

Subcontractor Report

The S827 and S828 Airfoils

Period of Performance: 1994 – 1995

D.M. Somers
Airfoils, Inc.
State College, Pennsylvania



NREL

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
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Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
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Contract No. DE-AC36-99-GO10337

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NREL Technical Monitor: Jim Tangler

Prepared under Subcontract No. AAF-4-14289-01



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ABSTRACT

A family of thick, natural-laminar-flow airfoils, the S827 and S828, for 40- to 50-meter, stall-regulated, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of restrained maximum lift, insensitive to roughness, and low profile drag have been achieved. The constraints on the pitching moments and the airfoil thicknesses have been satisfied. The airfoils should exhibit docile stalls.

INTRODUCTION

The majority of the airfoils in use on horizontal-axis wind turbines today were originally developed for aircraft. The design requirements for these airfoils, primarily National Advisory Committee for Aeronautics (NACA) and National Aeronautics and Space Administration (NASA) airfoils (refs. 1–6), are significantly different from those for wind-turbine airfoils (ref. 7). Accordingly, several families of airfoils have been designed specifically for horizontal-axis wind-turbine applications, as shown in the following table.

Diameter	Type	Thickness Category	Airfoil			Reference
			Primary	Tip	Root	
2–10 m	Variable speed Variable pitch	Thick		S822	S823	13
10–20 m	Variable speed Variable pitch	Thin	S801	S802 S803	S804	8
	Stall regulated	Thin	S805 S805A	S806 S806A	S807 S808	8
	Stall regulated	Thick	S819	S820	S821	12
20–30 m	Stall regulated	Thick	S809	S810	S811	9
	Stall regulated	Thick	S812	S813	S814 S815	9 and 10
20–40 m	Variable speed Variable pitch	—	S825	S826		14
30–50 m	Stall regulated	Thick	S816	S817	S818	11

An overview of almost all these airfoil families is given in reference 15.

The family of airfoils designed under the present study is intended for 40- to 50-meter, stall-regulated, horizontal-axis wind turbines. The specific tasks performed under this study are described in National Renewable Energy Laboratory (NREL) Subcontract Number AAF-4-14289-01. The specifications for the airfoils are outlined in the Statement of Work.

These specifications were later refined during discussions with James L. Tangler of NREL.

Because of the limitations of the theoretical methods (refs. 16 and 17) employed in this study, the results presented are in no way guaranteed to be accurate—either in an absolute or in a relative sense. This statement applies to the entire study.

SYMBOLS

C_p	pressure coefficient
c	airfoil chord, m
c_d	section profile-drag coefficient
c_l	section lift coefficient
c_m	section pitching-moment coefficient about quarter-chord point
$L.$	lower surface
R	Reynolds number based on free-stream conditions and airfoil chord
$S.$	boundary-layer separation location, $1 - s_{sep}/c$
s_{sep}	arc length along which boundary layer is separated, m
s_{turb}	arc length along which boundary layer is turbulent including s_{sep} , m
$T.$	boundary-layer transition location, $1 - s_{turb}/c$
$U.$	upper surface
x	airfoil abscissa, m
y	airfoil ordinate, m
α	angle of attack relative to x-axis, deg

AIRFOIL DESIGN

OBJECTIVES AND CONSTRAINTS

The design specifications for the family of airfoils are contained in table I. The family consists of two airfoils, primary and tip, corresponding to the 0.75 and 0.95 blade radial sta-

tions, respectively. (It is recommended that the S818 airfoil (ref. 11) be used for the root region of a wind-turbine blade incorporating this family.)

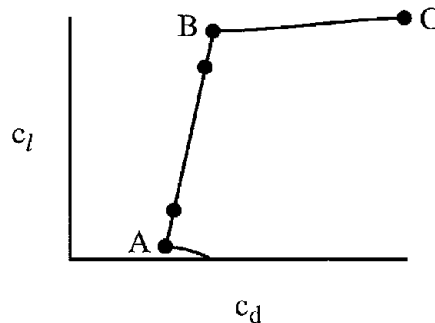
Two primary objectives are evident from the specifications. The first objective is to restrain the maximum lift coefficients of the primary and tip airfoils to the relatively low values of 1.00 and 0.90, respectively. A requirement related to this objective is that the maximum lift coefficient not decrease with transition fixed near the leading edge on both surfaces. In addition, the airfoils should exhibit docile stall characteristics. The second objective is to obtain low profile-drag coefficients over the ranges of lift coefficients from 0.20 to 0.80 for the primary airfoil and from 0.10 to 0.70 for the tip airfoil.

Two major constraints were placed on the designs of these airfoils. First, the zero-lift pitching-moment coefficient must be no more negative than -0.07 for both airfoils. Second, the airfoil thickness must equal 21-percent chord for the primary airfoil and 16-percent chord for the tip airfoil.

In essence, the specifications for these two airfoils are identical to those for the S816 and S817 airfoils (ref. 11) except that all the lift coefficients are reduced by 0.20.

PHILOSOPHY

Given the above objectives and constraints, certain characteristics of the designs are apparent. The following sketch illustrates a drag polar that meets the goals for these designs.



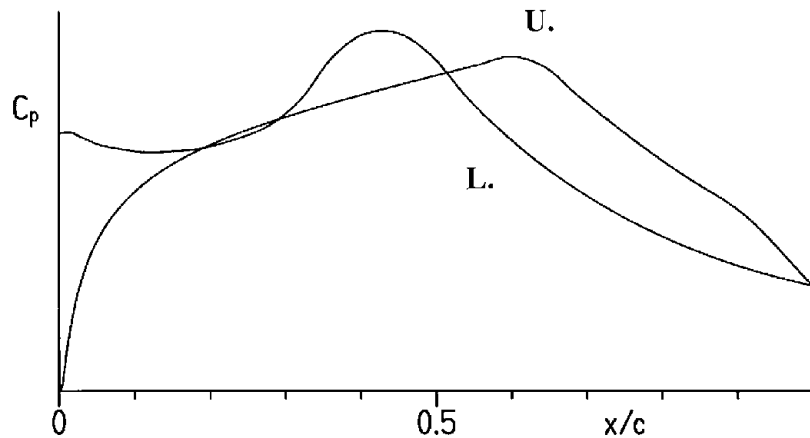
Sketch 1

The desired airfoil shapes can be traced to the pressure distributions that occur at the various points in sketch 1. Point A is the lower limit of the low-drag, lift-coefficient range. The lift coefficient at point A is 0.15 lower than the objective specified in table I. The difference is intended as a margin against such contingencies as manufacturing tolerances, operational deviations, three-dimensional effects, and inaccuracies in the theoretical method. A similar margin is also desirable at the upper limit of the low-drag range, point B, although this margin

is constrained by the proximity of the upper limit to the maximum lift coefficient. The drag at point B is not as low as at point A, unlike the polars of many other laminar-flow airfoils where the drag within the laminar bucket is nearly constant. This characteristic is related to the elimination of significant (drag-producing) laminar separation bubbles on the upper surface. (See ref. 18.) It is acceptable because the ratio of the profile drag to the total drag of the wind-turbine blade decreases with increasing lift coefficient. The drag increases very rapidly outside the low-drag range because the boundary-layer transition point moves quickly toward the leading edge with increasing (or decreasing) lift coefficient. This feature results in a leading edge that produces a suction peak at higher lift coefficients, which ensures that transition on the upper surface will occur very near the leading edge. Thus, the maximum lift coefficient, point C, occurs with turbulent flow along the entire upper surface and, therefore, should be relatively insensitive to roughness at the leading edge.

Because the large thickness of the primary airfoil allows a wider low-drag range than specified, the lower limit of the low-drag range should be below point A.

From the preceding discussion, the pressure distributions along the polar can be deduced. The pressure distribution at point A for the primary airfoil should look something like sketch 2. (The pressure distribution for the tip airfoil should be qualitatively similar.)



Sketch 2

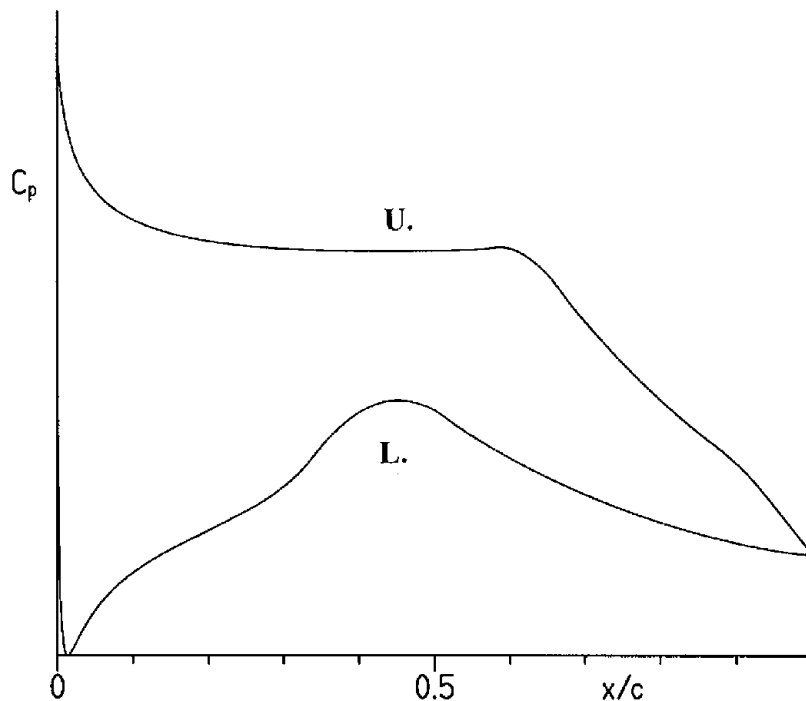
To achieve low drag, a favorable pressure gradient is desirable along the upper surface to about 60-percent chord. Aft of this point, a short region having a shallow, adverse pressure gradient ("transition ramp") promotes the efficient transition from laminar to turbulent flow (ref. 19). The transition ramp is followed by a nearly linear pressure recovery. The specific pressure recovery employed represents a compromise between maximum lift, drag, and stall characteristics. The steep, adverse pressure gradient aft of about 90-percent chord is a "separation ramp," originally proposed by F. X. Wortmann,¹ which confines turbulent separation to

a small region near the trailing edge. By constraining the movement of the separation point at high angles of attack, high lift coefficients can be achieved with little drag penalty. This feature has the added benefit of promoting docile stall characteristics. (See ref. 20.)

A generally favorable pressure gradient is desirable along the lower surface to about 45-percent chord to achieve low drag. The specific pressure gradients employed along the forward portion of the lower surface increase the amount of camber in the leading-edge region while maintaining low drag at the lower lift coefficients. The forward camber serves to balance, with respect to the pitching-moment constraint, the aft camber, both of which contribute to the achievement of the specified maximum lift coefficient and low profile-drag coefficients. This region is followed by a transition ramp and then a concave pressure recovery that produces lower drag and has less tendency to separate than the corresponding linear or convex pressure recovery (ref. 19). The pressure recovery must begin relatively far forward to alleviate separation at lower lift coefficients, especially with transition fixed near the leading edge.

The amounts of pressure recovery on the upper and lower surfaces are determined by the airfoil-thickness and pitching-moment constraints.

At point B, the pressure distribution should look like sketch 3.



Sketch 3

¹Director, Institute for Aerodynamics and Gas Dynamics, University of Stuttgart, Germany.

Transition is essentially imminent over the entire forward portion of the upper surface. This feature allows a wider low-drag range to be achieved and higher lift coefficients to be reached without significant separation. It also causes the transition point to move very quickly toward the leading edge with increasing lift coefficient, which leads to the roughness insensitivity of the maximum lift coefficient.

EXECUTION

Given the pressure distributions previously discussed, the design of the airfoils is reduced to the inverse problem of transforming the pressure distributions into airfoil shapes. The Eppler Airfoil Design and Analysis Code (refs. 16 and 17) was used because of its unique capability for multipoint design and because of confidence gained during the design, analysis, and experimental verification of several other airfoils. (See refs. 21–24.)

The primary airfoil is designated the S827. The tip airfoil, the S828, was derived from the S827 airfoil to increase the aerodynamic and geometric compatibilities of the two airfoils. The airfoil shapes are shown in figure 1 and the coordinates are contained in tables II and III. The S827 airfoil thickness is 21-percent chord and the S828, 16-percent chord.

THEORETICAL PROCEDURE

The section characteristics are predicted for Reynolds numbers of 2.0×10^6 , 2.5×10^6 , 3.0×10^6 , 3.5×10^6 , and 4.0×10^6 . The computations were performed with transition free using transition mode 3.0, with transition fixed at 2-percent chord on the upper surface and 5-percent chord on the lower surface using transition mode 1.3, and “rough” using transition mode 9.0, which simulates distributed roughness due to, for example, leading-edge contamination by insects or rain. (See ref. 17.) Because the free-stream Mach number for all relevant operating conditions remains below 0.3, all results are incompressible.

DISCUSSION OF RESULTS

S827 AIRFOIL

Pressure Distributions

The inviscid pressure distributions for the S827 airfoil at various angles of attack are shown in figure 2 and tabulated in the appendix.

Transition and Separation Locations

The variation of boundary-layer transition location with lift coefficient for the S827 airfoil is shown in figure 3 and tabulated in the appendix. It should be remembered that the

method of references 16 and 17 “defines” the transition location as the end of the laminar boundary layer whether due to natural transition or laminar separation. Thus, for conditions that result in relatively long laminar separation bubbles (low lift coefficients for the upper surface, high lift coefficients for the lower surface, and low Reynolds numbers), poor agreement between the predicted “transition” locations and the locations measured experimentally can be expected. This poor agreement is worsened by the fact that transition is normally confirmed in the wind tunnel only by the detection of attached turbulent flow. For conditions that result in shorter laminar separation bubbles (high lift coefficients for the upper surface, low lift coefficients for the lower surface, and high Reynolds numbers), the agreement between theory and experiment should be quite good. (See refs. 21 and 25.)

The variation of turbulent boundary-layer separation location with lift coefficient for the S827 airfoil is shown in figure 3 and tabulated in the appendix. Trailing-edge separation is predicted on the upper surface at all lift coefficients. This separation, which is caused by the separation ramp (fig. 2), increases in length with transition fixed and rough. Separation is predicted on the lower surface at lower lift coefficients. Such separation usually has little effect on the section characteristics. (See ref. 21.)

Section Characteristics

Reynolds number effects.— The section characteristics of the S827 airfoil are shown in figure 3 and tabulated in the appendix. It should be noted that the maximum lift coefficient computed by the method of references 16 and 17 is not always realistic. Accordingly, an empirical criterion should be applied to the computed results. This criterion assumes that the maximum lift coefficient has been reached if the drag coefficient of the upper surface is greater than 0.0150 or if the length of turbulent separation on the upper surface is greater than 0.10. Thus, the maximum lift coefficient for the design Reynolds number of 4.0×10^6 is estimated to be 1.00, which meets the design objective. Based on the variation of the upper-surface separation location with lift coefficient, the stall characteristics are expected to be docile, which meets the design goal. Low profile-drag coefficients are predicted over the range of lift coefficients from below 0 to more than 0.9, which exceeds the range specified (0.20 to 0.80). The drag coefficient at the specified lower limit of the low-drag range ($c_l = 0.20$) is predicted to be 0.0051, which is 36 percent below the design objective. The zero-lift pitching-moment coefficient is predicted to be -0.084 , which exceeds the design constraint. However, the method of references 16 and 17 generally overpredicts the pitching-moment coefficient by about 20 percent. Therefore, the actual zero-lift pitching-moment coefficient should be about -0.07 , which satisfies the constraint.

An additional analysis (not shown) indicates that significant (drag-producing) laminar separation bubbles should not occur on either surface for any relevant operating condition.

Effect of roughness.— The effect of roughness on the section characteristics of the S827 airfoil is shown in figure 3. The maximum lift coefficient for the design Reynolds number of 4.0×10^6 is unaffected by fixing transition because transition on the upper surface is predicted to occur forward of 2-percent chord at the maximum lift coefficient. For the rough

condition, the maximum lift coefficient for the design Reynolds number is estimated to be 0.99, a reduction of 1 percent from that for the transition-free condition. Thus, the design requirement has been satisfied. The effect of roughness on the maximum lift coefficient increases with decreasing Reynolds number. The drag coefficients are, of course, adversely affected by the roughness.

S828 AIRFOIL

Pressure Distributions

The inviscid pressure distributions for the S828 airfoil at various angles of attack are shown in figure 4 and tabulated in the appendix.

Transition and Separation Locations

The variations of transition and turbulent-separation locations with lift coefficient for the S828 airfoil are shown in figure 5 and tabulated in the appendix. Trailing-edge separation is predicted on the upper surface at almost all lift coefficients. This separation, which is caused by the separation ramp (fig. 4), increases in length with transition fixed and rough. A small separation is predicted on the lower surface at lower lift coefficients. Such separation usually has little effect on the section characteristics.

Section Characteristics

Reynolds number effects.— The section characteristics of the S828 airfoil are shown in figure 5 and tabulated in the appendix. Using the previously described criterion, the maximum lift coefficient for the design Reynolds number of 3.0×10^6 is estimated to be 0.90, which meets the design objective. The stall characteristics are expected to be docile, which meets the design goal. Low profile-drag coefficients are predicted over the range of lift coefficients from below 0 to more than 0.8, which exceeds the range specified (0.10 to 0.70). The drag coefficient at the specified lower limit of the low-drag range ($c_l = 0.10$) is predicted to be 0.0040, which is 43 percent below the design objective. The zero-lift pitching-moment coefficient is predicted to be -0.043 , which satisfies the design constraint. Significant (drag-producing) laminar separation bubbles should not occur on either surface for any relevant operating condition.

Effect of roughness.— The effect of roughness on the section characteristics of the S828 airfoil is shown in figure 5. The maximum lift coefficient for the design Reynolds number of 3.0×10^6 is unaffected by fixing transition because transition on the upper surface is predicted to occur forward of 2-percent chord at the maximum lift coefficient. For the rough condition, the maximum lift coefficient for the design Reynolds number is estimated to be 0.89, a reduction of 1 percent from that for the transition-free condition. Thus, the design requirement has been satisfied. The effect of roughness on the maximum lift coefficient

increases with decreasing Reynolds number. The drag coefficients are, of course, adversely affected by the roughness.

CONCLUDING REMARKS

A family of thick, natural-laminar-flow airfoils, the S827 and S828, for 40- to 50-meter, stall-regulated, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of restrained maximum lift coefficient, insensitive to leading-edge roughness, and low profile-drag coefficients have been achieved. The constraints on the zero-lift pitching-moment coefficients and the airfoil thicknesses have been satisfied. The airfoils should exhibit docile stall characteristics.

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TABLE I.– AIRFOIL DESIGN SPECIFICATIONS

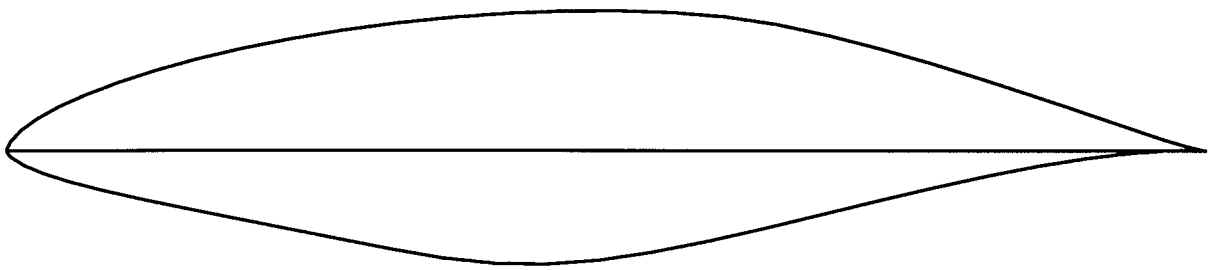
<u>Parameter</u>	<u>Objective/Constraint</u>	
Airfoil	Primary	Tip
Blade radial station	0.75	0.95
Reynolds number	4.0×10^6	3.0×10^6
Maximum lift coefficient	1.00	0.90
Low-drag, lift-coefficient range		
Lower limit	0.20	0.10
Upper limit	0.80	0.70
Minimum profile-drag coefficient	≤ 0.0080	≤ 0.0070
Zero-lift pitching-moment coefficient	≥ -0.07	≥ -0.07
Thickness	0.21c	0.16c

TABLE II.- S827 AIRFOIL COORDINATES

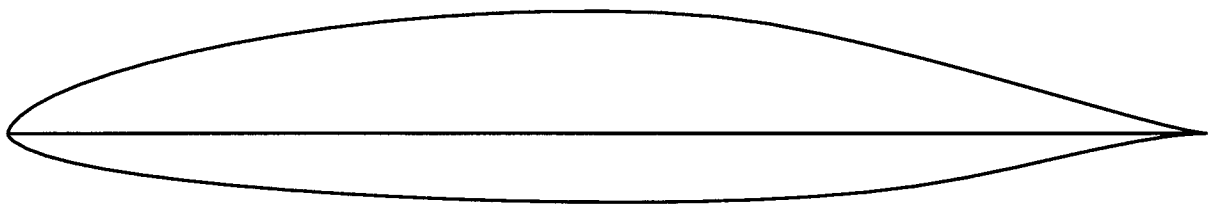
Upper Surface		Lower Surface	
x/c	y/c	x/c	y/c
0.00003	0.00054	0.00010	-0.00098
.00040	.00228	.00075	-.00240
.00327	.00789	.00194	-.00390
.01168	.01688	.00388	-.00572
.02501	.02661	.01440	-.01227
.04304	.03671	.03068	-.01907
.06557	.04692	.05249	-.02597
.09234	.05703	.07952	-.03303
.12305	.06686	.11138	-.04031
.15735	.07623	.14752	-.04794
.19486	.08497	.18727	-.05596
.23516	.09293	.22978	-.06438
.27779	.09996	.27409	-.07310
.32229	.10593	.31892	-.08183
.36815	.11068	.36288	-.08933
.41487	.11409	.40597	-.09376
.46193	.11603	.44906	-.09443
.50881	.11636	.49274	-.09126
.55498	.11490	.53770	-.08456
.59988	.11131	.58417	-.07538
.64347	.10497	.63172	-.06463
.68639	.09591	.67984	-.05305
.72880	.08503	.72787	-.04136
.77025	.07315	.77506	-.03025
.81021	.06086	.82049	-.02035
.84805	.04872	.86316	-.01216
.88305	.03718	.90192	-.00603
.91460	.02643	.93560	-.00204
.94236	.01682	.96306	-.00001
.96586	.00900	.98337	.00052
.98413	.00360	.99581	.00025
.99591	.00078	1.00000	.00000
1.00000	.00000		

TABLE III.— S828 AIRFOIL COORDINATES

Upper Surface		Lower Surface	
x/c	y/c	x/c	y/c
0.00003	0.00053	0.00009	−0.00090
.00038	.00215	.00069	−.00224
.00226	.00609	.00179	−.00364
.00956	.01419	.00481	−.00633
.02173	.02295	.01546	−.01240
.03860	.03202	.03146	−.01840
.05999	.04116	.05264	−.02409
.08569	.05019	.07880	−.02943
.11542	.05894	.10964	−.03438
.14886	.06724	.14480	−.03894
.18564	.07497	.18387	−.04309
.22536	.08199	.22636	−.04679
.26758	.08817	.27176	−.05002
.31183	.09340	.31952	−.05274
.35762	.09756	.36907	−.05490
.40444	.10053	.41982	−.05645
.45176	.10219	.47117	−.05732
.49904	.10241	.52253	−.05746
.54576	.10103	.57329	−.05681
.59134	.09770	.62288	−.05527
.63573	.09180	.67072	−.05275
.67954	.08339	.71627	−.04898
.72289	.07334	.75939	−.04362
.76532	.06246	.80026	−.03672
.80626	.05131	.83903	−.02873
.84507	.04046	.87561	−.02049
.88101	.03029	.90947	−.01301
.91342	.02103	.93959	−.00705
.94187	.01297	.96481	−.00298
.96579	.00665	.98395	−.00080
.98420	.00250	.99592	−.00008
.99595	.00050	1.00000	.00000
1.00000	.00000		

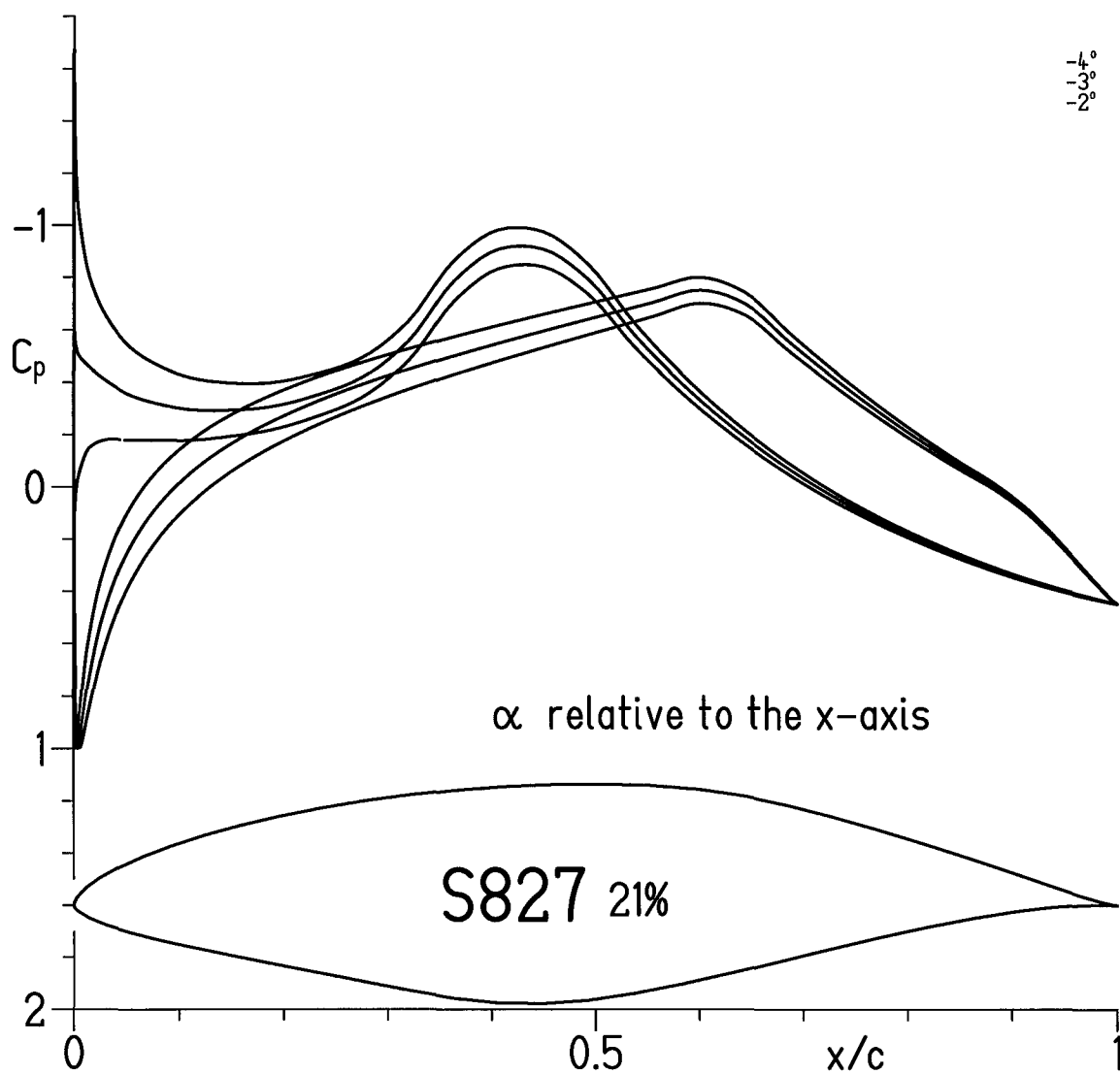


(a) S827.



