The S830, S831, and S832 Airfoils

November 2001 – November 2002

Dan M. Somers
Airfoils Incorporated
Port Matilda, Pennsylvania

Subcontract Report
NREL/SR-500-36339
August 2005

NREL is operated by Midwest Research Institute • Battelle Contract No. DE-AC36-99-GO10337

The S830, S831, and S832 Airfoils

November 2001 – November 2002

Dan M. Somers
Airfoils Incorporated
Port Matilda, Pennsylvania

NREL Technical Monitor: Jim Tangler
Prepared under Subcontract No(s). AAM-1-31212-01

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

Subcontract Report
NREL/SR-500-36339
August 2005

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy
and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: <mailto:reports@adonis.osti.gov>

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/ordering.htm>

This publication received minimal editorial review at NREL

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

ABSTRACT

A family of quiet, thick, natural-laminar-flow airfoils, the S830, S831, and S832, for 40- to 50-meter-diameter, variable-speed/variable-pitch, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of high maximum lift, relatively insensitive to roughness, and low profile drag have been achieved. The airfoils should exhibit docile stalls, which meets the design goal. The constraints on the pitching moment and the airfoil thicknesses have been satisfied.

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, both in the United States, as shown in the following table, and in Europe (e.g., ref. 8).

Wind Turbine		Airfoil-Thickness Category	Airfoil			Reference
Diameter	Type		Primary	Tip	Root	
3–10 m	Variable speed Variable pitch	Thick	—	S822	S823	14
10–20 m	Variable speed Variable pitch	Thin	S801	S802 S803	S804	9
	Stall regulated	Thin	S805 S805A	S806 S806A	S807 S808	
		Thick	S819	S820	S821	13
20–30 m	Stall regulated	Thick	S809	S810	S811	10
			S812	S813	S814 S815	10 and 11
20–40 m	Variable speed Variable pitch	—	S825	S826	S814 S815	15 and 11
30–50 m	Stall regulated	Thick	S816	S817	S818	12
40–50 m	Stall regulated	Thick	S827	S828	S818	16 and 12

An overview of all the airfoil families in this table is given in reference 17.

The family of airfoils designed under the present study is intended for 40- to 50-meter-diameter, variable-speed/variable-pitch, horizontal-axis wind turbines. It is meant to not only augment the table but also to be quieter than the previous families. The airfoils of the present family should be thicker than the S825 and S826 airfoils (ref. 15) and appropriate for higher Reynolds numbers (i.e., larger machines).

Because of the limitations of the theoretical method (refs. 18 and 19) 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
R	Reynolds number based on free-stream conditions and airfoil chord
t	airfoil thickness, m
x	airfoil abscissa, m
y	airfoil ordinate, m
α	angle of attack relative to x-axis, deg

Subscripts:

ll	lower limit of low-drag range
max	maximum
S	separation
T	transition
ul	upper limit of low-drag range
0	zero lift

Abbreviations:

L.	lower surface
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NREL	National Renewable Energy Laboratory
S.	boundary-layer separation location, x_S/c
T.	boundary-layer transition location, x_T/c
U.	upper surface

AIRFOIL DESIGN

OBJECTIVES AND CONSTRAINTS

The aerodynamic noise produced by wind-turbine blades is generated primarily by the outboard portion of the blades, where the flow velocity is highest (ref. 20). Recent research suggests that the lift (lift coefficient times blade chord) produced by the outboard portion of the blade should be constrained to alleviate the noise. Accordingly, a decreasing, as opposed to increasing outboard, maximum lift coefficient is specified for the outer quarter of the blade. In addition, the airfoil thickness decreases rapidly toward the blade tip to reduce the noise due to thickness. The remainder of the design specifications for the family of airfoils are consistent with those for previous airfoil families having large thickness or high maximum lift coefficient.

The design specifications were originally outlined by, and later refined during discussions with, James L. Tangler of the National Renewable Energy Laboratory (NREL). The final specifications are contained in table I. The family consists of three airfoils, primary, intermediate, and tip, corresponding to the 0.75, 0.90, and 1.00 blade radial stations, respectively. The S818 airfoil (ref. 12) can be used as the root airfoil for this family because it has suitable thickness, maximum lift coefficient, and Reynolds number.

Two primary objectives are evident from the specifications. The first objective is to achieve high maximum lift coefficients. A requirement related to this objective is that the maximum lift coefficients not decrease significantly 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 specified ranges of lift coefficients.

Two major constraints were placed on the design of these airfoils. First, the zero-lift pitching-moment coefficient must be no more negative than -0.15 . Second, the airfoil thicknesses must equal those specified.

The specifications for these airfoils are similar to those for the S825 and S826 airfoils (ref. 15), except the airfoil thicknesses and Reynolds numbers are higher.

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 the primary airfoil. (The polars for the intermediate and tip airfoils should be qualitatively similar.)

Sketch 1

The desired airfoil shape 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 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 profile-drag coefficient at point B is not as low as at point A, unlike the polars of many laminar-flow airfoils where the drag coefficient within the laminar bucket is nearly constant. This characteristic is related to the mitigation of drag- and noise-producing laminar separation bubbles on the upper surface. (See ref. 21.) The small increase in profile-drag coefficient with increasing lift coefficient is relatively inconsequential because the ratio of the profile drag to the total drag of the wind-turbine blade decreases with increasing lift coefficient. The profile-drag

coefficient increases very rapidly outside the low-drag range because boundary-layer transition 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. Note that, because the large thickness of the primary airfoil allows a wider low-drag range to be achieved 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 distributions for the other airfoils should be qualitatively similar.)

Sketch 2

To achieve low drag, a favorable pressure gradient is desirable along the upper surface to about 35-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. 22). The transition ramp is followed by a nearly linear pressure recovery. The pressure recovery begins farther forward than dictated by transition-free minimum-drag requirements to decrease the boundary-layer thickness and increase the skin-friction coefficient at the trailing edge with transition fixed, which reduces the noise due to the interaction between the turbulent boundary layer and the trailing edge, which is the primary noise source for large wind turbines. (See ref. 23.) Thus, the specific pressure recovery employed represents a compromise between maximum lift, drag, pitching moment, stall characteristics, and noise. 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 initiating docile stall characteristics. (See ref. 24.)

