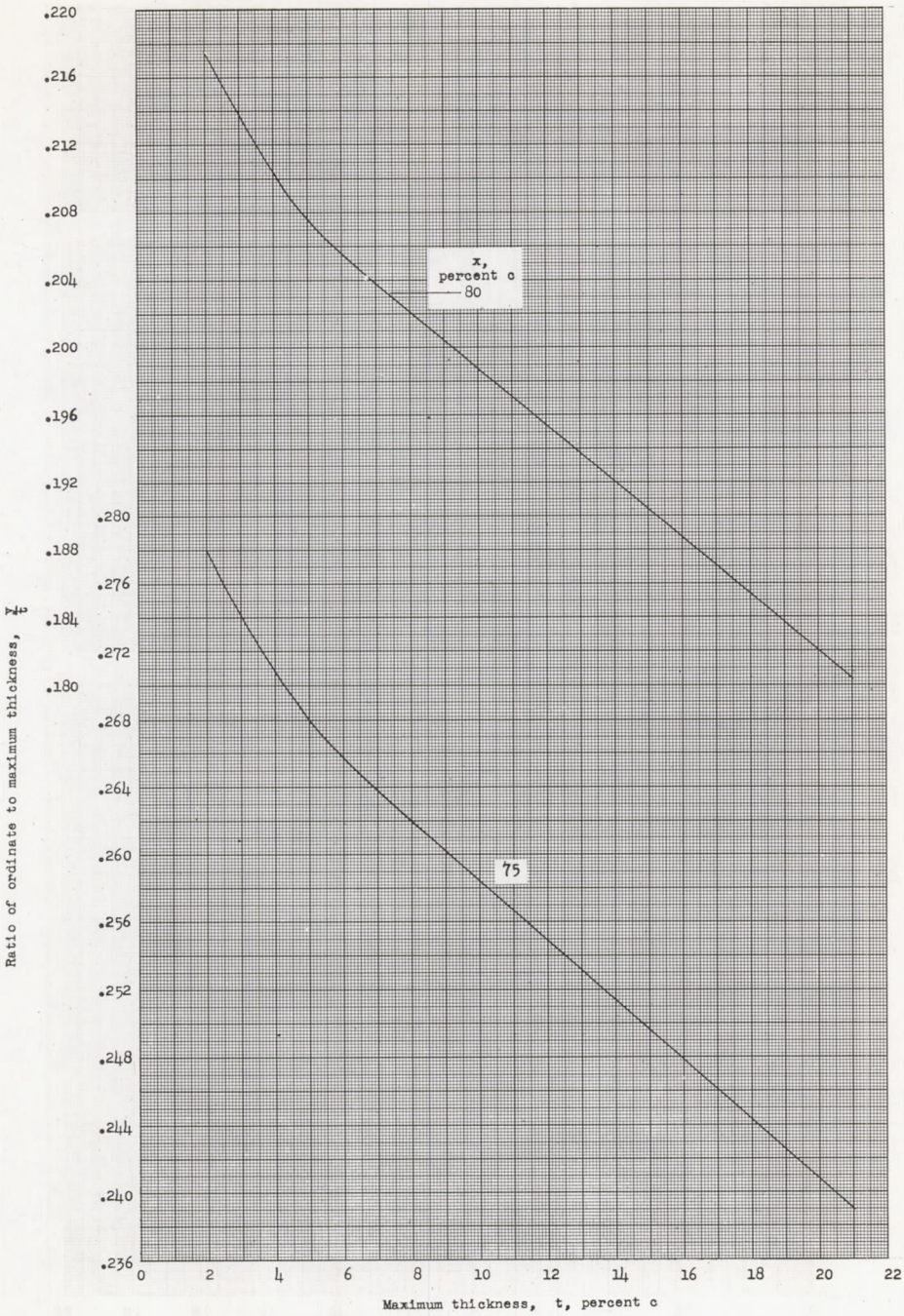
(c) x = 45 to 60 percent c.

Figure 27.- Continued.



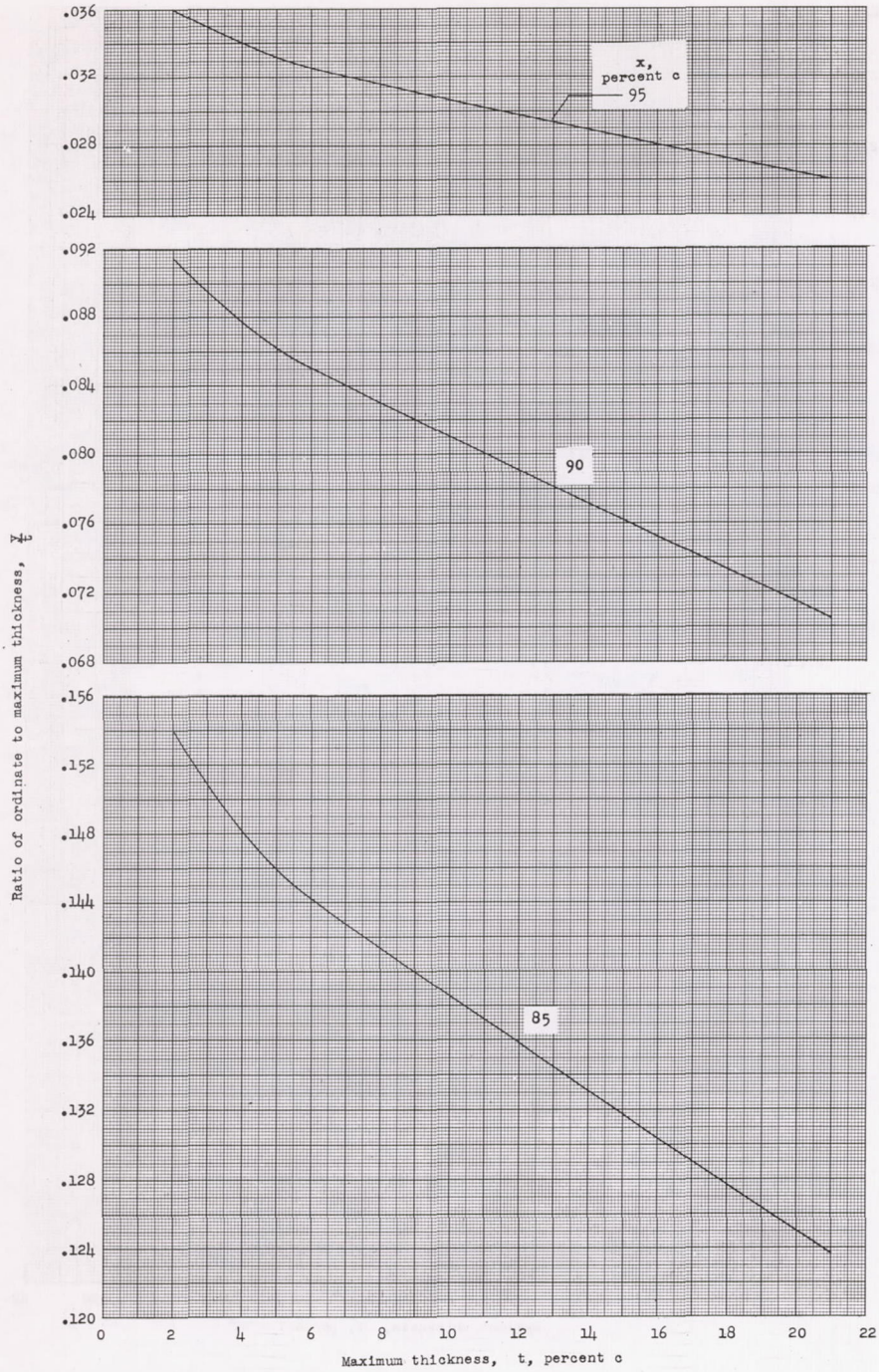
(d) x = 65 to 70 percent c.

Figure 27.- Continued.



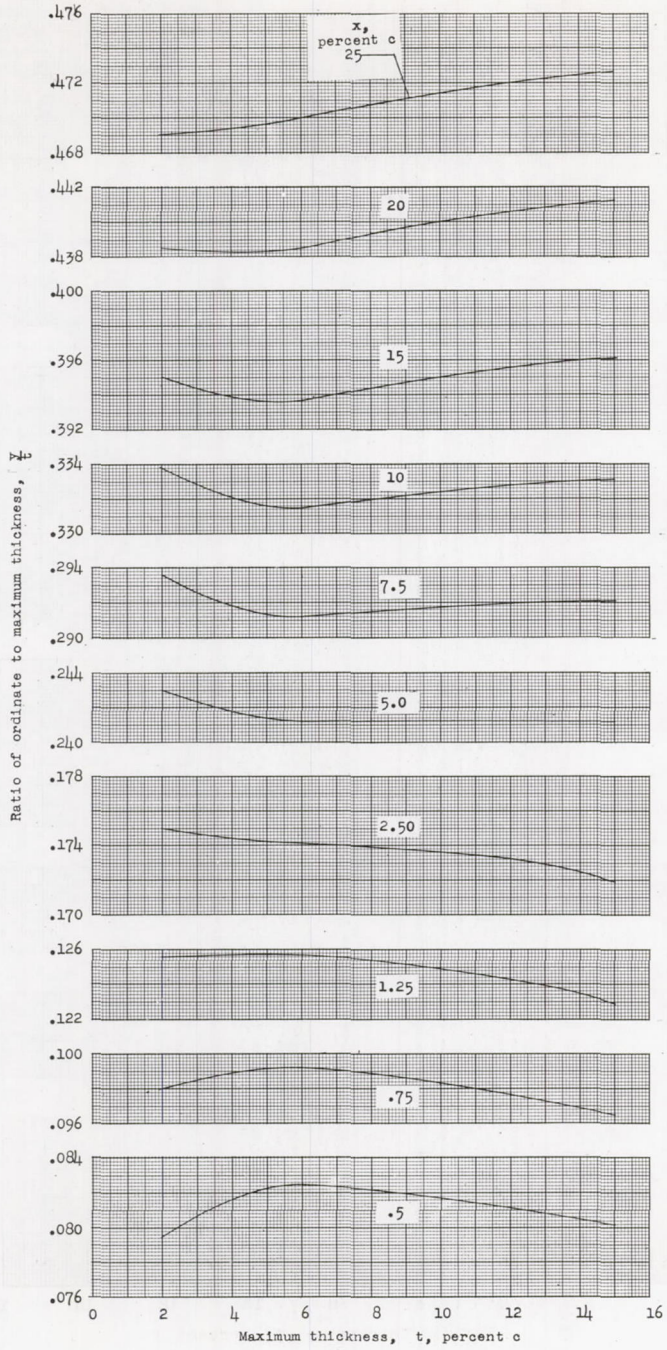
(e) x = 75 to 80 percent c.

Figure 27.- Continued.



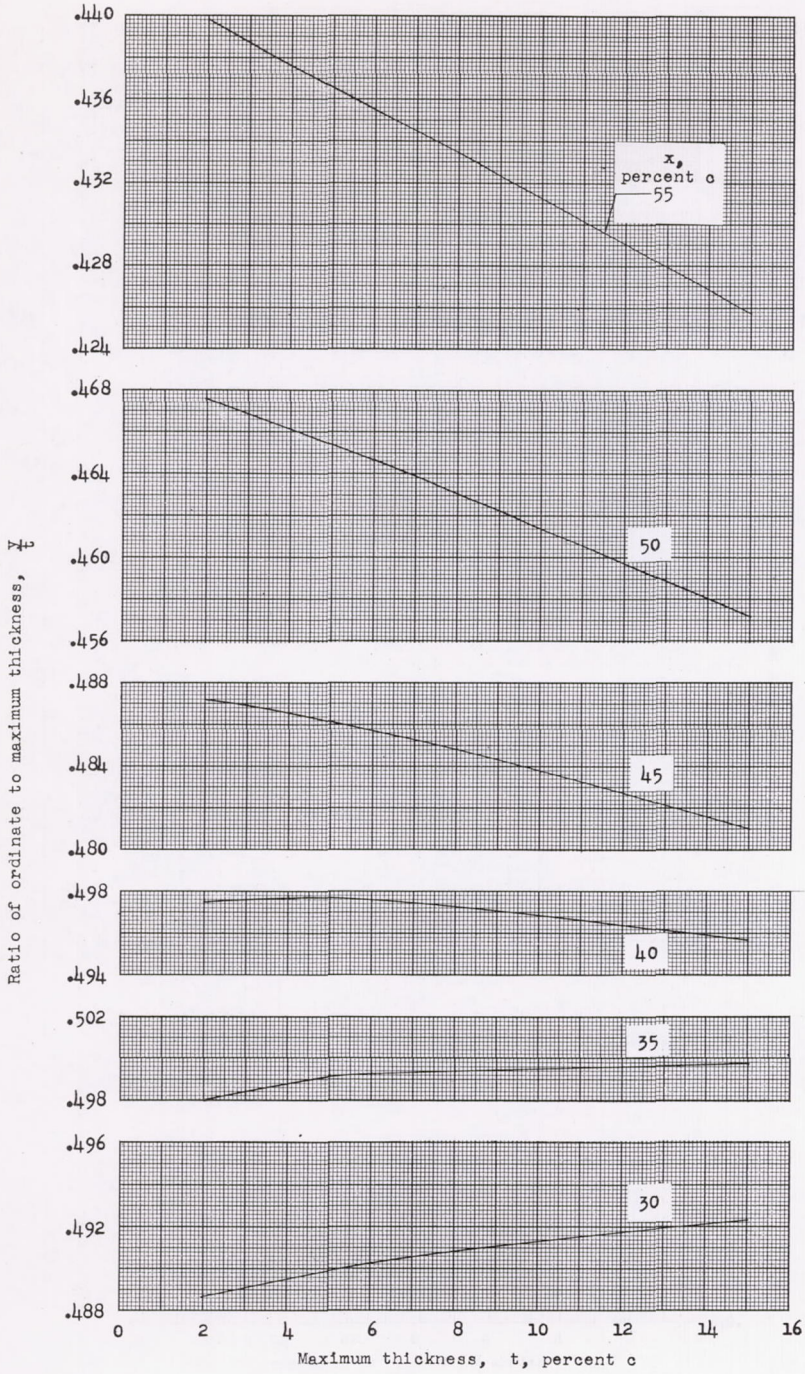
(f) x = 85 to 95 percent c.

Figure 27.- Concluded.



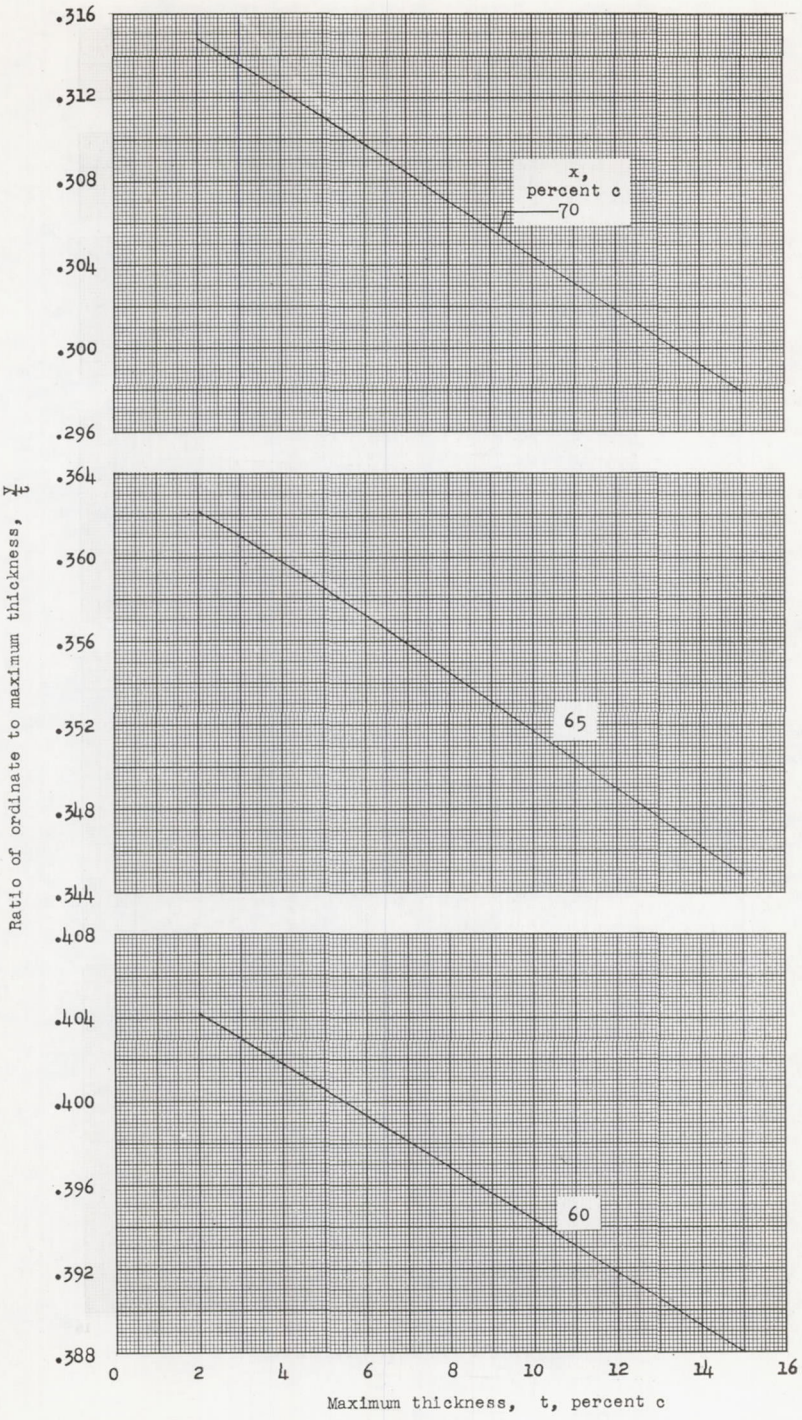
(a) x = 0.5 to 25 percent c.

Figure 28.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 63A-series airfoil sections.



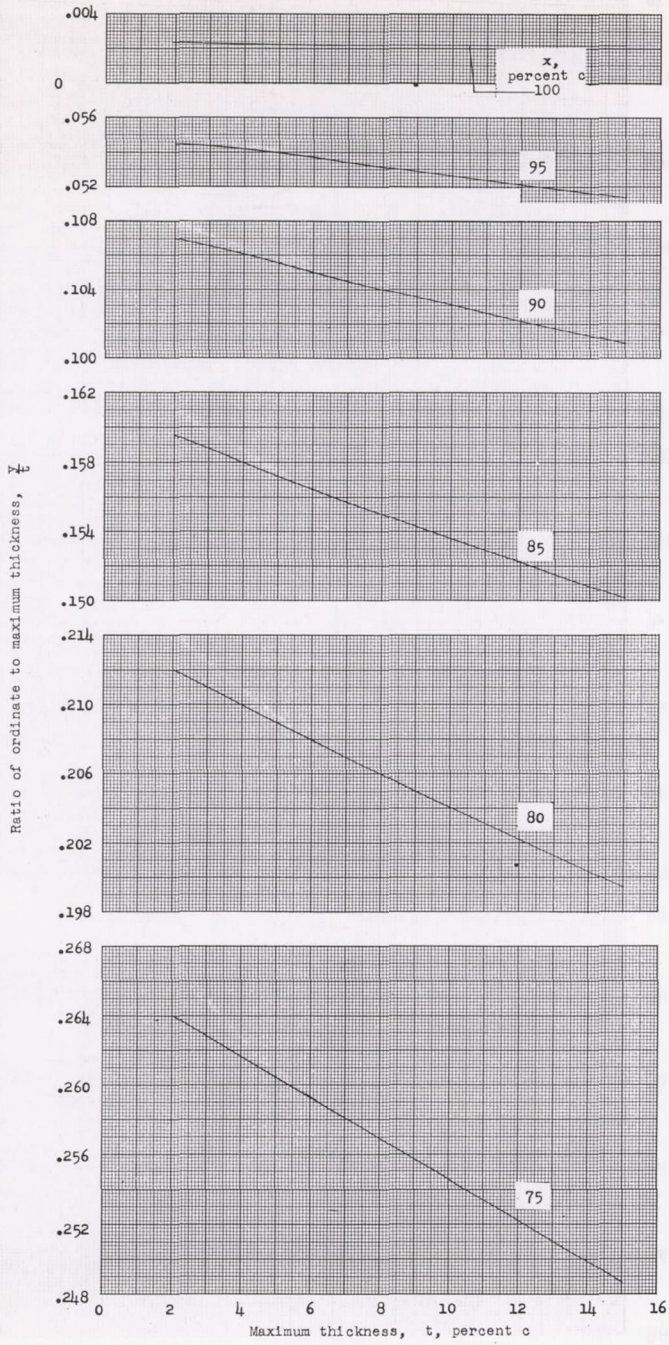
(b) x = 30 to 55 percent c.

Figure 28.- Continued.



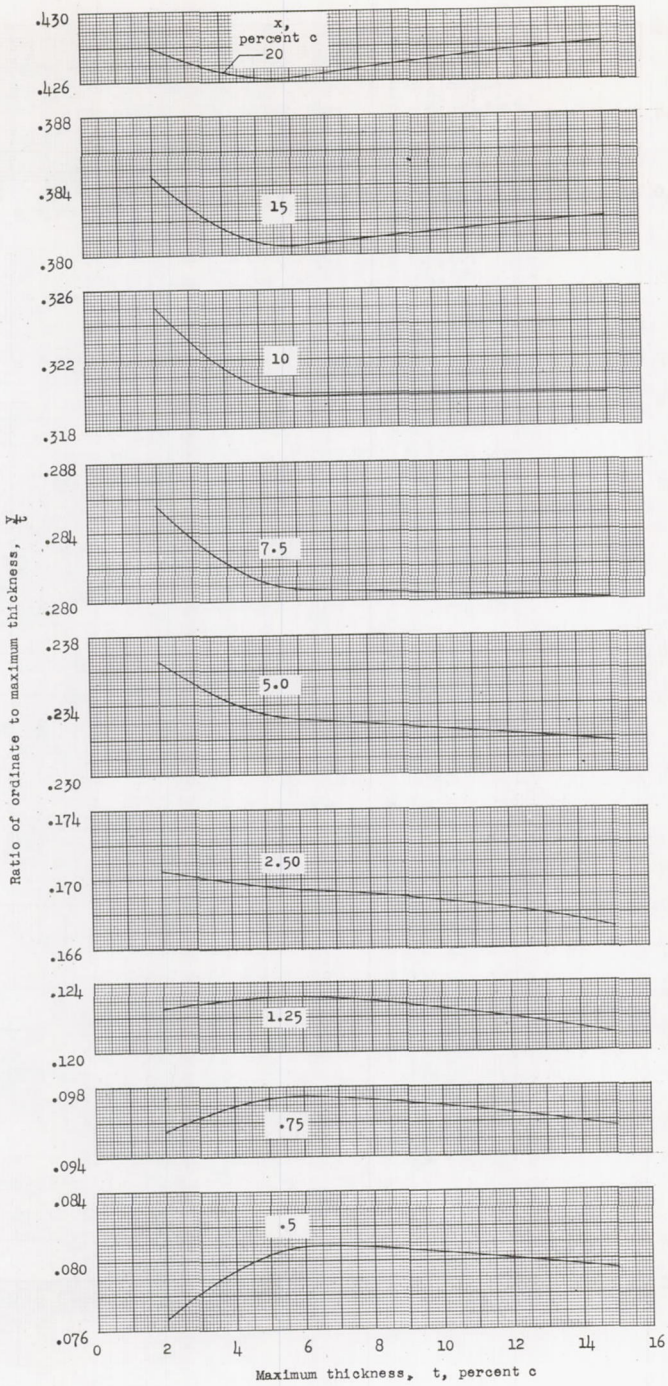
(c) x = 60 to 70 percent c.

Figure 28.- Continued.



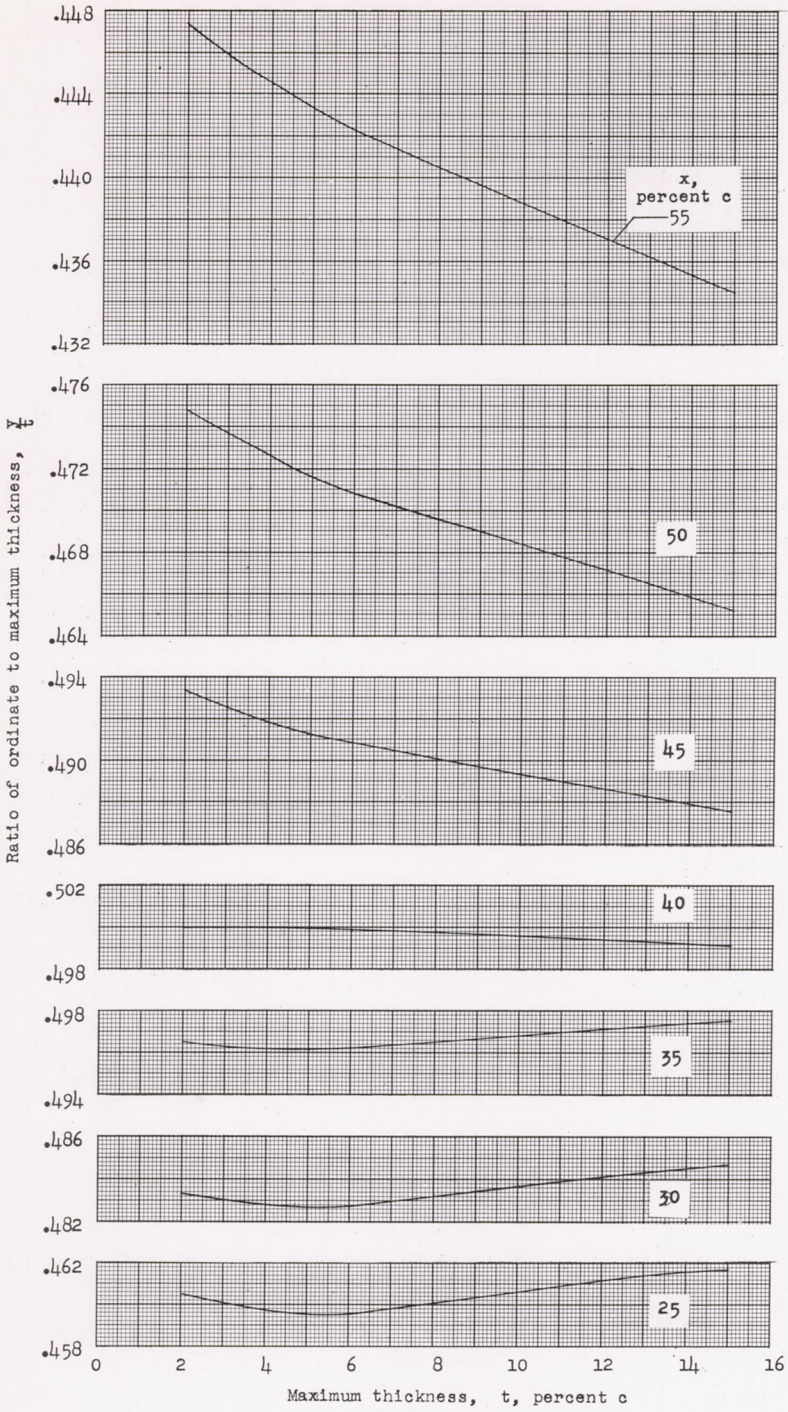
(d) x = 75 to 100 percent c.