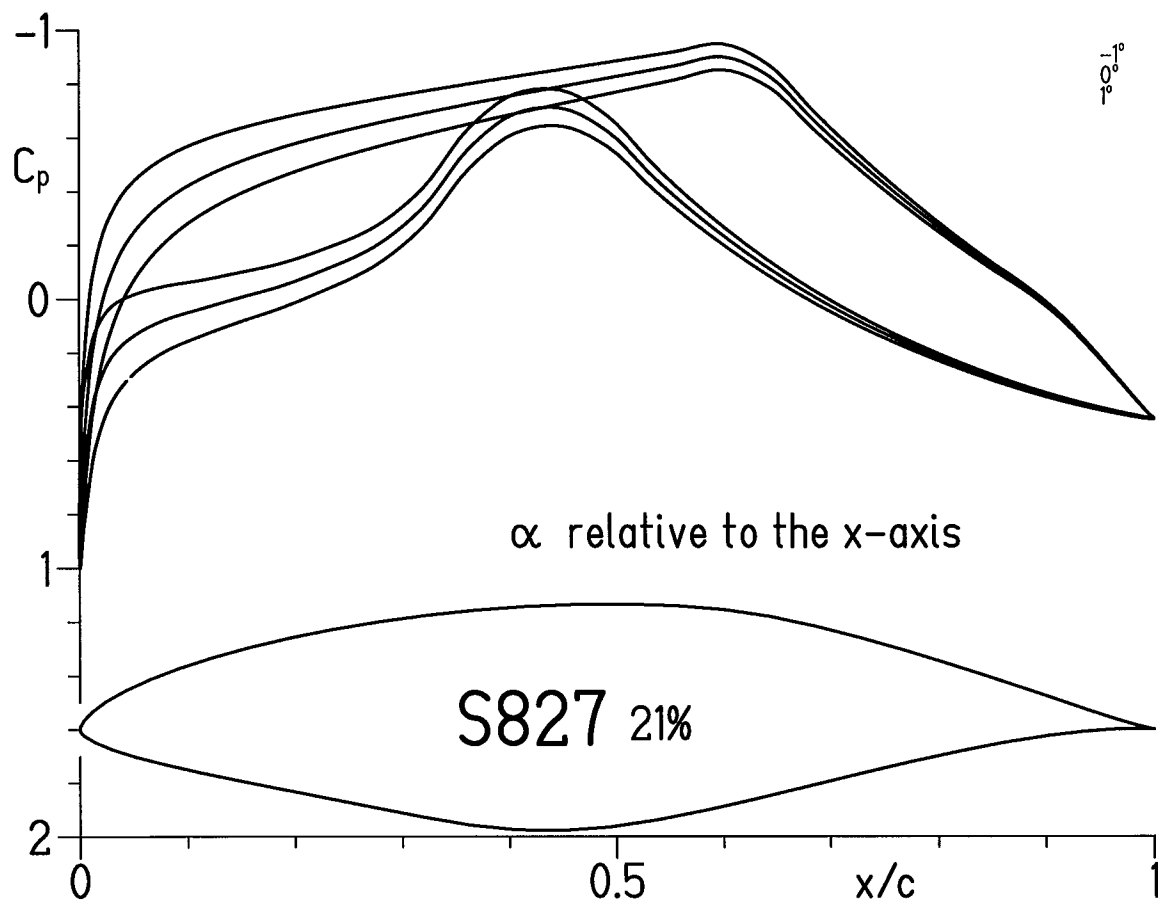
(b) S828.

Figure 1.— Airfoil shapes.



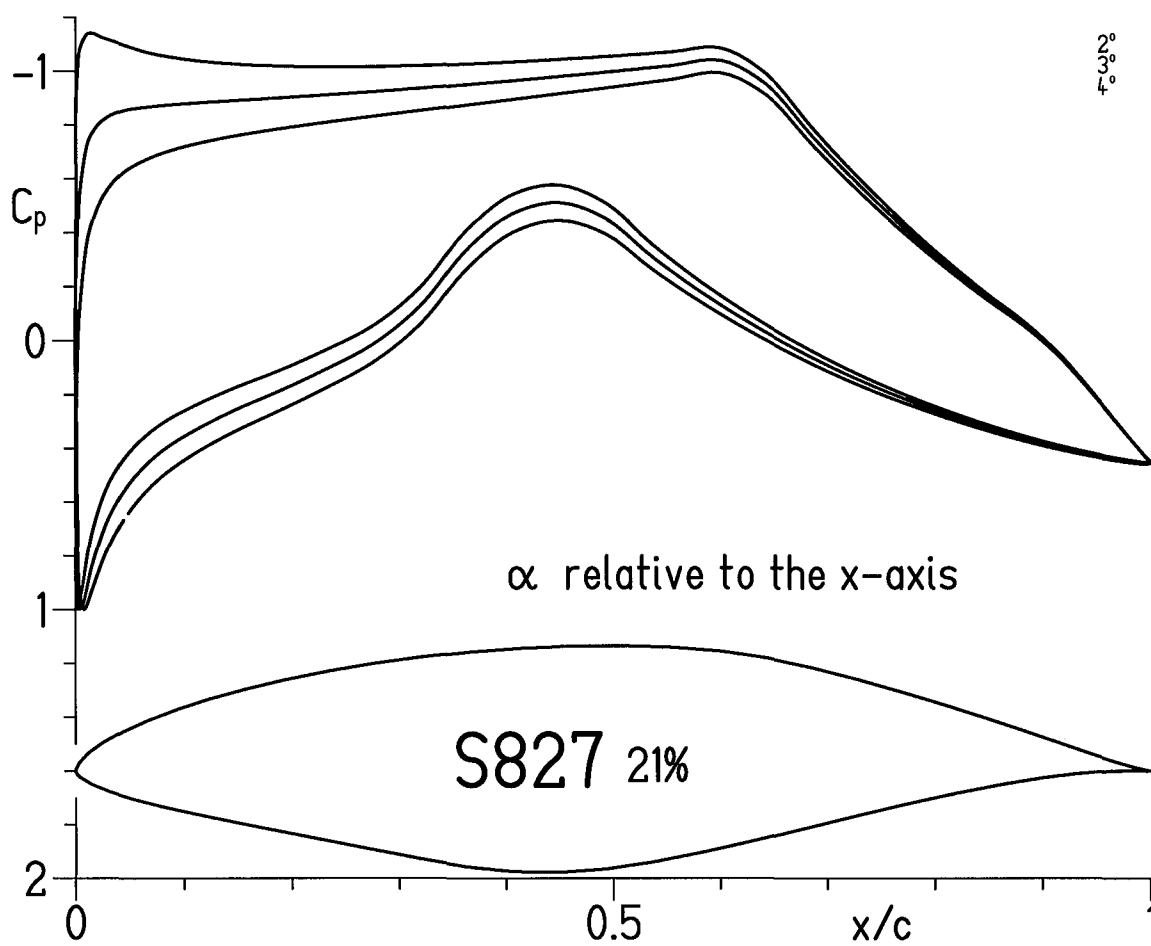
(a) $\alpha = -4^\circ, -3^\circ$, and -2° .

Figure 2.— Inviscid pressure distributions for S827 airfoil.



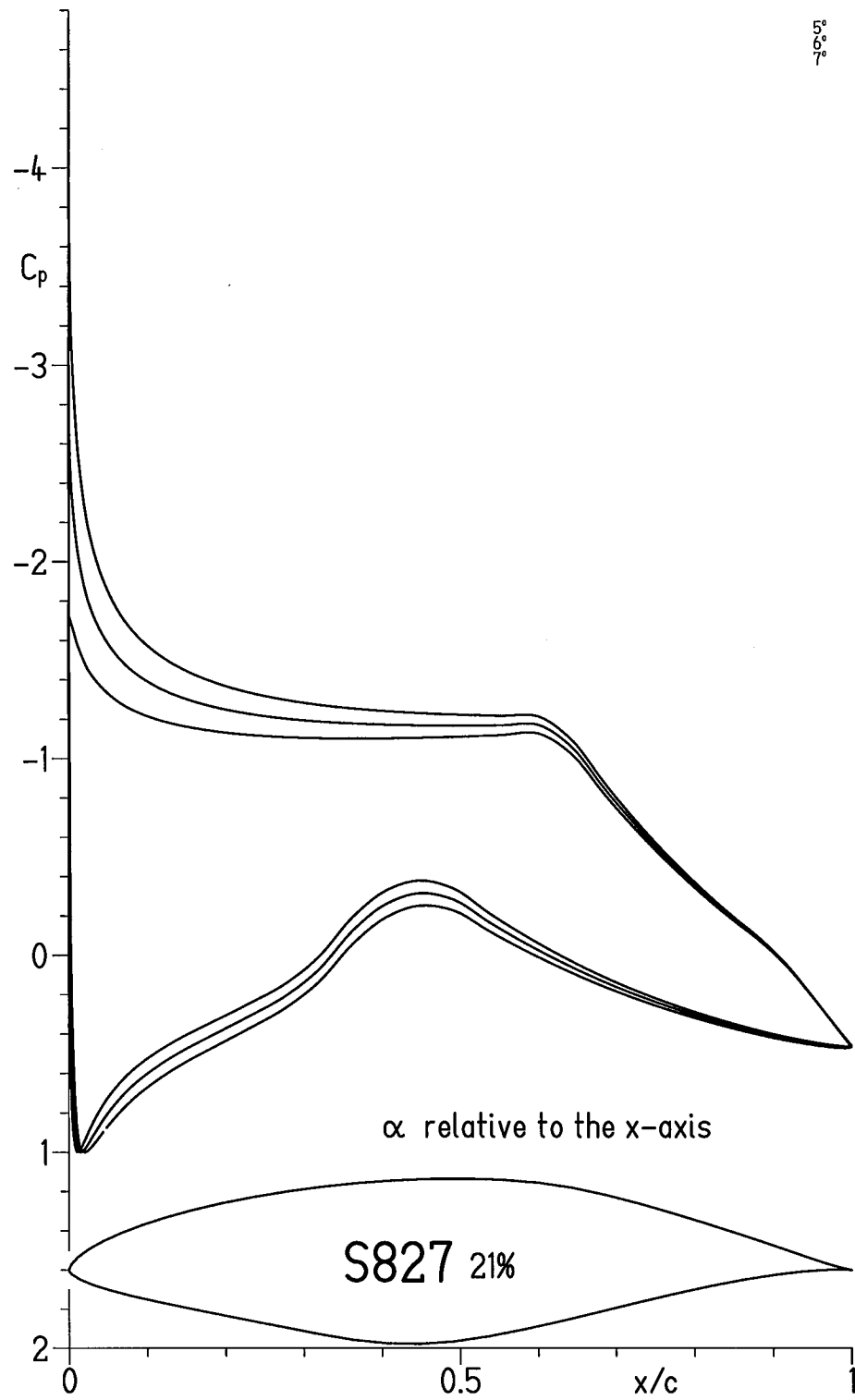
(b) $\alpha = -1^\circ, 0^\circ$, and 1° .

Figure 2.— Continued.



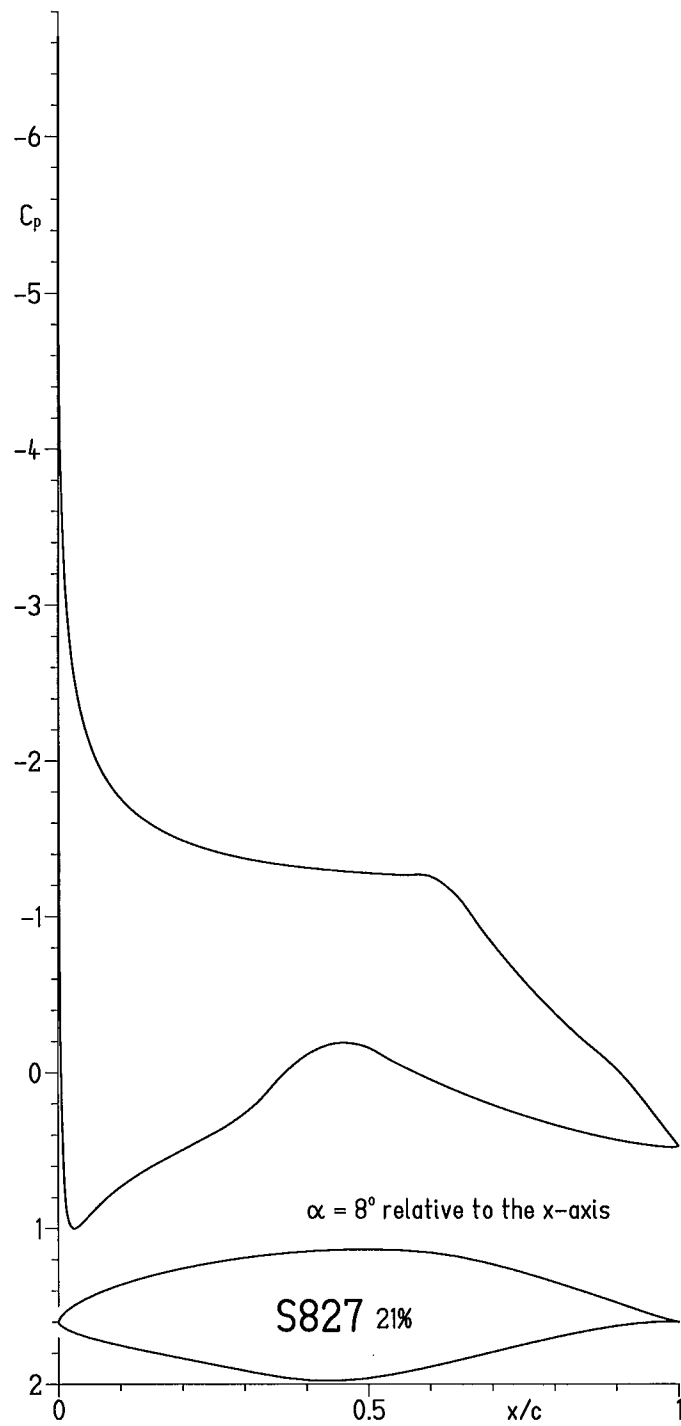
(c) $\alpha = 2^\circ$, 3° , and 4° .

Figure 2.— Continued.



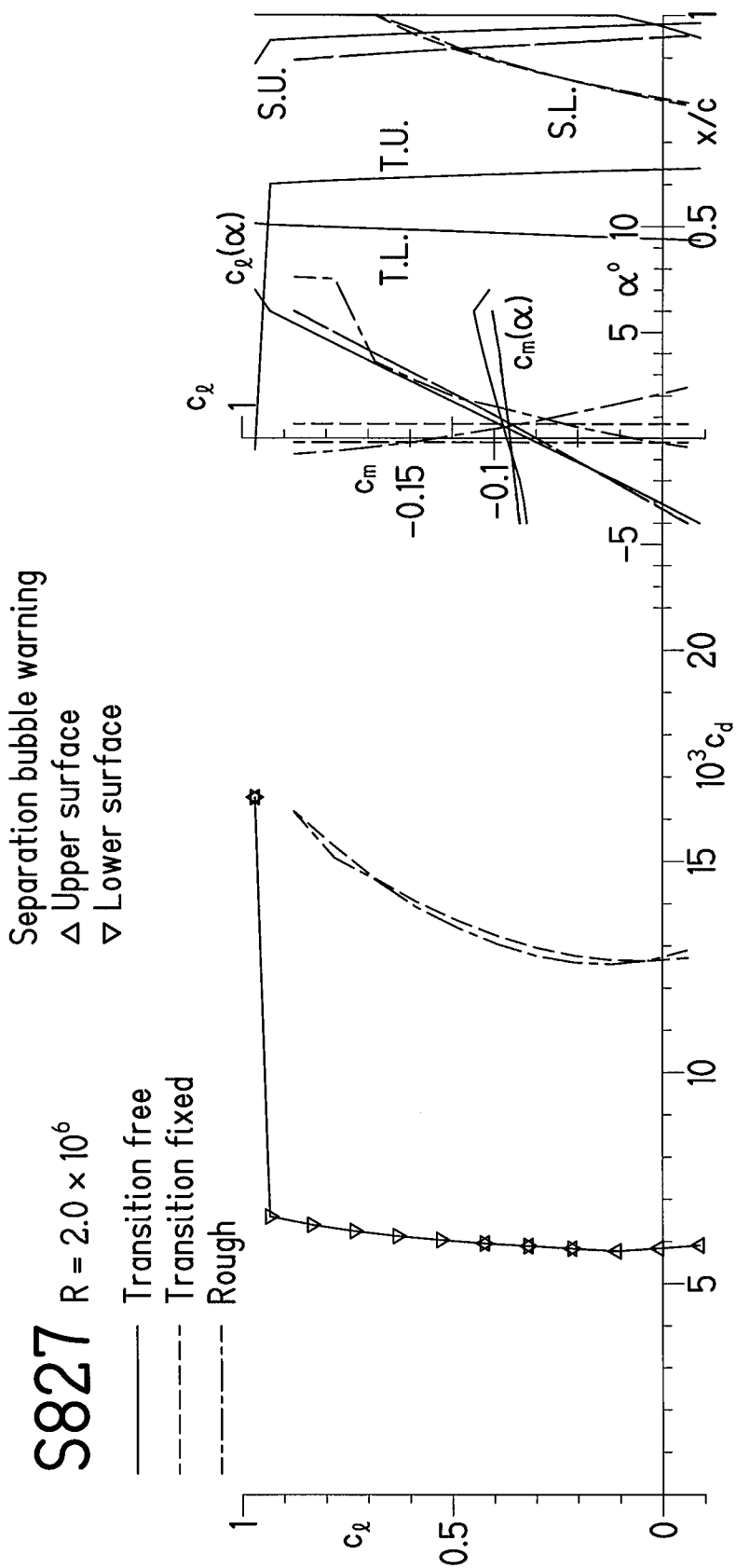
(d) $\alpha = 5^\circ, 6^\circ$, and 7° .

Figure 2.— Continued.



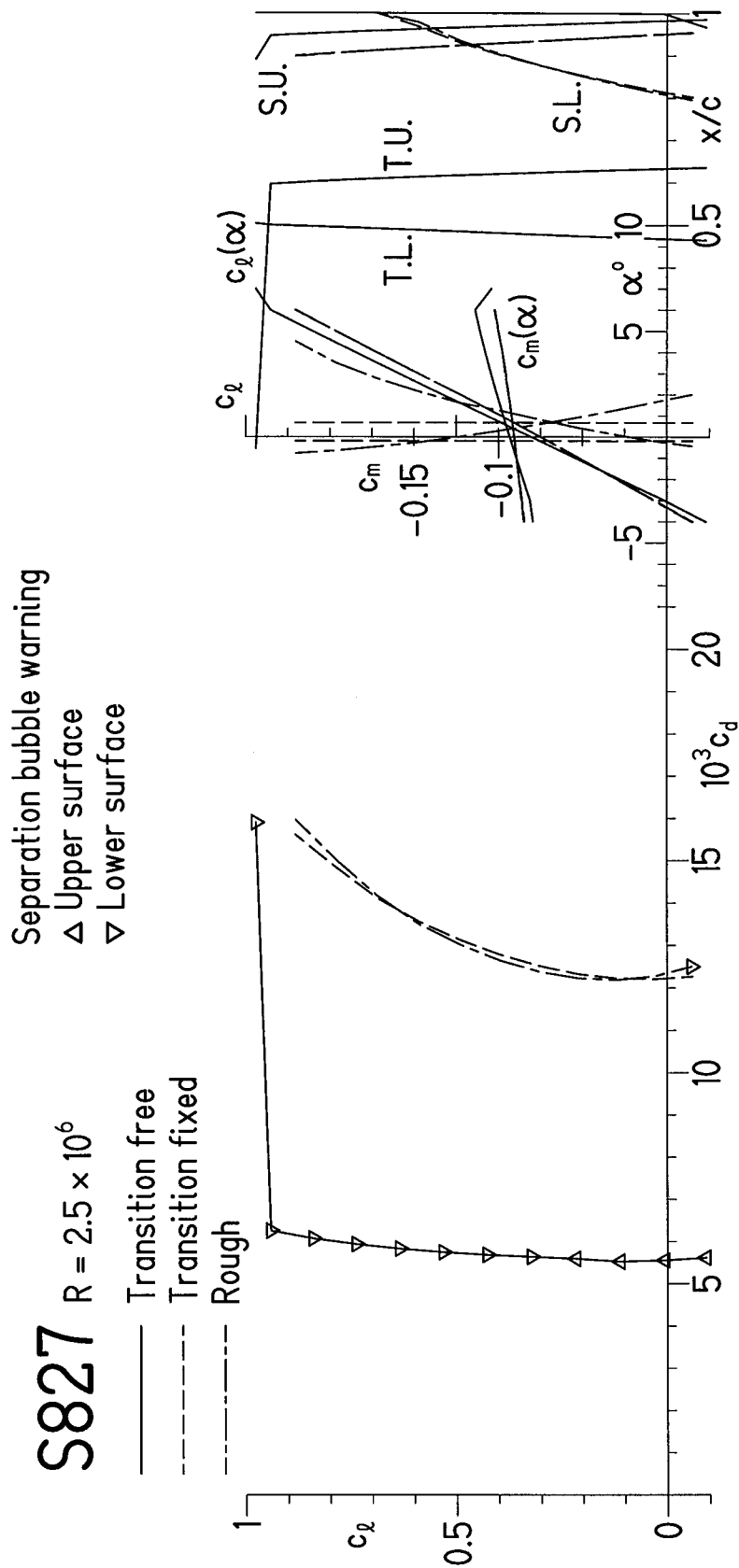
(e) $\alpha = 8^\circ$.

Figure 2.— Concluded.