A favorable pressure gradient is desirable along the lower surface to about 40-percent chord to achieve low drag. The specific pressure gradients employed along the forward portion of the lower surface increase the loading in the leading-edge region while maintaining low drag at the lower lift coefficients. The forward loading serves to balance, with respect to the pitching-moment constraint, the aft loading, both of which contribute to the achievement of a high maximum lift coefficient and low profile-drag coefficients. This region is followed by a curved transition ramp (ref. 21) and then a concave pressure recovery, which exhibits lower drag and has less tendency to separate than the corresponding linear or convex pressure recovery (ref. 22). 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.

No suction spike exists at the leading edge. Instead, a rounded peak occurs just aft of the leading edge. 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 transition to move very quickly toward the leading edge with increasing lift coefficient, which leads to the roughness insensitivity of the maximum lift coefficient.

Mitigation of laminar separation bubbles, especially on the upper surface, was increasingly emphasized with increasing blade radial station, because of the increasing flow velocity and decreasing Reynolds number, to eliminate this possible noise source.

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. 18 and 19) was used because of its unique capability for multipoint design and because of confidence gained during the design, analysis, and experimental verification of many other airfoils. (See refs. 25–30, for example.)

The primary airfoil, which corresponds to the 0.75 blade radial station, is designated the S830. The intermediate and tip airfoils, the S831 and S832, which correspond to the 0.90 and 1.00 blade radial stations, respectively, were derived from the S830 airfoil to increase the aerodynamic and geometric compatibilities of the three airfoils. The airfoil shapes are shown in figure 1 and the coordinates are contained in tables II, III, and IV. The S830 airfoil thickness is 21-percent chord; the S831, 18-percent chord; and the S832, 15-percent chord, which satisfy the design constraints.

THEORETICAL PROCEDURE

The section characteristics are predicted for Reynolds numbers of 1×10^6 to 9×10^6 . The computations were performed with transition free using transition mode 3, with transition fixed at 2-percent chord on the upper surface and 5-percent chord on the lower surface using transition mode 1, and “rough” using transition mode 9, which simulates distributed roughness due to, for example, leading-edge contamination by water drops or insects. (See ref. 19.)

Because the free-stream Mach number for all relevant wind-turbine operating conditions remains below 0.3, all results are incompressible.

DISCUSSION OF RESULTS

S830 AIRFOIL

Pressure Distributions

The inviscid pressure distributions for the S830 airfoil at various angles of attack are shown in figure 2 and tabulated in appendix A.

Transition and Separation Locations

The variation of boundary-layer transition location with lift coefficient for the S830 airfoil is shown in figure 3 and tabulated in appendix A. In the method of references 18 and 19, the transition location is defined as the end of the laminar boundary layer whether due to natural transition or laminar separation. Transition is normally confirmed in experiments, however, by the detection of an attached turbulent boundary layer. 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), the apparent agreement between the theoretical and experimental transition locations is poor. In actuality, the difference between the predicted and measured transition locations represents the length of the laminar separation bubble (from laminar separation to turbulent reattachment). Accordingly, 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 apparent agreement between theory and experiment improves. (See refs. 27 and 30.)

The variation of turbulent boundary-layer separation location with lift coefficient for the S830 airfoil is shown in figure 3 and tabulated in appendix A. A small, trailing-edge separation is predicted on the upper surface at all lift coefficients. This separation, which is caused by the separation ramp (fig. 2), generally increases in length with transition fixed and rough. Separation is predicted on the lower surface at lift coefficients below the operating range for the intended application. Such separation usually has little effect on the section characteristics. (See ref. 27.)

Section Characteristics

Reynolds number effects.- The section characteristics of the S830 airfoil are shown in figure 3 and tabulated in appendix A. It should be noted that the maximum lift coefficient computed by the method of references 18 and 19, as well as other theoretical methods, is not always realistic. Accordingly, an empirical criterion has been 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 0.01920, which is based on correlations with results for Reynolds numbers from 1×10^6 to 9×10^6 from the NASA Langley Low-Turbulence Pressure Tunnel. Thus, the maximum lift coefficient for the design Reynolds number of 4.0×10^6 is estimated to be 1.60, 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 0.27 to 1.33. Thus, the lower limit of the low-drag, lift-coefficient range is below the design objective of $c_{l,11} = 0.80$, although the upper limit of the low-drag range is also below the design objective of $c_{l,11} = 1.40$, primarily to meet other, more important goals. The zero-lift pitching-moment coefficient is predicted to be -0.18 , which exceeds the design constraint of $c_{m,0} \geq -0.15$. Because of boundary-layer displacement effects not accounted for in the present analysis, the pitching-moment coefficient is generally overpredicted by about 20 percent. Therefore, the actual zero-lift pitching-moment coefficient should be about -0.15 , which satisfies the design constraint.

Effect of roughness.- The effect of roughness on the section characteristics of the S830 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 1.57, a reduction of 2 percent from that with transition free. Thus, the design requirement has been satisfied. The effect of roughness on the maximum lift coefficient decreases with increasing Reynolds number. The drag coefficients are, of course, adversely affected by the roughness.

S831 AIRFOIL

Pressure Distributions

The inviscid pressure distributions for the S831 airfoil at various angles of attack are shown in figure 4 and tabulated in appendix B.

Transition and Separation Locations

The variations of transition and separation locations with lift coefficient for the S831 airfoil are shown in figure 5 and tabulated in appendix B. A small, trailing-edge separation is predicted on the upper surface at all lift coefficients. This separation, which is caused by the separation ramp (fig. 4), generally increases in length with transition fixed and rough.

Section Characteristics

Reynolds number effects.- The section characteristics of the S831 airfoil are shown in figure 5 and tabulated in appendix B. Using the previously described criterion, the maximum lift coefficient for the design Reynolds number of 3.5×10^6 is estimated to be 1.50, which meets the design objective. The stall characteristics are expected to be docile, which meets the design goal. Low drag coefficients are predicted over the range of lift coefficients from 0.50 to 1.23. Thus, the lower limit of the low-drag range is below the design objective of $c_{l,11} = 0.70$, although the upper limit is also below the design objective of $c_{l,11} = 1.30$, prima-

rily to meet other, more important goals. The zero-lift pitching-moment coefficient is predicted to be -0.17 , which exceeds the design constraint of $c_{m,0} \geq -0.15$, although the actual zero-lift pitching-moment coefficient should be about -0.14 , which satisfies the constraint.