Figure 28.- Concluded.



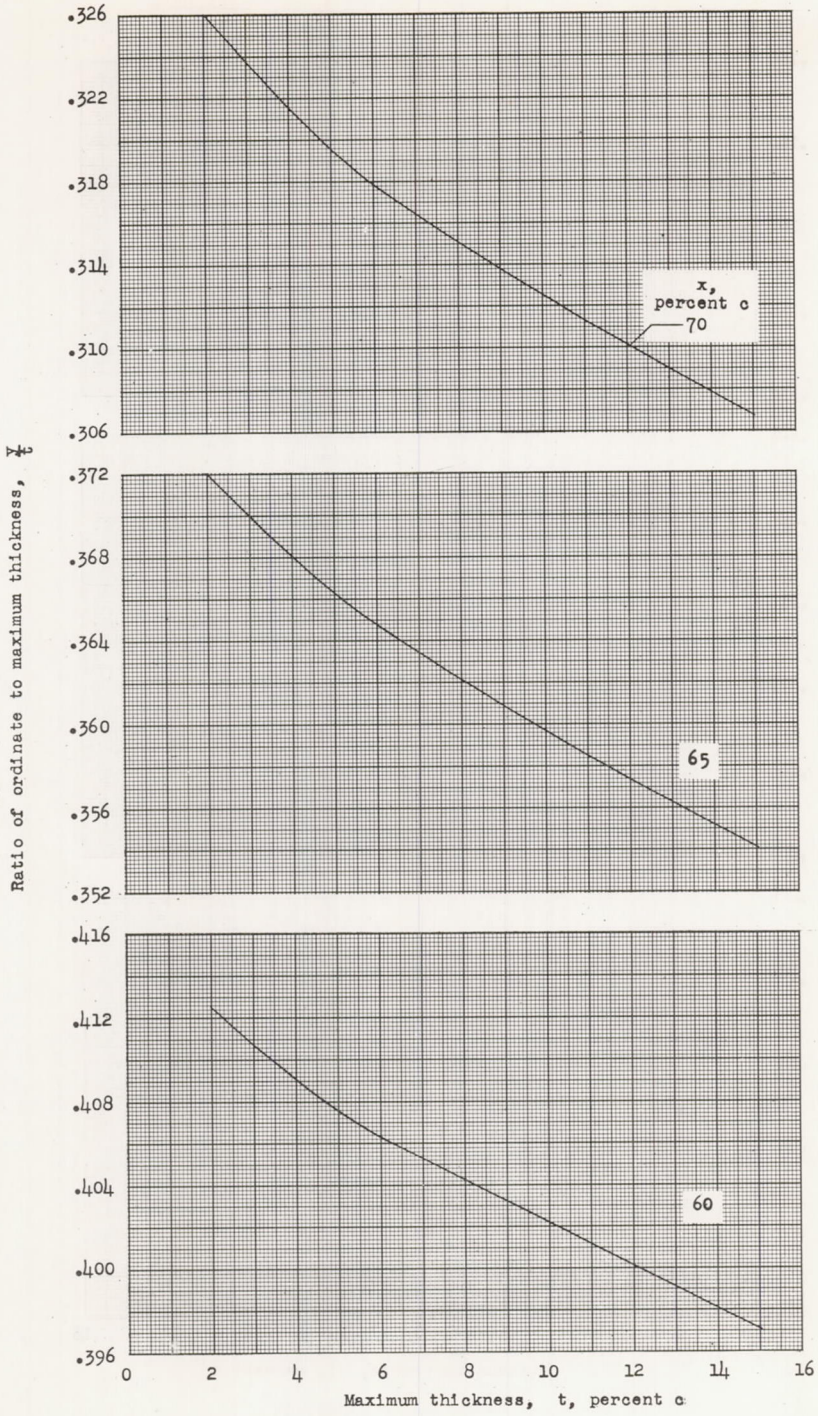
(a) x = 0.5 to 20 percent c.

Figure 29.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 64A-series airfoil sections.



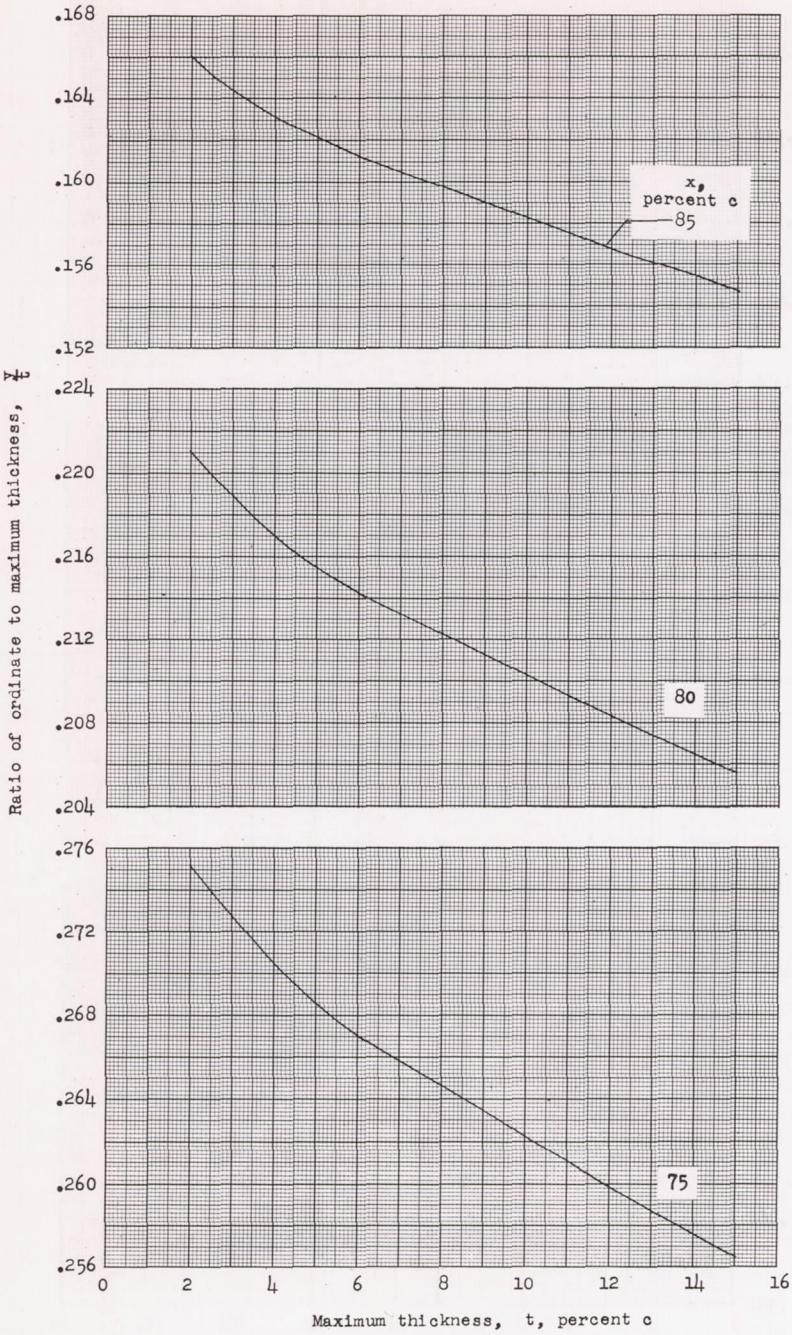
(b) x = 25 to 55 percent c.

Figure 29.- Continued.



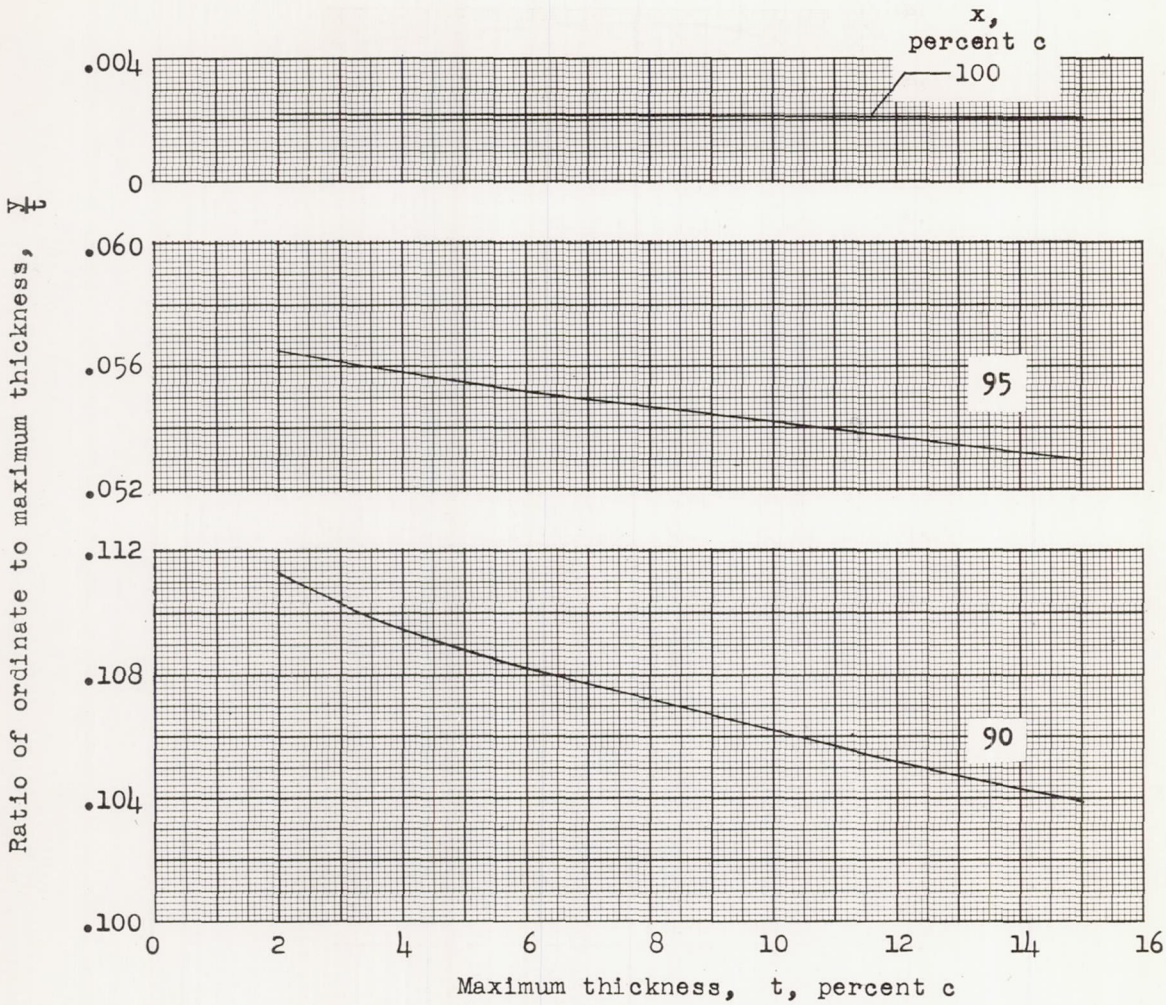
(c) x = 60 to 70 percent c.

Figure 29.- Continued.



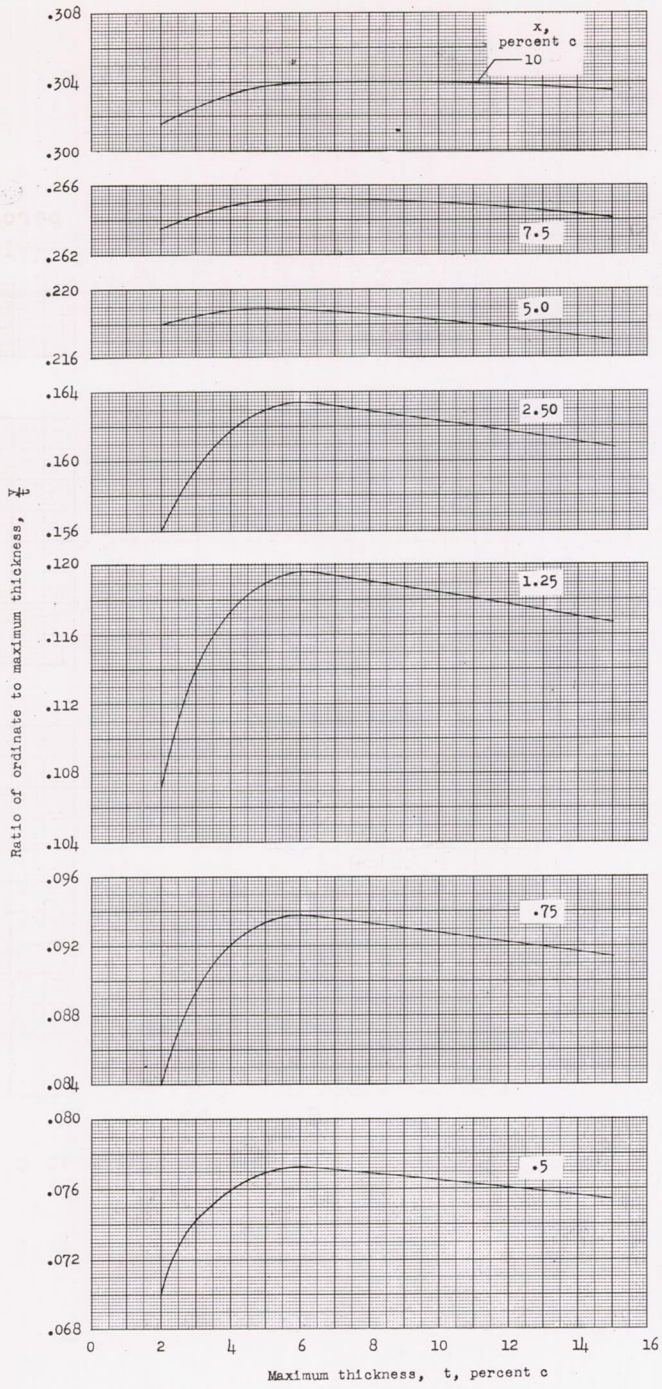
(d) x = 75 to 85 percent c.

Figure 29.- Continued.



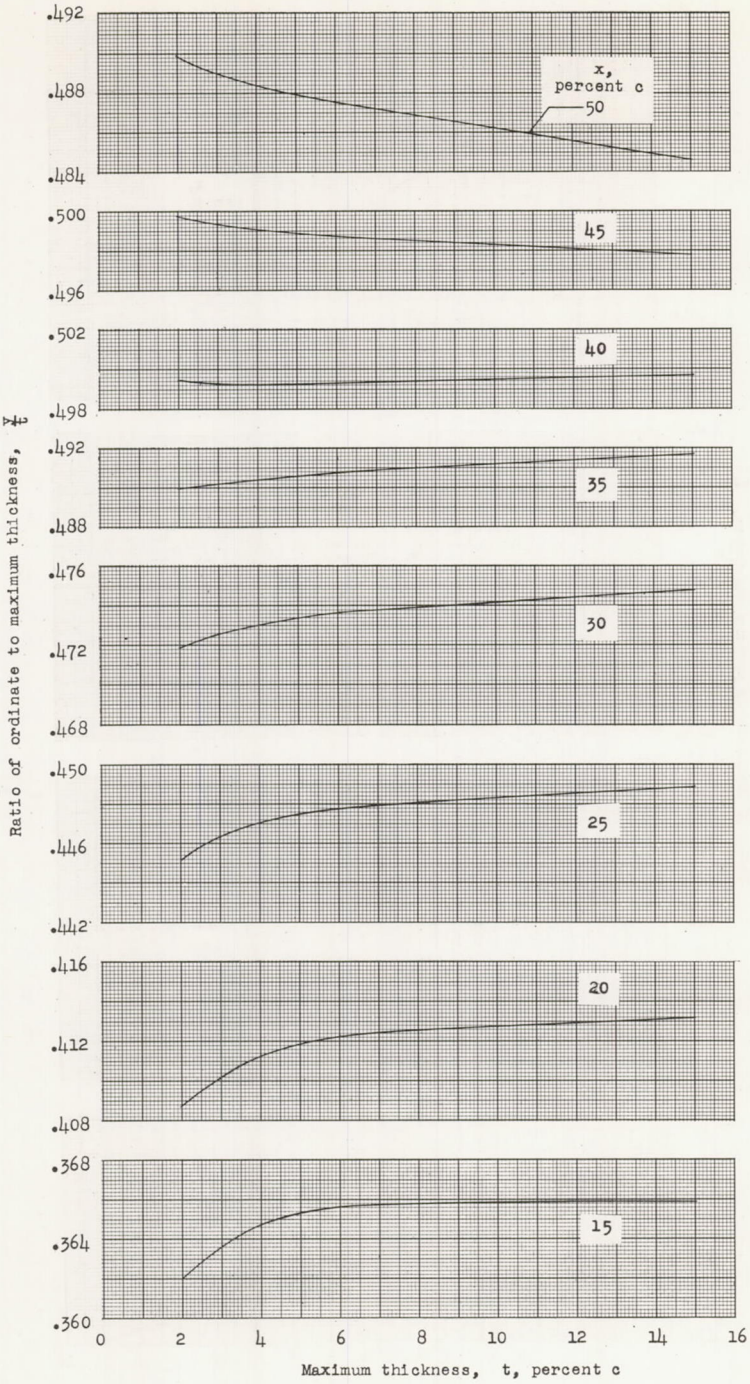
(e) x = 90 to 100 percent c.

Figure 29.- Concluded.



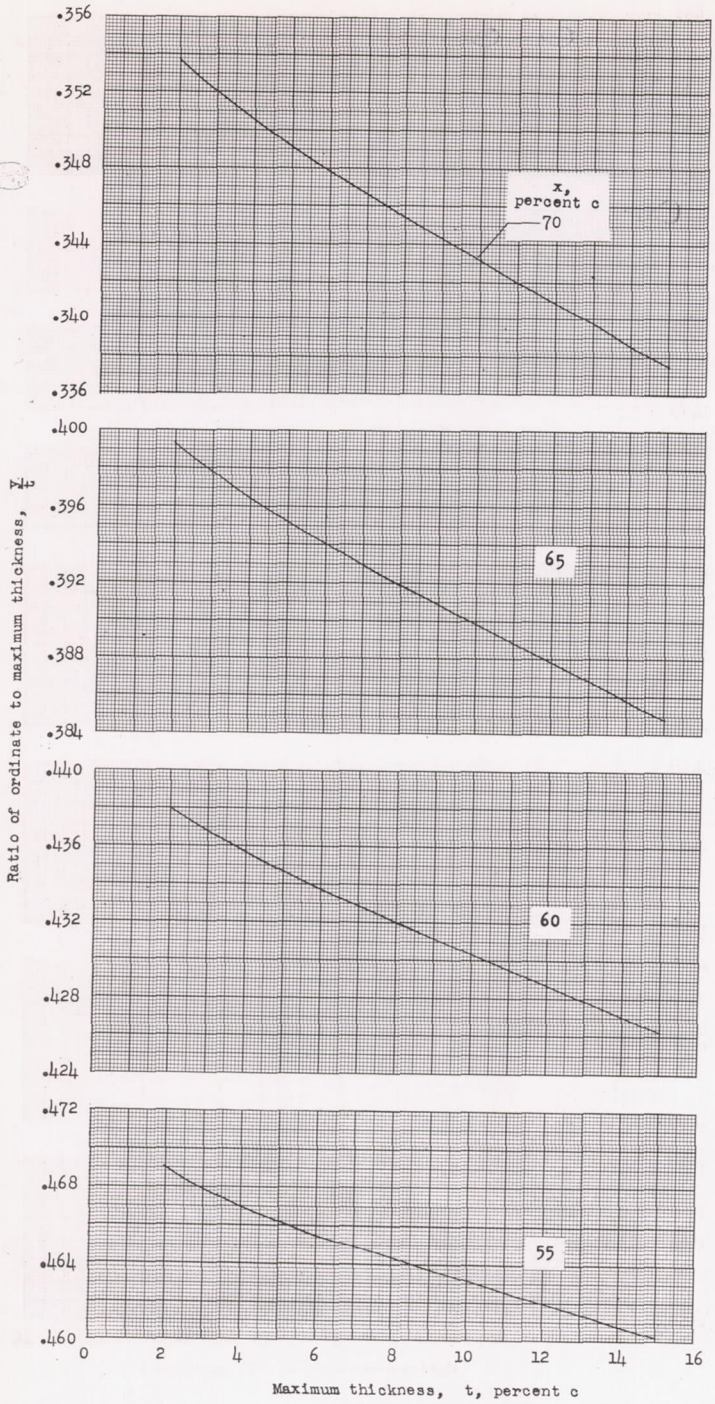
(a) x = 0.5 to 10 percent c.

Figure 30.- Variation of ratio of ordinate to maximum thickness with airfoil maximum thickness for the NACA 65A-series airfoil sections.



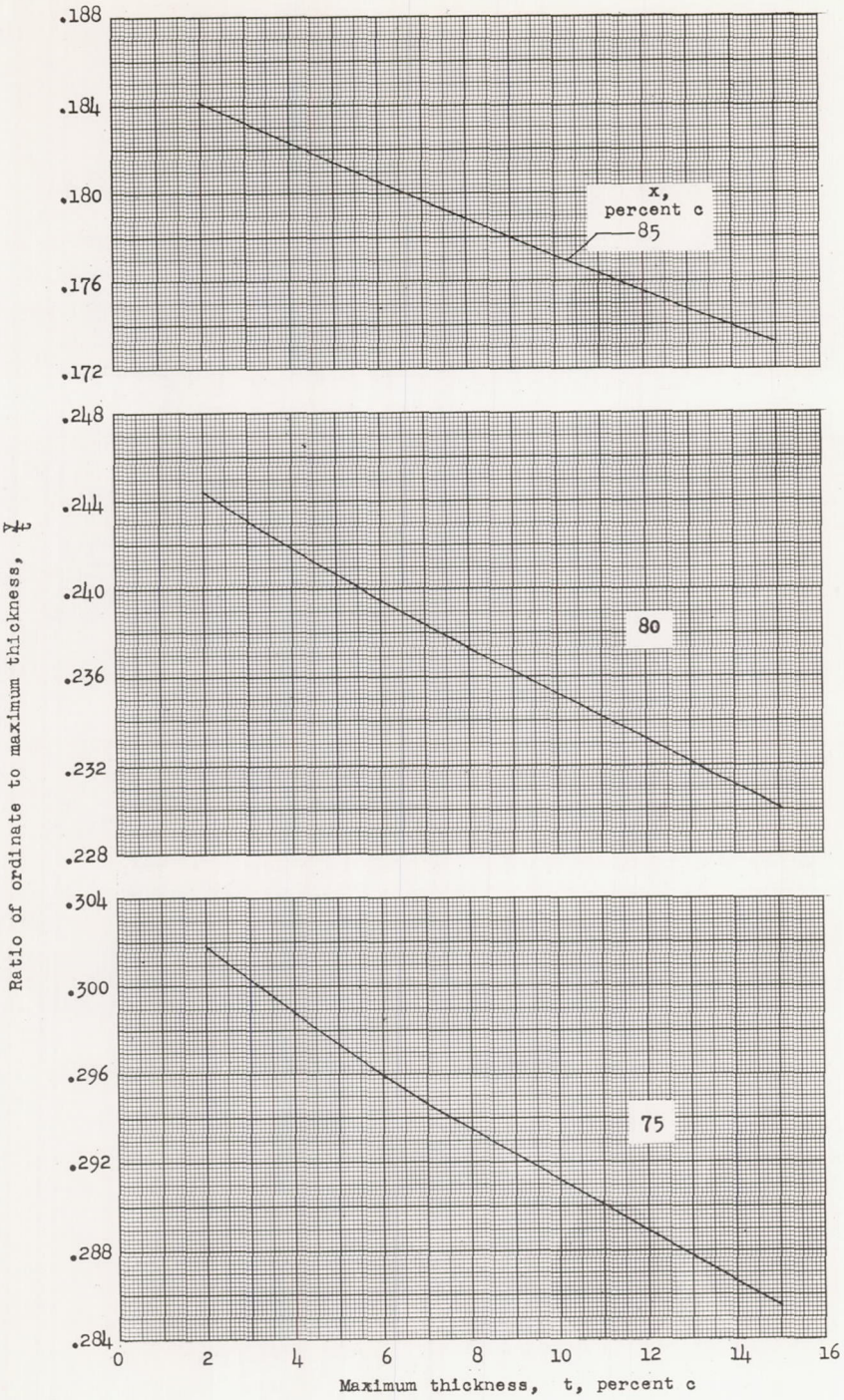
(b) x = 15 to 50 percent c.

Figure 30.- Continued.