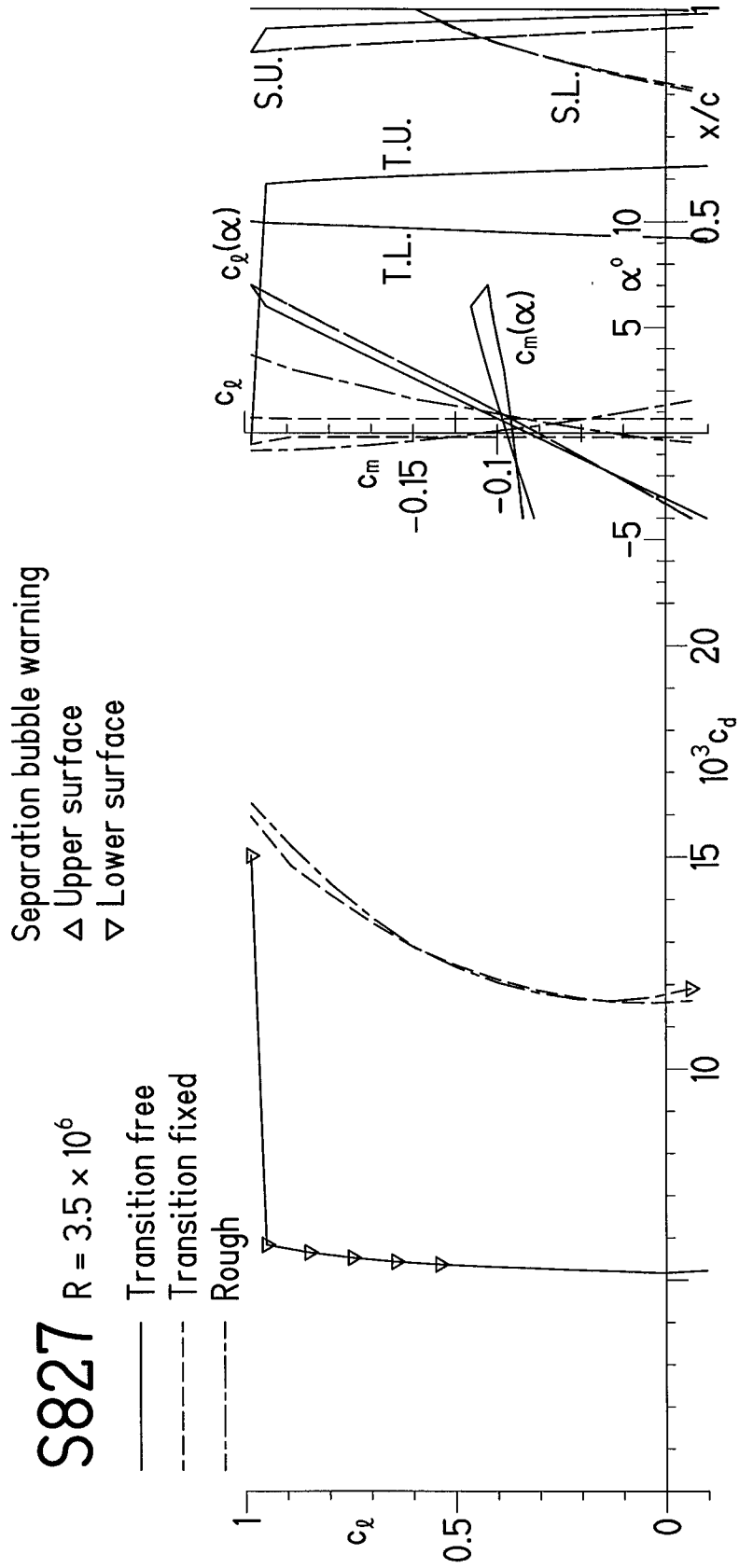
(a) $R = 2.0 \times 10^6$.

Figure 3.— Section characteristics of S827 airfoil with transition free, transition fixed, and rough.



(b) $R = 2.5 \times 10^6$.

Figure 3.— Continued.



(d) $R = 3.5 \times 10^6$.

Figure 3.- Continued.

S827

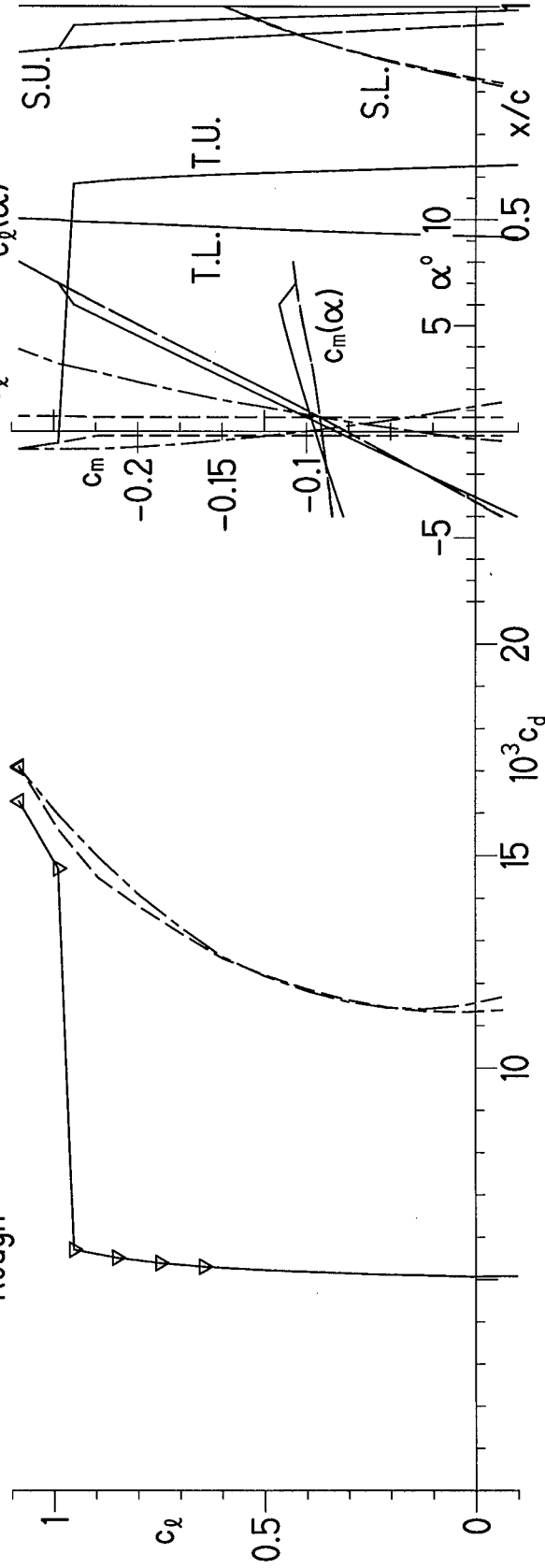
$R = 4.0 \times 10^6$

— Transition free
 - - - Transition fixed
 - - - Rough

Separation bubble warning

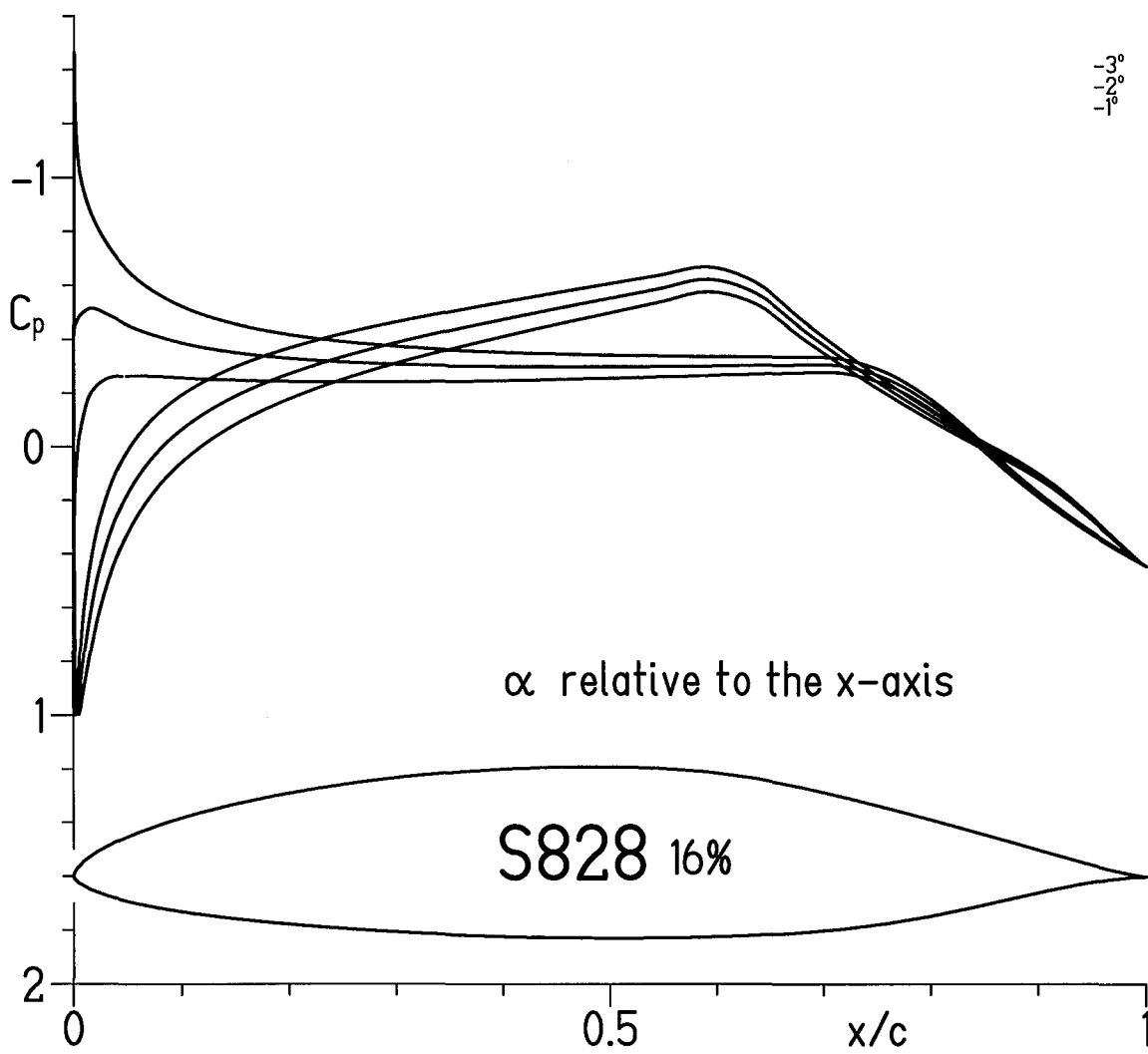
△ Upper surface

▽ Lower surface



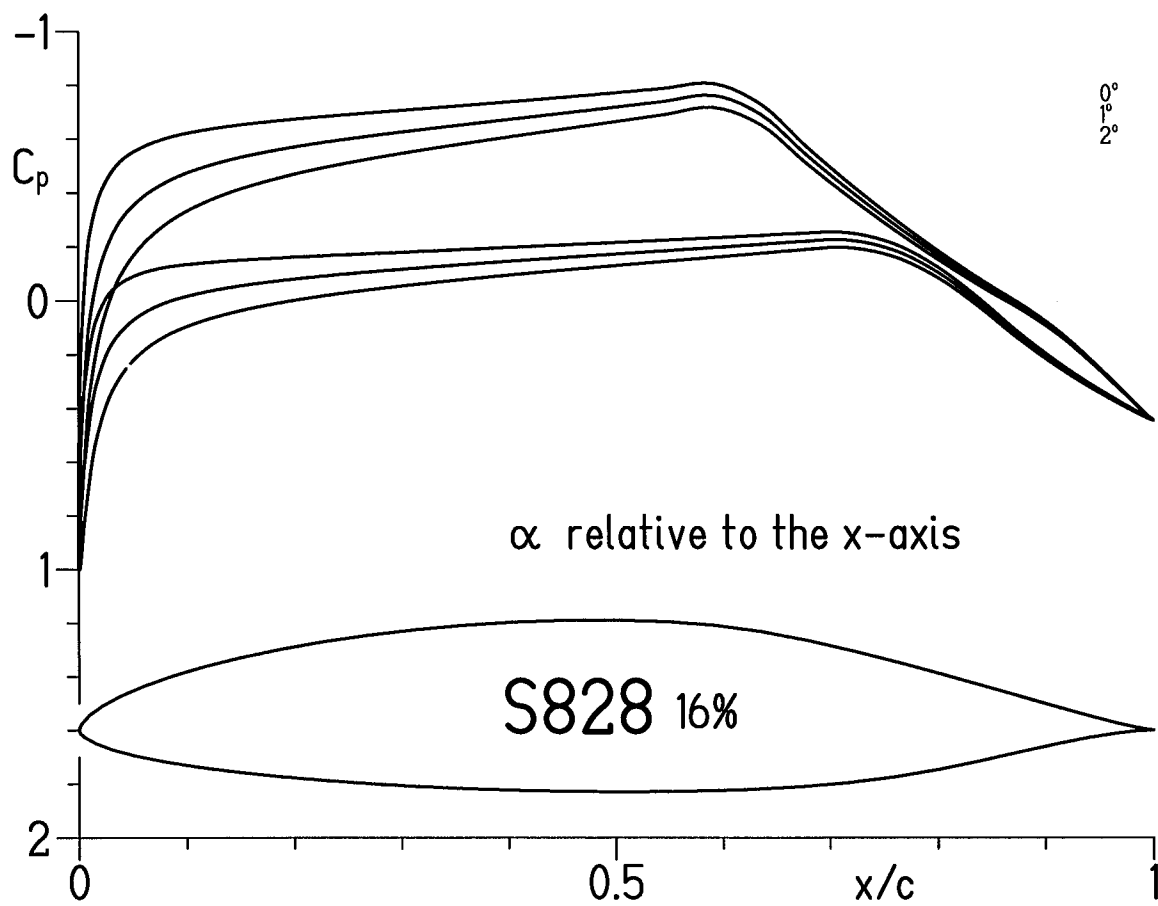
(e) $R = 4.0 \times 10^6$.

Figure 3.— Concluded.



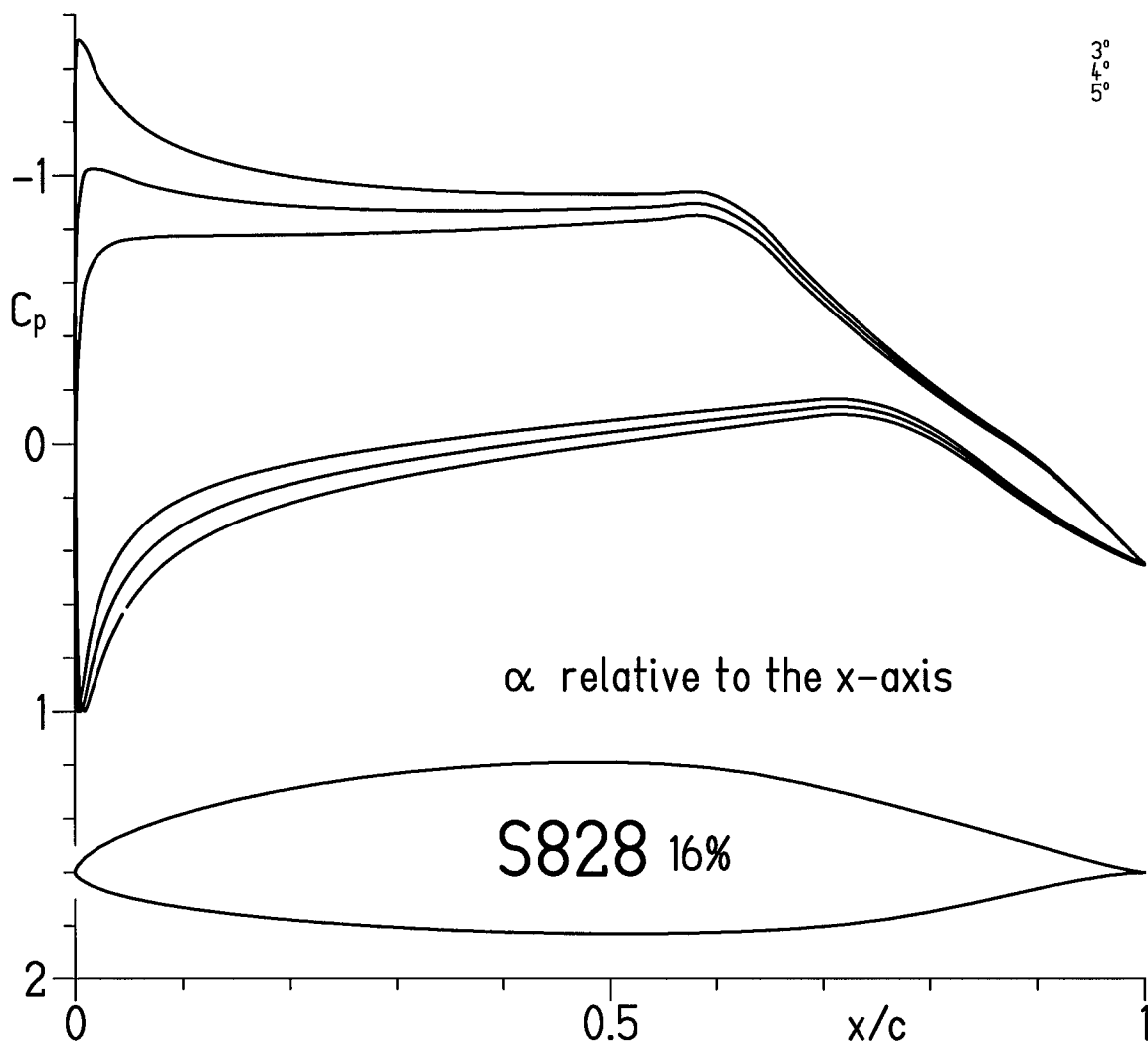
(a) $\alpha = -3^\circ, -2^\circ$, and -1° .

Figure 4.— Inviscid pressure distributions for S828 airfoil.



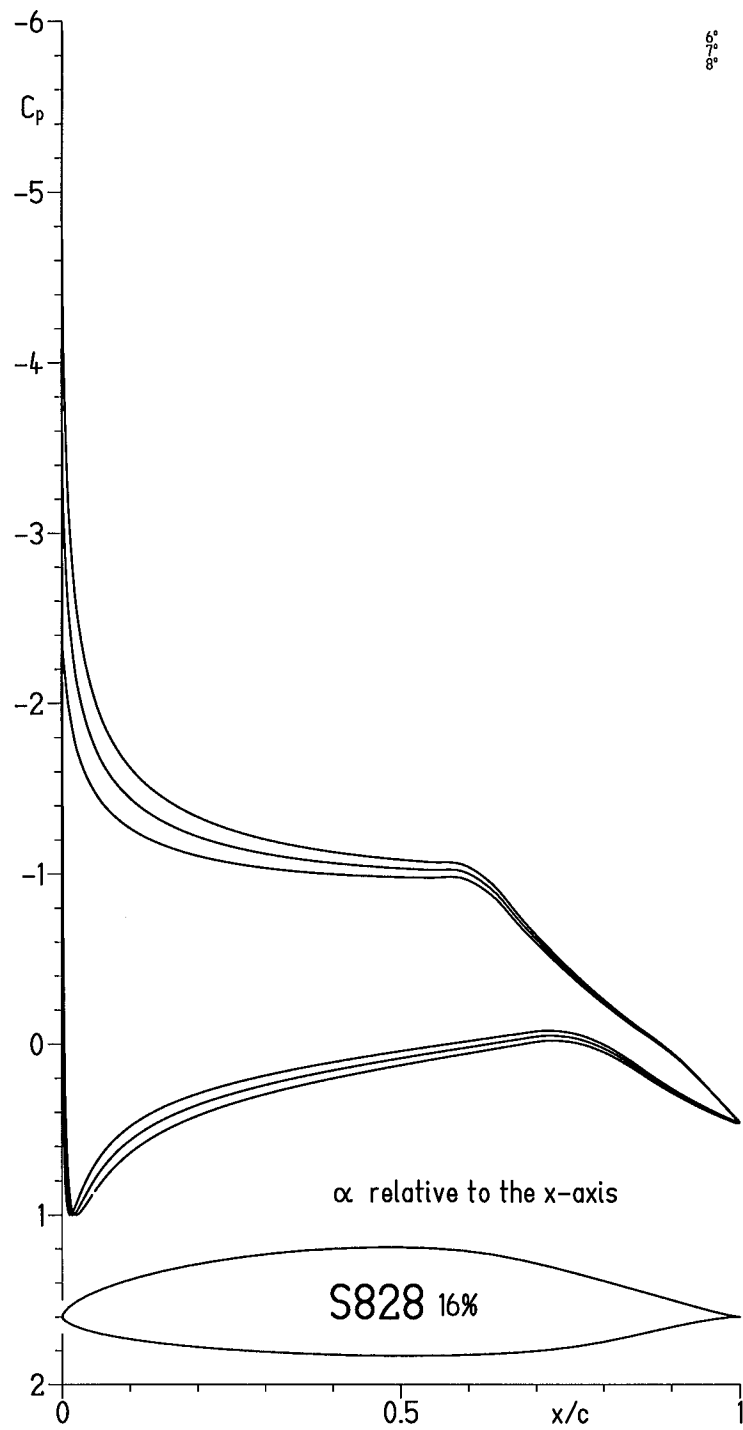
(b) $\alpha = 0^\circ, 1^\circ$, and 2° .

Figure 4.— Continued.



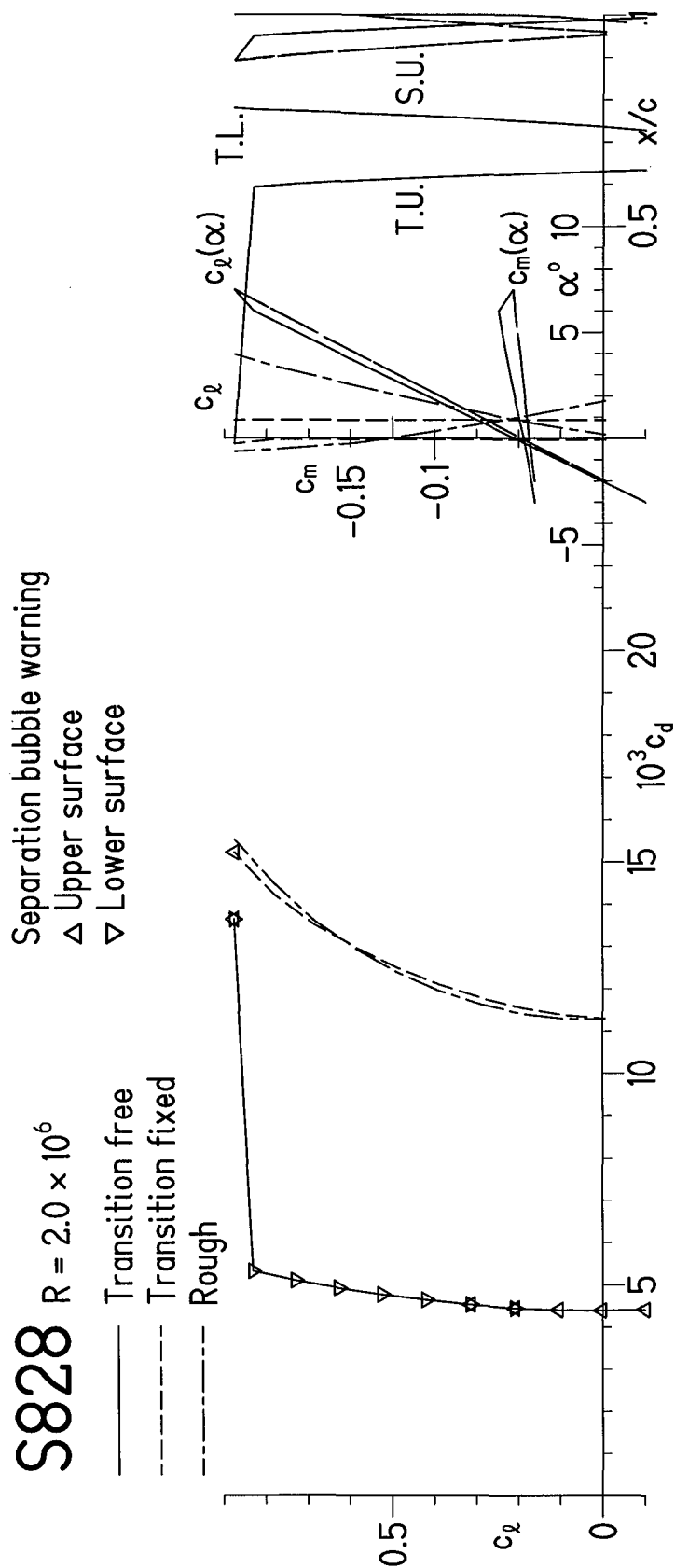
(c) $\alpha = 3^\circ, 4^\circ,$ and 5° .

Figure 4.— Continued.