Effect of roughness.- The effect of roughness on the section characteristics of the S831 airfoil is shown in figure 5. The maximum lift coefficient for the design Reynolds number of 3.5×10^6 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 1.48, a reduction of 1 percent from that with transition free. Thus, the design requirement has been satisfied. The effect of roughness on the maximum lift coefficient generally decreases with increasing Reynolds number. The drag coefficients are, of course, adversely affected by the roughness.

S832 AIRFOIL

Pressure Distributions

The inviscid pressure distributions for the S832 airfoil at various angles of attack are shown in figure 6 and tabulated in appendix C.

Transition and Separation Locations

The variations of transition and separation locations with lift coefficient for the S832 airfoil are shown in figure 7 and tabulated in appendix C. A small, trailing-edge separation is predicted on the upper surface at almost all lift coefficients. This separation, which is caused by the separation ramp (fig. 6), generally increases in length with transition fixed and rough.

Section Characteristics

Reynolds number effects.- The section characteristics of the S832 airfoil are shown in figure 7 and tabulated in appendix C. Using the previously described criterion, the maximum lift coefficient for the design Reynolds number of 2.5×10^6 is estimated to be 1.40, which meets the design objective. The stall characteristics are expected to be docile, which meets the design goal. Low drag coefficients are predicted over the range of lift coefficients from 0.52 to 1.12. Thus, the lower limit of the low-drag range is below the design objective of $c_{l,II} = 0.60$, although the upper limit is also below the design objective of $c_{l,III} = 1.20$, primarily to meet other, more important goals. The zero-lift pitching-moment coefficient is predicted to be -0.12 , which satisfies the design constraint. The actual zero-lift pitching-moment coefficient should be about -0.10 .

Effect of roughness.- The effect of roughness on the section characteristics of the S832 airfoil is shown in figure 7. The maximum lift coefficient for the design Reynolds number of

2.5×10^6 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. The maximum lift coefficient for the design Reynolds number is also unaffected by the rough condition. Thus, the design requirement has been satisfied. The effect of roughness on the maximum lift coefficient generally decreases with increasing Reynolds number. The drag coefficients are, of course, adversely affected by the roughness.

CONCLUDING REMARKS

A family of quiet, thick, natural-laminar-flow airfoils, the S830, S831, and S832, for 40- to 50-meter-diameter, variable-speed/variable-pitch, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of high maximum lift coefficients, relatively insensitive to leading-edge roughness, and low profile-drag coefficients have been achieved. The airfoils should exhibit docile stall characteristics, which meets the design goal. The constraints on the zero-lift pitching-moment coefficient and the airfoil thicknesses have been satisfied.

REFERENCES

1. Jacobs, Eastman N.; Ward, Kenneth E.; and Pinkerton, Robert M.: The Characteristics of 78 Related Airfoil Sections from Tests in the Variable-Density Wind Tunnel. NACA Rep. 460, 1933.
2. Jacobs, Eastman N.; and Pinkerton, Robert M.: Tests in the Variable-Density Wind Tunnel of Related Airfoils Having the Maximum Camber Unusually far Forward. NACA Rep. 537, 1935.
3. Jacobs, Eastman N.; Pinkerton, Robert M.; and Greenberg, Harry: Tests of Related Forward-Camber Airfoils in the Variable-Density Wind Tunnel. NACA Rep. 610, 1937.
4. Abbott, Ira H.; Von Doenhoff, Albert E.; and Stivers, Louis S., Jr.: Summary of Airfoil Data. NACA Rep. 824, 1945. (Supersedes NACA WR L-560.)
5. Abbott, Ira H.; and Von Doenhoff, Albert E.: Theory of Wing Sections. Dover Publ., Inc., c.1959.
6. McGhee, Robert J.; Beasley, William D.; and Whitcomb, Richard T.: NASA Low- and Medium-Speed Airfoil Development. NASA TM-78709, 1979.
7. Tangler, J. L.; and Somers, D. M.: Status of the Special-Purpose Airfoil Families. SERI/TP-217-3264, Dec. 1987.
8. Timmer, W. A.; and van Rooij, R. P. J. O. M.: Summary of the Delft University Wind Turbine Dedicated Airfoils. AIAA Paper 2003-0352, Jan. 2003.
9. Somers, Dan M.: The S801 through S808 Airfoils. Airfoils, Inc., 1987. [Proprietary to NREL]
10. Somers, Dan M.: The S809 through S813 Airfoils. Airfoils, Inc., 1988. [Proprietary to NREL]
11. Somers, Dan M.: The S814 and S815 Airfoils. Airfoils, Inc., 1992. [Proprietary to NREL]
12. Somers, Dan M.: The S816, S817, and S818 Airfoils. Airfoils, Inc., 1992. [Proprietary to NREL]
13. Somers, Dan M.: The S819, S820, and S821 Airfoils. Airfoils, Inc., 1993. [Proprietary to NREL]
14. Somers, Dan M.: The S822 and S823 Airfoils. Airfoils, Inc., 1993. [Proprietary to NREL]

15. Somers, Dan M.: The S825 and S826 Airfoils. Airfoils, Inc., 1995. [Proprietary to NREL]
16. Somers, Dan M.: The S827 and S828 Airfoils. Airfoils, Inc., 1995. [Proprietary to NREL]
17. Tangler, J. L.; and Somers, D. M.: NREL Airfoil Families for HAWTs. NREL/TP-442-7109, Jan. 1995.
18. Eppler, Richard: Airfoil Design and Data. Springer-Verlag (Berlin), 1990.
19. Eppler, Richard: Airfoil Program System "PROFIL00." User's Guide. Richard Eppler, c.2001.
20. Guidati, G.; Ostertag, J.; and Wagner, S.: Prediction and Reduction of Wind Turbine Noise. An Overview of Research Activities in Europe. AIAA Paper 2000-0042, Jan. 2000.
21. Eppler, Richard; and Somers, Dan M.: Airfoil Design for Reynolds Numbers Between 50,000 and 500,000. Proceedings of the Conference on Low Reynolds Number Airfoil Aerodynamics, UNDAS-CP-77B123, Univ. of Notre Dame, June 1985, pp. 1–14.
22. Wortmann, F. X.: Experimental Investigations on New Laminar Profiles for Gliders and Helicopters. TIL/T.4906, British Minist. Aviat., Mar. 1960. (Translated from Z. Flugwissenschaften, Bd. 5, Heft 8, Aug. 1957, S. 228–243.)
23. Guidati, Gianfranco; and Wagner, Siegfried: Design of Reduced Noise Airfoils for Wind Turbines. Proceedings of ECCOMAS 2000, c.ECCOMAS, Barcelona, Sept. 2000.
24. Maughmer, Mark D.; and Somers, Dan M.: Design and Experimental Results for a High-Altitude, Long-Endurance Airfoil. J. Aircr., vol. 26, no. 2, Feb. 1989, pp. 148–153.
25. Somers, Dan M.: Design and Experimental Results for the S805 Airfoil. NREL/SR-440-6917, Jan. 1997.
26. Somers, Dan M.: Design and Experimental Results for the S809 Airfoil. NREL/SR-440-6918, Jan. 1997.
27. Somers, Dan M.: Design and Experimental Results for the S814 Airfoil. NREL/SR-440-6919, Jan. 1997.
28. Somers, Dan M.: Design and Experimental Results for the S825 Airfoil. Airfoils, Inc., 1999. [Proprietary to NREL]
29. Somers, Dan M.: Design and Experimental Results for the S827 Airfoil. Airfoils, Inc., 1999. [Proprietary to NREL]