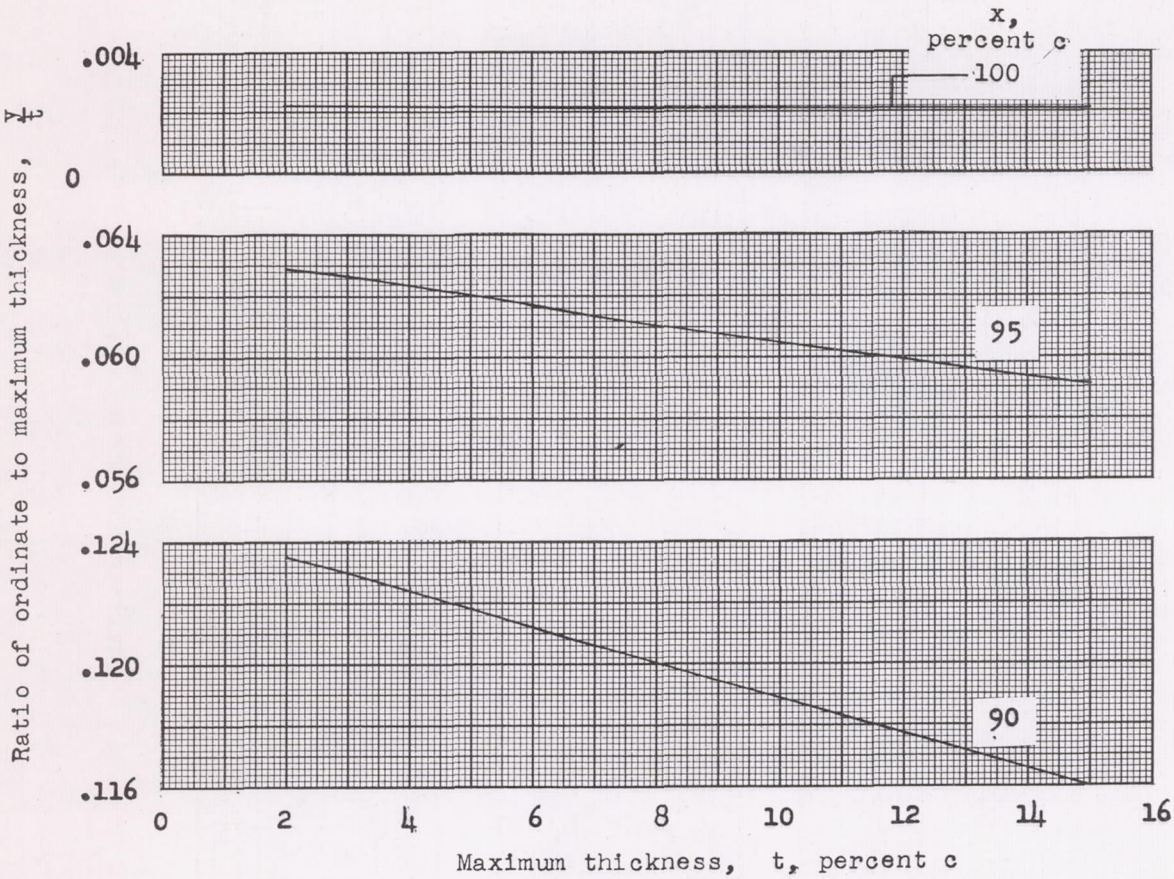
(c) x = 55 to 70 percent c.

Figure 30.- Continued.



(d) x = 75 to 85 percent c.

Figure 30.- Continued.



(e) x = 90 to 100 percent c.

Figure 30.- Concluded.

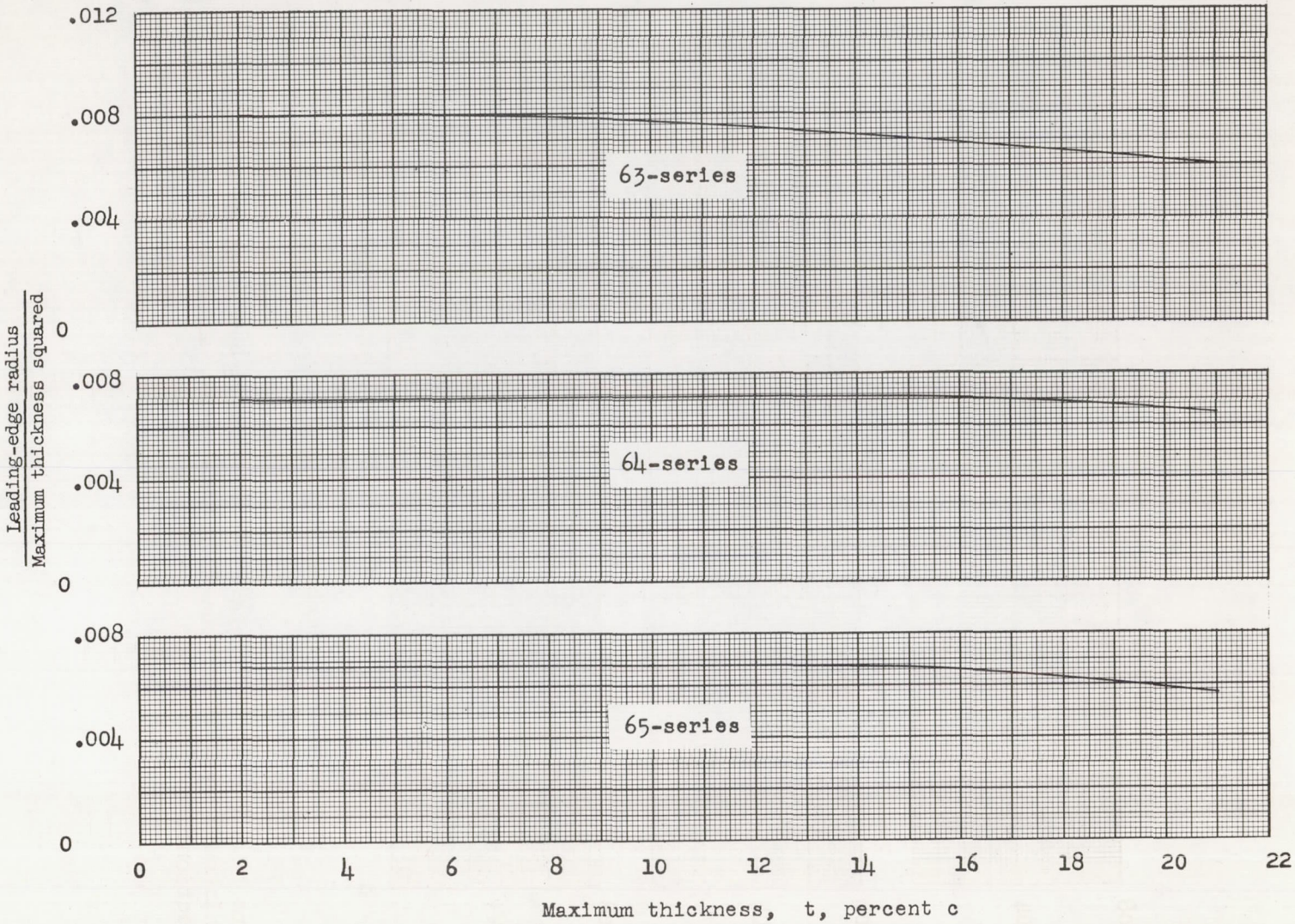


Figure 31.- Variation of the ratio of leading-edge radius to maximum thickness squared for the NACA 63-, 64-, and 65-series airfoil sections.

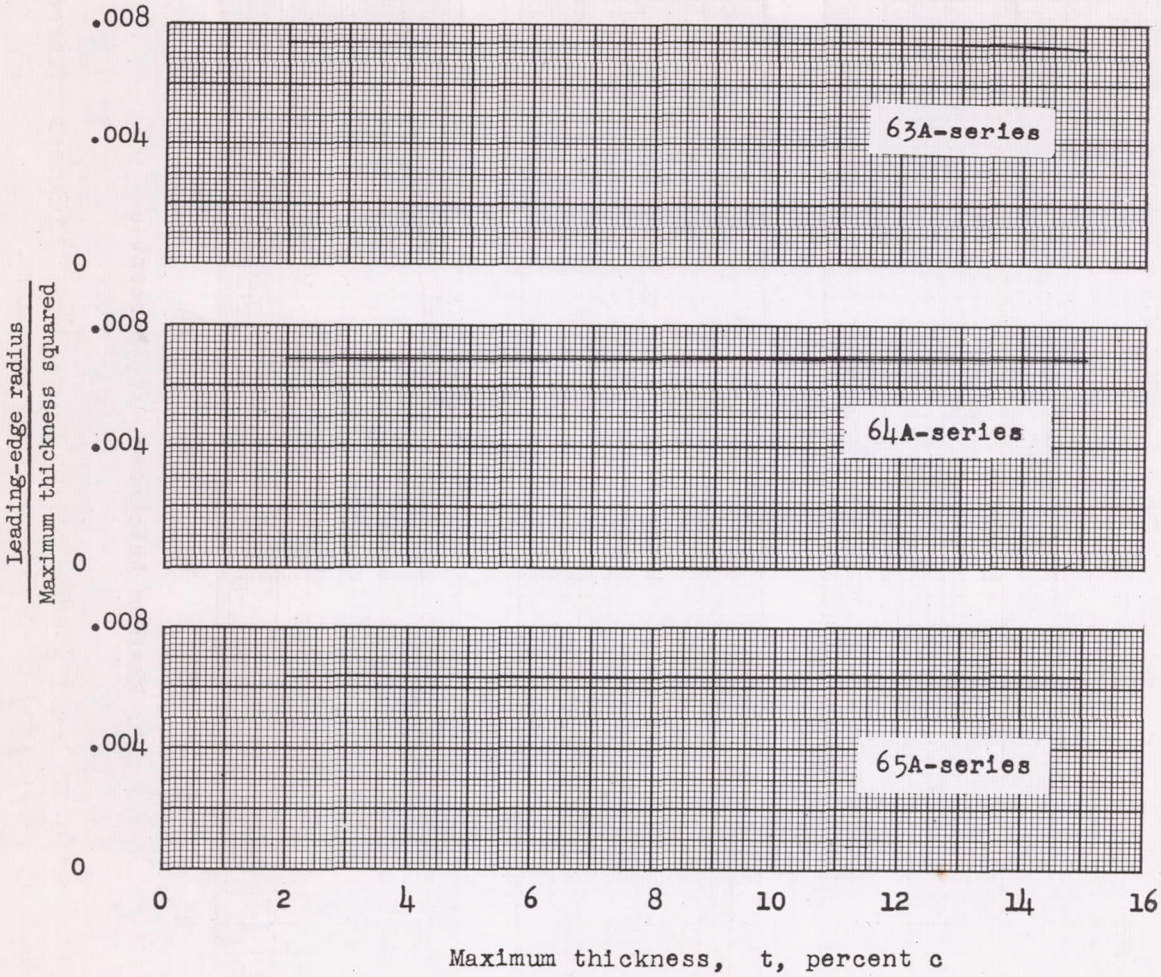
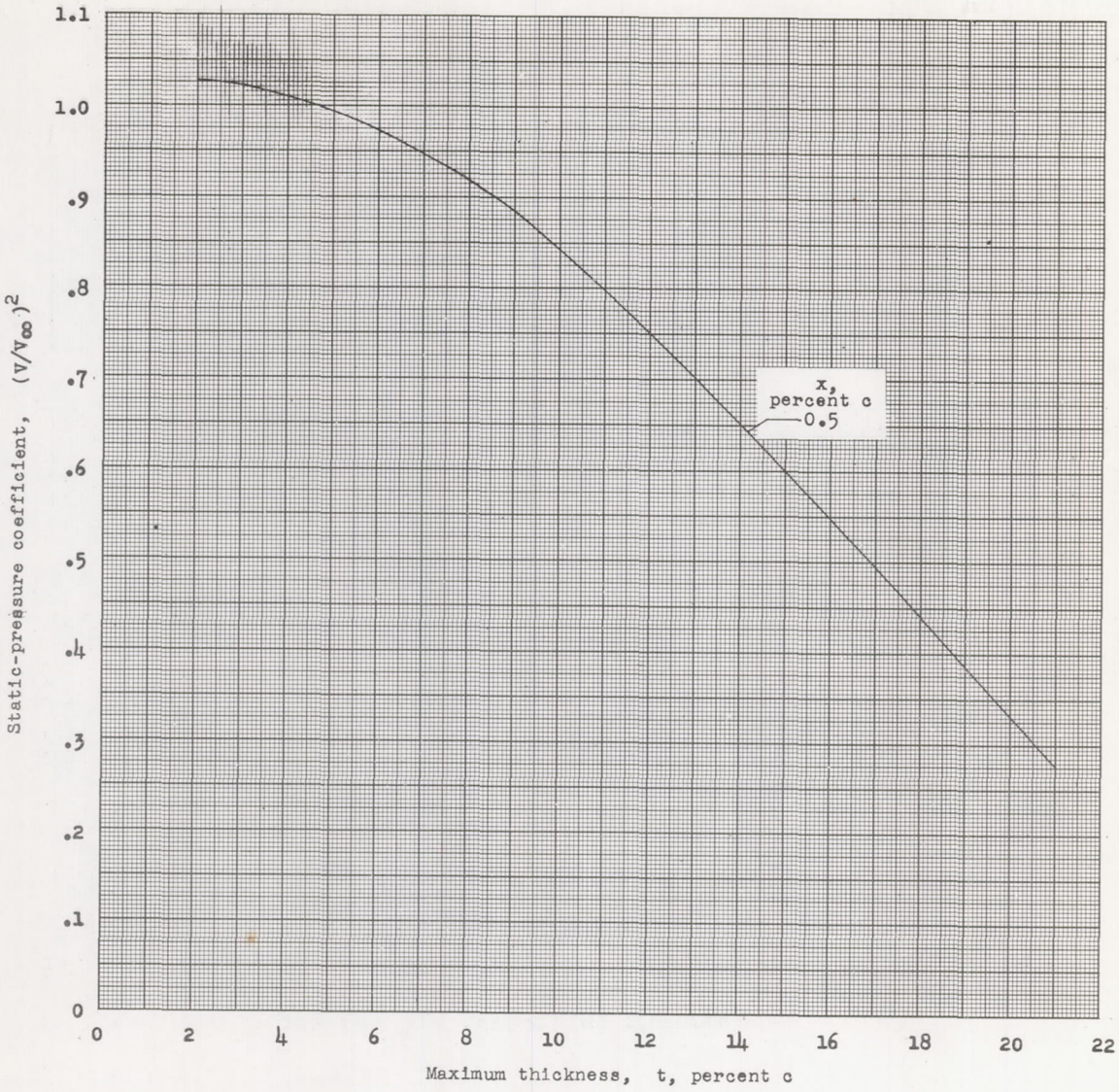
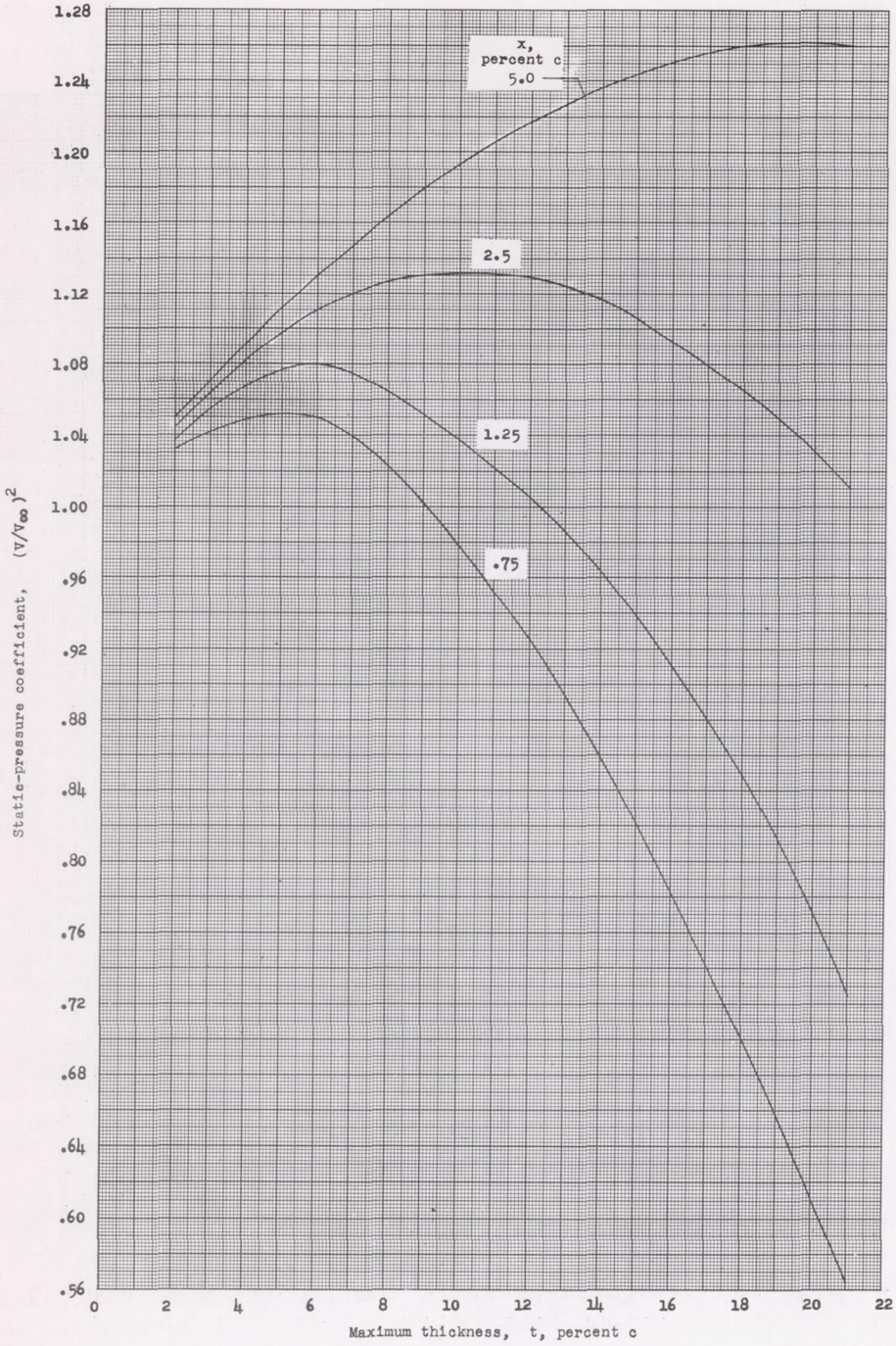


Figure 32.- Variation of the ratio of leading-edge radius to maximum thickness squared for the NACA 63A-, 64A-, and 65A-series airfoil sections.



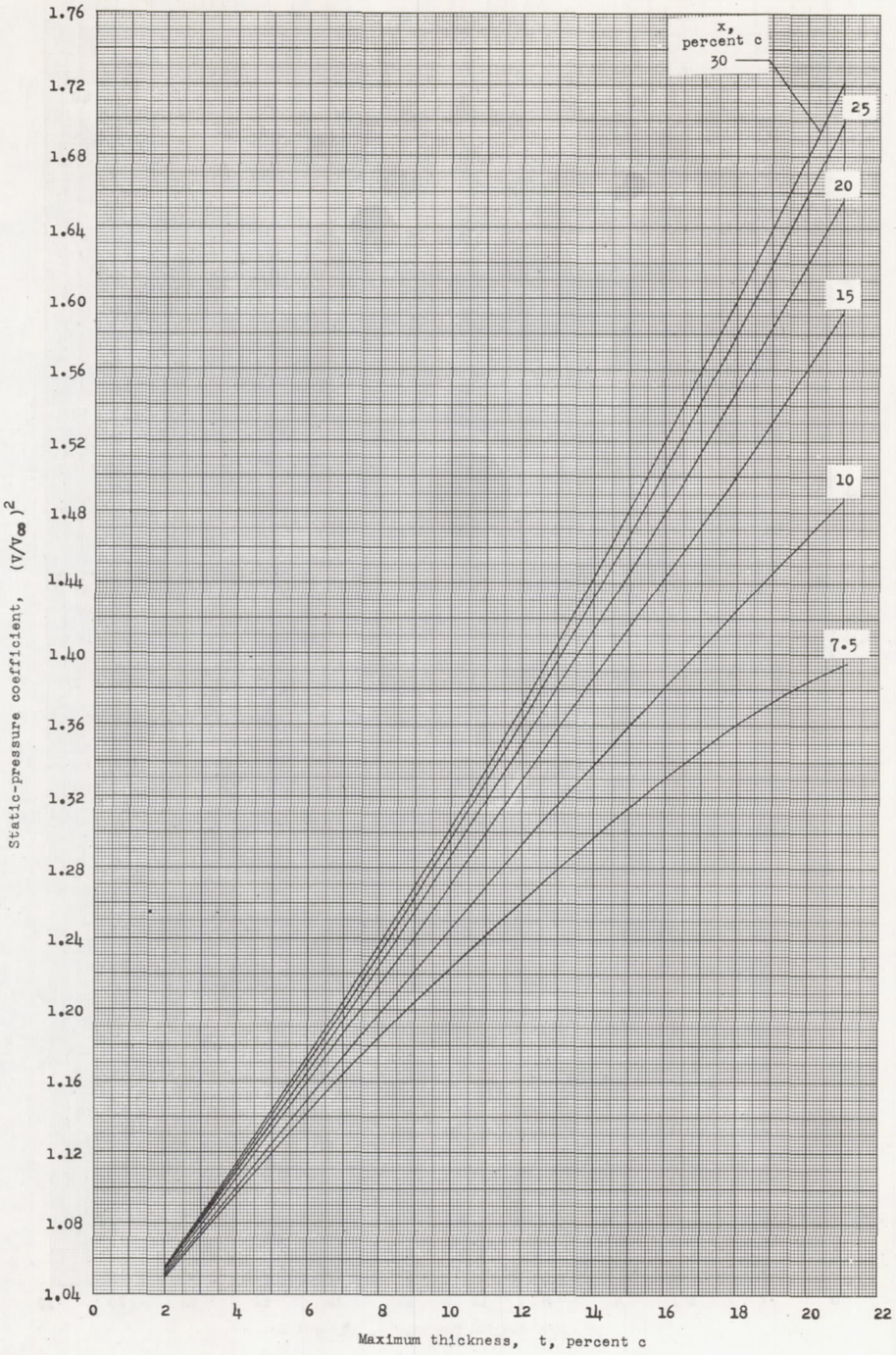
(a) x = 0.5 percent c.

Figure 33.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 63-series airfoil sections.



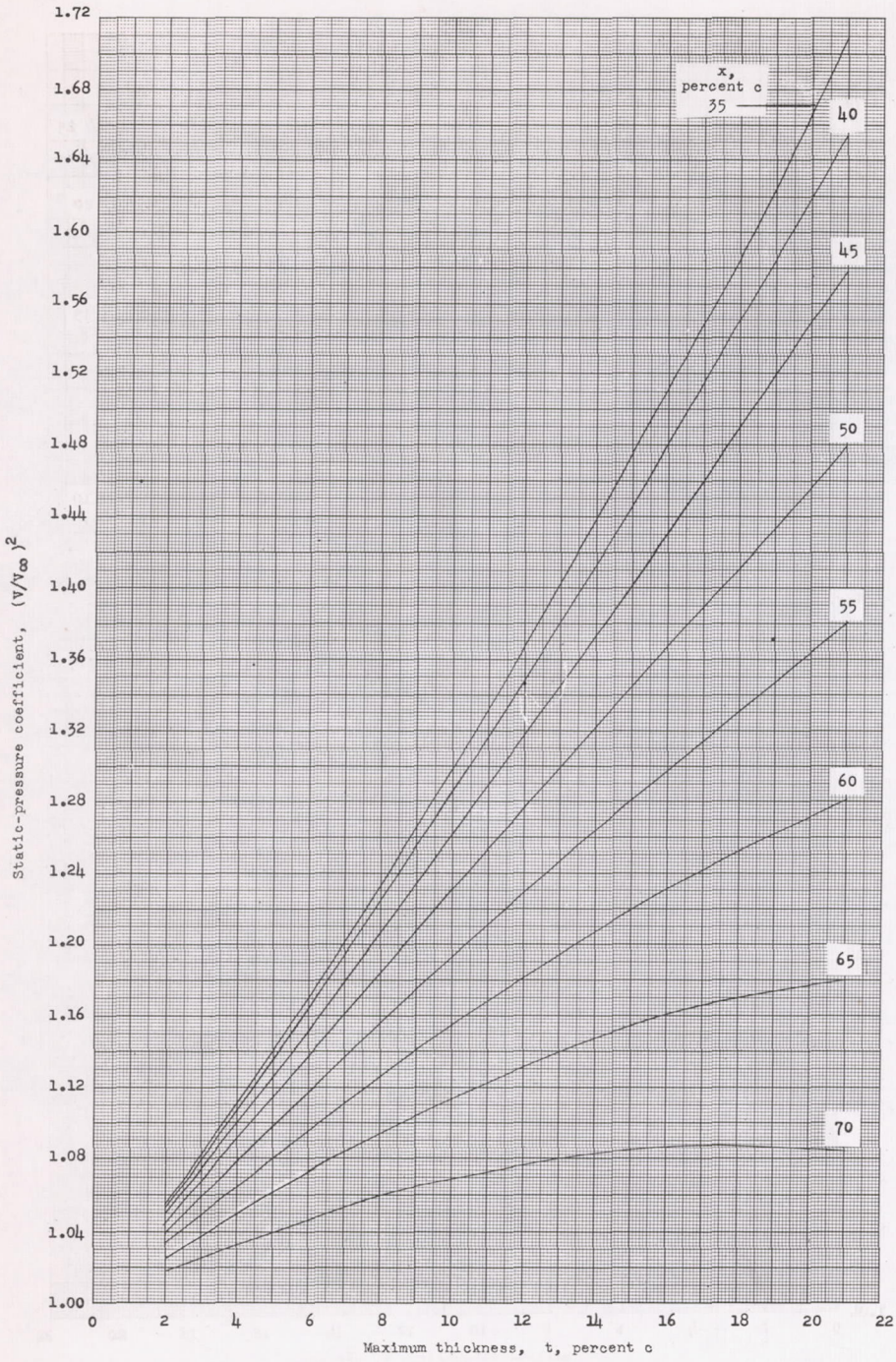
(b) x = 0.75 to 5.0 percent c.

Figure 33.- Continued.