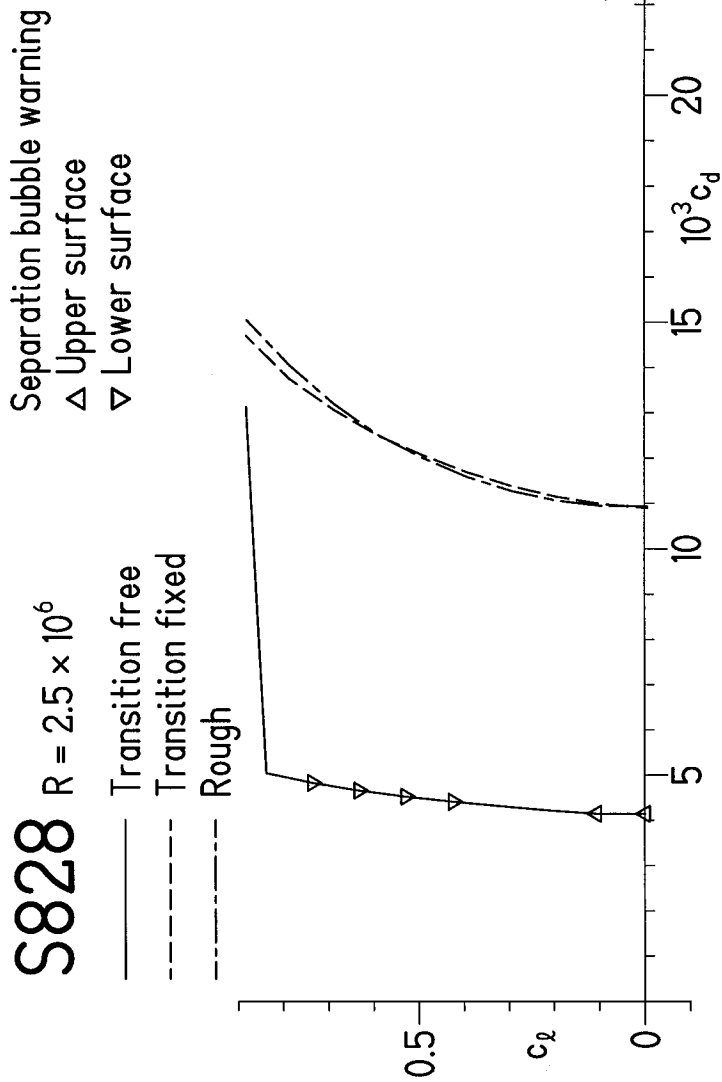
(d) $\alpha = 6^\circ, 7^\circ,$ and 8° .

Figure 4.— Concluded.



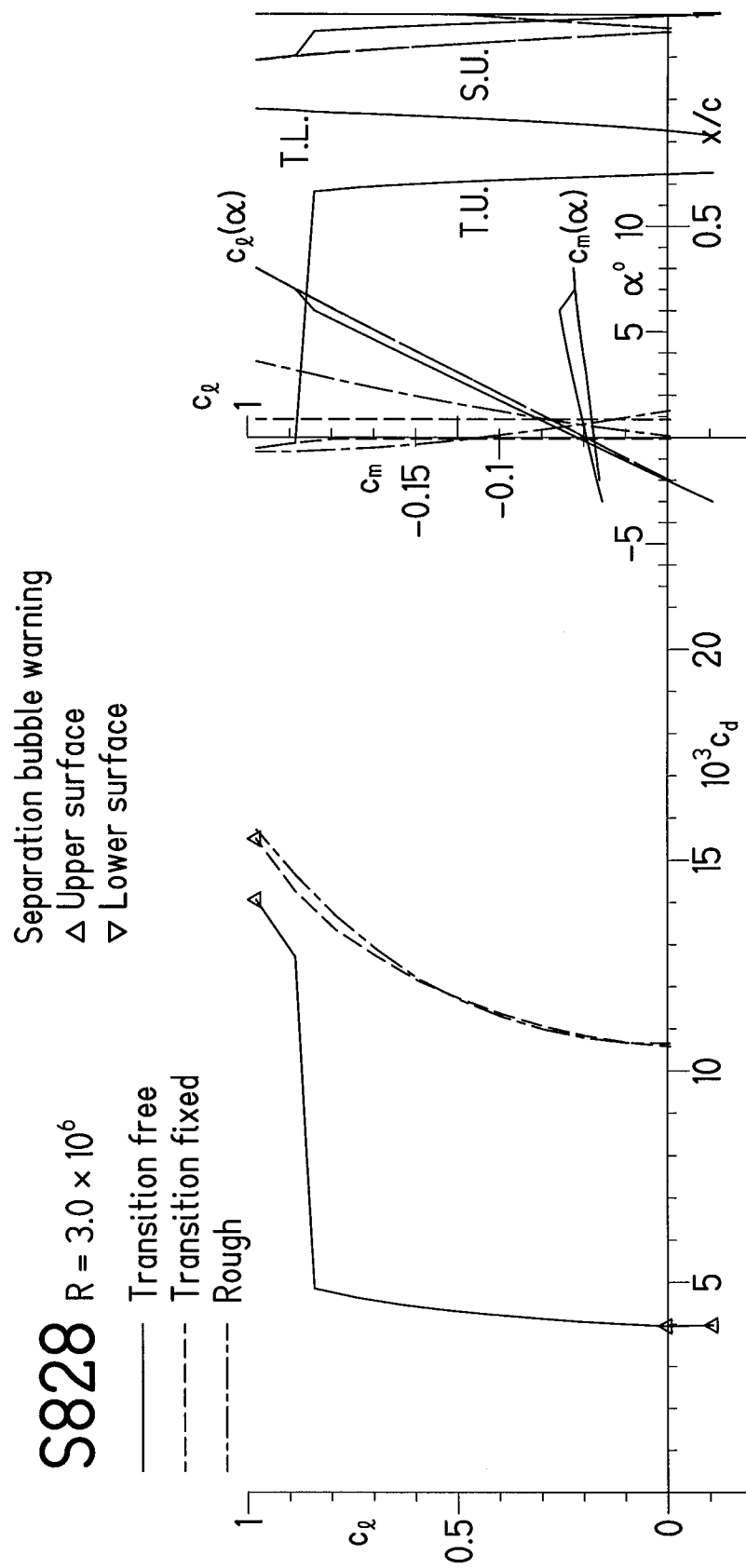
(a) $R = 2.0 \times 10^6$.

Figure 5.— Section characteristics of S828 airfoil with transition free, transition fixed, and rough.



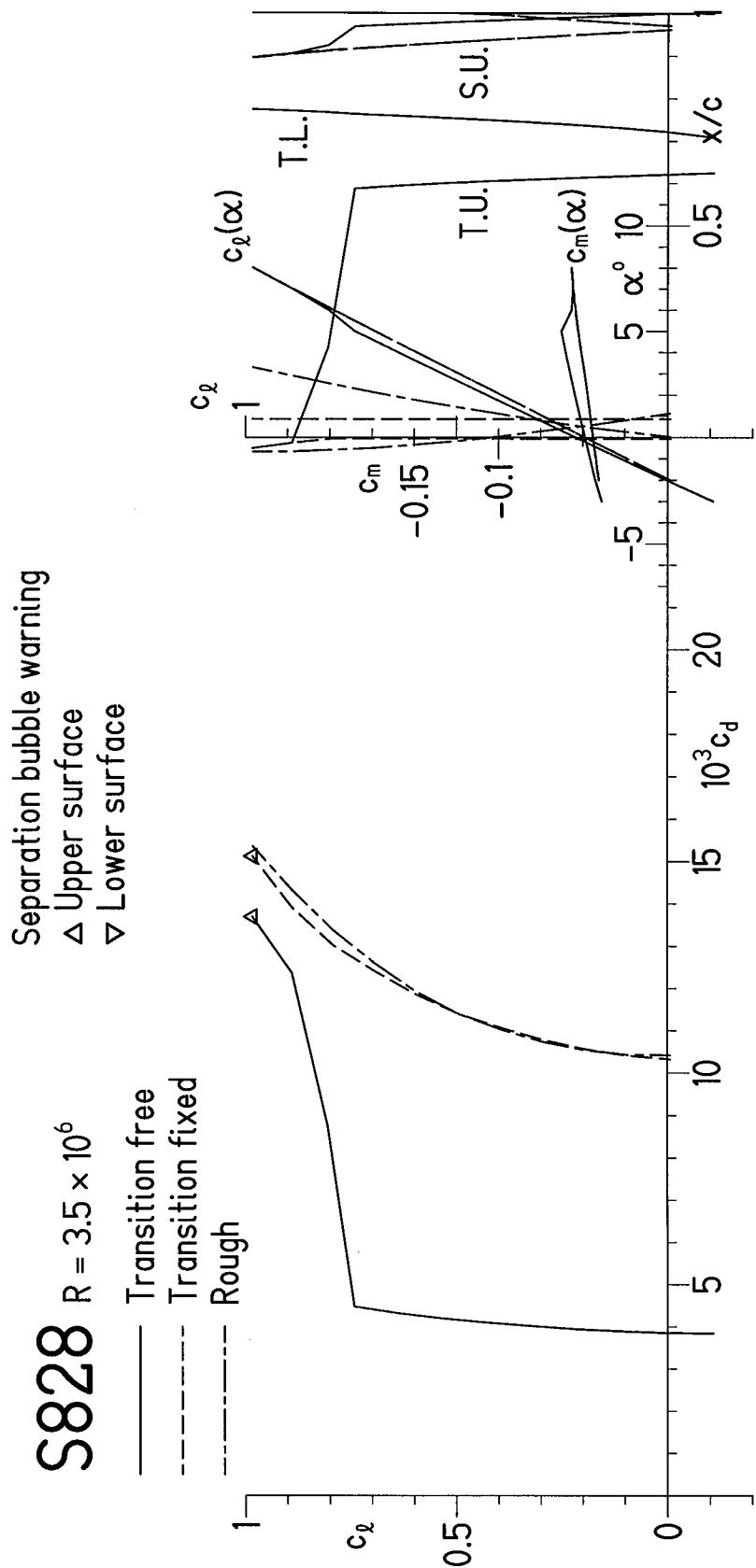
(b) $R = 2.5 \times 10^6$.

Figure 5.— Continued.



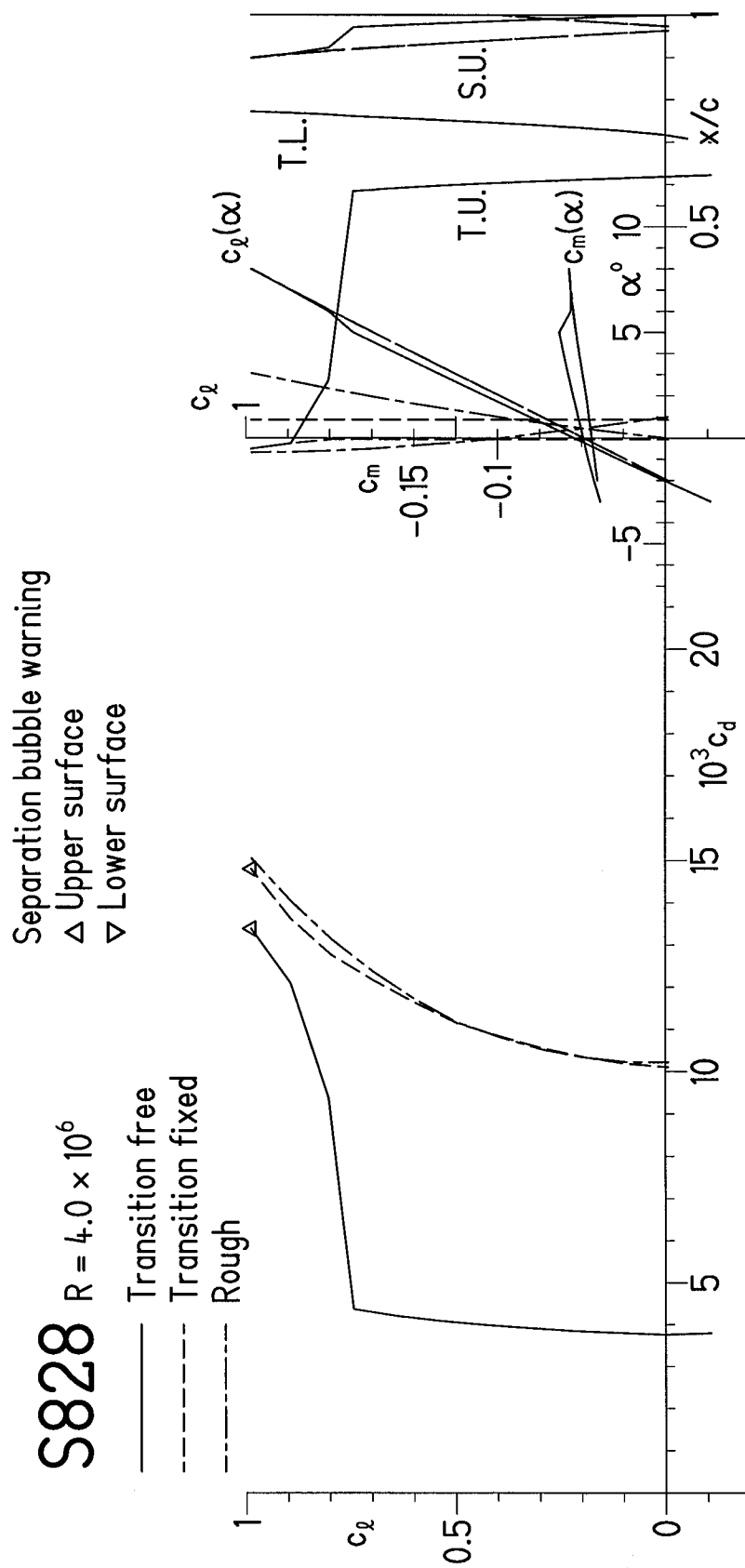
(c) $R = 3.0 \times 10^6$.

Figure 5.— Continued.



(d) $R = 3.5 \times 10^6$.

Figure 5.— Continued.



(e) $R = 4.0 \times 10^6$.

Figure 5.- Concluded.

APPENDIX

PRESSURE DISTRIBUTIONS, TRANSITION AND SEPARATION LOCATIONS, AND SECTION CHARACTERISTICS

AIRFOIL S827 21%				-4.00	-3.00	-2.00	-1.00	0.00	1.00	2.00	3.00
N	X	Y	NUE	CP-DISTR.	FOR THE	ABOVE	ALPHA REL.	CHORD	LINE		
1	1.00000	0.00000	0.00	0.446	0.446	0.446	0.447	0.448	0.449	0.450	0.452
2	0.99591	0.00078	1.00	0.436	0.435	0.434	0.433	0.433	0.434	0.434	0.435
3	0.98413	0.00360	2.00	0.388	0.386	0.384	0.382	0.381	0.380	0.379	0.379
4	0.96586	0.00900	3.00	0.309	0.305	0.301	0.298	0.295	0.293	0.291	0.290
5	0.94236	0.01682	4.00	0.208	0.202	0.196	0.191	0.186	0.182	0.179	0.175
6	0.91460	0.02643	5.00	0.100	0.092	0.083	0.076	0.069	0.062	0.056	0.051
7	0.88305	0.03718	6.00	0.008	-0.003	-0.014	-0.025	-0.035	-0.044	-0.053	-0.061
8	0.84805	0.04872	7.00	-0.072	-0.087	-0.101	-0.115	-0.128	-0.140	-0.152	-0.163
9	0.81021	0.06086	8.00	-0.167	-0.185	-0.203	-0.221	-0.237	-0.253	-0.269	-0.284
10	0.77025	0.07315	9.00	-0.274	-0.297	-0.319	-0.341	-0.363	-0.383	-0.403	-0.423
11	0.72880	0.08503	10.00	-0.392	-0.421	-0.449	-0.477	-0.504	-0.530	-0.555	-0.580
12	0.68639	0.09591	11.00	-0.521	-0.557	-0.592	-0.626	-0.659	-0.692	-0.724	-0.756
13	0.64347	0.10497	12.00	-0.658	-0.702	-0.744	-0.786	-0.828	-0.869	-0.909	-0.948
14	0.59988	0.11131	13.00	-0.704	-0.753	-0.802	-0.851	-0.899	-0.947	-0.994	-1.040
15	0.55498	0.11490	14.00	-0.653	-0.707	-0.760	-0.813	-0.866	-0.918	-0.970	-1.021
16	0.50881	0.11636	15.00	-0.602	-0.659	-0.717	-0.774	-0.832	-0.889	-0.946	-1.002
17	0.46193	0.11603	16.00	-0.549	-0.611	-0.673	-0.735	-0.798	-0.860	-0.922	-0.984
18	0.41487	0.11409	17.00	-0.494	-0.561	-0.628	-0.695	-0.763	-0.831	-0.899	-0.967
19	0.36815	0.11068	18.00	-0.437	-0.508	-0.581	-0.654	-0.728	-0.802	-0.877	-0.952
20	0.32229	0.10593	19.00	-0.376	-0.453	-0.531	-0.611	-0.691	-0.772	-0.854	-0.937
21	0.27779	0.09996	20.00	-0.312	-0.395	-0.479	-0.565	-0.653	-0.742	-0.832	-0.924
22	0.23516	0.09293	21.00	-0.242	-0.332	-0.423	-0.517	-0.613	-0.711	-0.811	-0.912
23	0.19486	0.08497	22.00	-0.166	-0.262	-0.362	-0.465	-0.570	-0.678	-0.789	-0.902
24	0.15735	0.07623	23.00	-0.079	-0.184	-0.293	-0.406	-0.522	-0.642	-0.766	-0.893
25	0.12305	0.06686	24.00	0.020	-0.093	-0.212	-0.337	-0.466	-0.601	-0.741	-0.885
26	0.09234	0.05703	25.00	0.138	0.014	-0.116	-0.254	-0.400	-0.552	-0.711	-0.877
27	0.06557	0.04692	26.00	0.280	0.147	0.003	-0.151	-0.315	-0.489	-0.673	-0.867
28	0.04304	0.03671	27.00	0.454	0.313	0.156	-0.016	-0.203	-0.405	-0.622	-0.854
29	0.02501	0.02661	28.00	0.668	0.528	0.363	0.174	-0.039	-0.275	-0.535	-0.818
30	0.01168	0.01688	29.00	0.902	0.791	0.637	0.443	0.207	-0.069	-0.386	-0.743
31	0.00327	0.00789	30.00	0.972	0.999	0.945	0.810	0.593	0.296	-0.081	-0.538
32	0.00040	0.00228	30.71	0.345	0.713	0.932	1.000	0.918	0.687	0.305	-0.225
33	0.00003	0.00054	30.96	-0.350	0.280	0.714	0.951	0.991	0.835	0.482	-0.067
34	0.00010	-0.00098	31.21	-1.674	-0.610	0.187	0.714	0.972	0.960	0.678	0.127
35	0.00075	-0.00240	31.46	-1.393	-0.563	0.091	0.569	0.871	0.996	0.944	0.715
36	0.00194	-0.00390	31.71	-1.210	-0.532	0.023	0.454	0.761	0.943	1.000	0.932
37	0.00388	-0.00572	32.00	-1.064	-0.506	-0.035	0.348	0.644	0.851	0.969	0.999
38	0.01440	-0.01227	33.00	-0.804	-0.458	-0.149	0.124	0.361	0.561	0.723	0.849
39	0.03068	-0.01907	34.00	-0.649	-0.406	-0.181	0.025	0.212	0.379	0.527	0.655
40	0.05249	-0.02597	35.00	-0.537	-0.353	-0.180	-0.019	0.132	0.271	0.398	0.513
41	0.07952	-0.03303	36.00	-0.466	-0.319	-0.180	-0.047	0.078	0.196	0.306	0.408
42	0.11138	-0.04031	37.00	-0.417	-0.296	-0.179	-0.068	0.039	0.141	0.237	0.328
43	0.14752	-0.04794	38.00	-0.398	-0.294	-0.193	-0.096	-0.002	0.088	0.174	0.257
44	0.18727	-0.05596	39.00	-0.398	-0.306	-0.217	-0.131	-0.047	0.035	0.113	0.189
45	0.22978	-0.06438	40.00	-0.431	-0.348	-0.267	-0.187	-0.110	-0.034	0.039	0.111
46	0.27409	-0.07310	41.00	-0.492	-0.415	-0.339	-0.265	-0.191	-0.120	-0.049	0.019
47	0.31892	-0.08183	42.00	-0.632	-0.556	-0.481	-0.408	-0.335	-0.263	-0.193	-0.124
48	0.36288	-0.08933	43.00	-0.865	-0.787	-0.710	-0.633	-0.558	-0.483	-0.409	-0.336
49	0.40597	-0.09376	44.00	-0.983	-0.909	-0.835	-0.761	-0.687	-0.614	-0.542	-0.471
50	0.44906	-0.09443	45.00	-0.976	-0.909	-0.842	-0.775	-0.708	-0.642	-0.575	-0.510
51	0.49274	-0.09126	46.00	-0.849	-0.792	-0.736	-0.679	-0.622	-0.565	-0.508	-0.451
52	0.53770	-0.08456	47.00	-0.624	-0.579	-0.534	-0.489	-0.444	-0.398	-0.352	-0.306
53	0.58417	-0.07538	48.00	-0.427	-0.392	-0.356	-0.320	-0.284	-0.247	-0.210	-0.173
54	0.63172	-0.06463	49.00	-0.257	-0.229	-0.201	-0.172	-0.143	-0.114	-0.084	-0.054
55	0.67984	-0.05305	50.00	-0.110	-0.088	-0.066	-0.043	-0.020	0.003	0.027	0.051
56	0.72787	-0.04136	51.00	0.014	0.031	0.049	0.067	0.085	0.104	0.123	0.142
57	0.77506	-0.03025	52.00	0.119	0.132	0.146	0.160	0.175	0.190	0.205	0.221
58	0.82049	-0.02035	53.00	0.206	0.216	0.227	0.238	0.250	0.262	0.274	0.287
59	0.86316	-0.01216	54.00	0.277	0.285	0.294	0.303	0.312	0.321	0.331	0.341
60	0.90192	-0.00603	55.00	0.334	0.340	0.346	0.353	0.360	0.368	0.376	0.384
61	0.93560	-0.00204	56.00	0.377	0.381	0.386	0.391	0.397	0.403	0.409	0.415
62	0.96306	-0.00001	57.00	0.408	0.411	0.414	0.418	0.422	0.427	0.432	0.437
63	0.98337	0.00052	58.00	0.429	0.431	0.433	0.436	0.439	0.442	0.446	0.450
64	0.99581	0.00025	59.00	0.441	0.442	0.443	0.445	0.447	0.449	0.452	0.455
65	1.00000	0.00000	60.00	0.446	0.446	0.446	0.447	0.448	0.449	0.450	0.452