30. Somers, Dan M.: Subsonic Natural-Laminar-Flow Airfoils. Natural Laminar Flow and Laminar Flow Control, R. W. Barnwell and M. Y. Hussaini, eds., Springer-Verlag New York, Inc., 1992, pp. 143–176.

TABLE I.- AIRFOIL DESIGN SPECIFICATIONS

Blade radial station	0.75	0.90	1.00
Parameter	Objective/Constraint		
Reynolds number R	4.0×10^6	3.5×10^6	2.5×10^6
Maximum lift coefficient $c_{l,max}$	1.60	1.50	1.40
Lower limit of low-drag, lift-coefficient range $c_{l,ll}$	0.80	0.70	0.60
Upper limit of low-drag, lift-coefficient range $c_{l,ul}$	1.40	1.30	1.20
Zero-lift pitching-moment coefficient $c_{m,0}$	≥ -0.15		
Airfoil thickness t/c	21%	18%	15%

TABLE II.- S830 AIRFOIL COORDINATES

Upper Surface		Lower Surface	
x/c	y/c	x/c	y/c
0.00006	0.00112	0.00004	-0.00084
.00321	.01040	.00041	-.00254
.01104	.02127	.00138	-.00406
.02343	.03307	.00288	-.00560
.04015	.04540	.01318	-.01192
.06101	.05794	.02942	-.01794
.08576	.07041	.05165	-.02385
.11413	.08253	.07932	-.03013
.14580	.09406	.11146	-.03674
.18042	.10474	.14756	-.04351
.21762	.11434	.18687	-.05030
.25699	.12262	.22887	-.05701
.29810	.12934	.27253	-.06393
.34048	.13417	.31589	-.07002
.38383	.13653	.35873	-.07334
.42854	.13632	.40193	-.07288
.47434	.13395	.44627	-.06859
.52084	.12962	.49216	-.06086
.56764	.12354	.53971	-.04984
.61431	.11592	.59018	-.03645
.66042	.10703	.64307	-.02282
.70550	.09715	.69724	-.01029
.74904	.08657	.75132	.00013
.79053	.07559	.80381	.00775
.82943	.06449	.85314	.01212
.86518	.05352	.89755	.01296
.89719	.04283	.93491	.01083
.92504	.03222	.96391	.00721
.94908	.02179	.98422	.00357
.96943	.01245	.99611	.00096
.98554	.00533	1.00000	.00000
.99621	.00120		
1.00000	.00000		

TABLE III.- S831 AIRFOIL COORDINATES

Upper Surface		Lower Surface	
x/c	y/c	x/c	y/c
0.00004	0.00088	0.00004	-0.00080
.00036	.00277	.00017	-.00155
.00449	.01168	.00041	-.00221
.01307	.02201	.00080	-.00281
.02606	.03319	.00134	-.00340
.04333	.04479	.00280	-.00458
.06483	.05655	.00966	-.00795
.09031	.06828	.02422	-.01170
.11951	.07975	.04525	-.01480
.15212	.09077	.07229	-.01796
.18776	.10113	.10441	-.02131
.22608	.11064	.14105	-.02479
.26663	.11912	.18146	-.02831
.30899	.12638	.22509	-.03171
.35269	.13226	.27122	-.03485
.39728	.13659	.31929	-.03752
.44223	.13917	.36859	-.03951
.48707	.13978	.41855	-.04054
.53137	.13799	.46850	-.04013
.57522	.13349	.51847	-.03767
.61871	.12640	.56861	-.03326
.66185	.11707	.61888	-.02718
.70445	.10608	.66924	-.01993
.74609	.09394	.71934	-.01226
.78632	.08116	.76865	-.00492
.82460	.06818	.81639	.00118
.86035	.05544	.86130	.00530
.89294	.04327	.90193	.00707
.92180	.03167	.93666	.00668
.94699	.02083	.96429	.00489
.96834	.01157	.98416	.00263
.98514	.00481	.99606	.00077
.99614	.00105	1.00000	.00000
1.00000	.00000		

TABLE IV.- S832 AIRFOIL COORDINATES

Upper Surface		Lower Surface	
x/c	y/c	x/c	y/c
0.00000	0.00028	0.00010	-0.00126
.00011	.00150	.00026	-.00194
.00328	.00973	.00053	-.00252
.01071	.01942	.00094	-.00303
.02242	.03000	.00150	-.00353
.03830	.04102	.00188	-.00380
.05831	.05217	.00298	-.00448
.08228	.06320	.01074	-.00728
.11007	.07390	.02577	-.00958
.14137	.08415	.04734	-.01088
.17583	.09376	.07510	-.01192
.21310	.10256	.10825	-.01295
.25274	.11037	.14628	-.01404
.29436	.11701	.18846	-.01522
.33747	.12233	.23423	-.01649
.38161	.12614	.28287	-.01779
.42629	.12824	.33377	-.01907
.47106	.12830	.38622	-.02025
.51577	.12599	.43959	-.02122
.56040	.12129	.49317	-.02188
.60480	.11436	.54634	-.02208
.64882	.10544	.59843	-.02158
.69229	.09486	.64911	-.02005
.73496	.08312	.69821	-.01745
.77642	.07079	.74555	-.01394
.81614	.05839	.79090	-.00991
.85352	.04638	.83384	-.00585
.88788	.03517	.87378	-.00234
.91858	.02488	.90980	.00013
.94539	.01576	.94089	.00144
.96785	.00839	.96613	.00169
.98514	.00333	.98476	.00118
.99619	.00069	.99616	.00041
1.00000	.00000	1.00000	.00000

Figure 1.- Airfoil shapes.