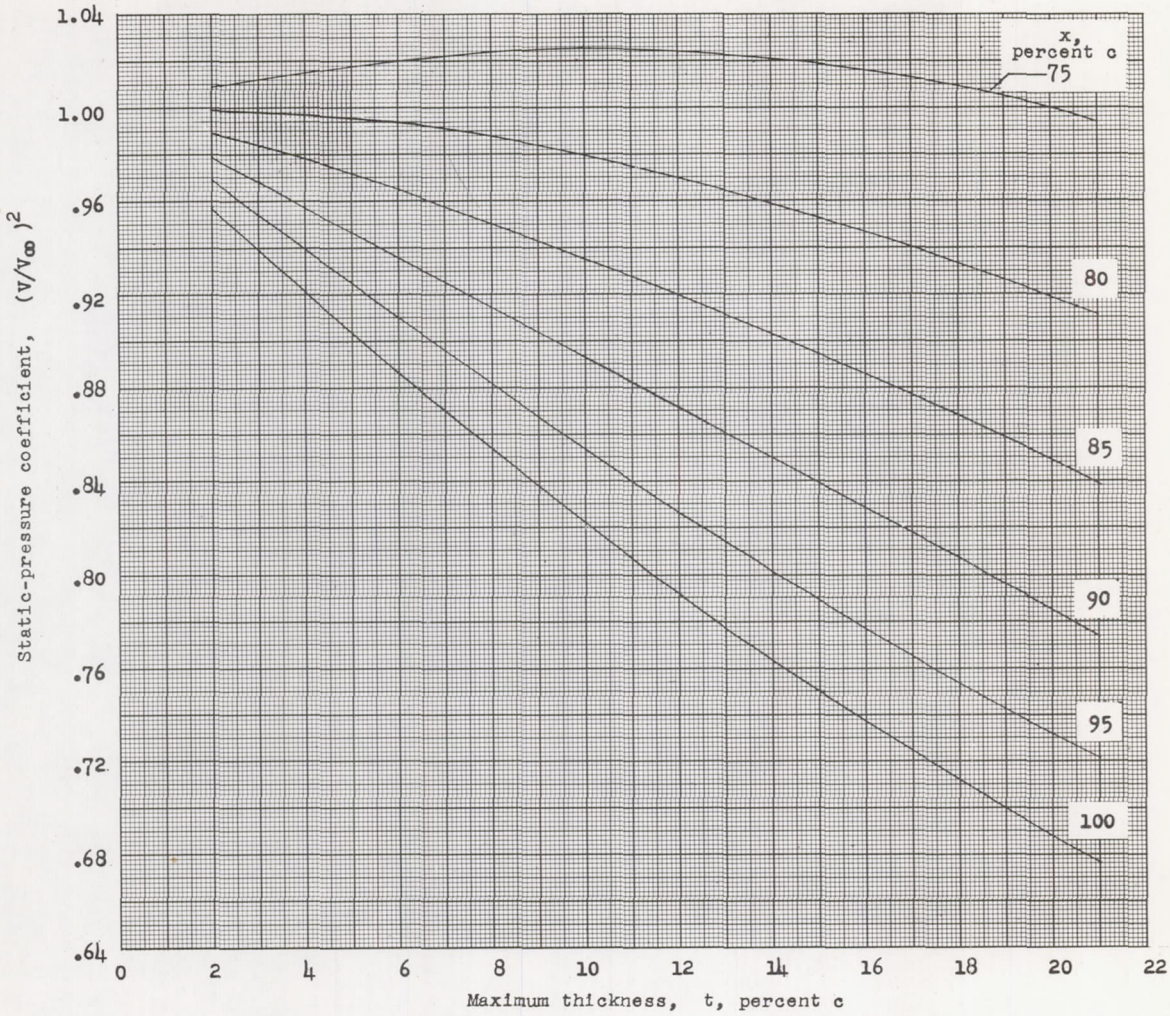
(c) x = 7.5 to 30 percent c.

Figure 33.- Continued.



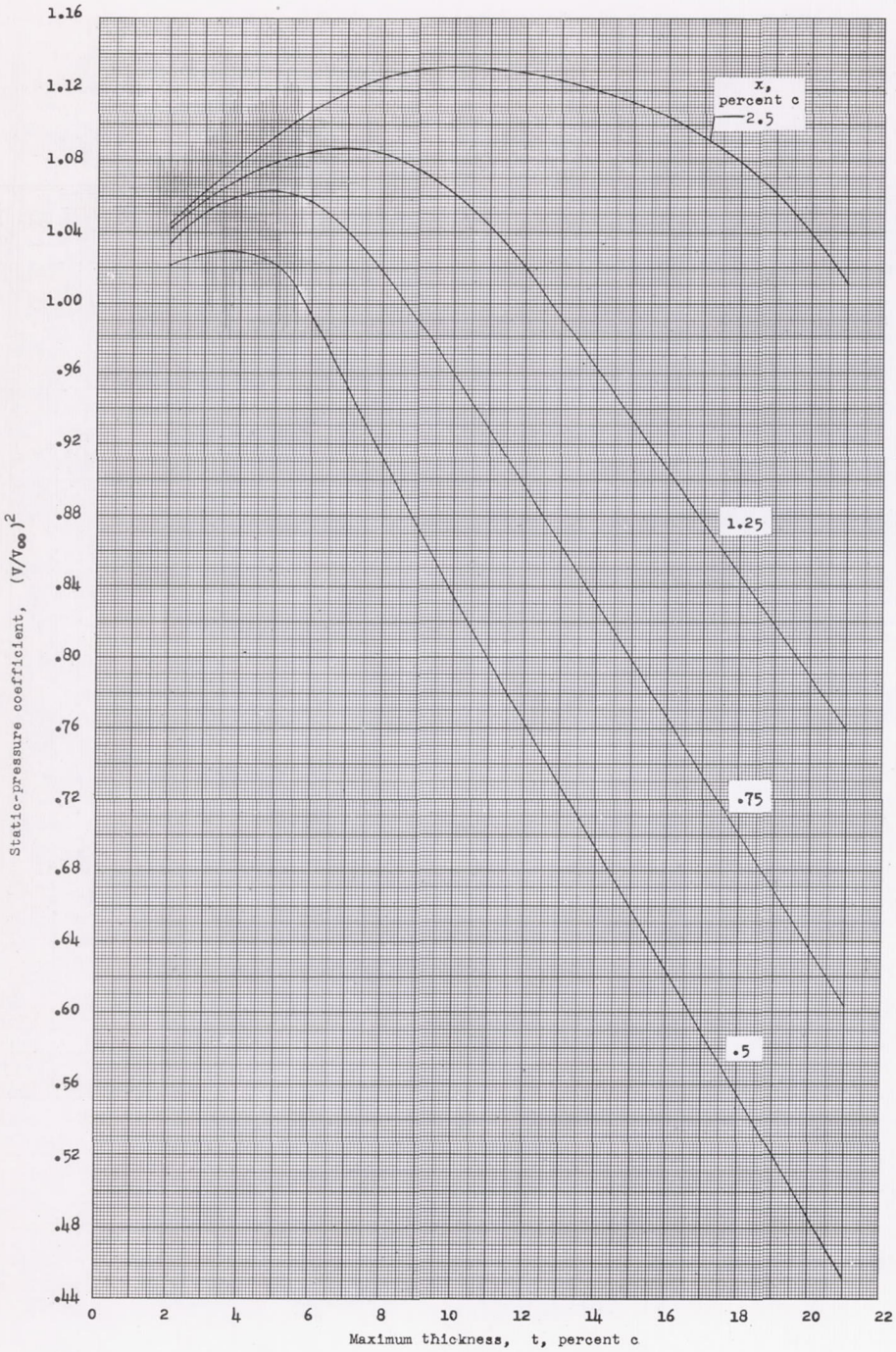
(d) x = 35 to 70 percent c.

Figure 33.- Continued.



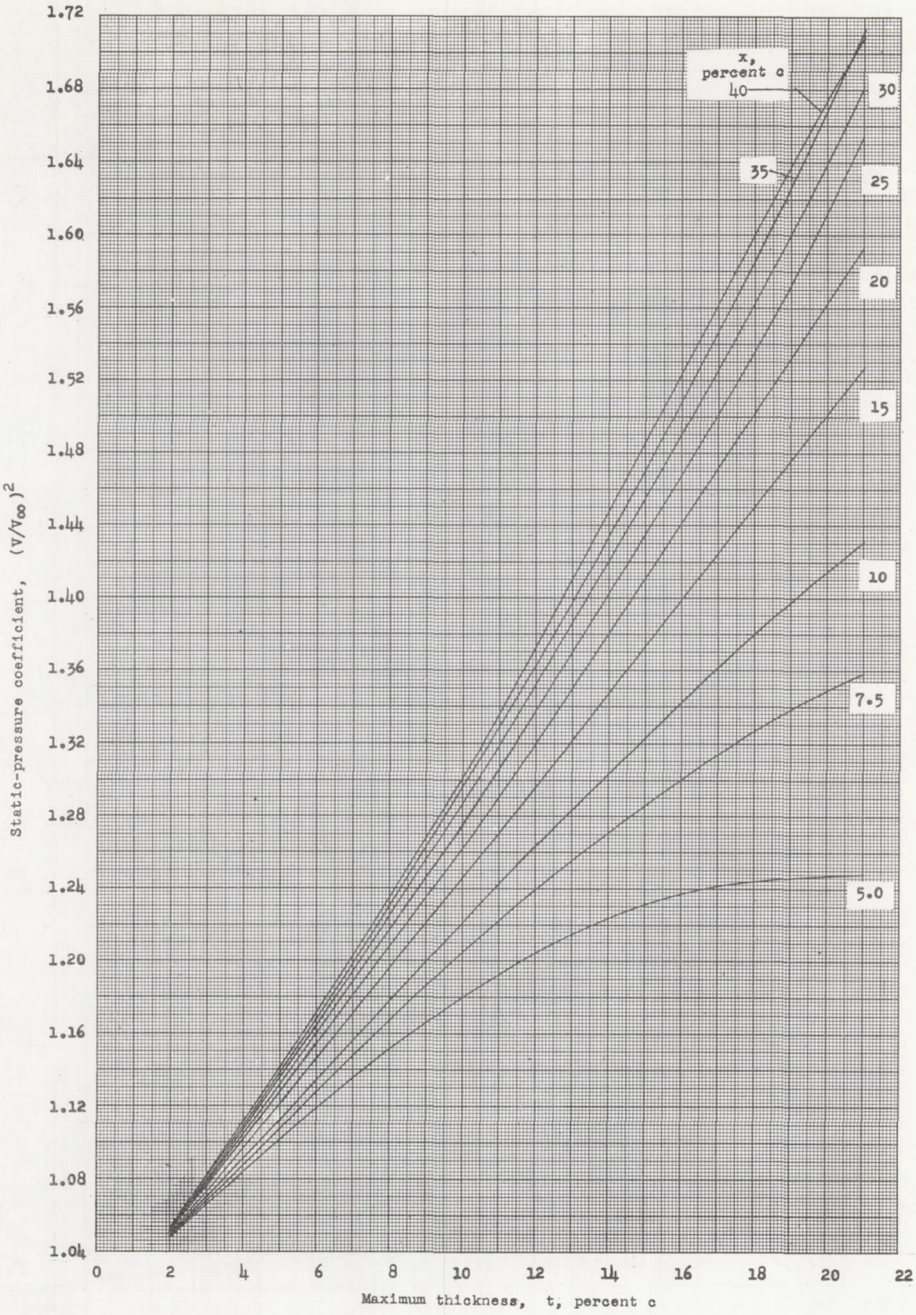
(e) x = 75 to 100 percent c.

Figure 33.- Concluded.



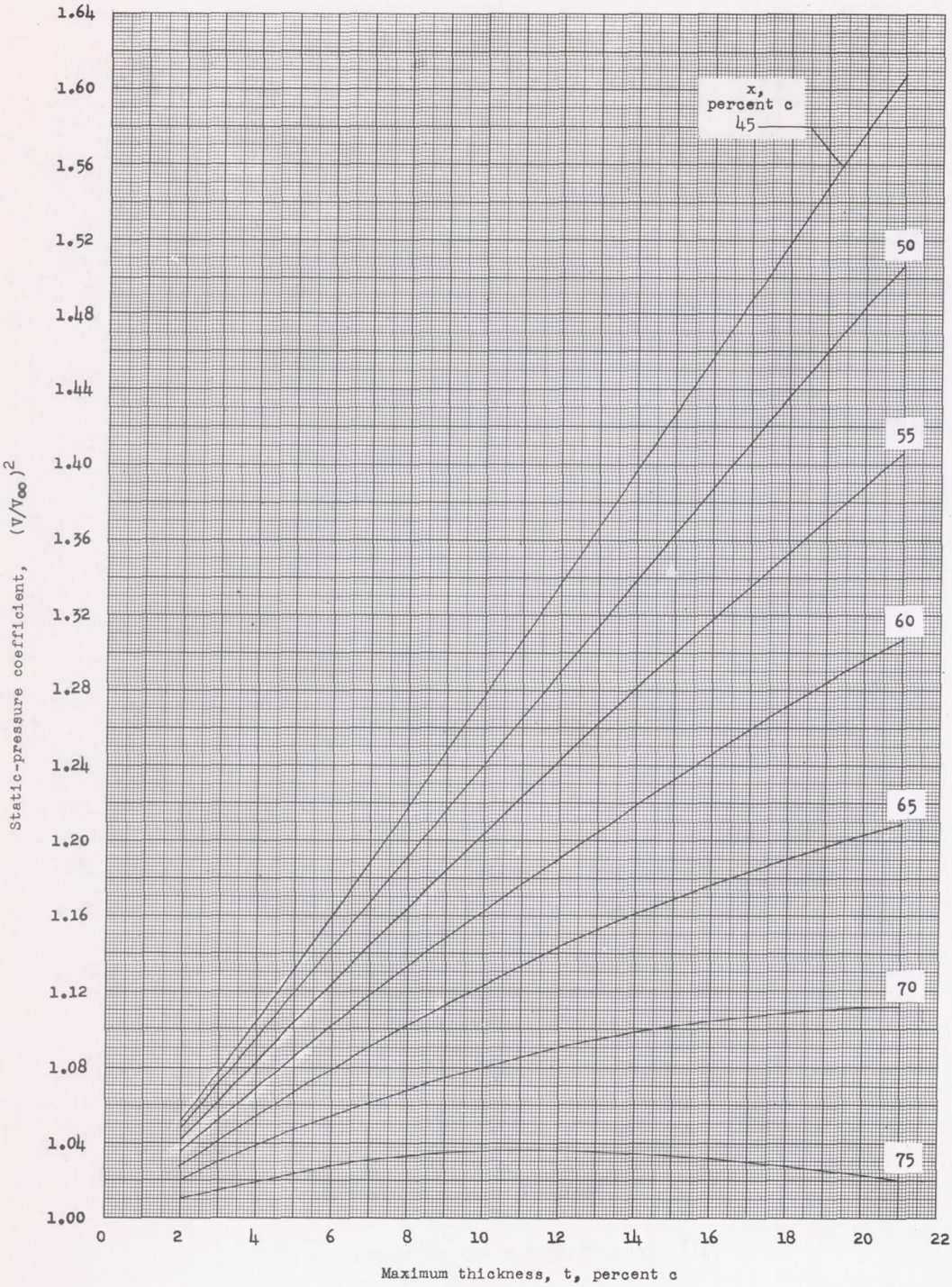
(a) x = 0.5 to 2.5 percent c.

Figure 34.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 64-series airfoil sections.



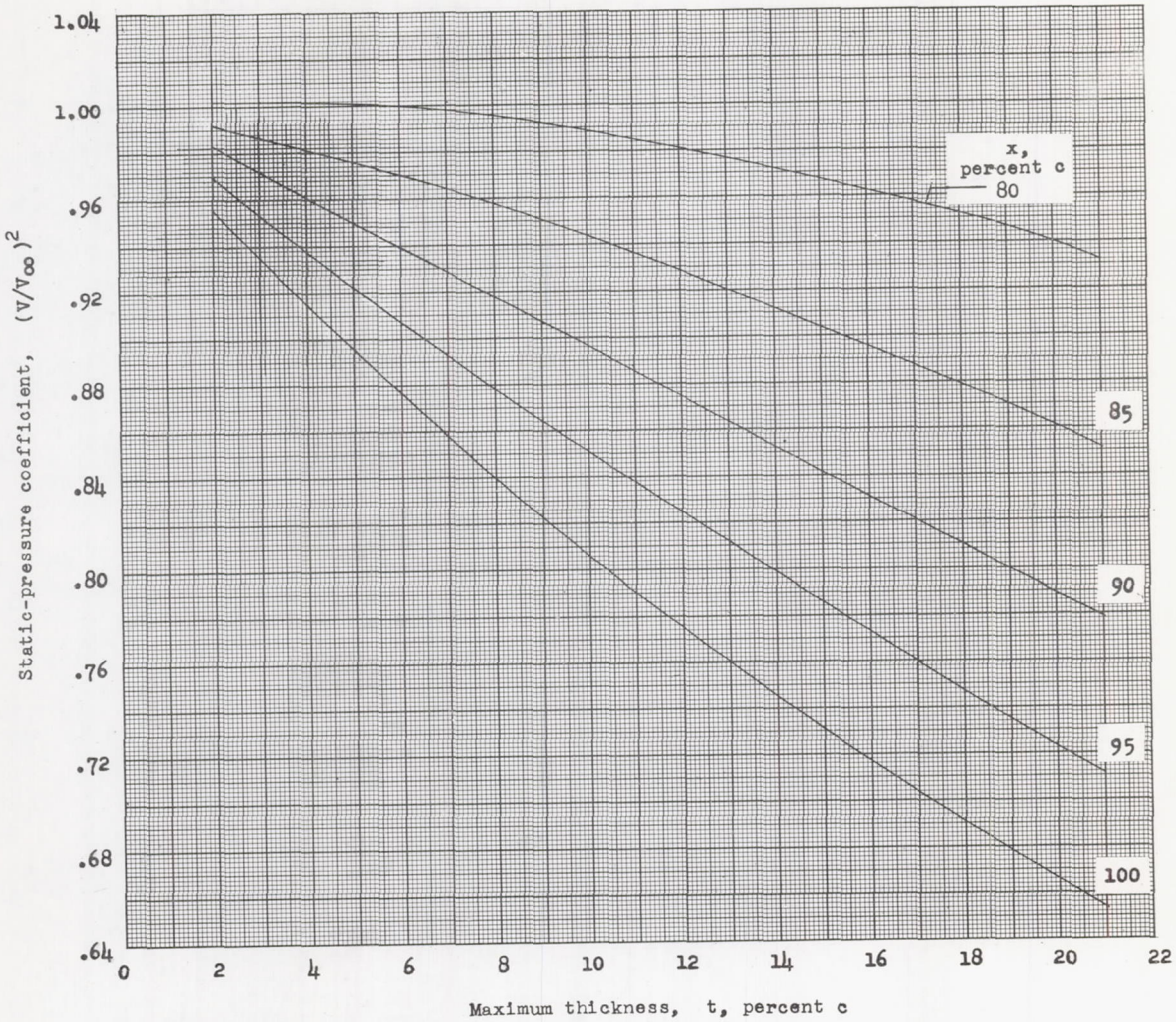
(b) x = 5.0 to 40 percent c.

Figure 34.- Continued.



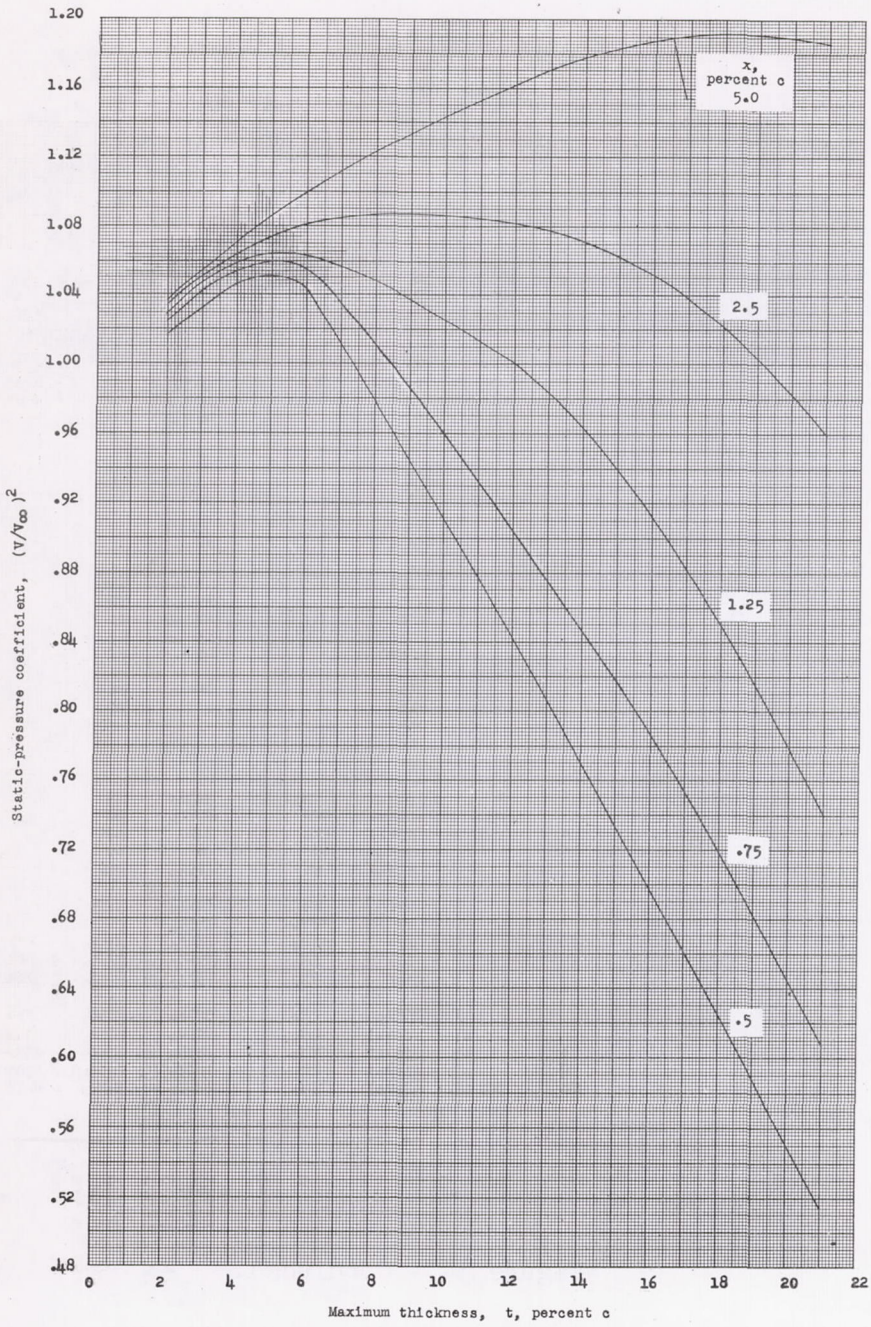
(c) x = 45 to 75 percent c.

Figure 34.- Continued.



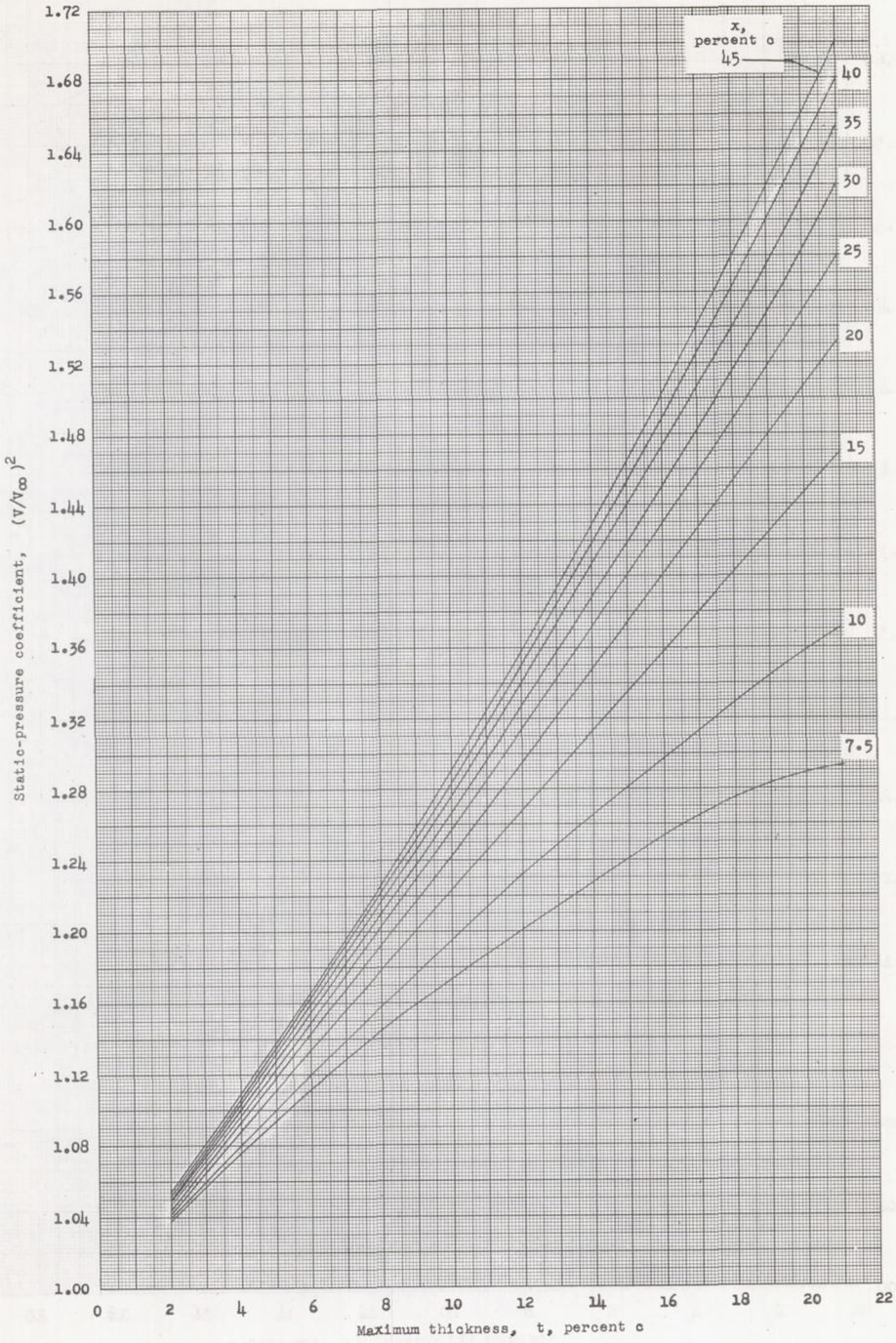
(d) x = 80 to 100 percent c.