ALPHA0= 3.17 DEGREES CM0=-0.0840 ETA= 1.145

AIRFOIL S827 21%				4.00	5.00	6.00	7.00	8.00	9.00	10.00
N	X	Y	NUE	CP-DISTR. FOR THE	ABOVE	ALPHA	REL.	CHORD	LINE	
1	1.00000	0.00000	0.00	0.455	0.457	0.460	0.463	0.467	0.470	0.475
2	0.99591	0.00078	1.00	0.436	0.438	0.440	0.442	0.445	0.448	0.451
3	0.98413	0.00360	2.00	0.379	0.380	0.381	0.382	0.384	0.386	0.389
4	0.96586	0.00900	3.00	0.289	0.288	0.288	0.288	0.289	0.290	0.292
5	0.94236	0.01682	4.00	0.173	0.171	0.169	0.168	0.167	0.167	0.167
6	0.91460	0.02643	5.00	0.046	0.042	0.038	0.035	0.032	0.030	0.029
7	0.88305	0.03718	6.00	-0.068	-0.075	-0.081	-0.087	-0.091	-0.096	-0.099
8	0.84805	0.04872	7.00	-0.173	-0.183	-0.192	-0.201	-0.208	-0.215	-0.221
9	0.81021	0.06086	8.00	-0.298	-0.311	-0.324	-0.335	-0.347	-0.357	-0.366
10	0.77025	0.07315	9.00	-0.441	-0.459	-0.476	-0.492	-0.507	-0.522	-0.536
11	0.72880	0.08503	10.00	-0.604	-0.627	-0.650	-0.671	-0.692	-0.711	-0.730
12	0.68639	0.09591	11.00	-0.786	-0.816	-0.845	-0.873	-0.900	-0.926	-0.951
13	0.64347	0.10497	12.00	-0.987	-1.025	-1.061	-1.097	-1.132	-1.166	-1.199
14	0.59988	0.11131	13.00	-1.086	-1.130	-1.174	-1.218	-1.260	-1.301	-1.341
15	0.55498	0.11490	14.00	-1.071	-1.121	-1.171	-1.219	-1.267	-1.314	-1.359
16	0.50881	0.11636	15.00	-1.058	-1.114	-1.169	-1.223	-1.277	-1.330	-1.382
17	0.46193	0.11603	16.00	-1.046	-1.108	-1.169	-1.230	-1.290	-1.349	-1.408
18	0.41487	0.11409	17.00	-1.036	-1.104	-1.172	-1.240	-1.307	-1.374	-1.440
19	0.36815	0.11068	18.00	-1.027	-1.102	-1.178	-1.254	-1.329	-1.404	-1.479
20	0.32229	0.10593	19.00	-1.020	-1.104	-1.188	-1.272	-1.357	-1.442	-1.527
21	0.27779	0.09996	20.00	-1.016	-1.109	-1.203	-1.298	-1.393	-1.489	-1.585
22	0.23516	0.09293	21.00	-1.015	-1.119	-1.225	-1.332	-1.440	-1.548	-1.658
23	0.19486	0.08497	22.00	-1.017	-1.135	-1.254	-1.375	-1.498	-1.623	-1.749
24	0.15735	0.07623	23.00	-1.024	-1.157	-1.293	-1.432	-1.574	-1.718	-1.864
25	0.12305	0.06686	24.00	-1.034	-1.187	-1.345	-1.506	-1.671	-1.840	-2.012
26	0.09234	0.05703	25.00	-1.050	-1.229	-1.413	-1.604	-1.800	-2.002	-2.208
27	0.06557	0.04692	26.00	-1.071	-1.283	-1.505	-1.735	-1.973	-2.220	-2.474
28	0.04304	0.03671	27.00	-1.099	-1.359	-1.633	-1.919	-2.219	-2.531	-2.855
29	0.02501	0.02661	28.00	-1.124	-1.452	-1.802	-2.174	-2.566	-2.980	-3.413
30	0.01168	0.01688	29.00	-1.140	-1.576	-2.051	-2.564	-3.115	-3.702	-4.326
31	0.00327	0.00789	30.00	-1.075	-1.691	-2.384	-3.154	-4.001	-4.923	-5.919
32	0.00040	0.00228	30.71	-0.904	-1.730	-2.703	-3.822	-5.085	-6.490	-8.036
33	0.00003	0.00054	30.96	-0.812	-1.752	-2.885	-4.211	-5.727	-7.431	-9.323
34	0.00010	-0.00098	31.21	-0.694	-1.782	-3.136	-4.756	-6.638	-8.782	-11.183
35	0.00075	-0.00240	31.46	0.309	-0.273	-1.030	-1.963	-3.068	-4.346	-5.794
36	0.00194	-0.00390	31.71	0.739	0.421	-0.021	-0.587	-1.276	-2.087	-3.020
37	0.00388	-0.00572	32.00	0.940	0.792	0.556	0.231	-0.181	-0.681	-1.267
38	0.01440	-0.01227	33.00	0.937	0.987	0.999	0.974	0.912	0.811	0.674
39	0.03068	-0.01907	34.00	0.763	0.851	0.918	0.966	0.993	1.000	0.986
40	0.05249	-0.02597	35.00	0.616	0.708	0.787	0.853	0.908	0.950	0.979
41	0.07952	-0.03303	36.00	0.503	0.590	0.668	0.739	0.801	0.855	0.900
42	0.11138	-0.04031	37.00	0.414	0.494	0.569	0.638	0.701	0.758	0.810
43	0.14752	-0.04794	38.00	0.335	0.410	0.481	0.547	0.609	0.667	0.720
44	0.18727	-0.05596	39.00	0.262	0.332	0.399	0.462	0.523	0.580	0.633
45	0.22978	-0.06438	40.00	0.180	0.247	0.311	0.373	0.432	0.489	0.543
46	0.27409	-0.07310	41.00	0.086	0.151	0.214	0.275	0.334	0.391	0.446
47	0.31892	-0.08183	42.00	-0.056	0.010	0.075	0.138	0.199	0.259	0.316
48	0.36288	-0.08933	43.00	-0.264	-0.194	-0.125	-0.057	0.009	0.074	0.137
49	0.40597	-0.09376	44.00	-0.400	-0.330	-0.261	-0.194	-0.127	-0.062	0.002
50	0.44906	-0.09443	45.00	-0.445	-0.380	-0.316	-0.253	-0.190	-0.129	-0.068
51	0.49274	-0.09126	46.00	-0.395	-0.339	-0.283	-0.227	-0.173	-0.118	-0.064
52	0.53770	-0.08456	47.00	-0.260	-0.215	-0.169	-0.123	-0.078	-0.033	0.011
53	0.58417	-0.07538	48.00	-0.136	-0.099	-0.062	-0.024	0.013	0.050	0.087
54	0.63172	-0.06463	49.00	-0.024	0.006	0.036	0.067	0.098	0.128	0.159
55	0.67984	-0.05305	50.00	0.075	0.100	0.125	0.150	0.175	0.200	0.225
56	0.72787	-0.04136	51.00	0.162	0.182	0.202	0.223	0.244	0.264	0.285
57	0.77506	-0.03025	52.00	0.237	0.253	0.270	0.286	0.303	0.321	0.338
58	0.82049	-0.02035	53.00	0.300	0.313	0.326	0.340	0.354	0.369	0.383
59	0.86316	-0.01216	54.00	0.352	0.362	0.374	0.385	0.396	0.408	0.420
60	0.90192	-0.00603	55.00	0.392	0.401	0.410	0.420	0.429	0.439	0.449
61	0.93560	-0.00204	56.00	0.422	0.429	0.437	0.445	0.453	0.461	0.470
62	0.96306	-0.00001	57.00	0.442	0.448	0.454	0.461	0.467	0.474	0.482
63	0.98337	0.00052	58.00	0.454	0.459	0.464	0.469	0.474	0.480	0.486
64	0.99581	0.00025	59.00	0.458	0.461	0.465	0.470	0.474	0.479	0.484
65	1.00000	0.00000	60.00	0.455	0.457	0.460	0.463	0.467	0.470	0.475
ALPHA= 3.17 DEGREES CM0=-0.0840				ETA= 1.145						

B.L.SUMMARY AIRFOIL S827 21% ALPHA0= 3.165 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU=3.0	R= 2000000 MU=1.3	R= 2000000 MU=9.0
-4.00	S TURB S SEP CD UPPER 0.3615 0.0172 0.0027* LOWER 0.5321 0.0523 0.0032 TOTAL CL=-0.087 CD=0.00591 CM=-0.0805	S TURB S SEP CD 1.0099 0.0484 0.0061 0.9664 0.2066 0.0067 CL=-0.060 CD=0.01272 CM=-0.0846	S TURB S SEP CD 0.8806 0.0474 0.0059 1.0205 0.2121 0.0070 CL=-0.057 CD=0.01289 CM=-0.0849
-3.00	S TURB S SEP CD UPPER 0.3641 0.0206 0.0028* LOWER 0.5290 0.0231 0.0030 TOTAL CL= 0.009 CD=0.00584 CM=-0.0822	S TURB S SEP CD 1.0099 0.0533 0.0066 0.9664 0.1910 0.0061 CL= 0.029 CD=0.01265 CM=-0.0861	S TURB S SEP CD 0.9016 0.0524 0.0064 1.0071 0.1949 0.0063 CL= 0.030 CD=0.01265 CM=-0.0864
-2.00	S TURB S SEP CD UPPER 0.3669 0.0241 0.0030* LOWER 0.5256 0.0000 0.0028 TOTAL CL= 0.109 CD=0.00577 CM=-0.0847	S TURB S SEP CD 1.0098 0.0583 0.0071 0.9664 0.1738 0.0056 CL= 0.118 CD=0.01266 CM=-0.0876	S TURB S SEP CD 0.9218 0.0576 0.0069 0.9901 0.1760 0.0057 CL= 0.119 CD=0.01257 CM=-0.0878
-1.00	S TURB S SEP CD UPPER 0.3700 0.0281 0.0031* LOWER 0.5220 0.0000 0.0027* TOTAL CL= 0.214 CD=0.00584 CM=-0.0886	S TURB S SEP CD 1.0099 0.0635 0.0077 0.9664 0.1551 0.0051 CL= 0.207 CD=0.01277 CM=-0.0891	S TURB S SEP CD 0.9401 0.0629 0.0075 0.9720 0.1556 0.0051 CL= 0.208 CD=0.01261 CM=-0.0892
0.00	S TURB S SEP CD UPPER 0.3735 0.0319 0.0033* LOWER 0.5180 0.0000 0.0026* TOTAL CL= 0.319 CD=0.00590 CM=-0.0924	S TURB S SEP CD 1.0099 0.0688 0.0083 0.9664 0.1340 0.0047 CL= 0.298 CD=0.01295 CM=-0.0905	S TURB S SEP CD 0.9595 0.0683 0.0081 0.9494 0.1325 0.0046 CL= 0.299 CD=0.01276 CM=-0.0906
1.00	S TURB S SEP CD UPPER 0.3770 0.0358 0.0035* LOWER 0.5138 0.0000 0.0025* TOTAL CL= 0.423 CD=0.00596 CM=-0.0962	S TURB S SEP CD 1.0099 0.0741 0.0090 0.9664 0.1101 0.0043 CL= 0.391 CD=0.01323 CM=-0.0920	S TURB S SEP CD 0.9766 0.0737 0.0088 0.9265 0.1070 0.0042 CL= 0.391 CD=0.01304 CM=-0.0920
2.00	S TURB S SEP CD UPPER 0.3807 0.0400 0.0037 LOWER 0.5102 0.0000 0.0023* TOTAL CL= 0.527 CD=0.00604 CM=-0.0997	S TURB S SEP CD 1.0099 0.0797 0.0097 0.9664 0.0828 0.0039 CL= 0.486 CD=0.01360 CM=-0.0937	S TURB S SEP CD 0.9918 0.0794 0.0096 0.9056 0.0772 0.0038 CL= 0.486 CD=0.01343 CM=-0.0936
3.00	S TURB S SEP CD UPPER 0.3846 0.0444 0.0039 LOWER 0.5066 0.0000 0.0022* TOTAL CL= 0.630 CD=0.00613 CM=-0.1032	S TURB S SEP CD 1.0099 0.0855 0.0105 0.9664 0.0478 0.0036 CL= 0.585 CD=0.01405 CM=-0.0957	S TURB S SEP CD 1.0083 0.0855 0.0105 0.8646 0.0347 0.0034 CL= 0.585 CD=0.01392 CM=-0.0953
4.00	S TURB S SEP CD UPPER 0.3888 0.0490 0.0042 LOWER 0.5033 0.0000 0.0021* TOTAL CL= 0.732 CD=0.00625 CM=-0.1064	S TURB S SEP CD 1.0099 0.0918 0.0113 0.9664 0.0000 0.0033 CL= 0.684 CD=0.01461 CM=-0.0967	S TURB S SEP CD 1.0202 0.0920 0.0114 0.8195 0.0000 0.0031 CL= 0.683 CD=0.01458 CM=-0.0967
5.00	S TURB S SEP CD UPPER 0.3936 0.0541 0.0044 LOWER 0.5000 0.0000 0.0020* TOTAL CL= 0.834 CD=0.00640 CM=-0.1094	S TURB S SEP CD 1.0099 0.0986 0.0123 0.9663 0.0000 0.0031 CL= 0.780 CD=0.01537 CM=-0.0991	S TURB S SEP CD 1.0305 0.0992 0.0125 0.6234 0.0000 0.0026 CL= 0.780 CD=0.01509 CM=-0.0990
6.00	S TURB S SEP CD UPPER 0.3994 0.0599 0.0047 LOWER 0.4966 0.0000 0.0019* TOTAL CL= 0.933 CD=0.00660 CM=-0.1122	S TURB S SEP CD 1.0099 0.1058 0.0133 0.9664 0.0000 0.0029 CL= 0.876 CD=0.01619 CM=-0.1013	S TURB S SEP CD 1.0375 0.1069 0.0137 0.6196 0.0000 0.0024 CL= 0.875 CD=0.01616 CM=-0.1010
7.00	S TURB S SEP CD UPPER 1.0268 0.1143 0.0147* LOWER 0.4931 0.0000 0.0018* TOTAL CL= 0.969 CD=0.01652 CM=-0.1030	S TURB S SEP CD 1.0268 0.1143 0.0147* 0.9638 0.0000 0.0027 CL= 0.969 CD=0.01747 CM=-0.1030	S TURB S SEP CD 1.0411 0.1151 0.0151* 0.6157 0.0000 0.0023 CL= 0.968 CD=0.01738 CM=-0.1028
8.00	S TURB S SEP CD UPPER 1.0409 0.1239 0.0166* LOWER 0.4893 0.0000 0.0017* TOTAL CL= 1.060 CD=0.01823 CM=-0.1043	S TURB S SEP CD 1.0409 0.1239 0.0166* 0.9638 0.0000 0.0025 CL= 1.060 CD=0.01909 CM=-0.1043	S TURB S SEP CD 1.0414 0.1240 0.0166* 0.6118 0.0000 0.0021 CL= 1.060 CD=0.01872 CM=-0.1043
9.00	S TURB S SEP CD UPPER 1.0412 0.1339 0.0182* LOWER 0.4851 0.0000 0.0016 TOTAL CL= 1.149 CD=0.01977 CM=-0.1055	S TURB S SEP CD 1.0412 0.1339 0.0182* 0.9638 0.0000 0.0023 CL= 1.149 CD=0.02055 CM=-0.1055	S TURB S SEP CD 1.0415 0.1339 0.0182* 0.6080 0.0000 0.0020 CL= 1.149 CD=0.02023 CM=-0.1055
10.00	S TURB S SEP CD UPPER 1.0413 0.1452 0.0200* LOWER 0.4801 0.0000 0.0015* TOTAL CL= 1.235 CD=0.02149 CM=-0.1062	S TURB S SEP CD 1.0413 0.1452 0.0200* 0.9358 0.0000 0.0022 CL= 1.235 CD=0.02219 CM=-0.1062	S TURB S SEP CD 1.0416 0.1453 0.0200* 0.6045 0.0000 0.0019 CL= 1.235 CD=0.02192 CM=-0.1062

B.L.SUMMARY AIRFOIL S827 21% ALPHA0= 3.165 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2500000 MU=3.0	R= 2500000 MU=1.3	R= 2500000 MU=9.0
-4.00	S TURB S SEP CD UPPER 0.3643 0.0138 0.0025* LOWER 0.5349 0.0321 0.0031 TOTAL CL=-0.091 CD=0.00561 CM=-0.0796	S TURB S SEP CD 1.0099 0.0456 0.0059 0.9664 0.1980 0.0064 CL=-0.060 CD=0.01227 CM=-0.0846	S TURB S SEP CD 0.8997 0.0449 0.0057 1.0216 0.2041 0.0068* CL=-0.058 CD=0.01250 CM=-0.0849
-3.00	S TURB S SEP CD UPPER 0.3670 0.0170 0.0027* LOWER 0.5319 0.0010 0.0029 TOTAL CL= 0.006 CD=0.00555 CM=-0.0813	S TURB S SEP CD 1.0099 0.0504 0.0063 0.9664 0.1822 0.0059 CL= 0.028 CD=0.01220 CM=-0.0861	S TURB S SEP CD 0.9180 0.0498 0.0062 1.0103 0.1865 0.0061 CL= 0.030 CD=0.01227 CM=-0.0864
-2.00	S TURB S SEP CD UPPER 0.3701 0.0204 0.0028* LOWER 0.5287 0.0000 0.0027 TOTAL CL= 0.112 CD=0.00552 CM=-0.0854	S TURB S SEP CD 1.0098 0.0553 0.0068 0.9664 0.1647 0.0054 CL= 0.118 CD=0.01222 CM=-0.0877	S TURB S SEP CD 0.9363 0.0548 0.0067 0.9949 0.1674 0.0055 CL= 0.119 CD=0.01218 CM=-0.0878
-1.00	S TURB S SEP CD UPPER 0.3735 0.0242 0.0030* LOWER 0.5252 0.0000 0.0026 TOTAL CL= 0.217 CD=0.00559 CM=-0.0894	S TURB S SEP CD 1.0099 0.0604 0.0074 0.9664 0.1454 0.0049 CL= 0.208 CD=0.01232 CM=-0.0892	S TURB S SEP CD 0.9537 0.0599 0.0073 0.9787 0.1465 0.0050 CL= 0.209 CD=0.01222 CM=-0.0893
0.00	S TURB S SEP CD UPPER 0.3770 0.0278 0.0031 LOWER 0.5214 0.0000 0.0025* TOTAL CL= 0.323 CD=0.00563 CM=-0.0933	S TURB S SEP CD 1.0099 0.0656 0.0080 0.9664 0.1237 0.0045 CL= 0.300 CD=0.01251 CM=-0.0907	S TURB S SEP CD 0.9697 0.0653 0.0079 0.9594 0.1231 0.0045 CL= 0.300 CD=0.01237 CM=-0.0907
1.00	S TURB S SEP CD UPPER 0.3806 0.0314 0.0033 LOWER 0.5172 0.0000 0.0024* TOTAL CL= 0.428 CD=0.00568 CM=-0.0971	S TURB S SEP CD 1.0099 0.0708 0.0087 0.9664 0.0992 0.0041 CL= 0.394 CD=0.01277 CM=-0.0922	S TURB S SEP CD 0.9847 0.0706 0.0086 0.9383 0.0969 0.0041 CL= 0.394 CD=0.01264 CM=-0.0922
2.00	S TURB S SEP CD UPPER 0.3843 0.0353 0.0035 LOWER 0.5131 0.0000 0.0022* TOTAL CL= 0.532 CD=0.00575 CM=-0.1008	S TURB S SEP CD 1.0099 0.0762 0.0094 0.9664 0.0703 0.0038 CL= 0.490 CD=0.01312 CM=-0.0940	S TURB S SEP CD 0.9996 0.0761 0.0093 0.9200 0.0658 0.0037 CL= 0.490 CD=0.01302 CM=-0.0939
3.00	S TURB S SEP CD UPPER 0.3882 0.0395 0.0037 LOWER 0.5093 0.0000 0.0021* TOTAL CL= 0.635 CD=0.00583 CM=-0.1043	S TURB S SEP CD 1.0099 0.0818 0.0101 0.9664 0.0315 0.0035 CL= 0.589 CD=0.01357 CM=-0.0959	S TURB S SEP CD 1.0132 0.0819 0.0101 0.8920 0.0212 0.0034 CL= 0.589 CD=0.01351 CM=-0.0956
4.00	S TURB S SEP CD UPPER 0.3925 0.0438 0.0039 LOWER 0.5059 0.0000 0.0020* TOTAL CL= 0.738 CD=0.00594 CM=-0.1077	S TURB S SEP CD 1.0099 0.0877 0.0109 0.9664 0.0000 0.0032 CL= 0.688 CD=0.01412 CM=-0.0976	S TURB S SEP CD 1.0233 0.0880 0.0111 0.8613 0.0000 0.0031 CL= 0.688 CD=0.01417 CM=-0.0975
5.00	S TURB S SEP CD UPPER 0.3975 0.0484 0.0042 LOWER 0.5025 0.0000 0.0019* TOTAL CL= 0.840 CD=0.00607 CM=-0.1109	S TURB S SEP CD 1.0099 0.0942 0.0118 0.9663 0.0000 0.0030 CL= 0.786 CD=0.01485 CM=-0.1001	S TURB S SEP CD 1.0324 0.0948 0.0121 0.8247 0.0000 0.0029 CL= 0.785 CD=0.01502 CM=-0.0999
6.00	S TURB S SEP CD UPPER 0.4038 0.0537 0.0045 LOWER 0.4991 0.0000 0.0018* TOTAL CL= 0.941 CD=0.00626 CM=-0.1138	S TURB S SEP CD 1.0099 0.1011 0.0128 0.9664 0.0000 0.0028 CL= 0.882 CD=0.01562 CM=-0.1023	S TURB S SEP CD 1.0386 0.1022 0.0133 0.7742 0.0000 0.0027 CL= 0.880 CD=0.01596 CM=-0.1020
7.00	S TURB S SEP CD UPPER 1.0268 0.1093 0.0142 LOWER 0.4956 0.0000 0.0017* TOTAL CL= 0.976 CD=0.01591 CM=-0.1041	S TURB S SEP CD 1.0268 0.1093 0.0142 0.9638 0.0000 0.0026 CL= 0.976 CD=0.01685 CM=-0.1041	S TURB S SEP CD 1.0412 0.1101 0.0146 0.6287 0.0000 0.0022 CL= 0.975 CD=0.01681 CM=-0.1039
8.00	S TURB S SEP CD UPPER 1.0409 0.1186 0.0160* LOWER 0.4920 0.0000 0.0016* TOTAL CL= 1.067 CD=0.01757 CM=-0.1055	S TURB S SEP CD 1.0409 0.1186 0.0160* 0.9638 0.0000 0.0025 CL= 1.067 CD=0.01842 CM=-0.1055	S TURB S SEP CD 1.0415 0.1187 0.0160* 0.6241 0.0000 0.0021 CL= 1.067 CD=0.01809 CM=-0.1055
9.00	S TURB S SEP CD UPPER 1.0412 0.1281 0.0175* LOWER 0.4880 0.0000 0.0015 TOTAL CL= 1.157 CD=0.01906 CM=-0.1068	S TURB S SEP CD 1.0412 0.1281 0.0175* 0.9638 0.0000 0.0023 CL= 1.157 CD=0.01982 CM=-0.1068	S TURB S SEP CD 1.0416 0.1282 0.0176* 0.6194 0.0000 0.0020 CL= 1.157 CD=0.01954 CM=-0.1067
10.00	S TURB S SEP CD UPPER 1.0413 0.1391 0.0193* LOWER 0.4834 0.0000 0.0014 TOTAL CL= 1.244 CD=0.02071 CM=-0.1075	S TURB S SEP CD 1.0413 0.1391 0.0193* 0.9358 0.0000 0.0021 CL= 1.244 CD=0.02140 CM=-0.1075	S TURB S SEP CD 1.0417 0.1392 0.0193* 0.6146 0.0000 0.0018 CL= 1.244 CD=0.02116 CM=-0.1075