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

Figure 2.- Inviscid pressure distributions for S830 airfoil.

(b) $\alpha = -4^\circ, -3^\circ, \text{ and } -2^\circ$.

Figure 2.- Continued.

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

Figure 2.- Continued.

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

Figure 2.- Continued.

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

Figure 2.- Continued.

(f) $\alpha = 8^\circ, 9^\circ,$ and 10° .

Figure 2.- Continued.

(g) $\alpha = 11^\circ$.

Figure 2.- Concluded.

(a) $R = 2 \times 10^6$.

Figure 3.- Section characteristics of S830 airfoil with transition free, transition fixed, and rough.

(b) $R = 3 \times 10^6$.

Figure 3.- Continued.

S830 $R = 4 \times 10^6$

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

(c) $R = 4 \times 10^6$.

Figure 3.- Continued.

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

Figure 3.- Continued.

S830 $R = 9 \times 10^6$

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

(e) $R = 9 \times 10^6$.

Figure 3.- Concluded.

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

Figure 4.- Inviscid pressure distributions for S831 airfoil.

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

Figure 4.- Continued.

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

Figure 4.- Continued.

(d) $\alpha = 2^\circ, 3^\circ, \text{ and } 4^\circ$.

Figure 4.- Continued.

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

Figure 4.- Continued.

(f) $\alpha = 8^\circ, 9^\circ,$ and 10° .

Figure 4.- Concluded.

(a) $R = 2 \times 10^6$.

Figure 5.- Section characteristics of S831 airfoil with transition free, transition fixed, and rough.

S831 $R = 3 \times 10^6$

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

(b) $R = 3 \times 10^6$.

Figure 5.- Continued.

(c) $R = 4 \times 10^6$.

Figure 5.- Continued.

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

Figure 5.- Continued.

(e) $R = 9 \times 10^6$.

Figure 5.- Concluded.

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

Figure 6.- Inviscid pressure distributions for S832 airfoil.

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

Figure 6.- Continued.

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

Figure 6.- Continued.

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

Figure 6.- Continued.

(e) $\alpha = 8^\circ, 9^\circ$, and 10° .

Figure 6.- Continued.

(f) $\alpha = 11^\circ$.

Figure 6.- Concluded.

(a) $R = 1 \times 10^6$.

Figure 7.- Section characteristics of S832 airfoil with transition free, transition fixed, and rough.

(b) $R = 2 \times 10^6$.

Figure 7.- Continued.

(c) $R = 3 \times 10^6$.

Figure 7.- Continued.

(d) $R = 4 \times 10^6$.

Figure 7.- Continued.

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

Figure 7.- Concluded.