Figure 34.- Concluded.



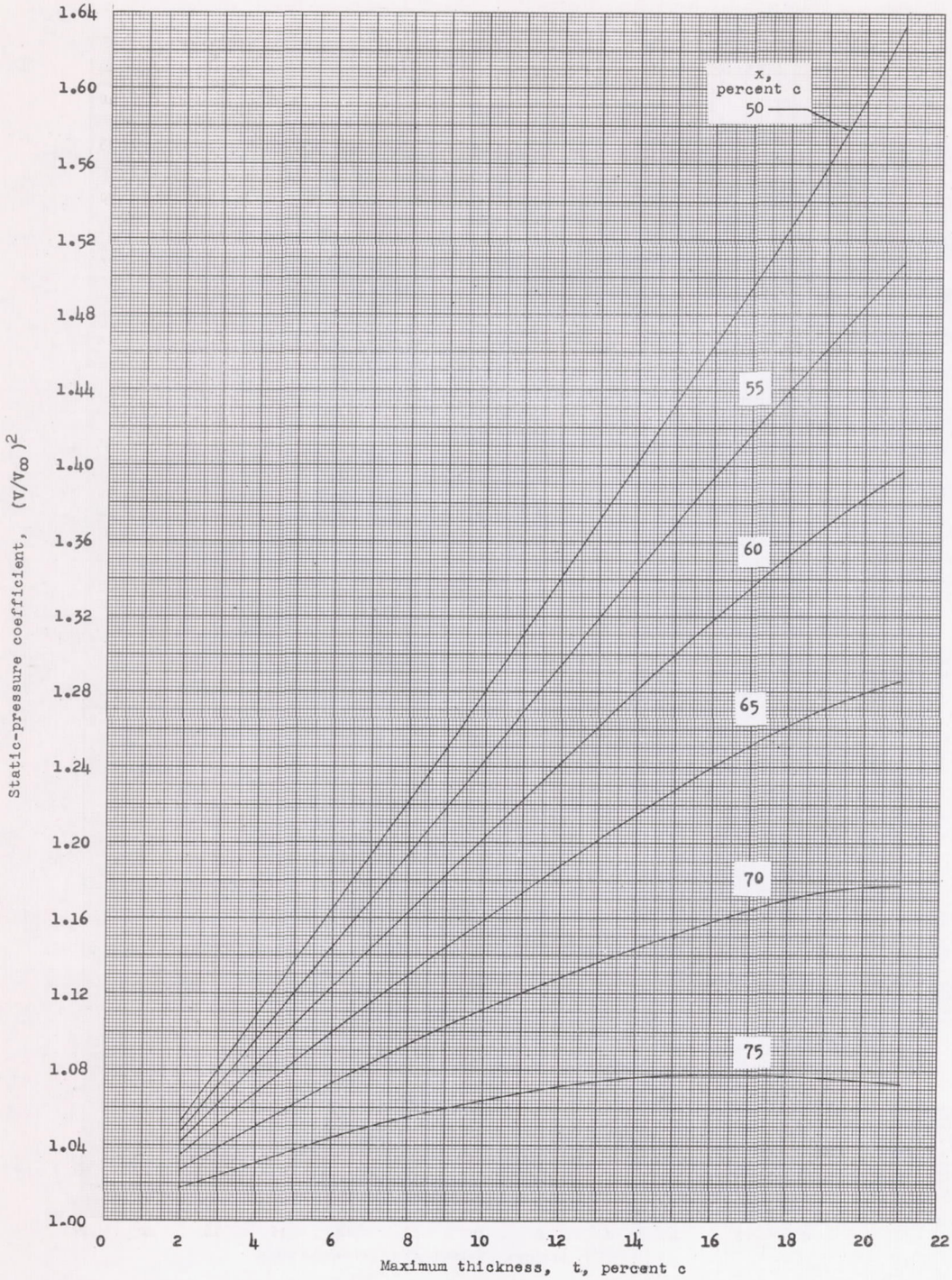
(a) x = 0.5 to 5.0 percent c.

Figure 35.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 65-series airfoil sections.



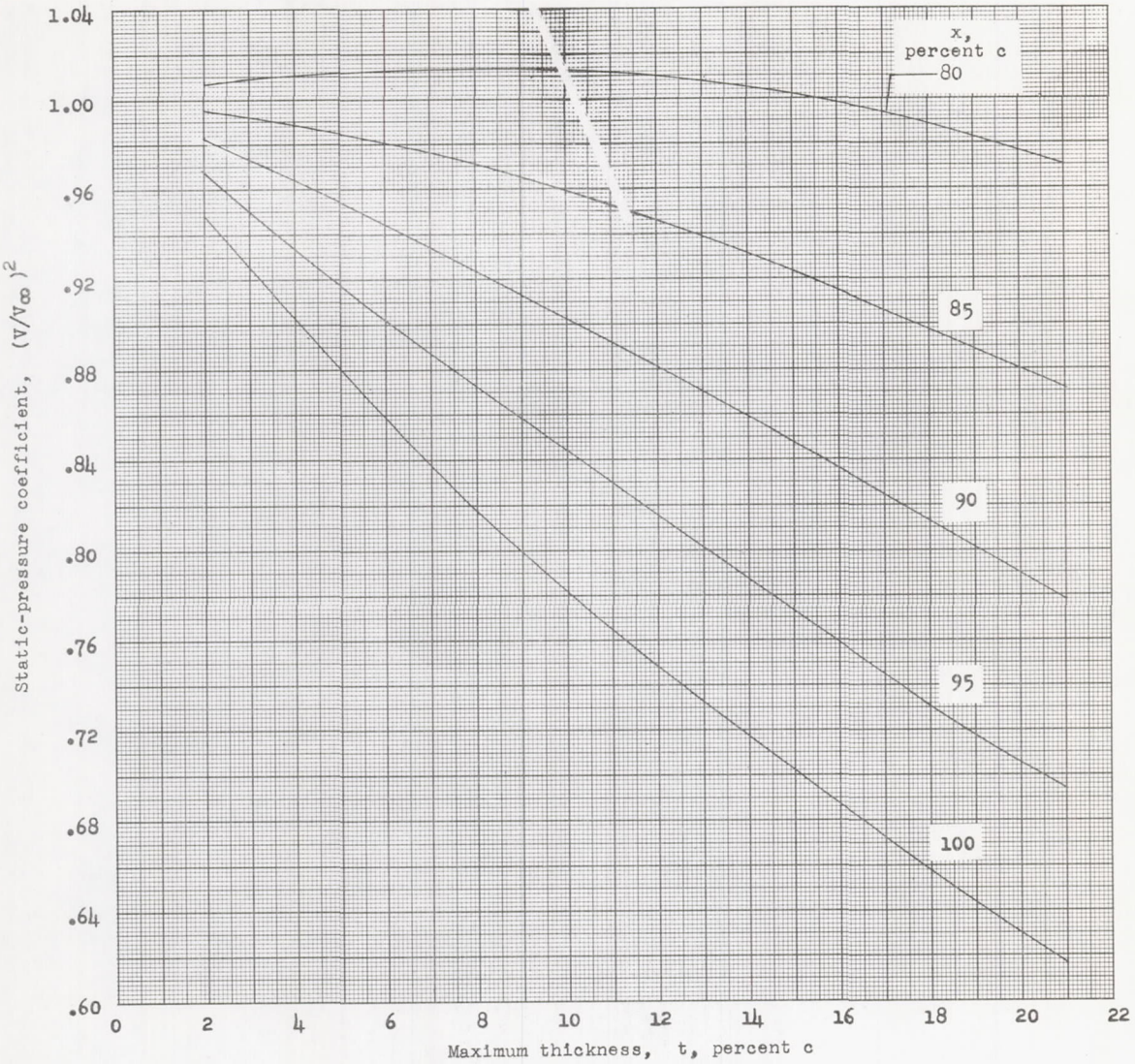
(b) x = 7.5 to 45 percent c.

Figure 35.- Continued.



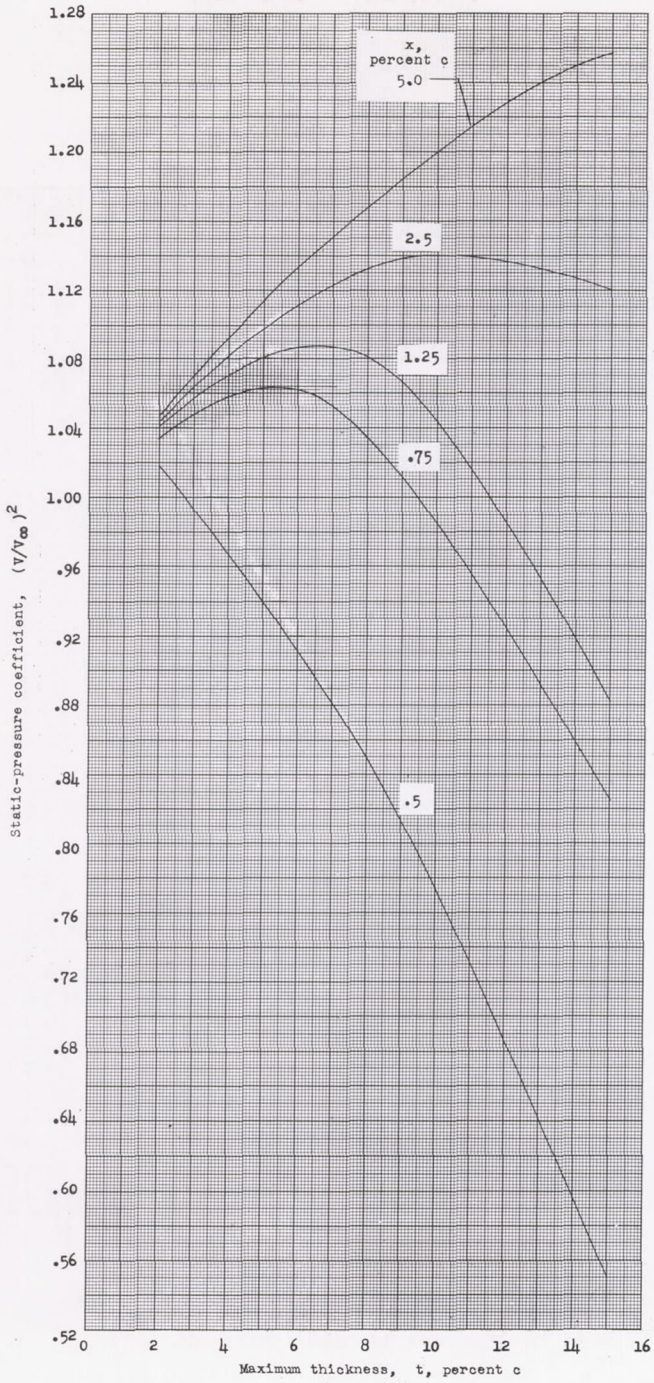
(c) x = 50 to 75 percent c.

Figure 35.- Continued.



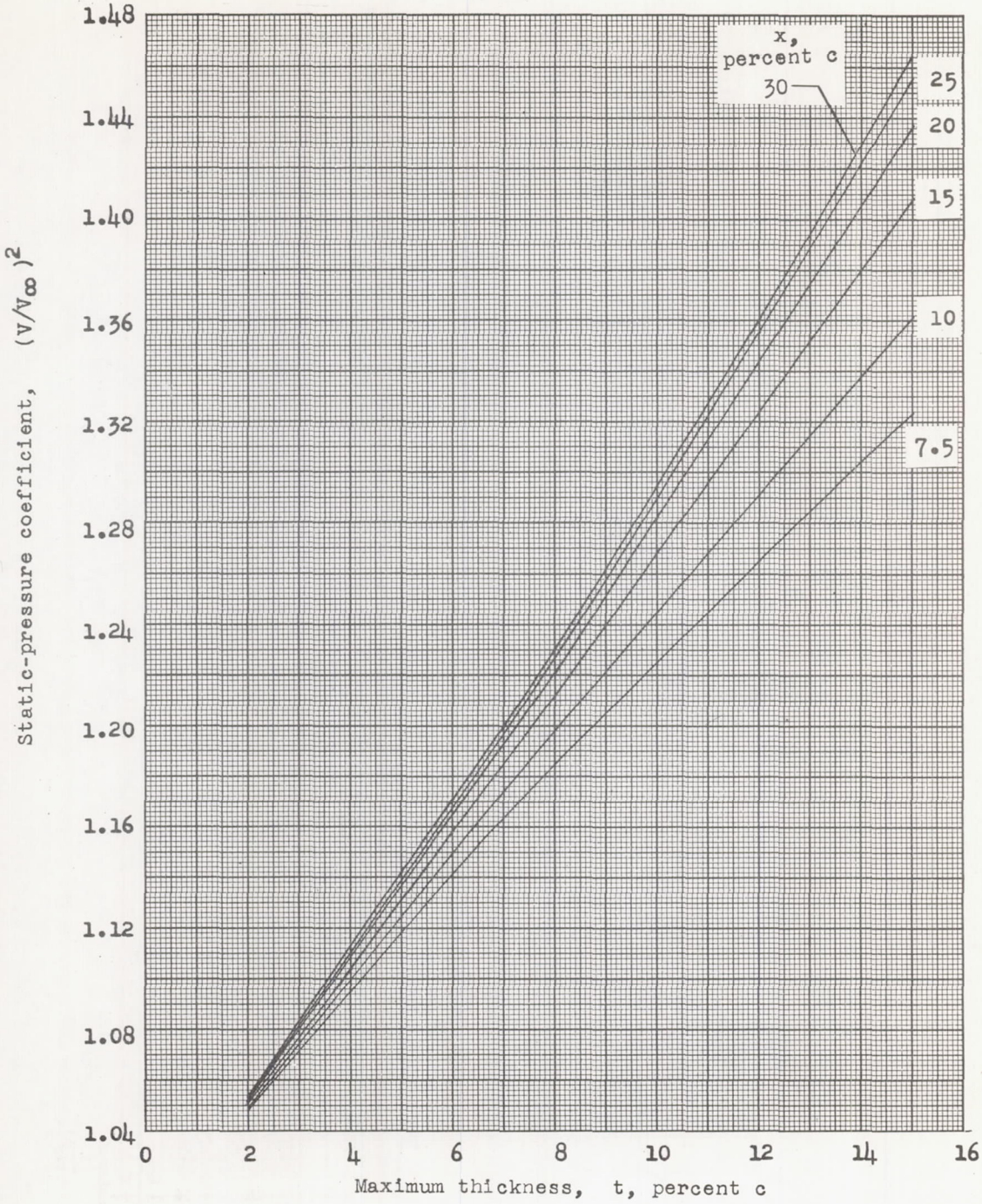
(d) x = 80 to 100 percent c.

Figure 35.- Concluded.



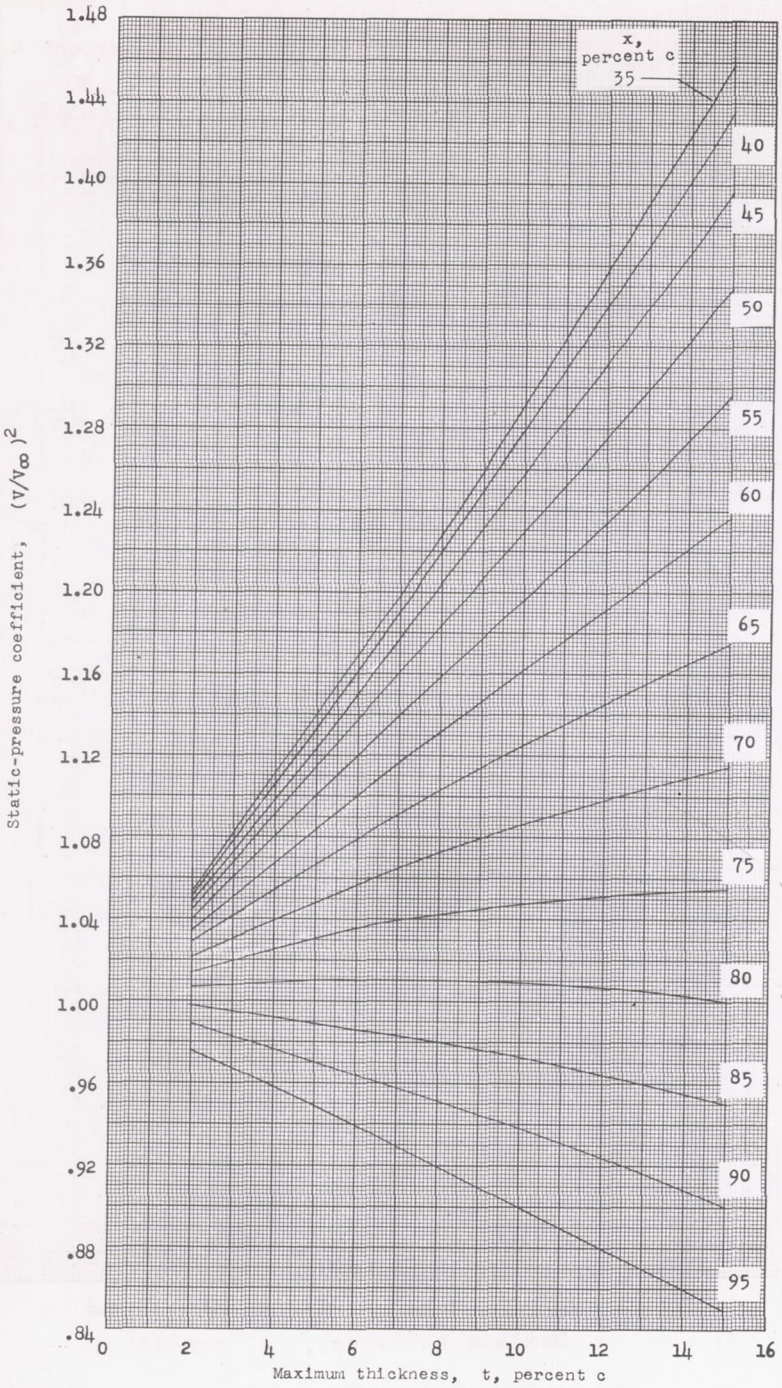
(a) x = 0.5 to 5.0 percent c.

Figure 36.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 63A-series airfoil sections.



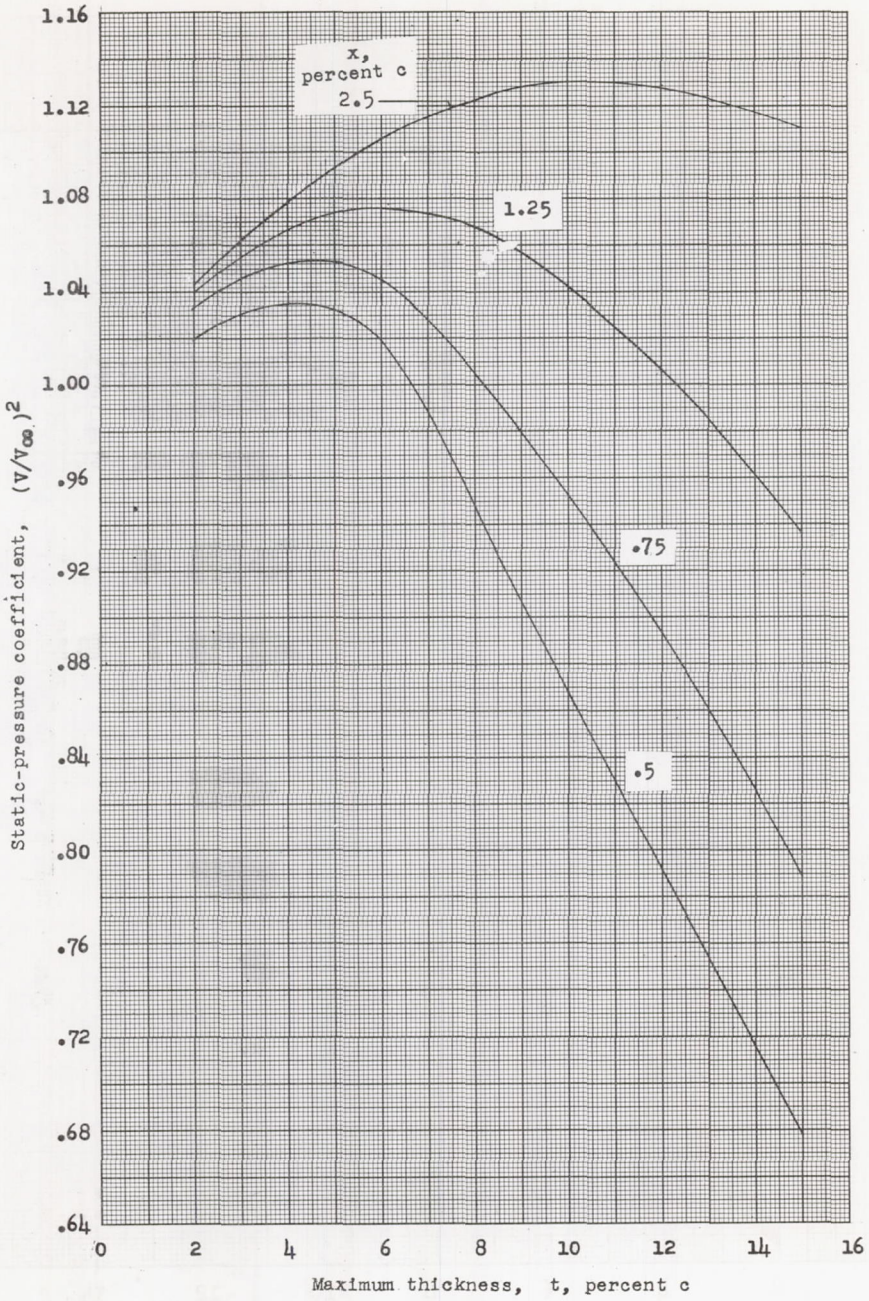
(b) x = 7.5 to 30 percent c.

Figure 36.- Continued.



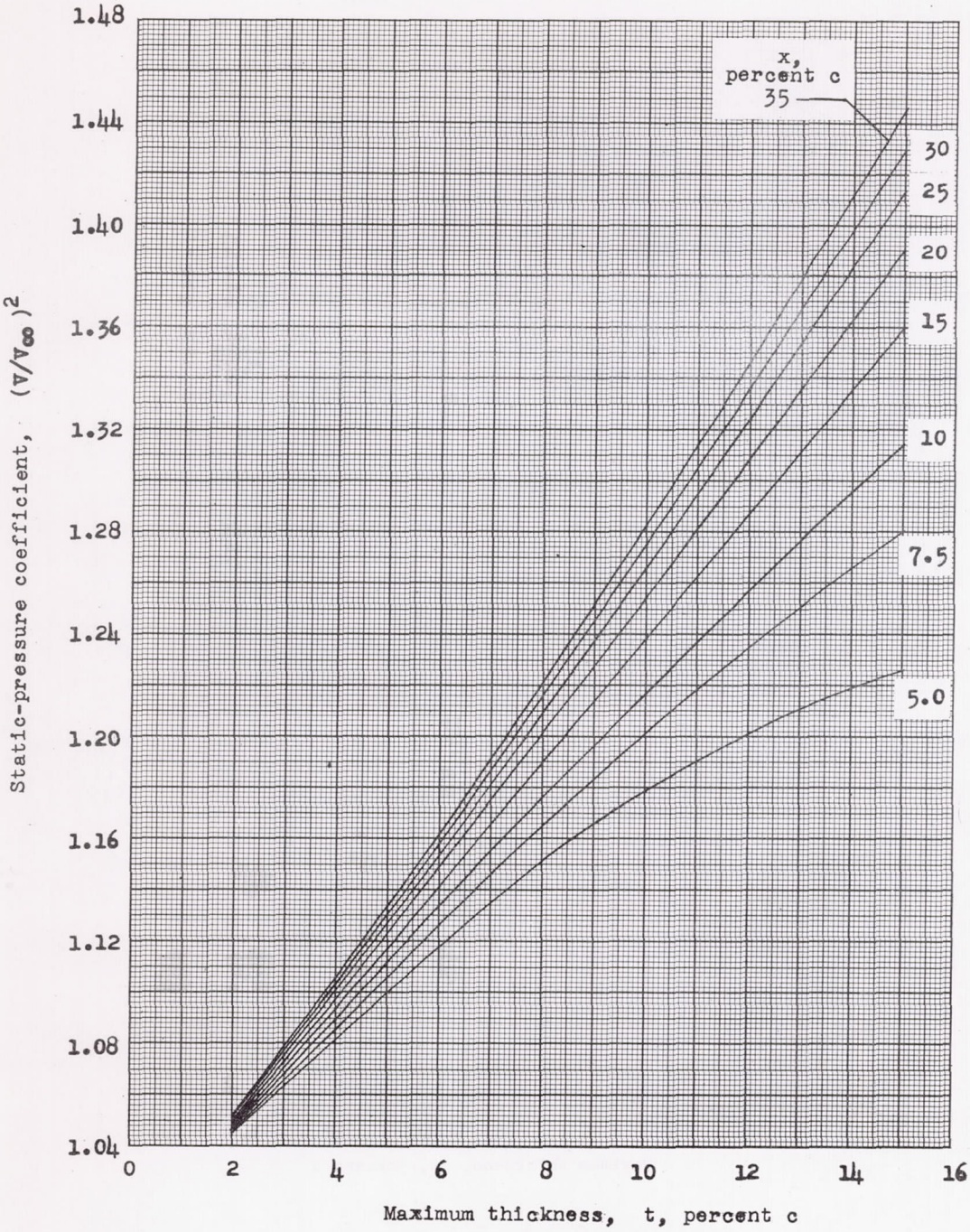
(c) x = 35 to 95 percent c.

Figure 36.- Concluded.