B.L.SUMMARY AIRFOIL S827 21% ALPHA0= 3.165 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU=3.0	R= 3000000 MU=1.3	R= 3000000 MU=9.0
-4.00	S TURB S SEP CD UPPER 0.3668 0.0113 0.0024* LOWER 0.5374 0.0168 0.0030 TOTAL CL=-0.094 CD=0.00539 CM=-0.0788	S TURB S SEP CD 1.0099 0.0433 0.0057 0.9664 0.1910 0.0062 CL=-0.061 CD=0.01191 CM=-0.0846	S TURB S SEP CD 0.9121 0.0428 0.0056 1.0218 0.1973 0.0066* CL=-0.059 CD=0.01217 CM=-0.0849
-3.00	S TURB S SEP CD UPPER 0.3697 0.0144 0.0026* LOWER 0.5345 0.0000 0.0028 TOTAL CL= 0.007 CD=0.00531 CM=-0.0818	S TURB S SEP CD 1.0099 0.0481 0.0062 0.9664 0.1748 0.0057 CL= 0.028 CD=0.01185 CM=-0.0861	S TURB S SEP CD 0.9298 0.0476 0.0060 1.0126 0.1795 0.0059 CL= 0.030 CD=0.01196 CM=-0.0864
-2.00	S TURB S SEP CD UPPER 0.3731 0.0177 0.0027 LOWER 0.5313 0.0000 0.0027 TOTAL CL= 0.114 CD=0.00535 CM=-0.0859	S TURB S SEP CD 1.0098 0.0529 0.0067 0.9664 0.1571 0.0052 CL= 0.118 CD=0.01187 CM=-0.0877	S TURB S SEP CD 0.9466 0.0525 0.0065 0.9985 0.1602 0.0053 CL= 0.119 CD=0.01188 CM=-0.0879
-1.00	S TURB S SEP CD UPPER 0.3766 0.0210 0.0028 LOWER 0.5279 0.0000 0.0025 TOTAL CL= 0.220 CD=0.00539 CM=-0.0900	S TURB S SEP CD 1.0099 0.0579 0.0072 0.9664 0.1373 0.0048 CL= 0.209 CD=0.01197 CM=-0.0892	S TURB S SEP CD 0.9628 0.0575 0.0071 0.9837 0.1389 0.0048 CL= 0.210 CD=0.01191 CM=-0.0893
0.00	S TURB S SEP CD UPPER 0.3801 0.0249 0.0030 LOWER 0.5242 0.0000 0.0024 TOTAL CL= 0.325 CD=0.00544 CM=-0.0939	S TURB S SEP CD 1.0099 0.0630 0.0078 0.9664 0.1152 0.0044 CL= 0.302 CD=0.01215 CM=-0.0908	S TURB S SEP CD 0.9776 0.0627 0.0077 0.9671 0.1152 0.0044 CL= 0.302 CD=0.01206 CM=-0.0908
1.00	S TURB S SEP CD UPPER 0.3836 0.0284 0.0032 LOWER 0.5202 0.0000 0.0023 TOTAL CL= 0.431 CD=0.00548 CM=-0.0978	S TURB S SEP CD 1.0099 0.0682 0.0084 0.9664 0.0897 0.0040 CL= 0.396 CD=0.01241 CM=-0.0924	S TURB S SEP CD 0.9903 0.0680 0.0083 0.9478 0.0880 0.0040 CL= 0.396 CD=0.01231 CM=-0.0924
2.00	S TURB S SEP CD UPPER 0.3873 0.0321 0.0034 LOWER 0.5159 0.0000 0.0022* TOTAL CL= 0.535 CD=0.00553 CM=-0.1016	S TURB S SEP CD 1.0099 0.0734 0.0091 0.9664 0.0594 0.0037 CL= 0.493 CD=0.01275 CM=-0.0942	S TURB S SEP CD 1.0046 0.0734 0.0091 0.9289 0.0556 0.0036 CL= 0.493 CD=0.01268 CM=-0.0941
3.00	S TURB S SEP CD UPPER 0.3913 0.0359 0.0035 LOWER 0.5118 0.0000 0.0021* TOTAL CL= 0.639 CD=0.00561 CM=-0.1052	S TURB S SEP CD 1.0099 0.0788 0.0098 0.9664 0.0147 0.0034 CL= 0.593 CD=0.01318 CM=-0.0960	S TURB S SEP CD 1.0166 0.0789 0.0099 0.9124 0.0056 0.0033 CL= 0.593 CD=0.01318 CM=-0.0957
4.00	S TURB S SEP CD UPPER 0.3958 0.0402 0.0038 LOWER 0.5082 0.0000 0.0020* TOTAL CL= 0.742 CD=0.00571 CM=-0.1086	S TURB S SEP CD 1.0099 0.0845 0.0106 0.9664 0.0000 0.0031 CL= 0.692 CD=0.01375 CM=-0.0983	S TURB S SEP CD 1.0259 0.0848 0.0107 0.8822 0.0000 0.0031 CL= 0.692 CD=0.01383 CM=-0.0982
5.00	S TURB S SEP CD UPPER 0.4010 0.0446 0.0040 LOWER 0.5047 0.0000 0.0018* TOTAL CL= 0.845 CD=0.00584 CM=-0.1119	S TURB S SEP CD 1.0099 0.0906 0.0115 0.9663 0.0000 0.0030 CL= 0.790 CD=0.01443 CM=-0.1008	S TURB S SEP CD 1.0339 0.0913 0.0118 0.8570 0.0000 0.0029 CL= 0.789 CD=0.01466 CM=-0.1007
6.00	S TURB S SEP CD UPPER 0.4079 0.0496 0.0043 LOWER 0.5013 0.0000 0.0017* TOTAL CL= 0.946 CD=0.00601 CM=-0.1149	S TURB S SEP CD 1.0099 0.0973 0.0124 0.9664 0.0000 0.0028 CL= 0.887 CD=0.01517 CM=-0.1031	S TURB S SEP CD 1.0397 0.0984 0.0129 0.8223 0.0000 0.0027 CL= 0.885 CD=0.01559 CM=-0.1029
7.00	S TURB S SEP CD UPPER 1.0268 0.1053 0.0138 LOWER 0.4978 0.0000 0.0017* TOTAL CL= 0.981 CD=0.01543 CM=-0.1050	S TURB S SEP CD 1.0268 0.1053 0.0138 0.9638 0.0000 0.0026 CL= 0.981 CD=0.01636 CM=-0.1050	S TURB S SEP CD 1.0413 0.1061 0.0141 0.7778 0.0000 0.0025 CL= 0.980 CD=0.01662 CM=-0.1048
8.00	S TURB S SEP CD UPPER 1.0409 0.1144 0.0155* LOWER 0.4943 0.0000 0.0016* TOTAL CL= 1.073 CD=0.01706 CM=-0.1065	S TURB S SEP CD 1.0409 0.1144 0.0155* 0.9638 0.0000 0.0024 CL= 1.073 CD=0.01790 CM=-0.1065	S TURB S SEP CD 1.0415 0.1144 0.0155* 0.6360 0.0000 0.0021 CL= 1.073 CD=0.01760 CM=-0.1065
9.00	S TURB S SEP CD UPPER 1.0412 0.1235 0.0170* LOWER 0.4904 0.0000 0.0015 TOTAL CL= 1.163 CD=0.01849 CM=-0.1078	S TURB S SEP CD 1.0412 0.1235 0.0170* 0.9638 0.0000 0.0022 CL= 1.163 CD=0.01925 CM=-0.1078	S TURB S SEP CD 1.0417 0.1236 0.0171* 0.6312 0.0000 0.0019 CL= 1.163 CD=0.01900 CM=-0.1078
10.00	S TURB S SEP CD UPPER 1.0413 0.1341 0.0187* LOWER 0.4861 0.0000 0.0014 TOTAL CL= 1.251 CD=0.02009 CM=-0.1087	S TURB S SEP CD 1.0413 0.1341 0.0187* 0.9358 0.0000 0.0021 CL= 1.251 CD=0.02078 CM=-0.1087	S TURB S SEP CD 1.0417 0.1342 0.0188* 0.6258 0.0000 0.0018 CL= 1.251 CD=0.02057 CM=-0.1086

B.L.SUMMARY AIRFOIL S827 21% ALPHA0= 3.165 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3500000 MU=3.0	R= 3500000 MU=1.3	R= 3500000 MU=9.0
-4.00	S TURB S SEP CD UPPER 0.3691 0.0093 0.0023 LOWER 0.5395 0.0046 0.0029 TOTAL CL=-0.097 CD=0.00523 CM=-0.0782	S TURB S SEP CD 1.0099 0.0414 0.0056 0.9664 0.1848 0.0061 CL=-0.062 CD=0.01162 CM=-0.0846	S TURB S SEP CD 0.9234 0.0410 0.0055 1.0218 0.1913 0.0064* CL=-0.059 CD=0.01190 CM=-0.0849
-3.00	S TURB S SEP CD UPPER 0.3724 0.0124 0.0025 LOWER 0.5367 0.0000 0.0027 TOTAL CL= 0.009 CD=0.00517 CM=-0.0821	S TURB S SEP CD 1.0099 0.0461 0.0060 0.9664 0.1684 0.0056 CL= 0.028 CD=0.01156 CM=-0.0861	S TURB S SEP CD 0.9387 0.0457 0.0059 1.0142 0.1735 0.0058 CL= 0.030 CD=0.01170 CM=-0.0864
-2.00	S TURB S SEP CD UPPER 0.3758 0.0155 0.0026 LOWER 0.5336 0.0000 0.0026 TOTAL CL= 0.116 CD=0.00521 CM=-0.0863	S TURB S SEP CD 1.0098 0.0509 0.0065 0.9664 0.1503 0.0051 CL= 0.119 CD=0.01158 CM=-0.0877	S TURB S SEP CD 0.9545 0.0505 0.0064 1.0011 0.1539 0.0052 CL= 0.120 CD=0.01162 CM=-0.0879
-1.00	S TURB S SEP CD UPPER 0.3793 0.0189 0.0028 LOWER 0.5303 0.0000 0.0025 TOTAL CL= 0.222 CD=0.00524 CM=-0.0904	S TURB S SEP CD 1.0099 0.0557 0.0070 0.9664 0.1303 0.0047 CL= 0.210 CD=0.01168 CM=-0.0893	S TURB S SEP CD 0.9694 0.0554 0.0069 0.9872 0.1323 0.0047 CL= 0.211 CD=0.01165 CM=-0.0894
0.00	S TURB S SEP CD UPPER 0.3828 0.0227 0.0029 LOWER 0.5267 0.0000 0.0024 TOTAL CL= 0.327 CD=0.00528 CM=-0.0944	S TURB S SEP CD 1.0099 0.0608 0.0076 0.9664 0.1076 0.0043 CL= 0.303 CD=0.01186 CM=-0.0909	S TURB S SEP CD 0.9832 0.0605 0.0075 0.9724 0.1083 0.0043 CL= 0.303 CD=0.01180 CM=-0.0909
1.00	S TURB S SEP CD UPPER 0.3863 0.0261 0.0031 LOWER 0.5228 0.0000 0.0023 TOTAL CL= 0.433 CD=0.00532 CM=-0.0983	S TURB S SEP CD 1.0099 0.0659 0.0082 0.9664 0.0813 0.0039 CL= 0.398 CD=0.01211 CM=-0.0925	S TURB S SEP CD 0.9947 0.0657 0.0081 0.9548 0.0803 0.0039 CL= 0.398 CD=0.01204 CM=-0.0925
2.00	S TURB S SEP CD UPPER 0.3900 0.0296 0.0032 LOWER 0.5187 0.0000 0.0021* TOTAL CL= 0.538 CD=0.00537 CM=-0.1021	S TURB S SEP CD 1.0099 0.0710 0.0089 0.9664 0.0495 0.0036 CL= 0.495 CD=0.01244 CM=-0.0943	S TURB S SEP CD 1.0080 0.0710 0.0089 0.9365 0.0464 0.0035 CL= 0.495 CD=0.01240 CM=-0.0943
3.00	S TURB S SEP CD UPPER 0.3941 0.0334 0.0034 LOWER 0.5142 0.0000 0.0020* TOTAL CL= 0.642 CD=0.00544 CM=-0.1058	S TURB S SEP CD 1.0099 0.0763 0.0096 0.9664 0.0000 0.0033 CL= 0.595 CD=0.01286 CM=-0.0960	S TURB S SEP CD 1.0190 0.0765 0.0096 0.9204 0.0000 0.0032 CL= 0.595 CD=0.01287 CM=-0.0960
4.00	S TURB S SEP CD UPPER 0.3987 0.0375 0.0036 LOWER 0.5103 0.0000 0.0019* TOTAL CL= 0.745 CD=0.00553 CM=-0.1093	S TURB S SEP CD 1.0099 0.0819 0.0103 0.9664 0.0000 0.0031 CL= 0.695 CD=0.01344 CM=-0.0988	S TURB S SEP CD 1.0280 0.0823 0.0105 0.8949 0.0000 0.0030 CL= 0.694 CD=0.01355 CM=-0.0988
5.00	S TURB S SEP CD UPPER 0.4043 0.0418 0.0039 LOWER 0.5067 0.0000 0.0018* TOTAL CL= 0.848 CD=0.00566 CM=-0.1126	S TURB S SEP CD 1.0099 0.0877 0.0112 0.9663 0.0000 0.0029 CL= 0.793 CD=0.01409 CM=-0.1015	S TURB S SEP CD 1.0352 0.0884 0.0115 0.8722 0.0000 0.0029 CL= 0.793 CD=0.01434 CM=-0.1013
6.00	S TURB S SEP CD UPPER 0.4121 0.0467 0.0041 LOWER 0.5033 0.0000 0.0017* TOTAL CL= 0.950 CD=0.00584 CM=-0.1156	S TURB S SEP CD 1.0099 0.0942 0.0121 0.9664 0.0000 0.0027 CL= 0.891 CD=0.01480 CM=-0.1038	S TURB S SEP CD 1.0402 0.0953 0.0126 0.8498 0.0000 0.0027 CL= 0.889 CD=0.01525 CM=-0.1036
7.00	S TURB S SEP CD UPPER 1.0268 0.1019 0.0134 LOWER 0.4998 0.0000 0.0016* TOTAL CL= 0.985 CD=0.01503 CM=-0.1058	S TURB S SEP CD 1.0268 0.1019 0.0134 0.9638 0.0000 0.0025 CL= 0.985 CD=0.01596 CM=-0.1058	S TURB S SEP CD 1.0414 0.1028 0.0138 0.8153 0.0000 0.0025 CL= 0.984 CD=0.01626 CM=-0.1056
8.00	S TURB S SEP CD UPPER 1.0409 0.1108 0.0151* LOWER 0.4963 0.0000 0.0015 TOTAL CL= 1.078 CD=0.01664 CM=-0.1073	S TURB S SEP CD 1.0409 0.1108 0.0151* 0.9638 0.0000 0.0024 CL= 1.078 CD=0.01747 CM=-0.1073	S TURB S SEP CD 1.0416 0.1109 0.0151* 0.7767 0.0000 0.0023 CL= 1.077 CD=0.01741 CM=-0.1073
9.00	S TURB S SEP CD UPPER 1.0412 0.1197 0.0166* LOWER 0.4925 0.0000 0.0014 TOTAL CL= 1.169 CD=0.01803 CM=-0.1087	S TURB S SEP CD 1.0412 0.1197 0.0166* 0.9638 0.0000 0.0022 CL= 1.169 CD=0.01878 CM=-0.1087	S TURB S SEP CD 1.0417 0.1198 0.0166* 0.6411 0.0000 0.0019 CL= 1.169 CD=0.01856 CM=-0.1087
10.00	S TURB S SEP CD UPPER 1.0413 0.1299 0.0182* LOWER 0.4884 0.0000 0.0013 TOTAL CL= 1.257 CD=0.01959 CM=-0.1096	S TURB S SEP CD 1.0413 0.1299 0.0182* 0.9358 0.0000 0.0020 CL= 1.257 CD=0.02026 CM=-0.1096	S TURB S SEP CD 1.0418 0.1301 0.0183* 0.6366 0.0000 0.0018 CL= 1.257 CD=0.02008 CM=-0.1096

B.L.SUMMARY AIRFOIL S827 21% ALPHA0= 3.165 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEC.)	R= 4000000 MU=3.0	R= 4000000 MU=1.3	R= 4000000 MU=9.0
-4.00	S TURB S SEP CD UPPER 0.3714 0.0077 0.0023 LOWER 0.5414 0.0000 0.0028 TOTAL CL=-0.097 CD=0.00508 CM=-0.0781	S TURB S SEP CD 1.0099 0.0398 0.0054 0.9664 0.1794 0.0059 CL=-0.062 CD=0.01137 CM=-0.0845	S TURB S SEP CD 0.9312 0.0394 0.0054 1.0219 0.1861 0.0063 CL=-0.060 CD=0.01167 CM=-0.0849
-3.00	S TURB S SEP CD UPPER 0.3748 0.0108 0.0024 LOWER 0.5386 0.0000 0.0027 TOTAL CL= 0.010 CD=0.00507 CM=-0.0824	S TURB S SEP CD 1.0099 0.0444 0.0059 0.9664 0.1627 0.0054 CL= 0.028 CD=0.01132 CM=-0.0861	S TURB S SEP CD 0.9453 0.0441 0.0058 1.0155 0.1681 0.0057 CL= 0.029 CD=0.01147 CM=-0.0864
-2.00	S TURB S SEP CD UPPER 0.3783 0.0139 0.0025 LOWER 0.5356 0.0000 0.0026 TOTAL CL= 0.117 CD=0.00510 CM=-0.0867	S TURB S SEP CD 1.0098 0.0491 0.0064 0.9664 0.1444 0.0050 CL= 0.119 CD=0.01134 CM=-0.0877	S TURB S SEP CD 0.9608 0.0488 0.0063 1.0031 0.1483 0.0051 CL= 0.120 CD=0.01139 CM=-0.0879
-1.00	S TURB S SEP CD UPPER 0.3817 0.0171 0.0027 LOWER 0.5324 0.0000 0.0024 TOTAL CL= 0.223 CD=0.00512 CM=-0.0908	S TURB S SEP CD 1.0099 0.0539 0.0069 0.9664 0.1241 0.0046 CL= 0.211 CD=0.01144 CM=-0.0893	S TURB S SEP CD 0.9746 0.0536 0.0068 0.9898 0.1264 0.0046 CL= 0.211 CD=0.01143 CM=-0.0894
0.00	S TURB S SEP CD UPPER 0.3852 0.0208 0.0028 LOWER 0.5289 0.0000 0.0023 TOTAL CL= 0.329 CD=0.00516 CM=-0.0948	S TURB S SEP CD 1.0099 0.0588 0.0074 0.9664 0.1009 0.0042 CL= 0.304 CD=0.01161 CM=-0.0909	S TURB S SEP CD 0.9872 0.0586 0.0074 0.9761 0.1018 0.0042 CL= 0.304 CD=0.01157 CM=-0.0910
1.00	S TURB S SEP CD UPPER 0.3887 0.0242 0.0030 LOWER 0.5252 0.0000 0.0022 TOTAL CL= 0.435 CD=0.00519 CM=-0.0987	S TURB S SEP CD 1.0099 0.0639 0.0080 0.9664 0.0739 0.0038 CL= 0.399 CD=0.01186 CM=-0.0926	S TURB S SEP CD 0.9995 0.0638 0.0080 0.9604 0.0733 0.0038 CL= 0.399 CD=0.01182 CM=-0.0926
2.00	S TURB S SEP CD UPPER 0.3925 0.0277 0.0031 LOWER 0.5211 0.0000 0.0021 TOTAL CL= 0.540 CD=0.00524 CM=-0.1026	S TURB S SEP CD 1.0099 0.0690 0.0087 0.9664 0.0404 0.0035 CL= 0.497 CD=0.01218 CM=-0.0945	S TURB S SEP CD 1.0107 0.0690 0.0087 0.9429 0.0377 0.0035 CL= 0.497 CD=0.01216 CM=-0.0944
3.00	S TURB S SEP CD UPPER 0.3966 0.0313 0.0033 LOWER 0.5166 0.0000 0.0020* TOTAL CL= 0.644 CD=0.00530 CM=-0.1063	S TURB S SEP CD 1.0099 0.0742 0.0094 0.9664 0.0000 0.0032 CL= 0.598 CD=0.01258 CM=-0.0965	S TURB S SEP CD 1.0206 0.0744 0.0094 0.9267 0.0000 0.0032 CL= 0.598 CD=0.01261 CM=-0.0964
4.00	S TURB S SEP CD UPPER 0.4014 0.0353 0.0035 LOWER 0.5123 0.0000 0.0019* TOTAL CL= 0.748 CD=0.00539 CM=-0.1099	S TURB S SEP CD 1.0099 0.0796 0.0101 0.9664 0.0000 0.0030 CL= 0.697 CD=0.01317 CM=-0.0993	S TURB S SEP CD 1.0296 0.0800 0.0103 0.9059 0.0000 0.0030 CL= 0.697 CD=0.01330 CM=-0.0993
5.00	S TURB S SEP CD UPPER 0.4075 0.0396 0.0038 LOWER 0.5086 0.0000 0.0018* TOTAL CL= 0.851 CD=0.00552 CM=-0.1132	S TURB S SEP CD 1.0099 0.0853 0.0109 0.9663 0.0000 0.0029 CL= 0.796 CD=0.01380 CM=-0.1020	S TURB S SEP CD 1.0362 0.0860 0.0112 0.8847 0.0000 0.0028 CL= 0.795 CD=0.01407 CM=-0.1019
6.00	S TURB S SEP CD UPPER 0.4168 0.0446 0.0040 LOWER 0.5050 0.0000 0.0017* TOTAL CL= 0.952 CD=0.00571 CM=-0.1162	S TURB S SEP CD 1.0099 0.0915 0.0118 0.9664 0.0000 0.0027 CL= 0.894 CD=0.01448 CM=-0.1045	S TURB S SEP CD 1.0408 0.0927 0.0123 0.8612 0.0000 0.0026 CL= 0.892 CD=0.01496 CM=-0.1042
7.00	S TURB S SEP CD UPPER 1.0268 0.0990 0.0131 LOWER 0.5016 0.0000 0.0016* TOTAL CL= 0.989 CD=0.01470 CM=-0.1064	S TURB S SEP CD 1.0268 0.0990 0.0131 0.9638 0.0000 0.0025 CL= 0.989 CD=0.01562 CM=-0.1064	S TURB S SEP CD 1.0415 0.0999 0.0135 0.8405 0.0000 0.0024 CL= 0.988 CD=0.01595 CM=-0.1062
8.00	S TURB S SEP CD UPPER 1.0409 0.1077 0.0148* LOWER 0.4980 0.0000 0.0015 TOTAL CL= 1.082 CD=0.01628 CM=-0.1080	S TURB S SEP CD 1.0409 0.1077 0.0148* 0.9638 0.0000 0.0023 CL= 1.082 CD=0.01710 CM=-0.1080	S TURB S SEP CD 1.0416 0.1078 0.0148* 0.8058 0.0000 0.0023 CL= 1.082 CD=0.01707 CM=-0.1080
9.00	S TURB S SEP CD UPPER 1.0412 0.1165 0.0162* LOWER 0.4944 0.0000 0.0014 TOTAL CL= 1.173 CD=0.01764 CM=-0.1094	S TURB S SEP CD 1.0412 0.1165 0.0162* 0.9638 0.0000 0.0021 CL= 1.173 CD=0.01838 CM=-0.1094	S TURB S SEP CD 1.0417 0.1166 0.0163* 0.7735 0.0000 0.0021 CL= 1.173 CD=0.01836 CM=-0.1094
10.00	S TURB S SEP CD UPPER 1.0413 0.1263 0.0178* LOWER 0.4904 0.0000 0.0013 TOTAL CL= 1.263 CD=0.01916 CM=-0.1105	S TURB S SEP CD 1.0413 0.1263 0.0178* 0.9358 0.0000 0.0020 CL= 1.263 CD=0.01983 CM=-0.1105	S TURB S SEP CD 1.0418 0.1265 0.0179* 0.6446 0.0000 0.0018 CL= 1.262 CD=0.01966 CM=-0.1104

AIRFOIL S828 16%				-3.00	-2.00	-1.00	0.00	1.00	2.00	3.00
N	X	Y	NUE	CP-DISTR.	FOR THE	ABOVE	ALPHA REL.	CHORD	LINE	
1	1.00000	0.00000	0.00	0.444	0.444	0.444	0.445	0.445	0.447	0.448
2	0.99595	0.00050	1.00	0.436	0.435	0.434	0.433	0.433	0.433	0.434
3	0.98420	0.00250	2.00	0.395	0.393	0.391	0.389	0.388	0.387	0.387
4	0.96579	0.00665	3.00	0.329	0.325	0.321	0.318	0.316	0.313	0.311
5	0.94187	0.01297	4.00	0.244	0.238	0.233	0.228	0.223	0.219	0.216
6	0.91342	0.02103	5.00	0.153	0.145	0.137	0.130	0.123	0.117	0.111
7	0.88101	0.03029	6.00	0.073	0.062	0.052	0.042	0.032	0.024	0.016
8	0.84507	0.04046	7.00	-0.001	-0.014	-0.028	-0.040	-0.053	-0.064	-0.075
9	0.80626	0.05131	8.00	-0.086	-0.104	-0.121	-0.137	-0.153	-0.168	-0.182
10	0.76532	0.06246	9.00	-0.184	-0.205	-0.227	-0.247	-0.267	-0.286	-0.305
11	0.72289	0.07334	10.00	-0.292	-0.319	-0.345	-0.371	-0.396	-0.420	-0.444
12	0.67954	0.08339	11.00	-0.409	-0.442	-0.475	-0.507	-0.538	-0.569	-0.599
13	0.63573	0.09180	12.00	-0.534	-0.575	-0.614	-0.653	-0.692	-0.730	-0.767
14	0.59134	0.09770	13.00	-0.579	-0.626	-0.671	-0.717	-0.761	-0.806	-0.850
15	0.54576	0.10103	14.00	-0.540	-0.590	-0.640	-0.690	-0.739	-0.788	-0.836
16	0.49904	0.10241	15.00	-0.500	-0.554	-0.609	-0.663	-0.717	-0.771	-0.824
17	0.45176	0.10219	16.00	-0.459	-0.518	-0.577	-0.636	-0.695	-0.754	-0.813
18	0.40444	0.10053	17.00	-0.417	-0.480	-0.544	-0.608	-0.673	-0.738	-0.803
19	0.35762	0.09756	18.00	-0.372	-0.441	-0.510	-0.581	-0.651	-0.723	-0.795
20	0.31183	0.09340	19.00	-0.325	-0.400	-0.475	-0.552	-0.630	-0.709	-0.788
21	0.26758	0.08817	20.00	-0.274	-0.355	-0.438	-0.522	-0.608	-0.695	-0.783
22	0.22536	0.08199	21.00	-0.218	-0.307	-0.397	-0.490	-0.584	-0.681	-0.780
23	0.18564	0.07497	22.00	-0.155	-0.251	-0.351	-0.453	-0.559	-0.667	-0.777
24	0.14886	0.06724	23.00	-0.082	-0.188	-0.297	-0.411	-0.529	-0.651	-0.776
25	0.11542	0.05894	24.00	0.006	-0.111	-0.233	-0.360	-0.493	-0.631	-0.775
26	0.08569	0.05019	25.00	0.112	-0.016	-0.152	-0.296	-0.448	-0.607	-0.773
27	0.05999	0.04116	26.00	0.246	0.106	-0.047	-0.210	-0.385	-0.570	-0.766
28	0.03860	0.03202	27.00	0.419	0.266	0.096	-0.091	-0.295	-0.515	-0.752
29	0.02173	0.02295	28.00	0.642	0.486	0.303	0.091	-0.147	-0.413	-0.705
30	0.00956	0.01419	29.00	0.898	0.772	0.596	0.371	0.098	-0.225	-0.596
31	0.00226	0.00609	30.00	0.952	1.000	0.946	0.791	0.533	0.174	-0.285
32	0.00038	0.00215	30.54	0.443	0.789	0.970	0.987	0.839	0.526	0.049
33	0.00003	0.00053	30.79	-0.208	0.405	0.803	0.987	0.955	0.707	0.245
34	0.00009	-0.00090	31.04	-1.464	-0.410	0.352	0.822	0.998	0.882	0.471
35	0.00069	-0.00224	31.29	-1.283	-0.440	0.210	0.667	0.930	0.998	0.872
36	0.00179	-0.00364	31.54	-1.163	-0.461	0.104	0.532	0.823	0.975	0.989
37	0.00481	-0.00633	32.00	-1.023	-0.486	-0.032	0.341	0.631	0.837	0.960
38	0.01546	-0.01240	33.00	-0.869	-0.516	-0.199	0.082	0.325	0.532	0.701
39	0.03146	-0.01840	34.00	-0.747	-0.492	-0.256	-0.040	0.157	0.333	0.489
40	0.05264	-0.02409	35.00	-0.642	-0.448	-0.264	-0.093	0.067	0.214	0.350
41	0.07880	-0.02943	36.00	-0.566	-0.411	-0.263	-0.122	0.011	0.136	0.253
42	0.10964	-0.03438	37.00	-0.506	-0.378	-0.255	-0.137	-0.024	0.083	0.185
43	0.14480	-0.03894	38.00	-0.462	-0.354	-0.250	-0.148	-0.051	0.043	0.133
44	0.18387	-0.04309	39.00	-0.428	-0.336	-0.245	-0.157	-0.072	0.011	0.091
45	0.22636	-0.04679	40.00	-0.403	-0.322	-0.243	-0.165	-0.090	-0.016	0.056
46	0.27176	-0.05002	41.00	-0.383	-0.312	-0.242	-0.173	-0.106	-0.040	0.025
47	0.31952	-0.05274	42.00	-0.369	-0.306	-0.244	-0.182	-0.121	-0.061	-0.002
48	0.36907	-0.05490	43.00	-0.359	-0.302	-0.246	-0.191	-0.136	-0.082	-0.028
49	0.41982	-0.05645	44.00	-0.351	-0.300	-0.250	-0.200	-0.150	-0.101	-0.052
50	0.47117	-0.05732	45.00	-0.345	-0.300	-0.255	-0.209	-0.164	-0.119	-0.074
51	0.52253	-0.05746	46.00	-0.342	-0.301	-0.260	-0.219	-0.178	-0.136	-0.095
52	0.57329	-0.05681	47.00	-0.339	-0.302	-0.265	-0.228	-0.191	-0.153	-0.116
53	0.62288	-0.05527	48.00	-0.338	-0.305	-0.272	-0.238	-0.204	-0.170	-0.136
54	0.67072	-0.05275	49.00	-0.338	-0.308	-0.278	-0.248	-0.217	-0.186	-0.155
55	0.71627	-0.04898	50.00	-0.331	-0.305	-0.278	-0.251	-0.224	-0.196	-0.167
56	0.75939	-0.04362	51.00	-0.278	-0.256	-0.234	-0.210	-0.187	-0.163	-0.138
57	0.80026	-0.03672	52.00	-0.179	-0.161	-0.142	-0.124	-0.104	-0.084	-0.064
58	0.83903	-0.02873	53.00	-0.048	-0.035	-0.020	-0.006	0.009	0.025	0.041
59	0.87561	-0.02049	54.00	0.088	0.098	0.109	0.119	0.131	0.143	0.155
60	0.90947	-0.01301	55.00	0.200	0.207	0.215	0.223	0.232	0.240	0.250
61	0.93959	-0.00705	56.00	0.289	0.294	0.299	0.305	0.311	0.318	0.325
62	0.96481	-0.00298	57.00	0.356	0.359	0.363	0.367	0.372	0.376	0.382
63	0.98395	-0.00080	58.00	0.403	0.405	0.408	0.410	0.414	0.417	0.421
64	0.99592	-0.00008	59.00	0.433	0.433	0.435	0.436	0.438	0.440	0.443
65	1.00000	0.00000	60.00	0.444	0.444	0.444	0.445	0.445	0.447	0.448