APPENDIX A

PRESSURE DISTRIBUTIONS, TRANSITION AND SEPARATION LOCATIONS, AND SECTION CHARACTERISTICS OF S830 AIRFOIL

AIRFOIL S830 21%				-7.00	-6.00	-5.00	-4.00	-3.00	-2.00	-1.00	0.00	1.00	2.00
N	X	Y	NU	CP(X)	FOR	THE	ABOVE	ALPHA	REL.	CHORD	LINE		
1	1.00000	0.00000	0.00	0.383	0.383	0.383	0.384	0.385	0.387	0.389	0.391	0.394	0.397
2	0.99621	0.00120	1.00	0.367	0.366	0.366	0.365	0.366	0.366	0.367	0.368	0.370	0.372
3	0.98554	0.00533	2.00	0.290	0.287	0.285	0.284	0.283	0.282	0.282	0.282	0.282	0.283
4	0.96943	0.01245	3.00	0.161	0.157	0.153	0.149	0.147	0.144	0.142	0.141	0.140	0.140
5	0.94908	0.02179	4.00	0.003	-0.004	-0.010	-0.016	-0.022	-0.027	-0.031	-0.034	-0.037	-0.040
6	0.92504	0.03222	5.00	-0.146	-0.156	-0.166	-0.175	-0.184	-0.192	-0.199	-0.205	-0.211	-0.216
7	0.89719	0.04283	6.00	-0.230	-0.243	-0.256	-0.269	-0.280	-0.291	-0.301	-0.311	-0.319	-0.327
8	0.86518	0.05352	7.00	-0.261	-0.278	-0.294	-0.309	-0.324	-0.338	-0.351	-0.363	-0.375	-0.386
9	0.82943	0.06449	8.00	-0.299	-0.319	-0.339	-0.357	-0.375	-0.393	-0.409	-0.425	-0.440	-0.454
10	0.79053	0.07559	9.00	-0.343	-0.366	-0.389	-0.412	-0.434	-0.455	-0.475	-0.494	-0.513	-0.531
11	0.74904	0.08657	10.00	-0.389	-0.417	-0.445	-0.471	-0.497	-0.523	-0.547	-0.571	-0.594	-0.616
12	0.70550	0.09715	11.00	-0.438	-0.471	-0.503	-0.534	-0.565	-0.595	-0.625	-0.654	-0.682	-0.709
13	0.66042	0.10703	12.00	-0.488	-0.526	-0.563	-0.600	-0.636	-0.671	-0.706	-0.741	-0.774	-0.807
14	0.61431	0.11592	13.00	-0.535	-0.579	-0.622	-0.665	-0.707	-0.749	-0.790	-0.830	-0.870	-0.909
15	0.56764	0.12354	14.00	-0.579	-0.629	-0.678	-0.728	-0.776	-0.825	-0.873	-0.921	-0.967	-1.014
16	0.52084	0.12962	15.00	-0.616	-0.673	-0.729	-0.786	-0.842	-0.898	-0.954	-1.009	-1.064	-1.119
17	0.47434	0.13395	16.00	-0.644	-0.708	-0.773	-0.837	-0.902	-0.966	-1.030	-1.094	-1.158	-1.222
18	0.42854	0.13632	17.00	-0.660	-0.733	-0.805	-0.878	-0.952	-1.025	-1.099	-1.173	-1.246	-1.320
19	0.38383	0.13653	18.00	-0.662	-0.743	-0.824	-0.907	-0.990	-1.073	-1.157	-1.241	-1.326	-1.410
20	0.34048	0.13417	19.00	-0.605	-0.692	-0.781	-0.871	-0.962	-1.053	-1.146	-1.240	-1.334	-1.428
21	0.29810	0.12934	20.00	-0.496	-0.588	-0.682	-0.777	-0.874	-0.972	-1.072	-1.172	-1.274	-1.377
22	0.25699	0.12262	21.00	-0.383	-0.479	-0.578	-0.679	-0.782	-0.888	-0.995	-1.103	-1.213	-1.325
23	0.21762	0.11434	22.00	-0.262	-0.364	-0.468	-0.575	-0.685	-0.798	-0.913	-1.031	-1.151	-1.273
24	0.18042	0.10474	23.00	-0.134	-0.240	-0.350	-0.463	-0.581	-0.702	-0.826	-0.954	-1.084	-1.218
25	0.14580	0.09406	24.00	0.006	-0.105	-0.220	-0.341	-0.466	-0.596	-0.731	-0.869	-1.012	-1.160
26	0.11413	0.08253	25.00	0.159	0.045	-0.076	-0.204	-0.337	-0.477	-0.623	-0.775	-0.932	-1.095
27	0.08576	0.07041	26.00	0.327	0.211	0.086	-0.048	-0.190	-0.341	-0.500	-0.666	-0.840	-1.022
28	0.06101	0.05794	27.00	0.513	0.398	0.271	0.132	-0.018	-0.180	-0.352	-0.536	-0.730	-0.935
29	0.04015	0.04540	28.00	0.712	0.605	0.482	0.343	0.187	0.015	-0.172	-0.375	-0.593	-0.826
30	0.02343	0.03307	29.00	0.902	0.822	0.717	0.588	0.436	0.260	0.060	-0.162	-0.407	-0.675
31	0.01104	0.02127	30.00	1.000	0.987	0.937	0.849	0.724	0.561	0.362	0.126	-0.147	-0.456
32	0.00321	0.01040	31.00	0.680	0.850	0.957	0.999	0.977	0.892	0.742	0.529	0.252	-0.088
33	0.00006	0.00112	31.99	-1.361	-0.655	-0.074	0.383	0.714	0.920	0.999	0.952	0.779	0.480
34	0.00004	-0.00084	32.24	-2.689	-1.698	-0.860	-0.177	0.352	0.724	0.940	0.999	0.901	0.648
35	0.00041	-0.00254	32.49	-4.778	-3.369	-2.154	-1.135	-0.313	0.310	0.735	0.961	0.986	0.812
36	0.00138	-0.00406	32.74	-3.756	-2.694	-1.765	-0.968	-0.305	0.222	0.614	0.870	0.990	0.974
37	0.00288	-0.00560	32.99	-3.095	-2.253	-1.506	-0.854	-0.300	0.157	0.515	0.776	0.937	0.999
38	0.01318	-0.01192	34.00	-1.837	-1.395	-0.990	-0.621	-0.288	0.006	0.264	0.483	0.663	0.806
39	0.02942	-0.01794	35.00	-1.253	-0.972	-0.708	-0.462	-0.234	-0.025	0.165	0.336	0.488	0.620
40	0.05165	-0.02385	36.00	-0.898	-0.701	-0.514	-0.337	-0.170	-0.013	0.133	0.268	0.392	0.505
41	0.07932	-0.03013	37.00	-0.732	-0.578	-0.431	-0.291	-0.157	-0.029	0.091	0.205	0.311	0.410
42	0.11146	-0.03674	38.00	-0.652	-0.526	-0.403	-0.285	-0.172	-0.063	0.042	0.141	0.236	0.325
43	0.14756	-0.04351	39.00	-0.611	-0.503	-0.398	-0.295	-0.196	-0.100	-0.008	0.082	0.167	0.249
44	0.18687	-0.05030	40.00	-0.594	-0.500	-0.407	-0.316	-0.228	-0.142	-0.058	0.023	0.101	0.177
45	0.22887	-0.05701	41.00	-0.591	-0.506	-0.424	-0.342	-0.262	-0.184	-0.108	-0.034	0.039	0.109
46	0.27253	-0.06393	42.00	-0.677	-0.597	-0.519	-0.441	-0.365	-0.289	-0.216	-0.143	-0.073	-0.004
47	0.31589	-0.07002	43.00	-0.843	-0.764	-0.686	-0.609	-0.532	-0.457	-0.382	-0.309	-0.237	-0.166
48	0.35873	-0.07334	44.00	-0.936	-0.862	-0.788	-0.714	-0.641	-0.568	-0.496	-0.425	-0.355	-0.286
49	0.40193	-0.07288	45.00	-0.883	-0.817	-0.752	-0.687	-0.622	-0.558	-0.493	-0.430	-0.366	-0.304
50	0.44627	-0.06859	46.00	-0.722	-0.668	-0.614	-0.559	-0.505	-0.451	-0.397	-0.344	-0.290	-0.237
51	0.49216	-0.06086	47.00	-0.523	-0.480	-0.437	-0.393	-0.350	-0.306	-0.262	-0.218	-0.175	-0.131
52	0.53971	-0.04984	48.00	-0.277	-0.244	-0.212	-0.179	-0.145	-0.112	-0.078	-0.044	-0.011	0.023
53	0.59018	-0.03645	49.00	-0.045	-0.022	0.002	0.027	0.051	0.076	0.101	0.127	0.152	0.178
54	0.64307	-0.02282	50.00	0.118	0.136	0.154	0.172	0.191	0.210	0.230	0.249	0.269	0.289
55	0.69724	-0.01029	51.00	0.237	0.251	0.265	0.279	0.294	0.308	0.324	0.339	0.355	0.370
56	0.75132	0.00013	52.00	0.326	0.336	0.347	0.359	0.370	0.382	0.394	0.406	0.419	0.431
57	0.80381	0.00775	53.00	0.393	0.401	0.410	0.419	0.428	0.437	0.447	0.457	0.467	0.477
58	0.85314	0.01212	54.00	0.444	0.451	0.457	0.464	0.472	0.479	0.487	0.495	0.503	0.512
59	0.89755	0.01296	55.00	0.470	0.475	0.481	0.486	0.492	0.498	0.505	0.512	0.518	0.526
60	0.93491	0.01083	56.00	0.468	0.472	0.477	0.481	0.486	0.492	0.497	0.503	0.509	0.515
61	0.96391	0.00721	57.00	0.448	0.451	0.455	0.459	0.463	0.467	0.472	0.477	0.482	0.488
62	0.98422	0.00357	58.00	0.419	0.421	0.424	0.427	0.430	0.434	0.438	0.442	0.447	0.452
63	0.99611	0.00096	59.00	0.393	0.394	0.396	0.398	0.400	0.403	0.406	0.409	0.413	0.417
64	1.00000	0.00000	60.00	0.383	0.383	0.383	0.384	0.385	0.387	0.389	0.391	0.394	0.397