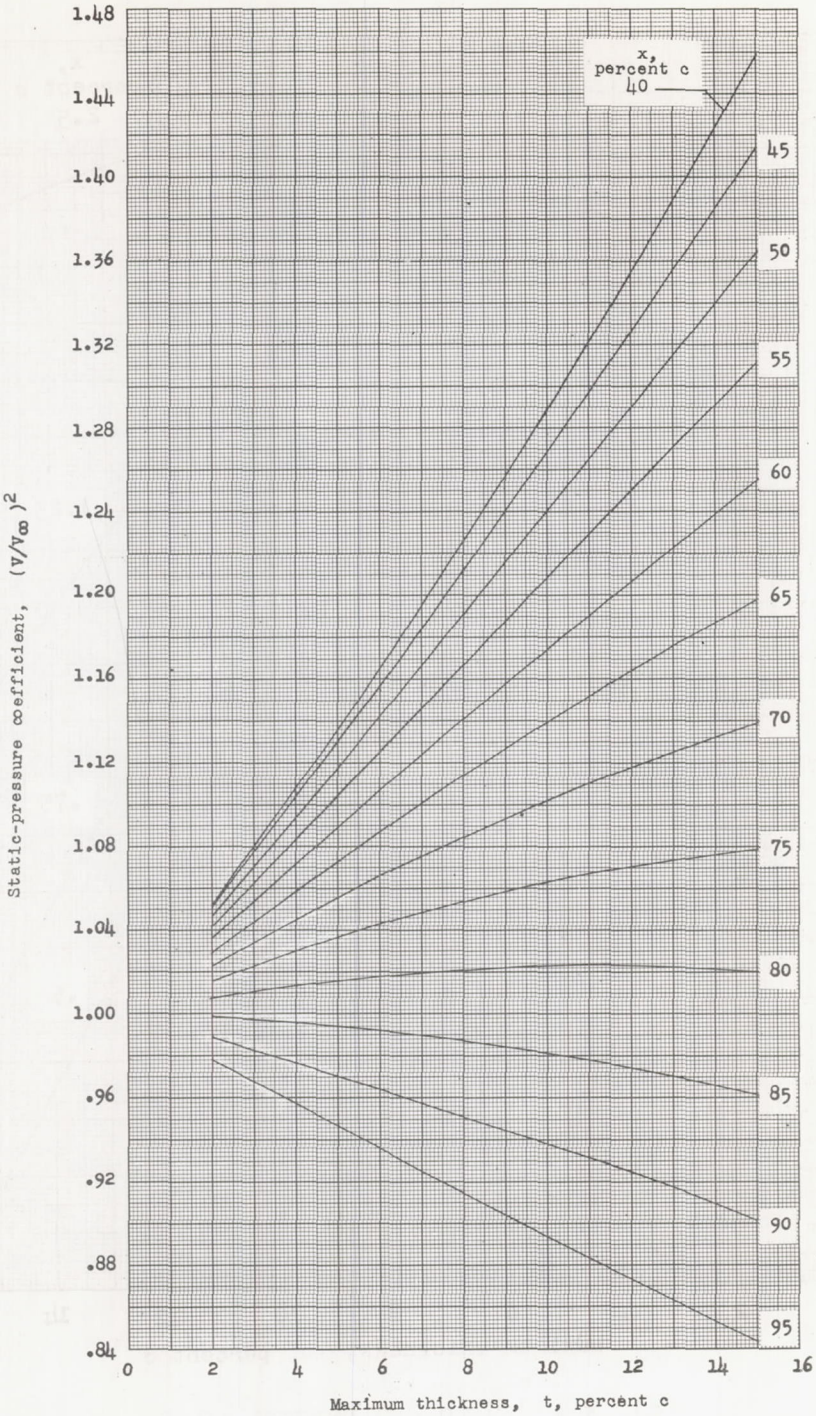
(a) x = 0.5 to 2.5 percent c.

Figure 37.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 64A-series airfoil sections.



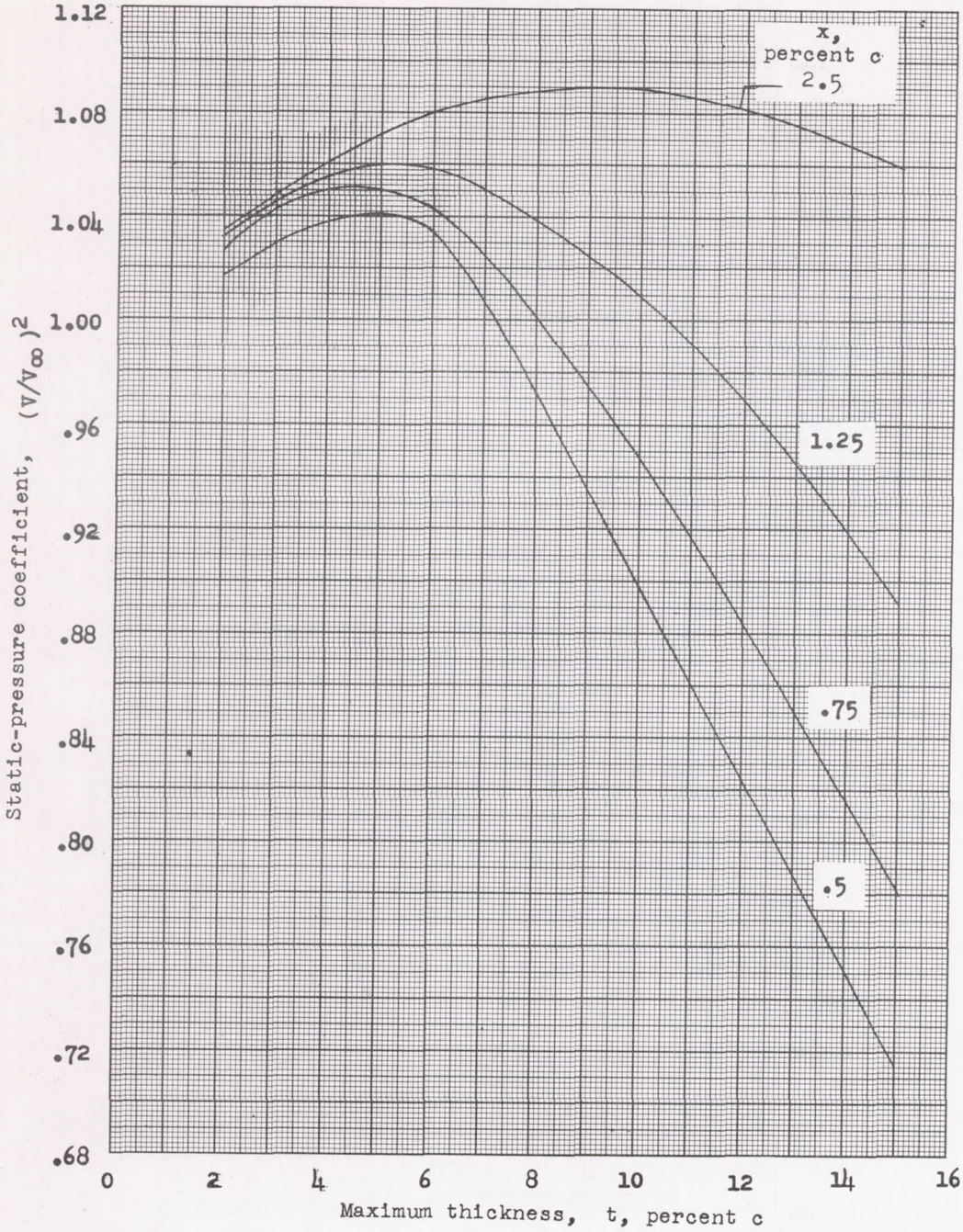
(b) x = 5.0 to 35 percent c.

Figure 37.- Continued.



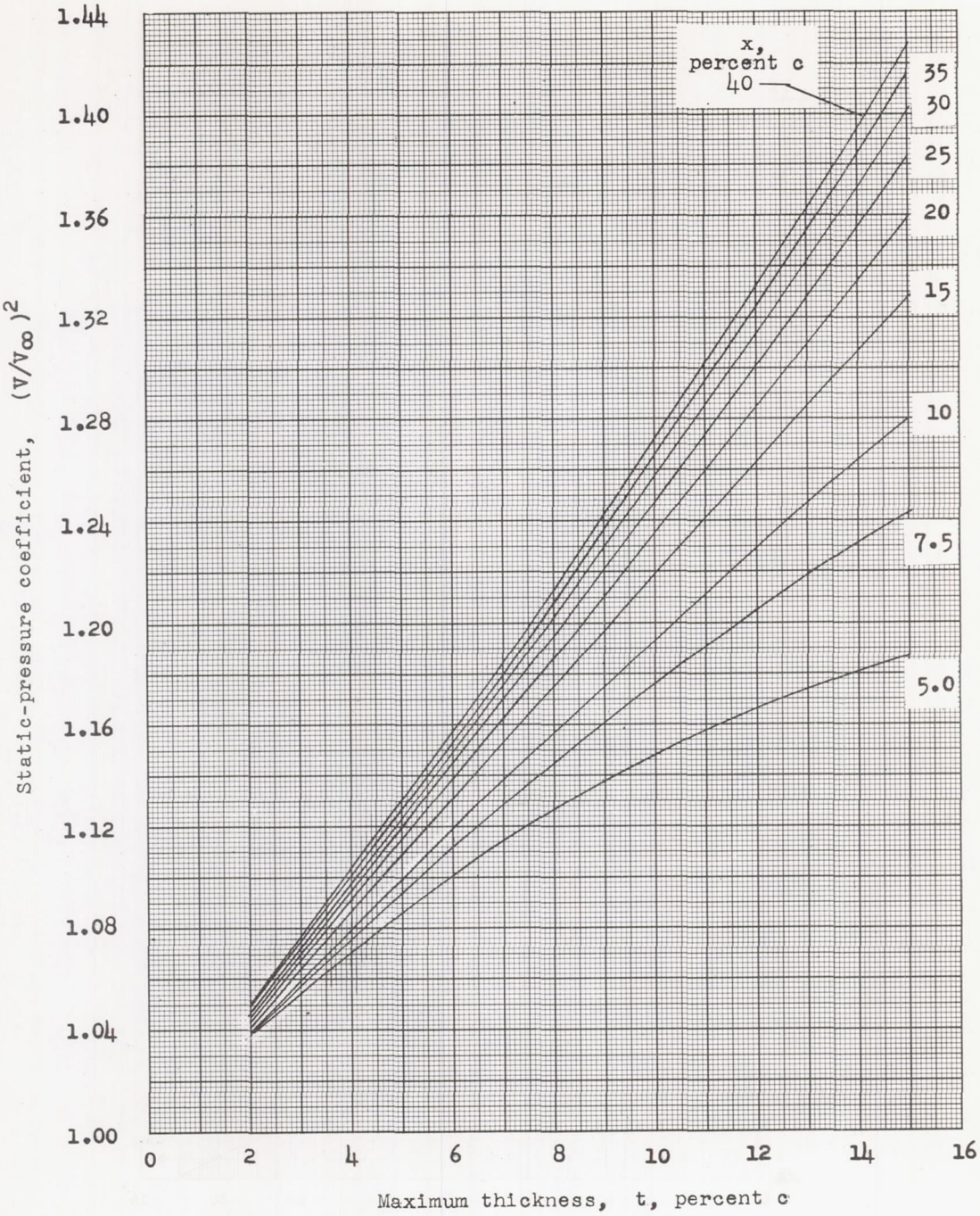
(c) x = 40 to 95 percent c.

Figure 37.- Concluded.



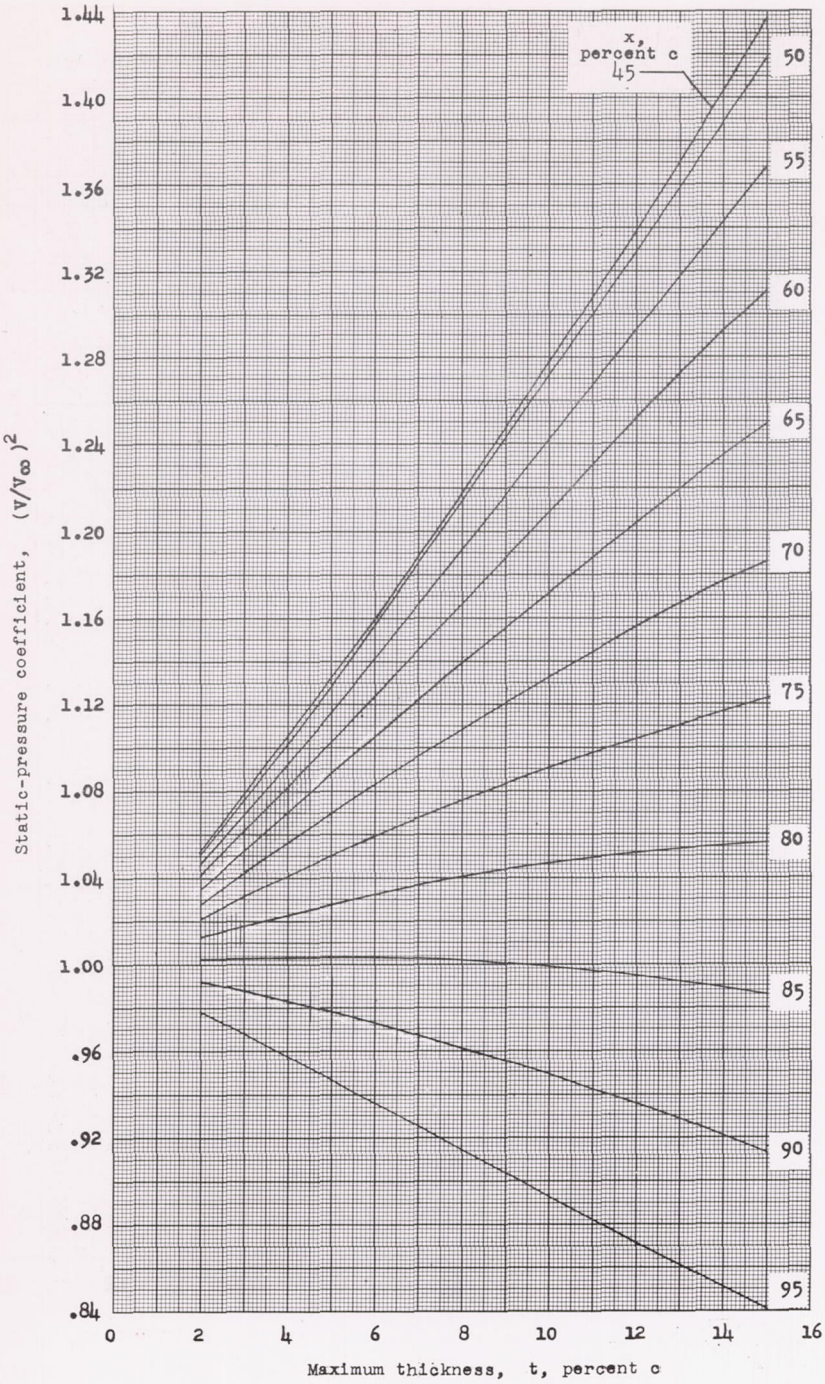
(a) x = 0.5 to 2.5 percent c.

Figure 38.- Variation of static-pressure coefficient with airfoil maximum thickness for the NACA 65A-series airfoil sections.



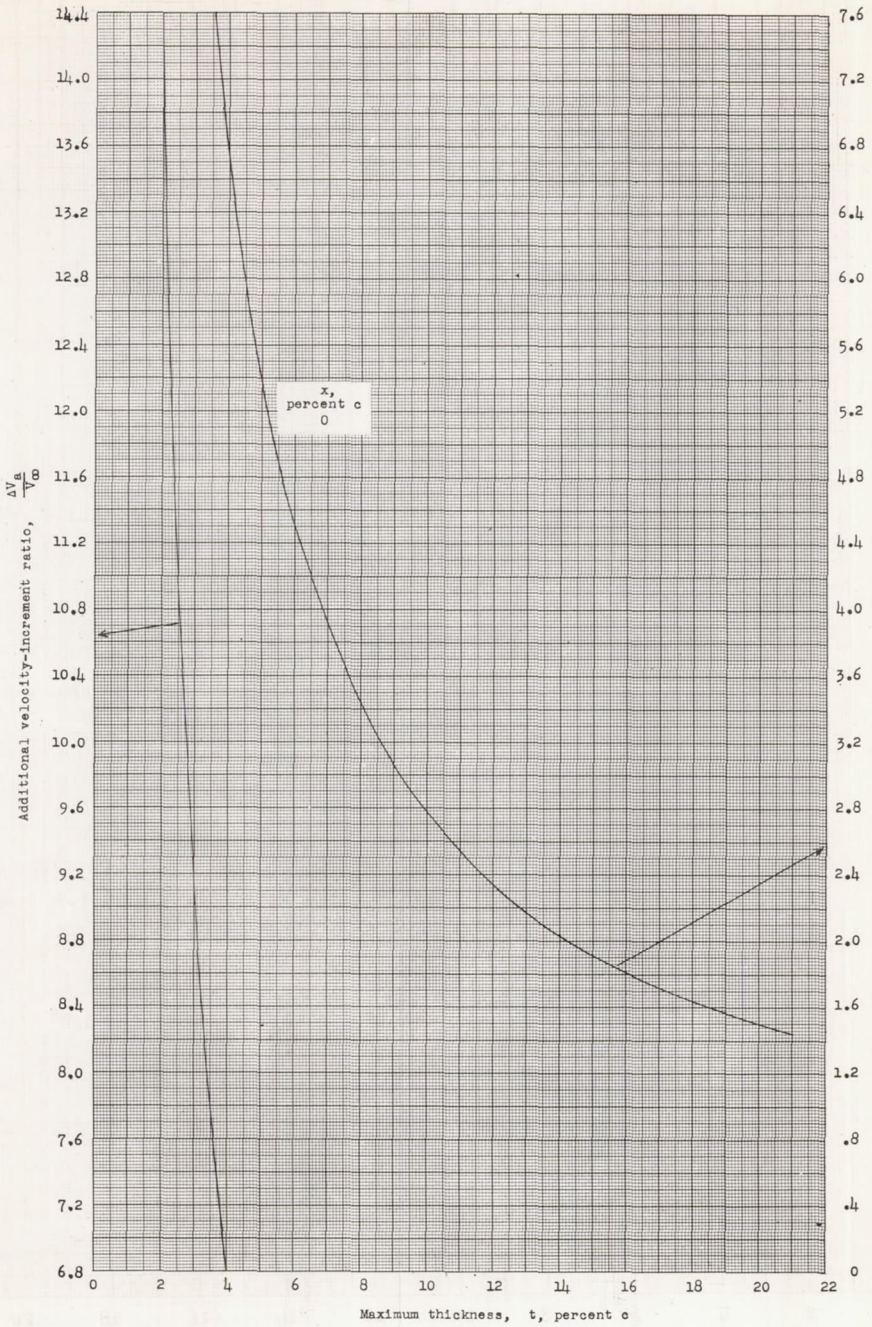
(b) x = 5.0 to 40 percent c.

Figure 38.- Continued.



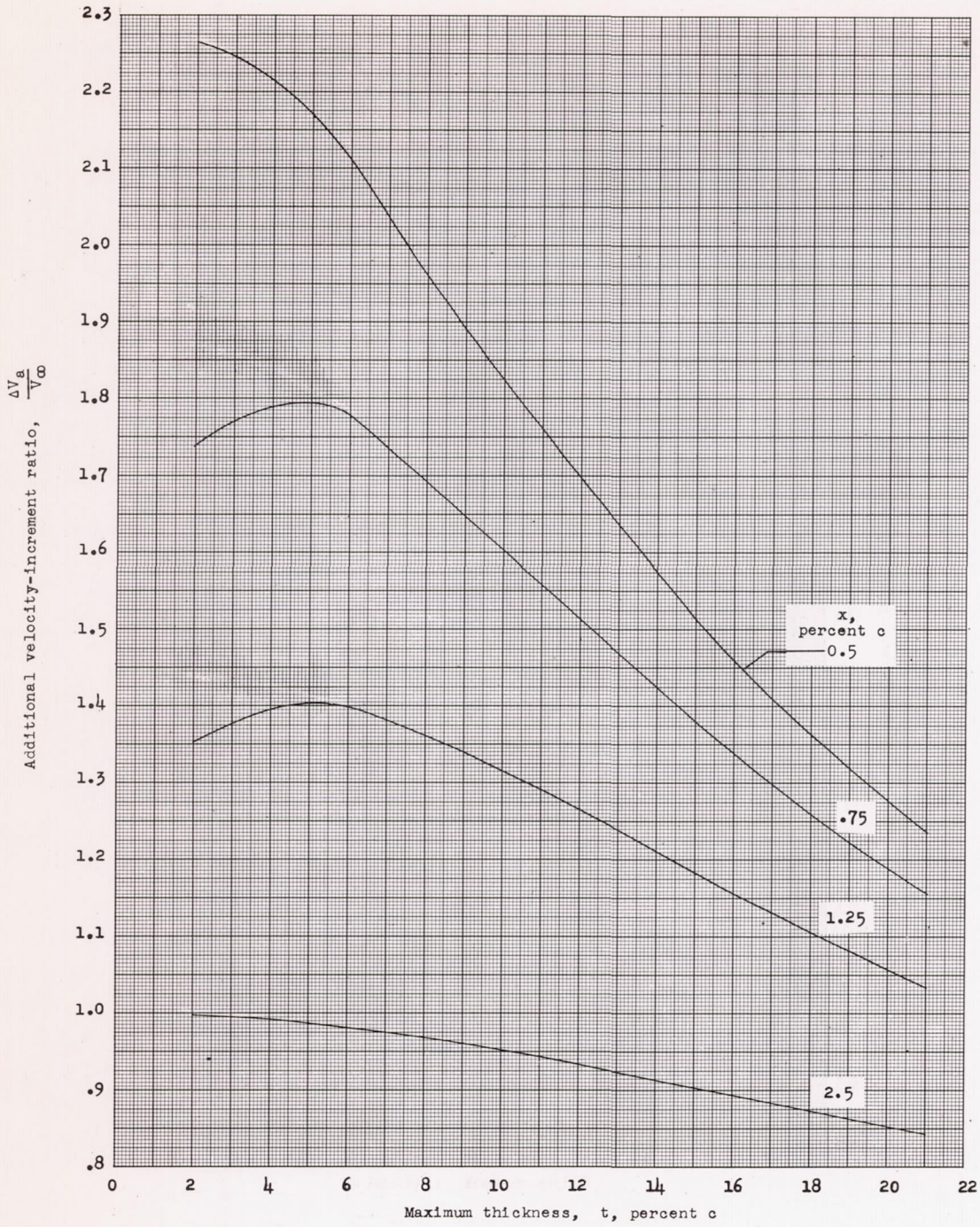
(c) x = 45 to 95 percent c.

Figure 38.- Concluded.



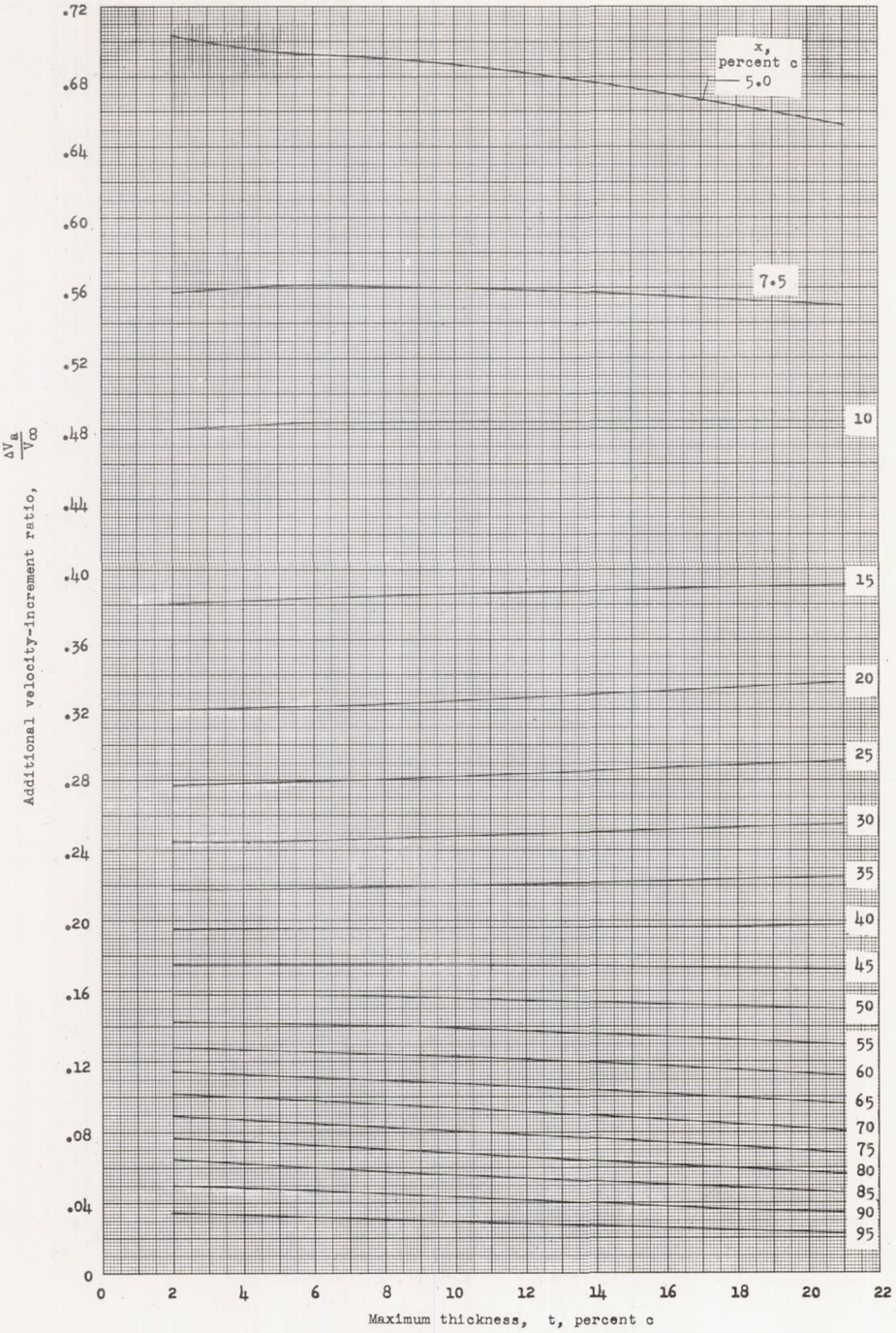
(a) x = 0 percent c.