ALPHA= 2.03 DEGREES CM0=-0.0432 ETA= 1.122

AIRFOIL S828 16%				4.00	5.00	6.00	7.00	8.00	9.00	10.00
N	X	Y	NUE	CP-DISTR.	FOR THE	ABOVE	ALPHA	REL.	CHORD	LINE
1	1.00000	0.00000	0.00	0.450	0.452	0.455	0.458	0.461	0.464	0.468
2	0.99595	0.00050	1.00	0.435	0.436	0.437	0.439	0.442	0.444	0.447
3	0.98420	0.00250	2.00	0.386	0.387	0.387	0.388	0.389	0.391	0.393
4	0.96579	0.00665	3.00	0.310	0.309	0.308	0.308	0.308	0.309	0.310
5	0.94187	0.01297	4.00	0.213	0.210	0.208	0.206	0.205	0.204	0.204
6	0.91342	0.02103	5.00	0.106	0.101	0.097	0.094	0.091	0.088	0.086
7	0.88101	0.03029	6.00	0.008	0.001	-0.006	-0.012	-0.017	-0.021	-0.026
8	0.84507	0.04046	7.00	-0.086	-0.096	-0.105	-0.113	-0.121	-0.129	-0.135
9	0.80626	0.05131	8.00	-0.196	-0.209	-0.222	-0.234	-0.245	-0.255	-0.265
10	0.76532	0.06246	9.00	-0.323	-0.341	-0.357	-0.373	-0.388	-0.403	-0.416
11	0.72289	0.07334	10.00	-0.467	-0.490	-0.511	-0.532	-0.552	-0.572	-0.590
12	0.67954	0.08339	11.00	-0.628	-0.656	-0.684	-0.711	-0.737	-0.762	-0.787
13	0.63573	0.09180	12.00	-0.804	-0.840	-0.875	-0.910	-0.943	-0.976	-1.007
14	0.59134	0.09770	13.00	-0.893	-0.935	-0.977	-1.018	-1.058	-1.098	-1.136
15	0.54576	0.10103	14.00	-0.884	-0.932	-0.979	-1.025	-1.070	-1.115	-1.159
16	0.49904	0.10241	15.00	-0.877	-0.930	-0.982	-1.034	-1.086	-1.136	-1.186
17	0.45176	0.10219	16.00	-0.872	-0.931	-0.989	-1.047	-1.104	-1.162	-1.218
18	0.40444	0.10053	17.00	-0.868	-0.933	-0.998	-1.063	-1.128	-1.192	-1.256
19	0.35762	0.09756	18.00	-0.867	-0.939	-1.012	-1.085	-1.157	-1.230	-1.302
20	0.31183	0.09340	19.00	-0.868	-0.949	-1.030	-1.112	-1.194	-1.276	-1.358
21	0.26758	0.08817	20.00	-0.872	-0.963	-1.054	-1.146	-1.239	-1.332	-1.426
22	0.22536	0.08199	21.00	-0.880	-0.981	-1.085	-1.189	-1.295	-1.401	-1.509
23	0.18564	0.07497	22.00	-0.890	-1.005	-1.123	-1.242	-1.364	-1.487	-1.611
24	0.14886	0.06724	23.00	-0.905	-1.037	-1.172	-1.310	-1.451	-1.594	-1.740
25	0.11542	0.05894	24.00	-0.923	-1.076	-1.233	-1.395	-1.561	-1.731	-1.904
26	0.08569	0.05019	25.00	-0.946	-1.126	-1.313	-1.506	-1.705	-1.911	-2.121
27	0.05999	0.04116	26.00	-0.973	-1.189	-1.416	-1.652	-1.897	-2.152	-2.415
28	0.03860	0.03202	27.00	-1.005	-1.273	-1.557	-1.856	-2.170	-2.498	-2.839
29	0.02173	0.02295	28.00	-1.023	-1.368	-1.738	-2.133	-2.552	-2.996	-3.463
30	0.00956	0.01419	29.00	-1.015	-1.482	-1.995	-2.554	-3.160	-3.809	-4.503
31	0.00226	0.00609	30.00	-0.846	-1.506	-2.264	-3.121	-4.075	-5.125	-6.269
32	0.00038	0.00215	30.54	-0.591	-1.395	-2.360	-3.486	-4.772	-6.215	-7.814
33	0.00003	0.00053	30.79	-0.432	-1.322	-2.425	-3.739	-5.263	-6.995	-8.932
34	0.00009	-0.00090	31.04	-0.232	-1.227	-2.513	-4.088	-5.950	-8.097	-10.527
35	0.00069	-0.00224	31.29	0.551	0.037	-0.671	-1.571	-2.662	-3.944	-5.413
36	0.00179	-0.00364	31.54	0.865	0.602	0.202	-0.335	-1.010	-1.820	-2.765
37	0.00481	-0.00633	32.00	1.000	0.956	0.828	0.617	0.323	-0.054	-0.513
38	0.01546	-0.01240	33.00	0.832	0.926	0.982	1.000	0.980	0.922	0.826
39	0.03146	-0.01840	34.00	0.625	0.740	0.834	0.907	0.959	0.990	1.000
40	0.05264	-0.02409	35.00	0.472	0.583	0.680	0.765	0.837	0.896	0.942
41	0.07880	-0.02943	36.00	0.362	0.463	0.556	0.640	0.715	0.782	0.840
42	0.10964	-0.03438	37.00	0.282	0.373	0.458	0.537	0.610	0.677	0.738
43	0.14480	-0.03894	38.00	0.219	0.301	0.379	0.452	0.522	0.587	0.647
44	0.18387	-0.04309	39.00	0.168	0.243	0.314	0.382	0.447	0.508	0.567
45	0.22636	-0.04679	40.00	0.126	0.193	0.258	0.321	0.382	0.440	0.496
46	0.27176	-0.05002	41.00	0.089	0.150	0.210	0.269	0.325	0.380	0.432
47	0.31952	-0.05274	42.00	0.055	0.112	0.167	0.221	0.274	0.325	0.375
48	0.36907	-0.05490	43.00	0.025	0.077	0.128	0.178	0.228	0.276	0.323
49	0.41982	-0.05645	44.00	-0.003	0.045	0.092	0.139	0.185	0.230	0.274
50	0.47117	-0.05732	45.00	-0.029	0.015	0.059	0.102	0.145	0.187	0.229
51	0.52253	-0.05746	46.00	-0.054	-0.013	0.027	0.068	0.108	0.147	0.187
52	0.57329	-0.05681	47.00	-0.078	-0.040	-0.003	0.035	0.072	0.109	0.146
53	0.62288	-0.05527	48.00	-0.101	-0.066	-0.031	0.003	0.038	0.073	0.108
54	0.67072	-0.05275	49.00	-0.123	-0.091	-0.059	-0.027	0.005	0.038	0.070
55	0.71627	-0.04898	50.00	-0.139	-0.110	-0.080	-0.051	-0.021	0.009	0.039
56	0.75939	-0.04362	51.00	-0.113	-0.087	-0.062	-0.035	-0.009	0.018	0.045
57	0.80026	-0.03672	52.00	-0.043	-0.022	0.000	0.022	0.044	0.067	0.090
58	0.83903	-0.02873	53.00	0.058	0.075	0.092	0.110	0.128	0.146	0.165
59	0.87561	-0.02049	54.00	0.168	0.181	0.195	0.208	0.223	0.237	0.252
60	0.90947	-0.01301	55.00	0.260	0.270	0.280	0.291	0.302	0.314	0.326
61	0.93959	-0.00705	56.00	0.332	0.340	0.348	0.357	0.365	0.375	0.384
62	0.96481	-0.00298	57.00	0.387	0.393	0.399	0.406	0.413	0.420	0.428
63	0.98395	-0.00080	58.00	0.425	0.429	0.434	0.439	0.445	0.450	0.456
64	0.99592	-0.00008	59.00	0.446	0.449	0.453	0.457	0.461	0.465	0.470
65	1.00000	0.00000	60.00	0.450	0.452	0.455	0.458	0.461	0.464	0.468

ALPHA0= 2.03 DEGREES CM0=-0.0432 ETA= 1.122

B.L.SUMMARY AIRFOIL S828 16% ALPHA0= 2.027 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU=3.0	R= 2000000 MU=1.3	R= 2000000 MU=9.0
-3.00	S TURB S SEP CD UPPER 0.3669 0.0064 0.0024* LOWER 0.2724 0.0203 0.0020 TOTAL CL=-0.100 CD=0.00441 CM=-0.0405	S TURB S SEP CD 1.0030 0.0409 0.0055 0.9568 0.0446 0.0058 CL=-0.105 CD=0.01128 CM=-0.0391	S TURB S SEP CD 0.8920 0.0399 0.0053 1.0071 0.0453 0.0061 CL=-0.104 CD=0.01142 CM=-0.0393
-2.00	S TURB S SEP CD UPPER 0.3699 0.0105 0.0025* LOWER 0.2634 0.0125 0.0019 TOTAL CL= 0.003 CD=0.00439 CM=-0.0425	S TURB S SEP CD 1.0030 0.0464 0.0059 0.9568 0.0392 0.0054 CL=-0.006 CD=0.01129 CM=-0.0406	S TURB S SEP CD 0.9116 0.0456 0.0058 0.9906 0.0395 0.0055 CL=-0.005 CD=0.01128 CM=-0.0407
-1.00	S TURB S SEP CD UPPER 0.3733 0.0145 0.0027* LOWER 0.2562 0.0043 0.0017 TOTAL CL= 0.105 CD=0.00440 CM=-0.0445	S TURB S SEP CD 1.0029 0.0522 0.0064 0.9568 0.0337 0.0050 CL= 0.093 CD=0.01138 CM=-0.0421	S TURB S SEP CD 0.9309 0.0514 0.0063 0.9759 0.0339 0.0050 CL= 0.094 CD=0.01129 CM=-0.0422
0.00	S TURB S SEP CD UPPER 0.3771 0.0193 0.0028* LOWER 0.2501 0.0000 0.0016* TOTAL CL= 0.209 CD=0.00444 CM=-0.0470	S TURB S SEP CD 1.0030 0.0581 0.0070 0.9568 0.0280 0.0046 CL= 0.192 CD=0.01155 CM=-0.0436	S TURB S SEP CD 0.9492 0.0574 0.0068 0.9597 0.0281 0.0046 CL= 0.193 CD=0.01141 CM=-0.0437
1.00	S TURB S SEP CD UPPER 0.3811 0.0237 0.0030* LOWER 0.2447 0.0000 0.0015* TOTAL CL= 0.315 CD=0.00453 CM=-0.0499	S TURB S SEP CD 1.0030 0.0642 0.0075 0.9568 0.0221 0.0042 CL= 0.291 CD=0.01179 CM=-0.0451	S TURB S SEP CD 0.9670 0.0637 0.0074 0.9396 0.0220 0.0042 CL= 0.292 CD=0.01163 CM=-0.0451
2.00	S TURB S SEP CD UPPER 0.3853 0.0283 0.0032 LOWER 0.2399 0.0000 0.0015* TOTAL CL= 0.420 CD=0.00464 CM=-0.0526	S TURB S SEP CD 1.0030 0.0704 0.0082 0.9568 0.0158 0.0039 CL= 0.390 CD=0.01210 CM=-0.0465	S TURB S SEP CD 0.9822 0.0700 0.0081 0.9200 0.0156 0.0039 CL= 0.390 CD=0.01195 CM=-0.0466
3.00	S TURB S SEP CD UPPER 0.3898 0.0331 0.0034 LOWER 0.2357 0.0000 0.0014* TOTAL CL= 0.524 CD=0.00477 CM=-0.0553	S TURB S SEP CD 1.0030 0.0767 0.0089 0.9568 0.0091 0.0036 CL= 0.488 CD=0.01250 CM=-0.0480	S TURB S SEP CD 0.9972 0.0766 0.0088 0.8988 0.0087 0.0035 CL= 0.488 CD=0.01239 CM=-0.0480
4.00	S TURB S SEP CD UPPER 0.3947 0.0384 0.0036 LOWER 0.2317 0.0000 0.0013* TOTAL CL= 0.627 CD=0.00492 CM=-0.0577	S TURB S SEP CD 1.0030 0.0834 0.0096 0.9568 0.0000 0.0033 CL= 0.586 CD=0.01297 CM=-0.0492	S TURB S SEP CD 1.0105 0.0836 0.0097 0.8766 0.0000 0.0033 CL= 0.586 CD=0.01294 CM=-0.0492
5.00	S TURB S SEP CD UPPER 0.4005 0.0441 0.0038 LOWER 0.2280 0.0000 0.0013* TOTAL CL= 0.730 CD=0.00510 CM=-0.0600	S TURB S SEP CD 1.0030 0.0906 0.0104 0.9568 0.0000 0.0031 CL= 0.684 CD=0.01351 CM=-0.0509	S TURB S SEP CD 1.0191 0.0911 0.0106 0.8536 0.0000 0.0030 CL= 0.684 CD=0.01360 CM=-0.0508
6.00	S TURB S SEP CD UPPER 0.4078 0.0504 0.0041 LOWER 0.2243 0.0000 0.0012* TOTAL CL= 0.831 CD=0.00533 CM=-0.0621	S TURB S SEP CD 1.0030 0.0984 0.0113 0.9568 0.0000 0.0029 CL= 0.781 CD=0.01423 CM=-0.0524	S TURB S SEP CD 1.0260 0.0995 0.0117 0.8310 0.0000 0.0028 CL= 0.780 CD=0.01449 CM=-0.0522
7.00	S TURB S SEP CD UPPER 1.0127 0.1075 0.0125* LOWER 0.2207 0.0000 0.0011* TOTAL CL= 0.876 CD=0.01364 CM=-0.0535	S TURB S SEP CD 1.0127 0.1075 0.0125* 0.9568 0.0000 0.0027 CL= 0.876 CD=0.01523 CM=-0.0535	S TURB S SEP CD 1.0310 0.1087 0.0129 0.8021 0.0000 0.0026 CL= 0.875 CD=0.01552 CM=-0.0533
8.00	S TURB S SEP CD UPPER 1.0253 0.1180 0.0140* LOWER 0.2171 0.0000 0.0011* TOTAL CL= 0.968 CD=0.01509 CM=-0.0542	S TURB S SEP CD 1.0253 0.1180 0.0140* 0.9568 0.0000 0.0026 CL= 0.968 CD=0.01656 CM=-0.0542	S TURB S SEP CD 1.0333 0.1189 0.0143* 0.7812 0.0000 0.0025 CL= 0.967 CD=0.01672 CM=-0.0541
9.00	S TURB S SEP CD UPPER 1.0331 0.1300 0.0157* LOWER 0.2135 0.0000 0.0010* TOTAL CL= 1.057 CD=0.01677 CM=-0.0546	S TURB S SEP CD 1.0331 0.1300 0.0157* 0.9541 0.0000 0.0024 CL= 1.057 CD=0.01813 CM=-0.0546	S TURB S SEP CD 1.0335 0.1301 0.0158* 0.7468 0.0000 0.0023 CL= 1.057 CD=0.01804 CM=-0.0546
10.00	S TURB S SEP CD UPPER 1.0333 0.1433 0.0174* LOWER 0.2097 0.0000 0.0010* TOTAL CL= 1.143 CD=0.01838 CM=-0.0546	S TURB S SEP CD 1.0333 0.1433 0.0174* 0.9541 0.0000 0.0022 CL= 1.143 CD=0.01964 CM=-0.0546	S TURB S SEP CD 1.0336 0.1434 0.0174* 0.7232 0.0000 0.0021 CL= 1.143 CD=0.01956 CM=-0.0546

B.L.SUMMARY AIRFOIL S828 16% ALPHA0= 2.027 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2500000 MU=3.0	R= 2500000 MU=1.3	R= 2500000 MU=9.0
-3.00	S TURB S SEP CD UPPER 0.3699 0.0002 0.0023* LOWER 0.2786 0.0078 0.0019 TOTAL CL=-0.103 CD=0.00416 CM=-0.0397	S TURB S SEP CD 1.0030 0.0378 0.0053 0.9568 0.0406 0.0056 CL=-0.106 CD=0.01088 CM=-0.0390	S TURB S SEP CD 0.9080 0.0370 0.0052 1.0082 0.0413 0.0059 CL=-0.105 CD=0.01106 CM=-0.0392
-2.00	S TURB S SEP CD UPPER 0.3731 0.0065 0.0024* LOWER 0.2686 0.0002 0.0017 TOTAL CL=-0.001 CD=0.00414 CM=-0.0416	S TURB S SEP CD 1.0030 0.0434 0.0057 0.9568 0.0351 0.0052 CL=-0.006 CD=0.01090 CM=-0.0406	S TURB S SEP CD 0.9262 0.0427 0.0056 0.9937 0.0355 0.0053 CL=-0.005 CD=0.01094 CM=-0.0407
-1.00	S TURB S SEP CD UPPER 0.3769 0.0106 0.0025* LOWER 0.2609 0.0000 0.0016 TOTAL CL= 0.106 CD=0.00414 CM=-0.0447	S TURB S SEP CD 1.0029 0.0490 0.0062 0.9568 0.0296 0.0048 CL= 0.094 CD=0.01098 CM=-0.0421	S TURB S SEP CD 0.9433 0.0484 0.0061 0.9806 0.0298 0.0049 CL= 0.094 CD=0.01094 CM=-0.0422
0.00	S TURB S SEP CD UPPER 0.3808 0.0145 0.0027 LOWER 0.2545 0.0000 0.0015 TOTAL CL= 0.213 CD=0.00422 CM=-0.0478	S TURB S SEP CD 1.0030 0.0547 0.0067 0.9568 0.0238 0.0044 CL= 0.193 CD=0.01114 CM=-0.0437	S TURB S SEP CD 0.9601 0.0542 0.0066 0.9664 0.0239 0.0045 CL= 0.194 CD=0.01106 CM=-0.0438
1.00	S TURB S SEP CD UPPER 0.3849 0.0192 0.0028 LOWER 0.2489 0.0000 0.0015 TOTAL CL= 0.318 CD=0.00431 CM=-0.0507	S TURB S SEP CD 1.0030 0.0607 0.0073 0.9568 0.0178 0.0041 CL= 0.292 CD=0.01138 CM=-0.0452	S TURB S SEP CD 0.9749 0.0603 0.0072 0.9494 0.0177 0.0041 CL= 0.293 CD=0.01127 CM=-0.0453
2.00	S TURB S SEP CD UPPER 0.3890 0.0235 0.0030 LOWER 0.2438 0.0000 0.0014* TOTAL CL= 0.424 CD=0.00441 CM=-0.0535	S TURB S SEP CD 1.0030 0.0667 0.0079 0.9568 0.0114 0.0038 CL= 0.392 CD=0.01168 CM=-0.0468	S TURB S SEP CD 0.9885 0.0665 0.0078 0.9309 0.0112 0.0037 CL= 0.392 CD=0.01158 CM=-0.0468
3.00	S TURB S SEP CD UPPER 0.3936 0.0280 0.0032 LOWER 0.2393 0.0000 0.0013* TOTAL CL= 0.529 CD=0.00452 CM=-0.0563	S TURB S SEP CD 1.0030 0.0729 0.0086 0.9568 0.0040 0.0035 CL= 0.490 CD=0.01206 CM=-0.0483	S TURB S SEP CD 1.0022 0.0729 0.0086 0.9123 0.0036 0.0034 CL= 0.490 CD=0.01200 CM=-0.0482
4.00	S TURB S SEP CD UPPER 0.3987 0.0329 0.0034 LOWER 0.2352 0.0000 0.0013* TOTAL CL= 0.633 CD=0.00466 CM=-0.0589	S TURB S SEP CD 1.0030 0.0793 0.0093 0.9568 0.0000 0.0032 CL= 0.590 CD=0.01249 CM=-0.0499	S TURB S SEP CD 1.0135 0.0796 0.0094 0.8918 0.0000 0.0031 CL= 0.589 CD=0.01250 CM=-0.0499
5.00	S TURB S SEP CD UPPER 0.4049 0.0383 0.0036 LOWER 0.2313 0.0000 0.0012* TOTAL CL= 0.735 CD=0.00483 CM=-0.0613	S TURB S SEP CD 1.0030 0.0862 0.0101 0.9568 0.0000 0.0030 CL= 0.689 CD=0.01307 CM=-0.0517	S TURB S SEP CD 1.0216 0.0867 0.0103 0.8729 0.0000 0.0029 CL= 0.688 CD=0.01320 CM=-0.0516
6.00	S TURB S SEP CD UPPER 0.4131 0.0441 0.0039 LOWER 0.2276 0.0000 0.0011 TOTAL CL= 0.837 CD=0.00504 CM=-0.0635	S TURB S SEP CD 1.0030 0.0936 0.0109 0.9568 0.0000 0.0028 CL= 0.786 CD=0.01375 CM=-0.0533	S TURB S SEP CD 1.0272 0.0947 0.0113 0.8489 0.0000 0.0028 CL= 0.785 CD=0.01404 CM=-0.0531
7.00	S TURB S SEP CD UPPER 1.0127 0.1023 0.0120 LOWER 0.2240 0.0000 0.0011 TOTAL CL= 0.882 CD=0.01312 CM=-0.0545	S TURB S SEP CD 1.0127 0.1023 0.0120 0.9568 0.0000 0.0027 CL= 0.882 CD=0.01469 CM=-0.0545	S TURB S SEP CD 1.0320 0.1036 0.0125 0.8254 0.0000 0.0026 CL= 0.880 CD=0.01504 CM=-0.0542
8.00	S TURB S SEP CD UPPER 1.0253 0.1125 0.0135* LOWER 0.2204 0.0000 0.0010 TOTAL CL= 0.974 CD=0.01451 CM=-0.0553	S TURB S SEP CD 1.0253 0.1125 0.0135* 0.9568 0.0000 0.0025 CL= 0.974 CD=0.01597 CM=-0.0553	S TURB S SEP CD 1.0334 0.1134 0.0138 0.8031 0.0000 0.0024 CL= 0.973 CD=0.01616 CM=-0.0551
9.00	S TURB S SEP CD UPPER 1.0331 0.1241 0.0152* LOWER 0.2168 0.0000 0.0010 TOTAL CL= 1.064 CD=0.01615 CM=-0.0557	S TURB S SEP CD 1.0331 0.1241 0.0152* 0.9541 0.0000 0.0023 CL= 1.064 CD=0.01750 CM=-0.0557	S TURB S SEP CD 1.0336 0.1242 0.0152* 0.7751 0.0000 0.0022 CL= 1.064 CD=0.01744 CM=-0.0557
10.00	S TURB S SEP CD UPPER 1.0333 0.1369 0.0168* LOWER 0.2131 0.0000 0.0009 TOTAL CL= 1.151 CD=0.01770 CM=-0.0558	S TURB S SEP CD 1.0333 0.1369 0.0168* 0.9541 0.0000 0.0022 CL= 1.151 CD=0.01895 CM=-0.0558	S TURB S SEP CD 1.0337 0.1370 0.0168* 0.7551 0.0000 0.0021 CL= 1.151 CD=0.01890 CM=-0.0558