ALPHA= 6.84 DEGREES CMO=-0.1792 ETA= 1.145

AIRFOIL S830 21%				3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00
N	X	Y	NU	CP(X)	FOR	THE	ABOVE	ALPHA	REL.	CHORD	LINE	
1	1.00000	0.00000	0.00	0.401	0.405	0.409	0.413	0.418	0.423	0.429	0.434	0.441
2	0.99621	0.00120	1.00	0.374	0.377	0.380	0.384	0.388	0.392	0.397	0.402	0.407
3	0.98554	0.00533	2.00	0.285	0.287	0.289	0.292	0.295	0.299	0.303	0.307	0.312
4	0.96943	0.01245	3.00	0.140	0.140	0.142	0.143	0.146	0.148	0.152	0.156	0.160
5	0.94908	0.02179	4.00	-0.041	-0.042	-0.043	-0.043	-0.042	-0.040	-0.038	-0.035	-0.032
6	0.92504	0.03222	5.00	-0.220	-0.224	-0.226	-0.228	-0.230	-0.230	-0.230	-0.229	-0.227
7	0.89719	0.04283	6.00	-0.334	-0.341	-0.346	-0.351	-0.355	-0.358	-0.360	-0.361	-0.362
8	0.86518	0.05352	7.00	-0.396	-0.405	-0.413	-0.421	-0.428	-0.434	-0.438	-0.443	-0.446
9	0.82943	0.06449	8.00	-0.467	-0.480	-0.492	-0.502	-0.512	-0.521	-0.529	-0.537	-0.543
10	0.79053	0.07559	9.00	-0.548	-0.565	-0.580	-0.594	-0.608	-0.621	-0.632	-0.643	-0.653
11	0.74904	0.08657	10.00	-0.638	-0.658	-0.678	-0.697	-0.715	-0.732	-0.747	-0.762	-0.776
12	0.70550	0.09715	11.00	-0.735	-0.761	-0.785	-0.809	-0.832	-0.853	-0.874	-0.894	-0.912
13	0.66042	0.10703	12.00	-0.839	-0.870	-0.900	-0.929	-0.958	-0.985	-1.011	-1.037	-1.061
14	0.61431	0.11592	13.00	-0.947	-0.985	-1.022	-1.057	-1.092	-1.126	-1.159	-1.190	-1.221
15	0.56764	0.12354	14.00	-1.059	-1.104	-1.148	-1.191	-1.233	-1.275	-1.315	-1.354	-1.392
16	0.52084	0.12962	15.00	-1.172	-1.226	-1.278	-1.329	-1.380	-1.430	-1.479	-1.526	-1.573
17	0.47434	0.13395	16.00	-1.285	-1.347	-1.409	-1.470	-1.530	-1.590	-1.648	-1.706	-1.762
18	0.42854	0.13632	17.00	-1.393	-1.466	-1.538	-1.610	-1.681	-1.752	-1.822	-1.891	-1.959
19	0.38383	0.13653	18.00	-1.495	-1.580	-1.664	-1.748	-1.832	-1.915	-1.997	-2.079	-2.160
20	0.34048	0.13417	19.00	-1.523	-1.618	-1.713	-1.808	-1.903	-1.998	-2.093	-2.187	-2.281
21	0.29810	0.12934	20.00	-1.480	-1.584	-1.689	-1.794	-1.899	-2.005	-2.110	-2.215	-2.321
22	0.25699	0.12262	21.00	-1.438	-1.552	-1.668	-1.784	-1.900	-2.018	-2.136	-2.254	-2.372
23	0.21762	0.11434	22.00	-1.397	-1.522	-1.649	-1.778	-1.908	-2.040	-2.172	-2.305	-2.439
24	0.18042	0.10474	23.00	-1.354	-1.493	-1.634	-1.778	-1.924	-2.071	-2.220	-2.371	-2.523
25	0.14580	0.09406	24.00	-1.310	-1.465	-1.623	-1.784	-1.948	-2.115	-2.285	-2.457	-2.632
26	0.11413	0.08253	25.00	-1.263	-1.436	-1.614	-1.797	-1.984	-2.175	-2.371	-2.569	-2.772
27	0.08576	0.07041	26.00	-1.211	-1.407	-1.610	-1.820	-2.035	-2.257	-2.485	-2.718	-2.956
28	0.06101	0.05794	27.00	-1.150	-1.375	-1.609	-1.853	-2.106	-2.368	-2.638	-2.917	-3.203
29	0.04015	0.04540	28.00	-1.074	-1.337	-1.613	-1.904	-2.207	-2.524	-2.853	-3.195	-3.549
30	0.02343	0.03307	29.00	-0.965	-1.277	-1.610	-1.965	-2.340	-2.735	-3.150	-3.584	-4.037
31	0.01104	0.02127	30.00	-0.801	-1.181	-1.596	-2.045	-2.529	-3.045	-3.594	-4.176	-4.788
32	0.00321	0.01040	31.00	-0.491	-0.956	-1.482	-2.070	-2.718	-3.425	-4.192	-5.015	-5.896
33	0.00006	0.00112	31.99	0.056	-0.494	-1.168	-1.966	-2.886	-3.927	-5.089	-6.369	-7.767
34	0.00004	-0.00084	32.24	0.237	-0.329	-1.050	-1.925	-2.953	-4.133	-5.464	-6.943	-8.569
35	0.00041	-0.00254	32.49	0.438	-0.134	-0.905	-1.874	-3.039	-4.398	-5.951	-7.695	-9.628
36	0.00138	-0.00406	32.74	0.821	0.531	0.106	-0.454	-1.150	-1.979	-2.940	-4.034	-5.258
37	0.00288	-0.00560	32.99	0.962	0.826	0.592	0.258	-0.173	-0.703	-1.329	-2.052	-2.870
38	0.01318	-0.01192	34.00	0.909	0.974	0.999	0.986	0.934	0.843	0.714	0.545	0.339
39	0.02942	-0.01794	35.00	0.733	0.827	0.900	0.953	0.986	1.000	0.993	0.966	0.919
40	0.05165	-0.02385	36.00	0.606	0.696	0.775	0.842	0.897	0.941	0.972	0.992	1.000
41	0.07932	-0.03013	37.00	0.502	0.586	0.663	0.732	0.793	0.847	0.892	0.930	0.960
42	0.11146	-0.03674	38.00	0.410	0.489	0.562	0.630	0.693	0.750	0.801	0.847	0.886
43	0.14756	-0.04351	39.00	0.327	0.401	0.471	0.537	0.599	0.657	0.710	0.759	0.804
44	0.18687	-0.05030	40.00	0.250	0.320	0.386	0.450	0.511	0.568	0.622	0.673	0.720
45	0.22887	-0.05701	41.00	0.177	0.243	0.307	0.368	0.427	0.483	0.537	0.588	0.636
46	0.27253	-0.06393	42.00	0.064	0.129	0.193	0.255	0.315	0.372	0.428	0.481	0.532
47	0.31589	-0.07002	43.00	-0.097	-0.029	0.037	0.102	0.165	0.226	0.285	0.343	0.398
48	0.35873	-0.07334	44.00	-0.218	-0.151	-0.085	-0.020	0.043	0.104	0.165	0.223	0.280
49	0.40193	-0.07288	45.00	-0.242	-0.181	-0.120	-0.061	-0.003	0.055	0.111	0.166	0.220
50	0.44627	-0.06859	46.00	-0.184	-0.132	-0.080	-0.029	0.022	0.072	0.121	0.170	0.217
51	0.49216	-0.06086	47.00	-0.087	-0.044	-0.001	0.042	0.084	0.126	0.168	0.209	0.249
52	0.53971	-0.04984	48.00	0.057	0.091	0.125	0.158	0.192	0.225	0.258	0.291	0.324
53	0.59018	-0.03645	49.00	0.204	0.230	0.255	0.281	0.307	0.333	0.358	0.384	0.409
54	0.64307	-0.02282	50.00	0.309	0.329	0.349	0.370	0.390	0.411	0.431	0.451	0.472
55	0.69724	-0.01029	51.00	0.386	0.402	0.419	0.435	0.452	0.468	0.485	0.501	0.518
56	0.75132	0.00013	52.00	0.444	0.457	0.471	0.484	0.498	0.511	0.525	0.539	0.553
57	0.80381	0.00775	53.00	0.488	0.499	0.509	0.521	0.532	0.543	0.555	0.567	0.578
58	0.85314	0.01212	54.00	0.520	0.529	0.539	0.548	0.557	0.567	0.577	0.587	0.597
59	0.89755	0.01296	55.00	0.533	0.541	0.549	0.557	0.565	0.573	0.582	0.591	0.600
60	0.93491	0.01083	56.00	0.522	0.529	0.536	0.543	0.550	0.558	0.566	0.574	0.582
61	0.96391	0.00721	57.00	0.494	0.500	0.506	0.513	0.520	0.527	0.535	0.542	0.550
62	0.98422	0.00357	58.00	0.457	0.462	0.468	0.474	0.481	0.487	0.494	0.502	0.509
63	0.99611	0.00096	59.00	0.422	0.426	0.432	0.437	0.443	0.449	0.455	0.462	0.469
64	1.00000	0.00000	60.00	0.401	0.405	0.409	0.413	0.418	0.423	0.429	0.434	0.441
ALPHA= 6.84 DEGREES CMO=-0.1792 ETA= 1.145												