Figure 39.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 63-series airfoil sections.



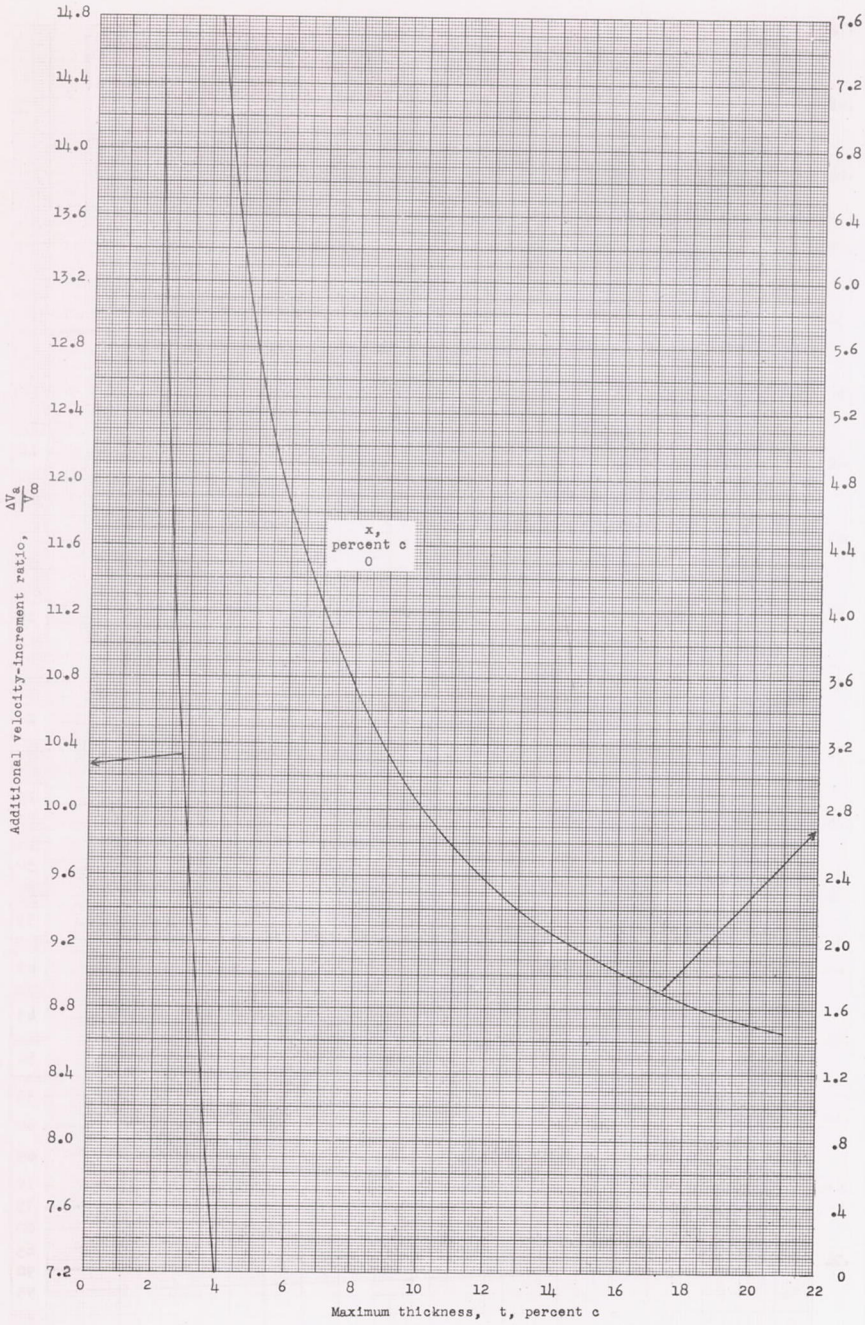
(b) x = 0.5 to 2.5 percent c.

Figure 39.- Continued.



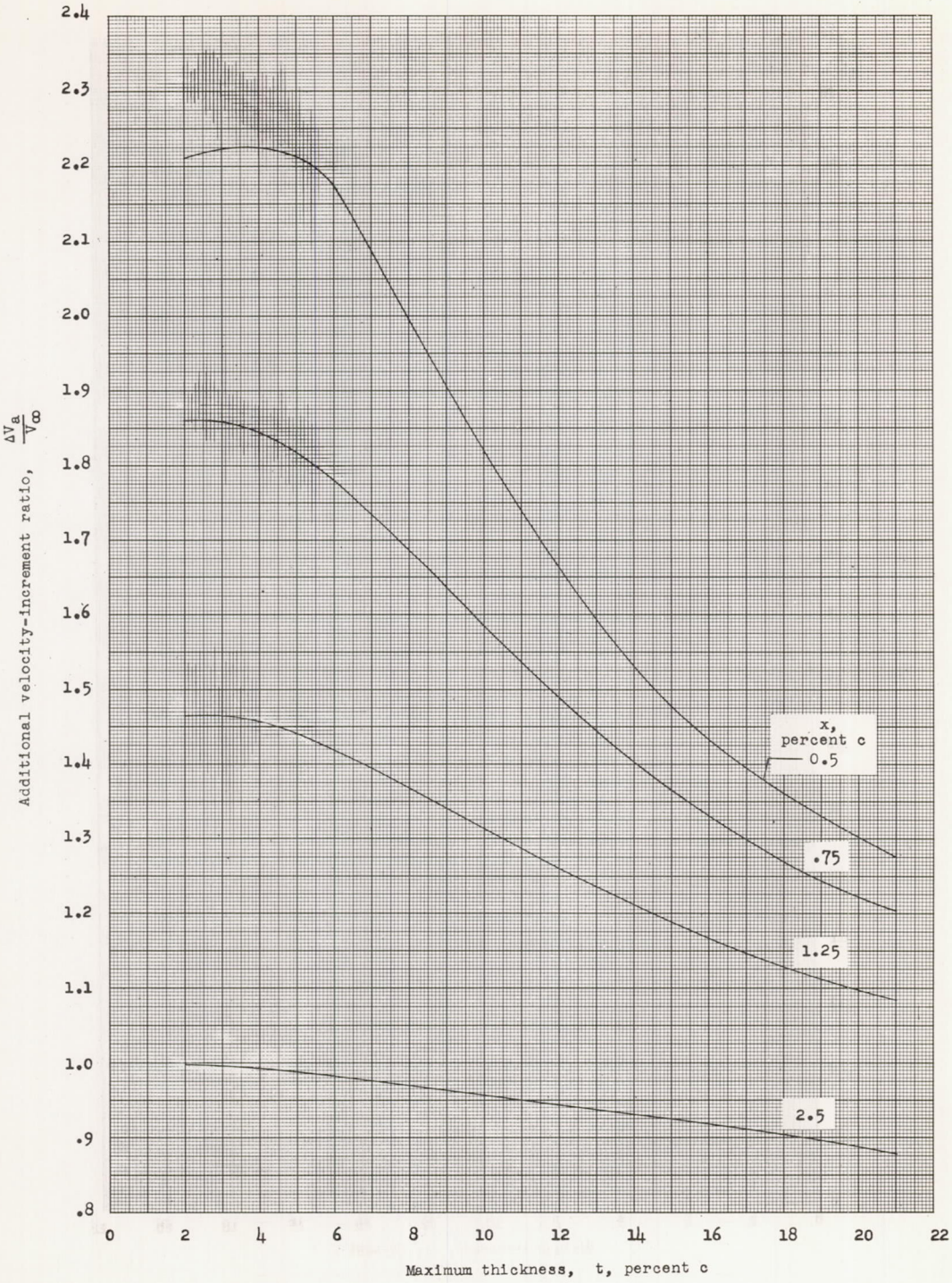
(c) x = 5.0 to 95 percent c.

Figure 39.- Concluded.



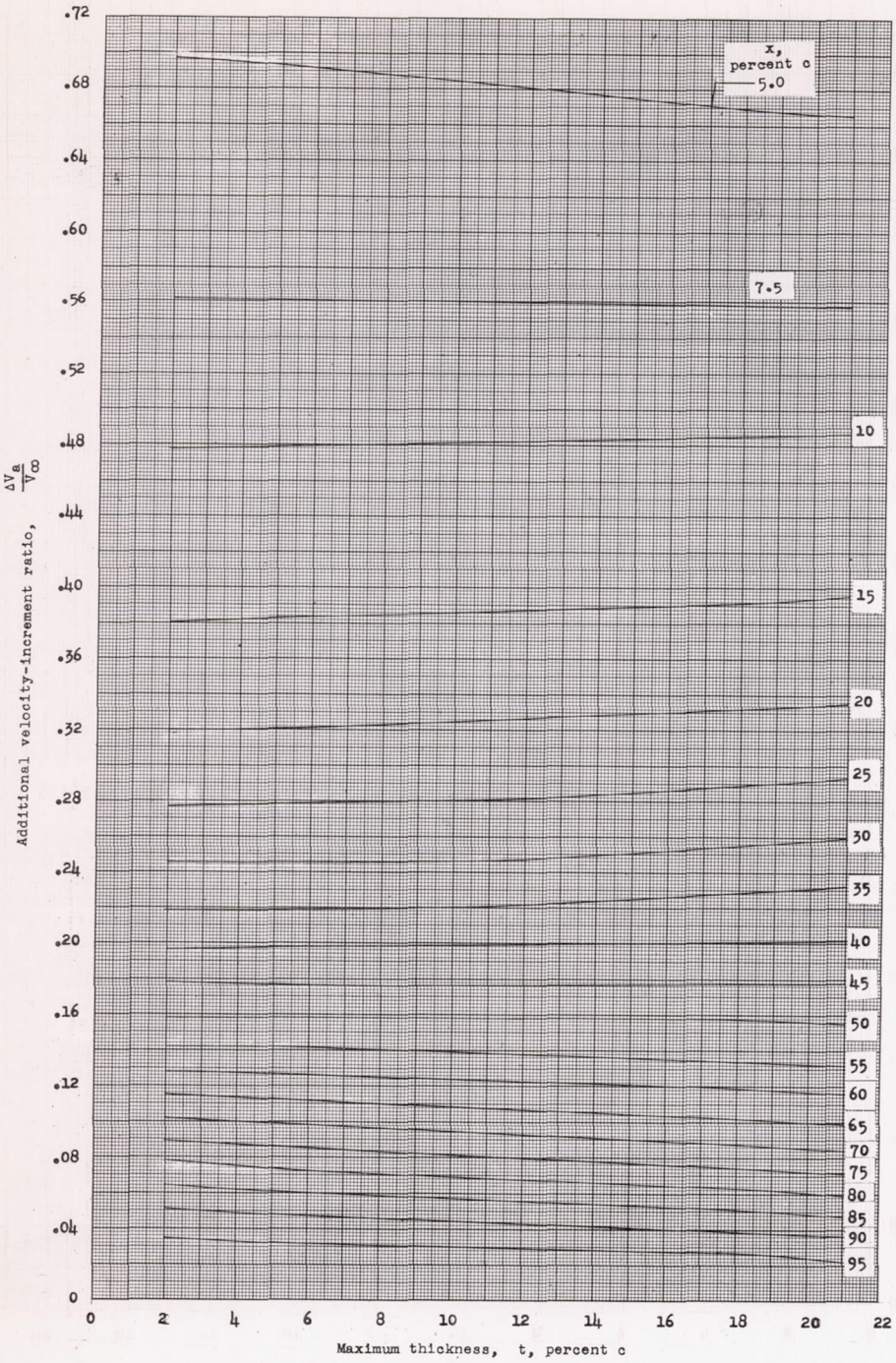
(a) x = 0 percent c.

Figure 40.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 64-series airfoil sections.



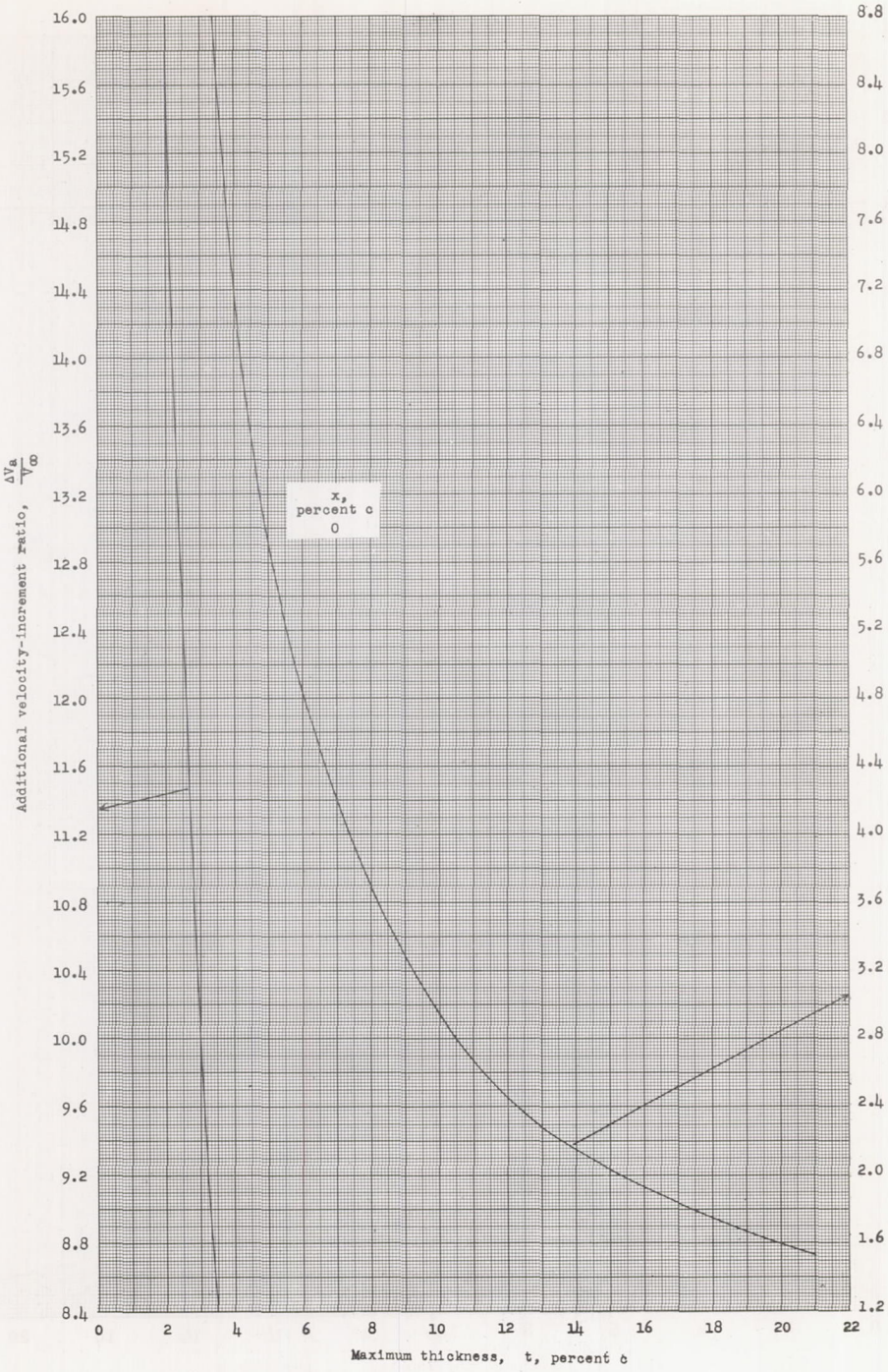
(b) x = 0.5 to 2.5 percent c.

Figure 40.- Continued.



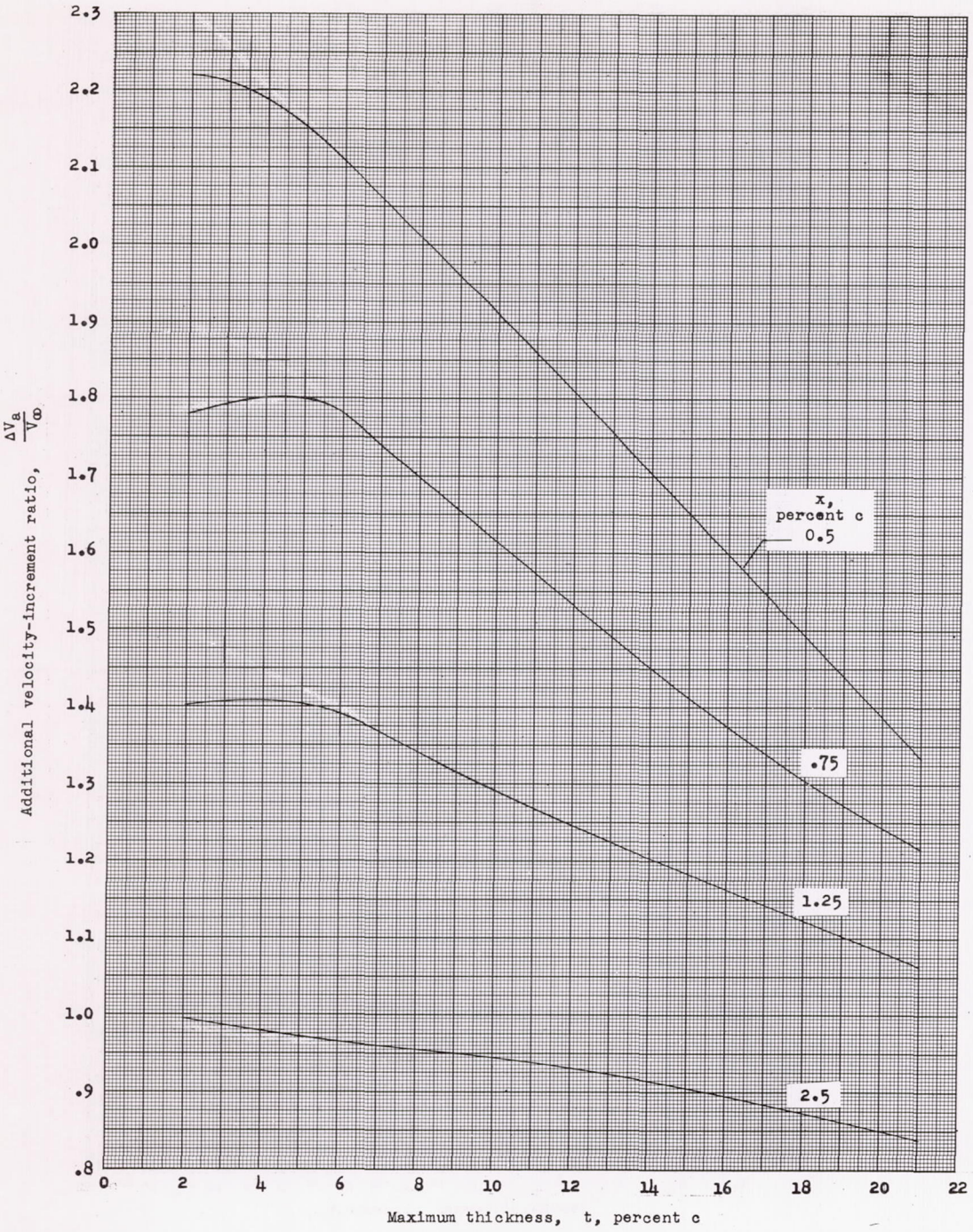
(c) x = 5.0 to 95 percent c.

Figure 40.- Concluded.



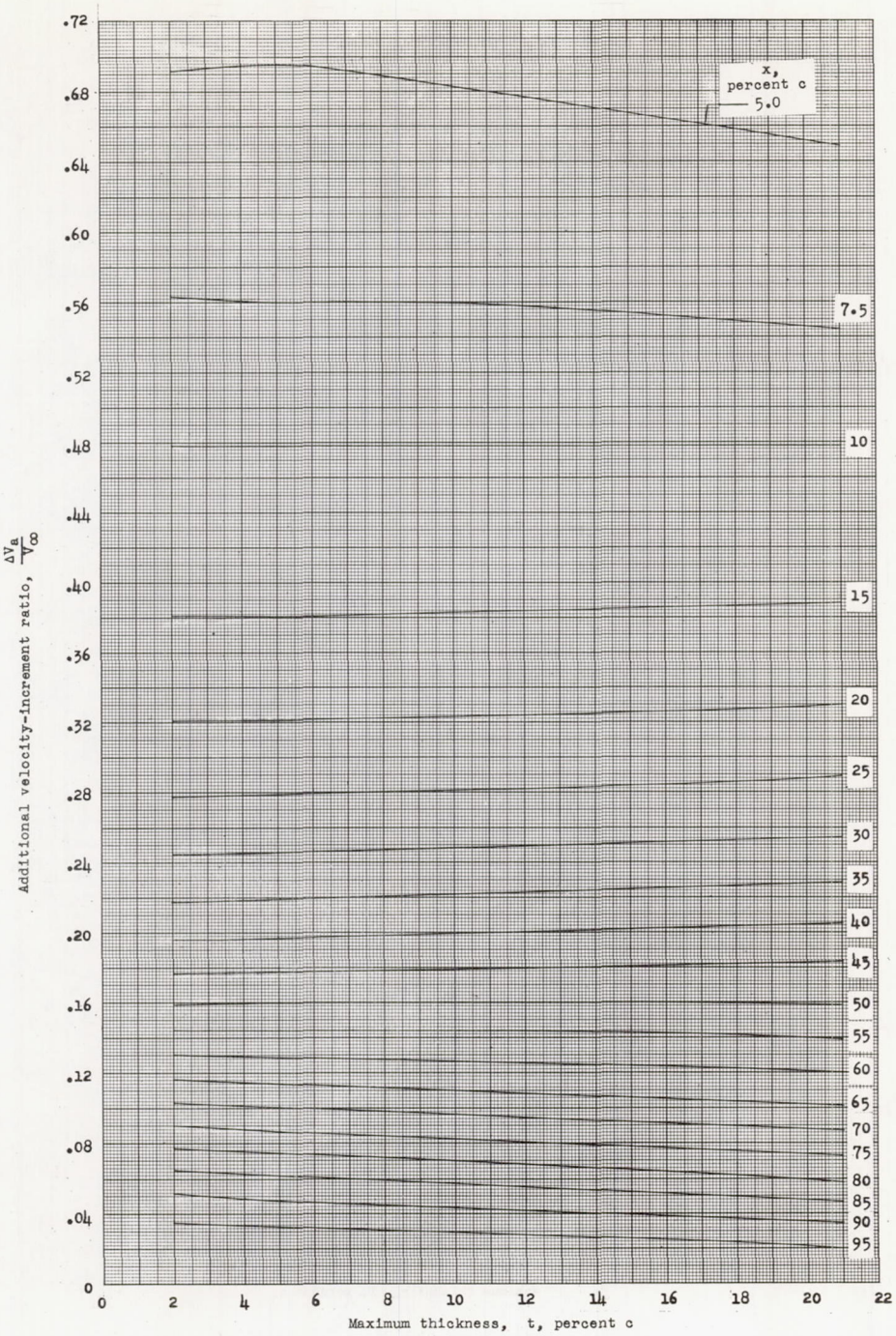
(a) x = 0 percent c.

Figure 41.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 65-series airfoil sections.



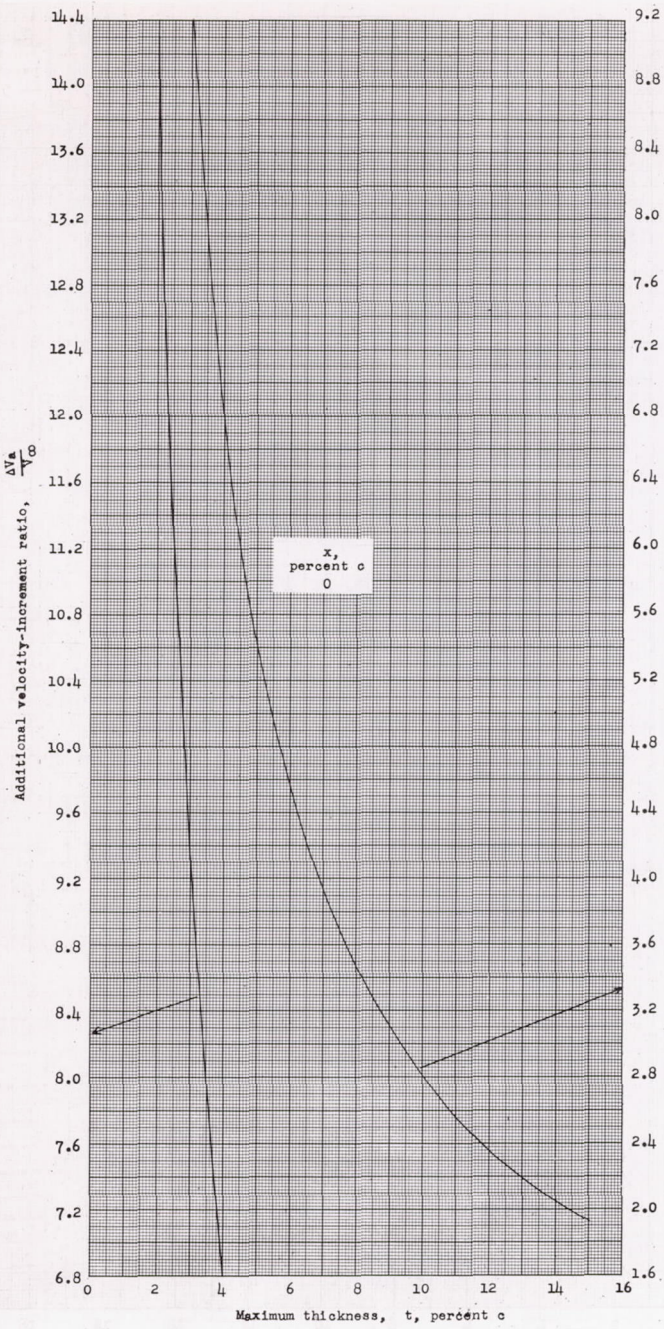
(b) x = 0.5 to 2.5 percent c.

Figure 41.- Continued.