B.L.SUMMARY AIRFOIL S828 16% ALPHA0= 2.027 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU=3.0	R= 3000000 MU=1.3	R= 3000000 MU=9.0
-3.00	S TURB S SEP CD UPPER 0.3726 0.0000 0.0022* LOWER 0.2847 0.0006 0.0018 TOTAL CL=-0.107 CD=0.00398 CM=-0.0388	S TURB S SEP CD 1.0030 0.0353 0.0051 0.9568 0.0372 0.0054 CL=-0.106 CD=0.01056 CM=-0.0389	S TURB S SEP CD 0.9198 0.0347 0.0050 1.0090 0.0380 0.0057 CL=-0.106 CD=0.01077 CM=-0.0391
-2.00	S TURB S SEP CD UPPER 0.3762 0.0025 0.0023* LOWER 0.2735 0.0000 0.0016 TOTAL CL= 0.001 CD=0.00396 CM=-0.0422	S TURB S SEP CD 1.0030 0.0409 0.0056 0.9568 0.0317 0.0050 CL=-0.006 CD=0.01058 CM=-0.0405	S TURB S SEP CD 0.9360 0.0403 0.0055 0.9964 0.0322 0.0052 CL=-0.006 CD=0.01065 CM=-0.0406
-1.00	S TURB S SEP CD UPPER 0.3801 0.0076 0.0024 LOWER 0.2652 0.0000 0.0016 TOTAL CL= 0.108 CD=0.00401 CM=-0.0452	S TURB S SEP CD 1.0029 0.0463 0.0060 0.9568 0.0261 0.0046 CL= 0.094 CD=0.01067 CM=-0.0421	S TURB S SEP CD 0.9519 0.0459 0.0059 0.9843 0.0264 0.0047 CL= 0.094 CD=0.01066 CM=-0.0422
0.00	S TURB S SEP CD UPPER 0.3840 0.0115 0.0026 LOWER 0.2585 0.0000 0.0015 TOTAL CL= 0.215 CD=0.00407 CM=-0.0483	S TURB S SEP CD 1.0030 0.0519 0.0065 0.9568 0.0202 0.0043 CL= 0.194 CD=0.01082 CM=-0.0438	S TURB S SEP CD 0.9674 0.0516 0.0064 0.9716 0.0203 0.0043 CL= 0.194 CD=0.01078 CM=-0.0438
1.00	S TURB S SEP CD UPPER 0.3881 0.0159 0.0027 LOWER 0.2526 0.0000 0.0014 TOTAL CL= 0.321 CD=0.00415 CM=-0.0512	S TURB S SEP CD 1.0030 0.0578 0.0071 0.9568 0.0141 0.0040 CL= 0.294 CD=0.01105 CM=-0.0454	S TURB S SEP CD 0.9808 0.0575 0.0070 0.9562 0.0141 0.0040 CL= 0.294 CD=0.01098 CM=-0.0454
2.00	S TURB S SEP CD UPPER 0.3923 0.0202 0.0029 LOWER 0.2474 0.0000 0.0013 TOTAL CL= 0.427 CD=0.00423 CM=-0.0542	S TURB S SEP CD 1.0030 0.0638 0.0077 0.9568 0.0076 0.0037 CL= 0.393 CD=0.01134 CM=-0.0470	S TURB S SEP CD 0.9934 0.0636 0.0076 0.9387 0.0074 0.0036 CL= 0.393 CD=0.01128 CM=-0.0470
3.00	S TURB S SEP CD UPPER 0.3970 0.0245 0.0031 LOWER 0.2426 0.0000 0.0013 TOTAL CL= 0.532 CD=0.00434 CM=-0.0570	S TURB S SEP CD 1.0030 0.0698 0.0083 0.9568 0.0000 0.0034 CL= 0.492 CD=0.01170 CM=-0.0485	S TURB S SEP CD 1.0057 0.0699 0.0083 0.9222 0.0000 0.0034 CL= 0.492 CD=0.01167 CM=-0.0485
4.00	S TURB S SEP CD UPPER 0.4023 0.0291 0.0033 LOWER 0.2383 0.0000 0.0012 TOTAL CL= 0.636 CD=0.00447 CM=-0.0597	S TURB S SEP CD 1.0030 0.0761 0.0090 0.9568 0.0000 0.0031 CL= 0.593 CD=0.01213 CM=-0.0505	S TURB S SEP CD 1.0155 0.0764 0.0091 0.9039 0.0000 0.0031 CL= 0.592 CD=0.01218 CM=-0.0505
5.00	S TURB S SEP CD UPPER 0.4089 0.0343 0.0035 LOWER 0.2343 0.0000 0.0011 TOTAL CL= 0.739 CD=0.00463 CM=-0.0621	S TURB S SEP CD 1.0030 0.0827 0.0098 0.9568 0.0000 0.0030 CL= 0.692 CD=0.01272 CM=-0.0524	S TURB S SEP CD 1.0233 0.0833 0.0100 0.8847 0.0000 0.0029 CL= 0.691 CD=0.01288 CM=-0.0522
6.00	S TURB S SEP CD UPPER 0.4186 0.0401 0.0038 LOWER 0.2305 0.0000 0.0011 TOTAL CL= 0.841 CD=0.00485 CM=-0.0644	S TURB S SEP CD 1.0030 0.0897 0.0106 0.9568 0.0000 0.0028 CL= 0.790 CD=0.01336 CM=-0.0540	S TURB S SEP CD 1.0283 0.0909 0.0110 0.8638 0.0000 0.0027 CL= 0.789 CD=0.01368 CM=-0.0538
7.00	S TURB S SEP CD UPPER 1.0127 0.0981 0.0117 LOWER 0.2269 0.0000 0.0010 TOTAL CL= 0.886 CD=0.01271 CM=-0.0553	S TURB S SEP CD 1.0127 0.0981 0.0117 0.9568 0.0000 0.0026 CL= 0.886 CD=0.01427 CM=-0.0553	S TURB S SEP CD 1.0325 0.0995 0.0121 0.8419 0.0000 0.0025 CL= 0.885 CD=0.01464 CM=-0.0550
8.00	S TURB S SEP CD UPPER 1.0253 0.1080 0.0131* LOWER 0.2232 0.0000 0.0010 TOTAL CL= 0.979 CD=0.01406 CM=-0.0562	S TURB S SEP CD 1.0253 0.1080 0.0131* 0.9568 0.0000 0.0024 CL= 0.979 CD=0.01551 CM=-0.0562	S TURB S SEP CD 1.0335 0.1089 0.0134 0.8206 0.0000 0.0024 CL= 0.978 CD=0.01573 CM=-0.0560
9.00	S TURB S SEP CD UPPER 1.0331 0.1194 0.0147* LOWER 0.2196 0.0000 0.0009 TOTAL CL= 1.070 CD=0.01566 CM=-0.0566	S TURB S SEP CD 1.0331 0.1194 0.0147* 0.9541 0.0000 0.0023 CL= 1.070 CD=0.01700 CM=-0.0566	S TURB S SEP CD 1.0336 0.1195 0.0148* 0.7985 0.0000 0.0022 CL= 1.070 CD=0.01696 CM=-0.0566
10.00	S TURB S SEP CD UPPER 1.0333 0.1317 0.0163* LOWER 0.2159 0.0000 0.0009 TOTAL CL= 1.158 CD=0.01717 CM=-0.0568	S TURB S SEP CD 1.0333 0.1317 0.0163* 0.9541 0.0000 0.0021 CL= 1.158 CD=0.01840 CM=-0.0568	S TURB S SEP CD 1.0337 0.1319 0.0163* 0.7749 0.0000 0.0021 CL= 1.158 CD=0.01837 CM=-0.0568

B.L.SUMMARY AIRFOIL S828 16% ALPHA0= 2.027 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3500000 MU=3.0	R= 3500000 MU=1.3	R= 3500000 MU=9.0
-3.00	S TURB S SEP CD UPPER 0.3753 0.0000 0.0021 LOWER 0.2912 0.0000 0.0017 TOTAL CL=-0.107 CD=0.00384 CM=-0.0387	S TURB S SEP CD 1.0030 0.0332 0.0050 0.9568 0.0344 0.0053 CL=-0.107 CD=0.01029 CM=-0.0388	S TURB S SEP CD 0.9291 0.0327 0.0049 1.0099 0.0351 0.0056 CL=-0.106 CD=0.01053 CM=-0.0390
-2.00	S TURB S SEP CD UPPER 0.3791 0.0000 0.0022 LOWER 0.2780 0.0000 0.0016 TOTAL CL= 0.003 CD=0.00385 CM=-0.0425	S TURB S SEP CD 1.0030 0.0387 0.0054 0.9568 0.0288 0.0049 CL=-0.006 CD=0.01032 CM=-0.0405	S TURB S SEP CD 0.9433 0.0382 0.0053 0.9987 0.0293 0.0051 CL=-0.006 CD=0.01042 CM=-0.0406
-1.00	S TURB S SEP CD UPPER 0.3829 0.0051 0.0024 LOWER 0.2692 0.0000 0.0015 TOTAL CL= 0.110 CD=0.00389 CM=-0.0456	S TURB S SEP CD 1.0029 0.0441 0.0059 0.9568 0.0231 0.0045 CL= 0.094 CD=0.01041 CM=-0.0421	S TURB S SEP CD 0.9587 0.0437 0.0058 0.9873 0.0234 0.0046 CL= 0.094 CD=0.01043 CM=-0.0422
0.00	S TURB S SEP CD UPPER 0.3868 0.0092 0.0025 LOWER 0.2621 0.0000 0.0015 TOTAL CL= 0.216 CD=0.00394 CM=-0.0487	S TURB S SEP CD 1.0030 0.0497 0.0064 0.9568 0.0172 0.0042 CL= 0.194 CD=0.01056 CM=-0.0438	S TURB S SEP CD 0.9729 0.0493 0.0063 0.9754 0.0173 0.0042 CL= 0.195 CD=0.01054 CM=-0.0439
1.00	S TURB S SEP CD UPPER 0.3909 0.0135 0.0026 LOWER 0.2560 0.0000 0.0014 TOTAL CL= 0.323 CD=0.00402 CM=-0.0517	S TURB S SEP CD 1.0030 0.0554 0.0069 0.9568 0.0110 0.0039 CL= 0.294 CD=0.01078 CM=-0.0455	S TURB S SEP CD 0.9848 0.0551 0.0068 0.9611 0.0110 0.0039 CL= 0.295 CD=0.01073 CM=-0.0455
2.00	S TURB S SEP CD UPPER 0.3952 0.0176 0.0028 LOWER 0.2506 0.0000 0.0013 TOTAL CL= 0.429 CD=0.00410 CM=-0.0547	S TURB S SEP CD 1.0030 0.0613 0.0075 0.9568 0.0040 0.0036 CL= 0.394 CD=0.01107 CM=-0.0471	S TURB S SEP CD 0.9973 0.0612 0.0075 0.9453 0.0039 0.0036 CL= 0.394 CD=0.01103 CM=-0.0471
3.00	S TURB S SEP CD UPPER 0.4000 0.0219 0.0030 LOWER 0.2456 0.0000 0.0012 TOTAL CL= 0.534 CD=0.00420 CM=-0.0575	S TURB S SEP CD 1.0030 0.0672 0.0081 0.9568 0.0000 0.0033 CL= 0.495 CD=0.01140 CM=-0.0490	S TURB S SEP CD 1.0083 0.0673 0.0081 0.9293 0.0000 0.0033 CL= 0.494 CD=0.01140 CM=-0.0489
4.00	S TURB S SEP CD UPPER 0.4056 0.0264 0.0031 LOWER 0.2411 0.0000 0.0012 TOTAL CL= 0.639 CD=0.00432 CM=-0.0603	S TURB S SEP CD 1.0030 0.0734 0.0088 0.9568 0.0000 0.0031 CL= 0.595 CD=0.01186 CM=-0.0510	S TURB S SEP CD 1.0166 0.0737 0.0089 0.9124 0.0000 0.0030 CL= 0.595 CD=0.01193 CM=-0.0509
5.00	S TURB S SEP CD UPPER 0.4128 0.0314 0.0034 LOWER 0.2370 0.0000 0.0011 TOTAL CL= 0.742 CD=0.00448 CM=-0.0628	S TURB S SEP CD 1.0030 0.0798 0.0095 0.9568 0.0000 0.0029 CL= 0.695 CD=0.01242 CM=-0.0529	S TURB S SEP CD 1.0245 0.0805 0.0097 0.8945 0.0000 0.0029 CL= 0.694 CD=0.01260 CM=-0.0528
6.00	S TURB S SEP CD UPPER 0.7884 0.0757 0.0077 LOWER 0.2331 0.0000 0.0011 TOTAL CL= 0.805 CD=0.00875 CM=-0.0567	S TURB S SEP CD 1.0030 0.0866 0.0103 0.9568 0.0000 0.0027 CL= 0.793 CD=0.01304 CM=-0.0546	S TURB S SEP CD 1.0292 0.0878 0.0107 0.8754 0.0000 0.0027 CL= 0.792 CD=0.01338 CM=-0.0544
7.00	S TURB S SEP CD UPPER 1.0127 0.0947 0.0114 LOWER 0.2294 0.0000 0.0010 TOTAL CL= 0.890 CD=0.01237 CM=-0.0560	S TURB S SEP CD 1.0127 0.0947 0.0114 0.9568 0.0000 0.0026 CL= 0.890 CD=0.01392 CM=-0.0560	S TURB S SEP CD 1.0331 0.0961 0.0118 0.8552 0.0000 0.0025 CL= 0.888 CD=0.01432 CM=-0.0557
8.00	S TURB S SEP CD UPPER 1.0253 0.1043 0.0127* LOWER 0.2258 0.0000 0.0010 TOTAL CL= 0.984 CD=0.01370 CM=-0.0569	S TURB S SEP CD 1.0253 0.1043 0.0127* 0.9568 0.0000 0.0024 CL= 0.984 CD=0.01513 CM=-0.0569	S TURB S SEP CD 1.0335 0.1052 0.0130 0.8357 0.0000 0.0023 CL= 0.983 CD=0.01536 CM=-0.0567
9.00	S TURB S SEP CD UPPER 1.0331 0.1155 0.0144* LOWER 0.2221 0.0000 0.0009 TOTAL CL= 1.075 CD=0.01526 CM=-0.0574	S TURB S SEP CD 1.0331 0.1155 0.0144* 0.9541 0.0000 0.0022 CL= 1.075 CD=0.01658 CM=-0.0574	S TURB S SEP CD 1.0337 0.1156 0.0144* 0.8139 0.0000 0.0022 CL= 1.074 CD=0.01656 CM=-0.0574
10.00	S TURB S SEP CD UPPER 1.0333 0.1274 0.0159* LOWER 0.2185 0.0000 0.0009 TOTAL CL= 1.163 CD=0.01673 CM=-0.0577	S TURB S SEP CD 1.0333 0.1274 0.0159* 0.9541 0.0000 0.0021 CL= 1.163 CD=0.01795 CM=-0.0577	S TURB S SEP CD 1.0338 0.1276 0.0159* 0.7928 0.0000 0.0020 CL= 1.163 CD=0.01793 CM=-0.0576

B.L.SUMMARY AIRFOIL S828 16% ALPHA0= 2.027 DEG.
 *-WARNING WITH VARIABLE LIMIT ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU=3.0	R= 4000000 MU=1.3	R= 4000000 MU=9.0
-3.00	S TURB S SEP CD UPPER 0.3778 0.0000 0.0021 LOWER 0.3007 0.0000 0.0017 TOTAL CL=-0.107 CD=0.00379 CM=-0.0387	S TURB S SEP CD 1.0030 0.0314 0.0049 0.9568 0.0318 0.0052 CL=-0.107 CD=0.01007 CM=-0.0387	S TURB S SEP CD 0.9359 0.0309 0.0048 1.0104 0.0326 0.0055 CL=-0.106 CD=0.01032 CM=-0.0389
-2.00	S TURB S SEP CD UPPER 0.3816 0.0000 0.0022 LOWER 0.2826 0.0000 0.0016 TOTAL CL= 0.003 CD=0.00376 CM=-0.0425	S TURB S SEP CD 1.0030 0.0368 0.0053 0.9568 0.0262 0.0048 CL=-0.006 CD=0.01010 CM=-0.0404	S TURB S SEP CD 0.9502 0.0364 0.0052 1.0003 0.0267 0.0050 CL=-0.006 CD=0.01022 CM=-0.0405
-1.00	S TURB S SEP CD UPPER 0.3855 0.0023 0.0023 LOWER 0.2729 0.0000 0.0015 TOTAL CL= 0.111 CD=0.00380 CM=-0.0460	S TURB S SEP CD 1.0029 0.0422 0.0058 0.9568 0.0205 0.0044 CL= 0.094 CD=0.01019 CM=-0.0421	S TURB S SEP CD 0.9638 0.0419 0.0057 0.9896 0.0207 0.0045 CL= 0.095 CD=0.01023 CM=-0.0422
0.00	S TURB S SEP CD UPPER 0.3894 0.0072 0.0024 LOWER 0.2654 0.0000 0.0014 TOTAL CL= 0.218 CD=0.00384 CM=-0.0490	S TURB S SEP CD 1.0030 0.0477 0.0062 0.9568 0.0145 0.0041 CL= 0.195 CD=0.01034 CM=-0.0439	S TURB S SEP CD 0.9773 0.0474 0.0062 0.9775 0.0147 0.0042 CL= 0.195 CD=0.01033 CM=-0.0439
1.00	S TURB S SEP CD UPPER 0.3935 0.0115 0.0026 LOWER 0.2592 0.0000 0.0013 TOTAL CL= 0.324 CD=0.00391 CM=-0.0520	S TURB S SEP CD 1.0030 0.0532 0.0068 0.9568 0.0082 0.0038 CL= 0.295 CD=0.01055 CM=-0.0456	S TURB S SEP CD 0.9882 0.0531 0.0067 0.9647 0.0083 0.0038 CL= 0.295 CD=0.01052 CM=-0.0456
2.00	S TURB S SEP CD UPPER 0.3978 0.0155 0.0027 LOWER 0.2536 0.0000 0.0013 TOTAL CL= 0.430 CD=0.00399 CM=-0.0551	S TURB S SEP CD 1.0030 0.0591 0.0073 0.9568 0.0003 0.0035 CL= 0.395 CD=0.01084 CM=-0.0472	S TURB S SEP CD 1.0005 0.0590 0.0073 0.9509 0.0002 0.0035 CL= 0.395 CD=0.01082 CM=-0.0472
3.00	S TURB S SEP CD UPPER 0.4028 0.0198 0.0029 LOWER 0.2485 0.0000 0.0012 TOTAL CL= 0.536 CD=0.00409 CM=-0.0580	S TURB S SEP CD 1.0030 0.0650 0.0079 0.9568 0.0000 0.0032 CL= 0.497 CD=0.01115 CM=-0.0494	S TURB S SEP CD 1.0105 0.0651 0.0080 0.9349 0.0000 0.0032 CL= 0.496 CD=0.01116 CM=-0.0493
4.00	S TURB S SEP CD UPPER 0.4087 0.0242 0.0031 LOWER 0.2438 0.0000 0.0011 TOTAL CL= 0.641 CD=0.00421 CM=-0.0607	S TURB S SEP CD 1.0030 0.0710 0.0086 0.9568 0.0000 0.0030 CL= 0.597 CD=0.01163 CM=-0.0514	S TURB S SEP CD 1.0176 0.0714 0.0087 0.9196 0.0000 0.0030 CL= 0.597 CD=0.01171 CM=-0.0514
5.00	S TURB S SEP CD UPPER 0.4167 0.0292 0.0033 LOWER 0.2395 0.0000 0.0011 TOTAL CL= 0.744 CD=0.00437 CM=-0.0633	S TURB S SEP CD 1.0030 0.0773 0.0093 0.9568 0.0000 0.0029 CL= 0.697 CD=0.01217 CM=-0.0534	S TURB S SEP CD 1.0255 0.0780 0.0095 0.9026 0.0000 0.0028 CL= 0.697 CD=0.01237 CM=-0.0532
6.00	S TURB S SEP CD UPPER 0.8637 0.0775 0.0083 LOWER 0.2355 0.0000 0.0010 TOTAL CL= 0.803 CD=0.00937 CM=-0.0564	S TURB S SEP CD 1.0030 0.0839 0.0101 0.9568 0.0000 0.0027 CL= 0.796 CD=0.01277 CM=-0.0551	S TURB S SEP CD 1.0300 0.0852 0.0105 0.8843 0.0000 0.0026 CL= 0.795 CD=0.01313 CM=-0.0549
7.00	S TURB S SEP CD UPPER 1.0127 0.0917 0.0111 LOWER 0.2317 0.0000 0.0010 TOTAL CL= 0.893 CD=0.01209 CM=-0.0565	S TURB S SEP CD 1.0127 0.0917 0.0111 0.9568 0.0000 0.0025 CL= 0.893 CD=0.01363 CM=-0.0565	S TURB S SEP CD 1.0332 0.0931 0.0116 0.8654 0.0000 0.0025 CL= 0.892 CD=0.01404 CM=-0.0563
8.00	S TURB S SEP CD UPPER 1.0253 0.1011 0.0125* LOWER 0.2280 0.0000 0.0009 TOTAL CL= 0.987 CD=0.01339 CM=-0.0575	S TURB S SEP CD 1.0253 0.1011 0.0125* 0.9568 0.0000 0.0024 CL= 0.987 CD=0.01481 CM=-0.0575	S TURB S SEP CD 1.0336 0.1021 0.0128 0.8465 0.0000 0.0023 CL= 0.986 CD=0.01506 CM=-0.0573
9.00	S TURB S SEP CD UPPER 1.0331 0.1121 0.0140* LOWER 0.2244 0.0000 0.0009 TOTAL CL= 1.079 CD=0.01493 CM=-0.0581	S TURB S SEP CD 1.0331 0.1121 0.0140* 0.9541 0.0000 0.0022 CL= 1.079 CD=0.01624 CM=-0.0581	S TURB S SEP CD 1.0337 0.1122 0.0141* 0.8265 0.0000 0.0021 CL= 1.078 CD=0.01623 CM=-0.0581
10.00	S TURB S SEP CD UPPER 1.0333 0.1237 0.0155* LOWER 0.2208 0.0000 0.0008 TOTAL CL= 1.168 CD=0.01636 CM=-0.0584	S TURB S SEP CD 1.0333 0.1237 0.0155* 0.9541 0.0000 0.0020 CL= 1.168 CD=0.01756 CM=-0.0584	S TURB S SEP CD 1.0338 0.1239 0.0156* 0.8058 0.0000 0.0020 CL= 1.168 CD=0.01756 CM=-0.0584

REPORT DOCUMENTATION PAGE

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1. REPORT DATE (DD-MM-YYYY) January 2005			2. REPORT TYPE Subcontract report		3. DATES COVERED (From - To) 1994 - 1995	
4. TITLE AND SUBTITLE The S827 and S828 Airfoils				5a. CONTRACT NUMBER DE-AC36-99-GO10337		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) D.M. Somers				5d. PROJECT NUMBER NREL/SR-500-36343		
				5e. TASK NUMBER WER4.3110		
				5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Airfoils, Inc. 601 Cricklewood Drive State College, PA 16083					8. PERFORMING ORGANIZATION REPORT NUMBER AAF-4-14289-01	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393					10. SPONSOR/MONITOR'S ACRONYM(S) NREL	
					11. SPONSORING/MONITORING AGENCY REPORT NUMBER NREL/SR-500-36343	
12. DISTRIBUTION AVAILABILITY STATEMENT National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161						
13. SUPPLEMENTARY NOTES NREL Technical Monitor: J. Tangler						
14. ABSTRACT (Maximum 200 Words) A family of thick, natural-laminar-flow airfoils, the S827 and S828, for 40- to 50-meter, stall -regulated, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of restrained maximum lift, insensitive to roughness, and low profile drag have been achieved. The constraints on the pitching moments and the airfoil thicknesses have been satisfied. The airfoils should exhibit docile stalls.						
15. SUBJECT TERMS airfoils; wind turbine; airfoil design; Pennsylvania State University; wind energy						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UL	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code)	

Standard Form 298 (Rev. 8/98)
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