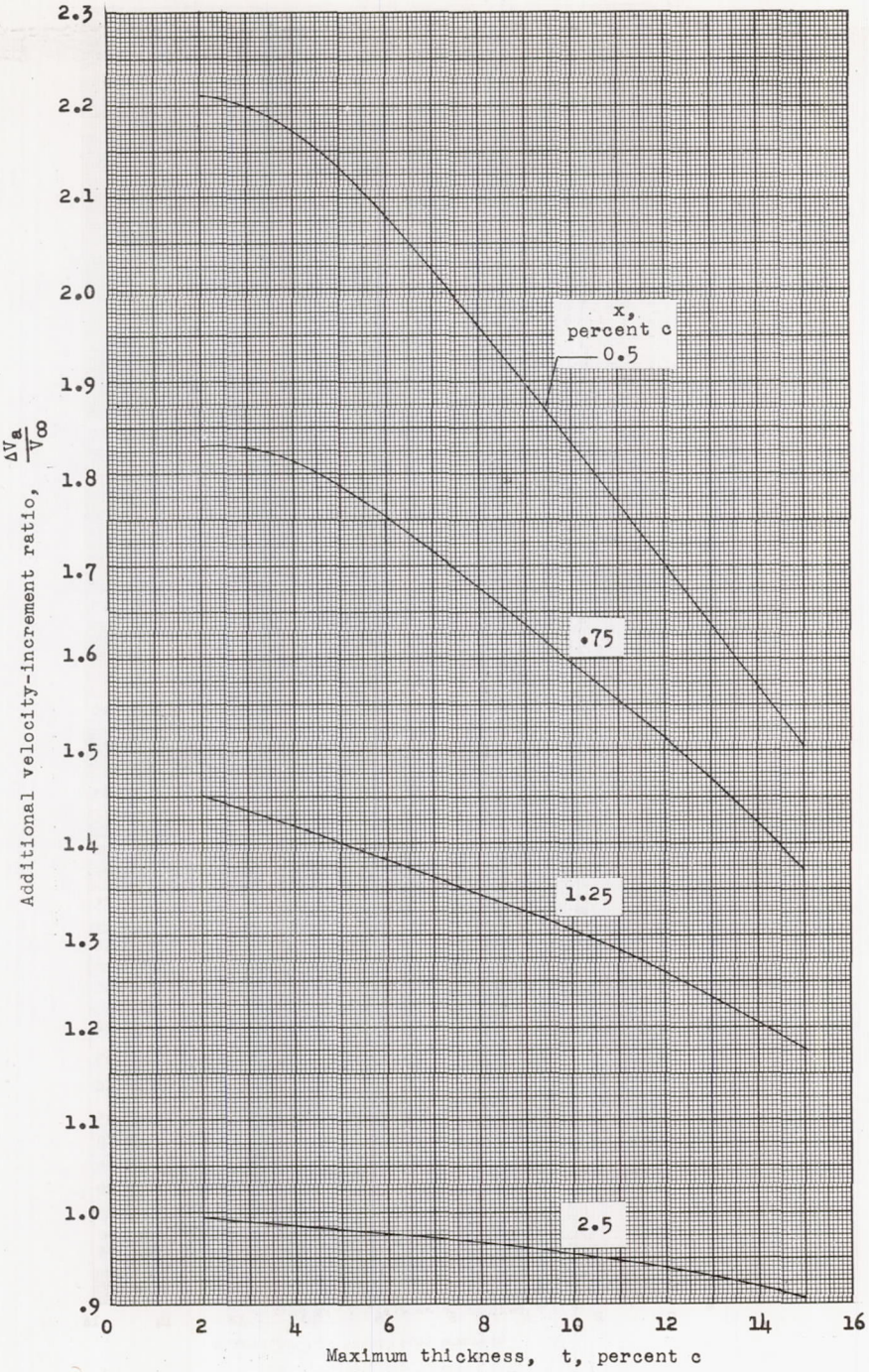
(c) x = 5.0 to 95 percent c.

Figure 41.- Concluded.



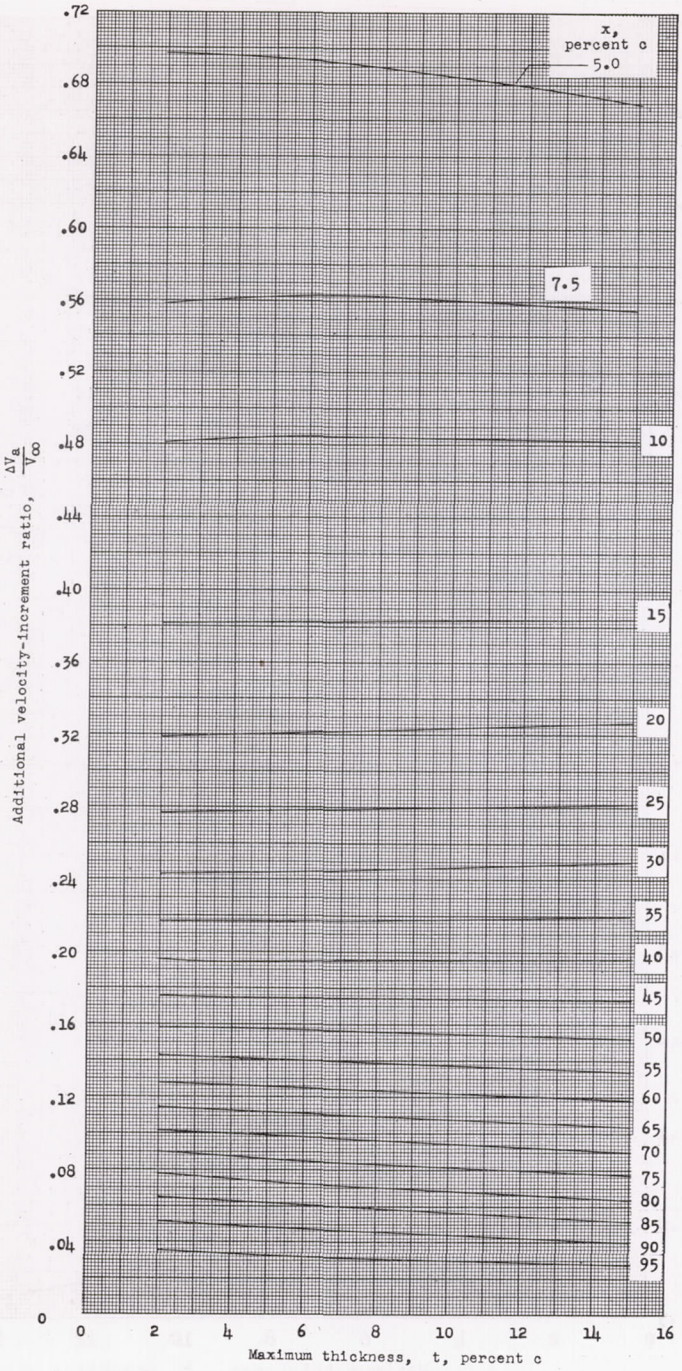
(a) x = 0 percent c.

Figure 42.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 63A-series airfoil sections.



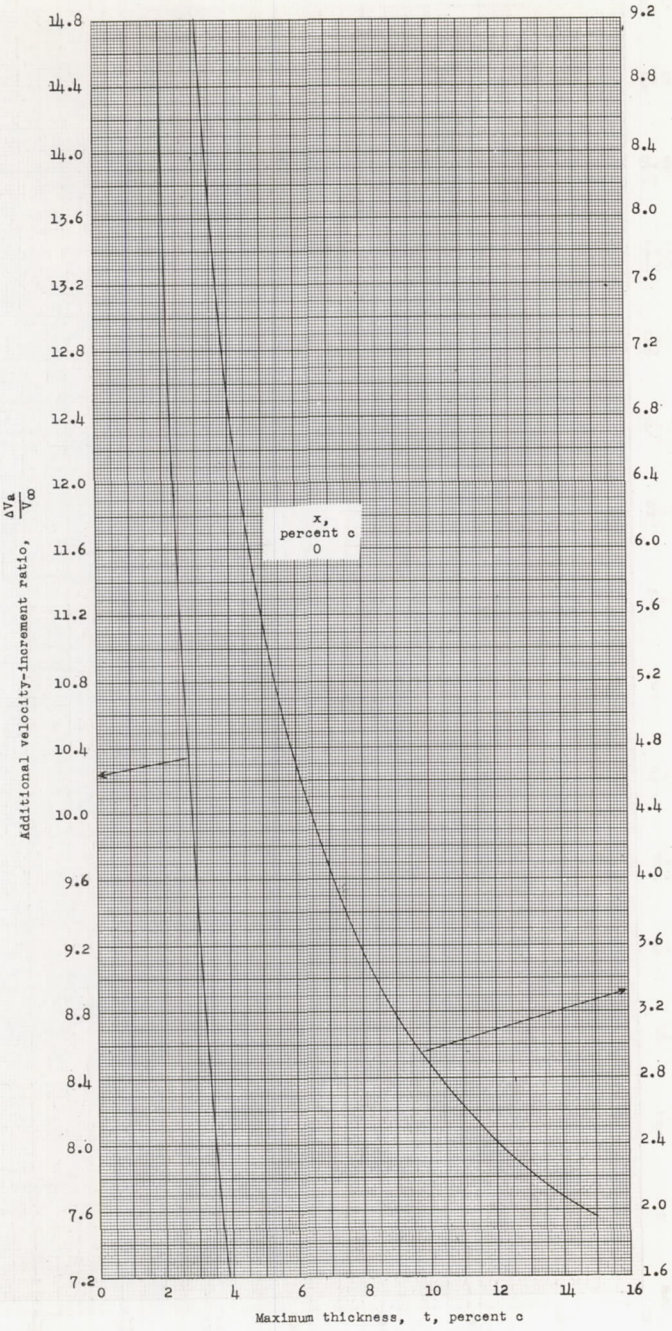
(b) x = 0.5 to 2.5 percent c.

Figure 42.- Continued.



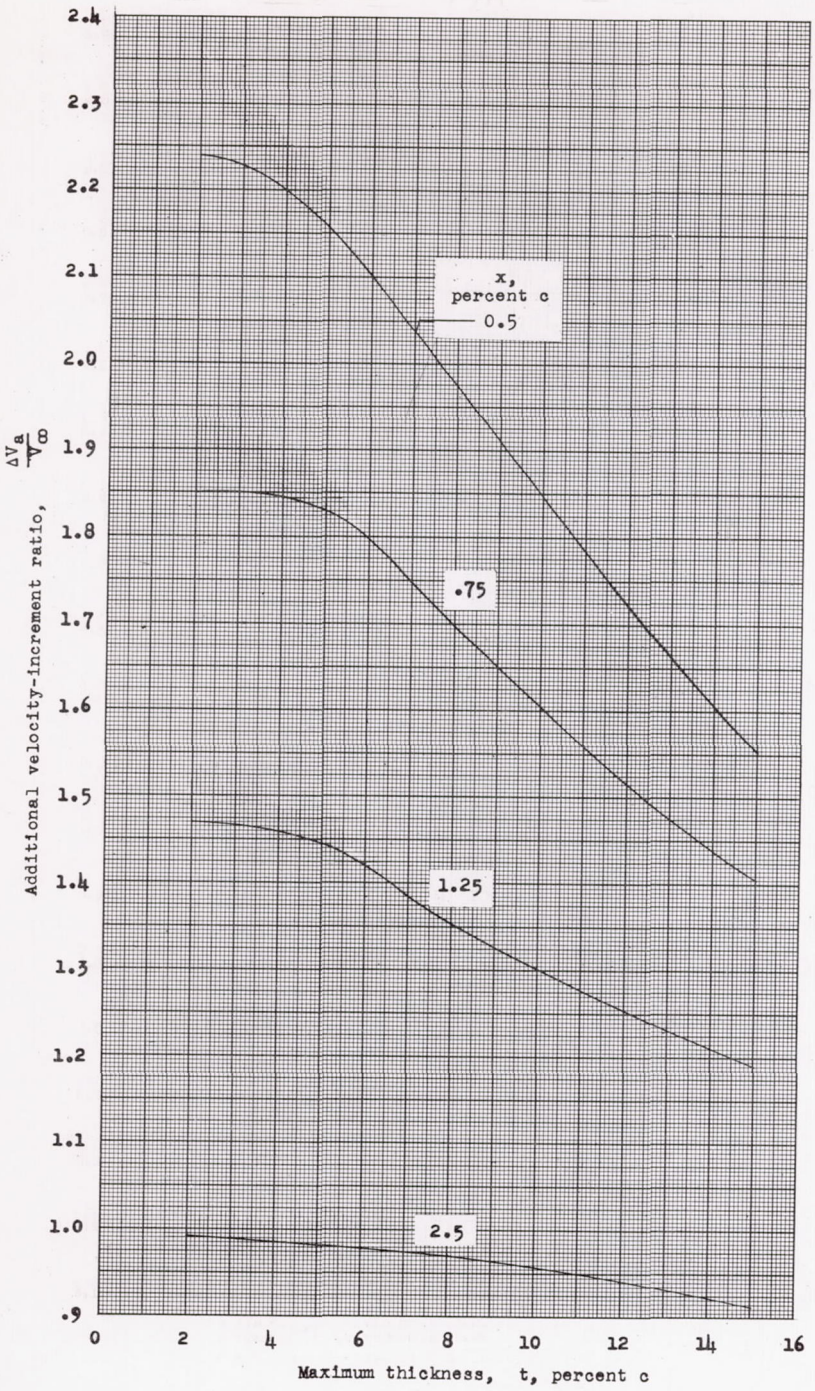
(c) x = 5.0 to 95 percent c.

Figure 42.- Concluded.



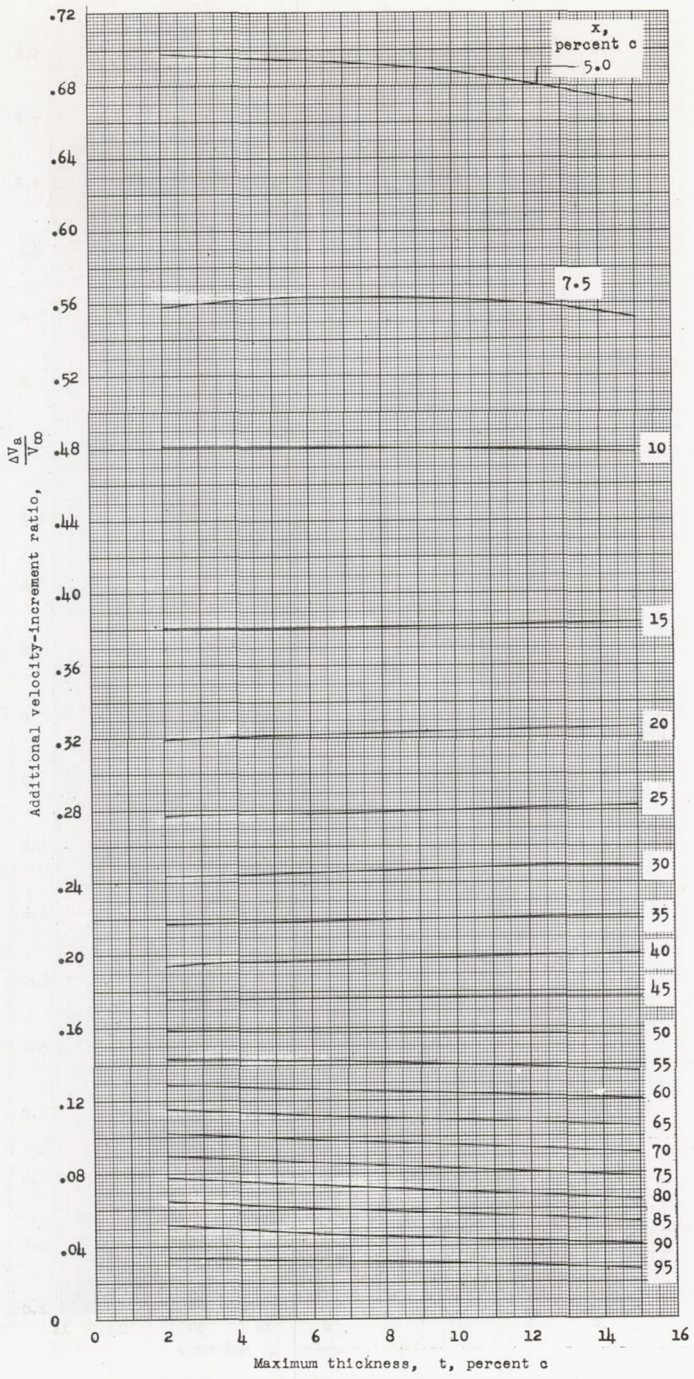
(a) x = 0 percent c.

Figure 43.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 64A-series airfoil sections.



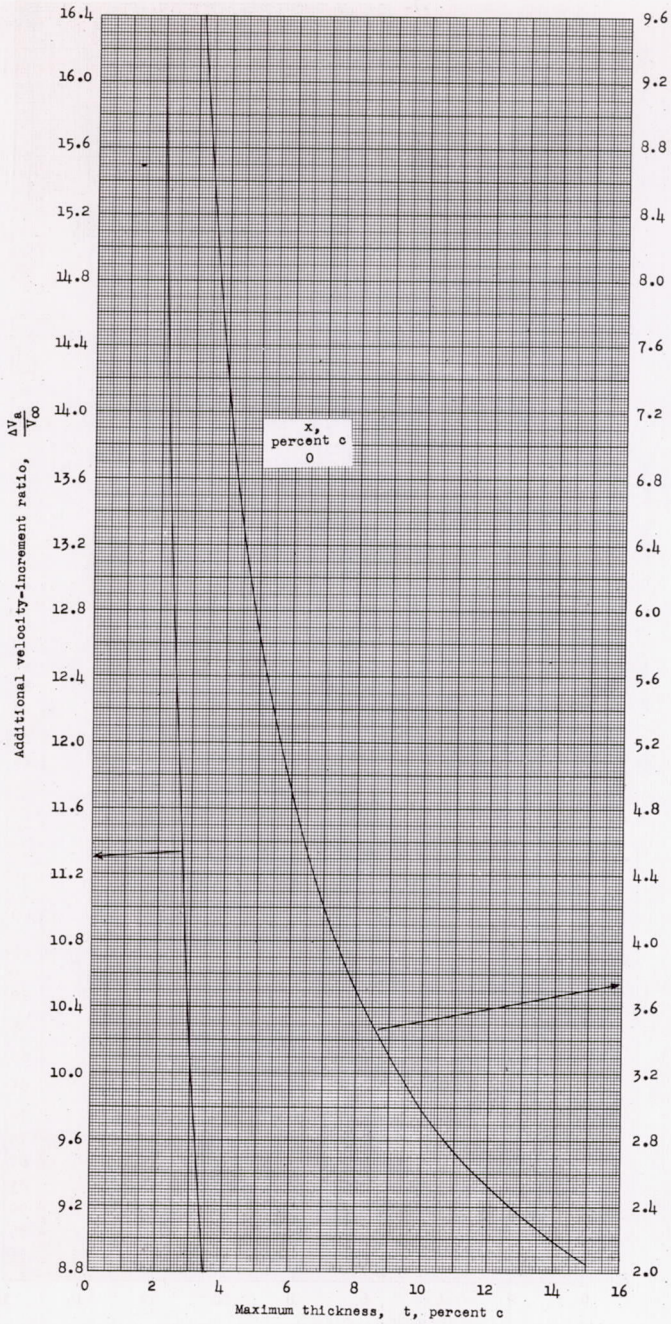
(b) x = 0.5 to 2.5 percent c.

Figure 43.- Continued.



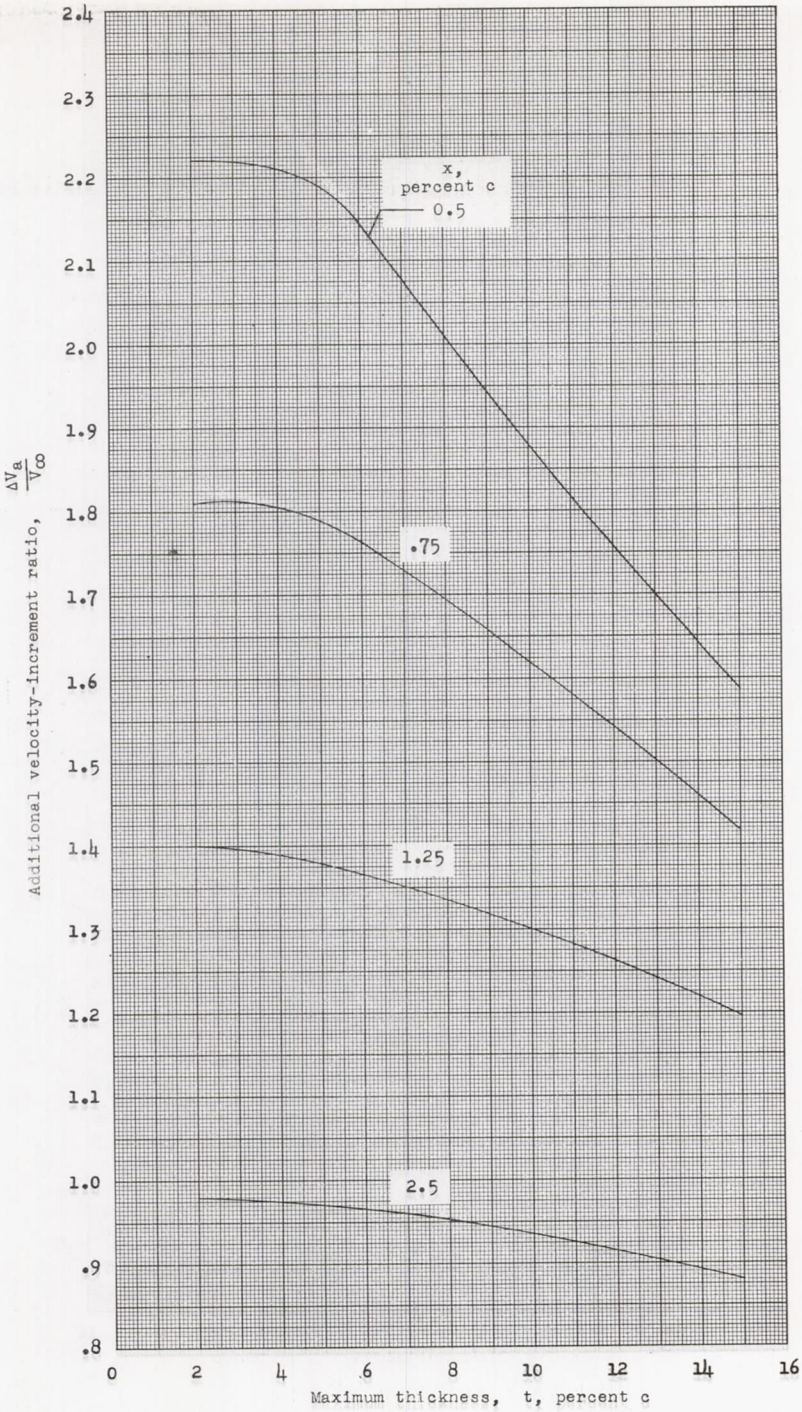
(c) x = 5.0 to 95 percent c.

Figure 43.- Concluded.



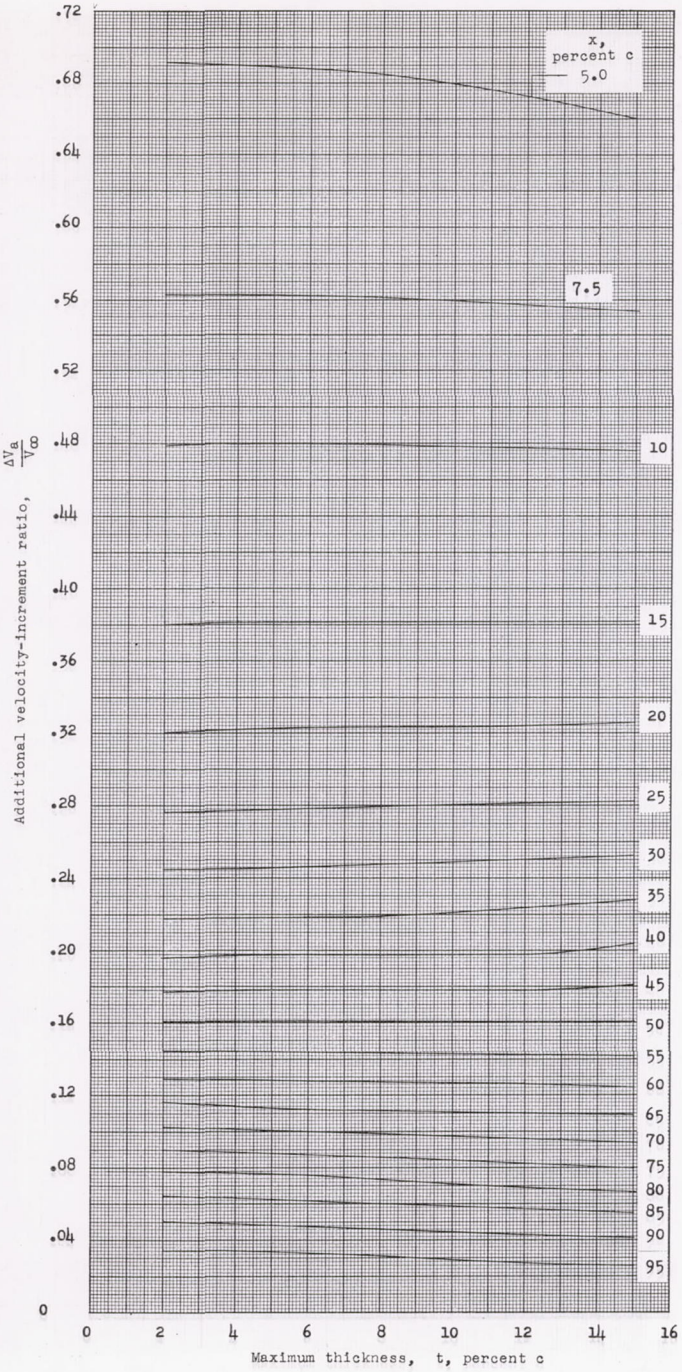
(a) x = 0 percent c.

Figure 44.- Variation of additional velocity-increment ratio with airfoil maximum thickness for the NACA 65A-series airfoil sections.



(b) x = 0.5 to 2.5 percent c.

Figure 44.- Continued.



(c) x = 5.0 to 95 percent c.

Figure 44.- Concluded.