ALPHA= 6.84 DEGREES CM0=-0.1792 ETA= 1.145

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
-7.00	S TURB S SEP 100CD UPPER 0.3940 0.0113 0.3329 LOWER 1.0180 0.9897 0.6545* TOTAL CL=-0.029 100CD=0.9874 CM=-0.1771	S TURB S SEP 100CD 1.0157 0.0170 0.6456 1.0180 0.9897 0.6545* CL=-0.035 100CD=1.3000 CM=-0.1766	S TURB S SEP 100CD 0.6582 0.0151 0.5264 1.0180 0.9897 0.6541* CL=-0.033 100CD=1.1805 CM=-0.1768
-6.00	S TURB S SEP 100CD UPPER 0.4176 0.0129 0.3644 LOWER 1.0179 0.3525 0.7055* TOTAL CL= 0.078 100CD=1.0699 CM=-0.1800	S TURB S SEP 100CD 1.0157 0.0191 0.6938 1.0179 0.3525 0.7055* CL= 0.071 100CD=1.3993 CM=-0.1790	S TURB S SEP 100CD 0.6797 0.0170 0.5710 1.0179 0.3525 0.7054* CL= 0.074 100CD=1.2764 CM=-0.1793
-5.00	S TURB S SEP 100CD UPPER 0.4400 0.0145 0.3975 LOWER 1.0175 0.3418 0.6124* TOTAL CL= 0.186 100CD=1.0099 CM=-0.1836	S TURB S SEP 100CD 1.0157 0.0212 0.7458 1.0175 0.3418 0.6124* CL= 0.178 100CD=1.3583 CM=-0.1825	S TURB S SEP 100CD 0.7198 0.0193 0.6328 1.0175 0.3418 0.6124* CL= 0.180 100CD=1.2451 CM=-0.1828
-4.00	S TURB S SEP 100CD UPPER 0.4613 0.0162 0.4325 LOWER 0.5781 0.0000 0.2630* TOTAL CL= 0.293 100CD=0.6955 CM=-0.1854	S TURB S SEP 100CD 1.0204 0.0234 0.8020 0.9642 0.3249 0.5049 CL= 0.284 100CD=1.3069 CM=-0.1859	S TURB S SEP 100CD 0.7538 0.0216 0.6944 0.9917 0.3280 0.5229 CL= 0.286 100CD=1.2173 CM=-0.1863
-3.00	S TURB S SEP 100CD UPPER 0.4814 0.0180 0.4691 LOWER 0.5752 0.0000 0.2450* TOTAL CL= 0.399 100CD=0.7141 CM=-0.1888	S TURB S SEP 100CD 1.0204 0.0258 0.8626 0.9642 0.3123 0.4578 CL= 0.389 100CD=1.3204 CM=-0.1893	S TURB S SEP 100CD 0.7867 0.0239 0.7591 0.9726 0.3130 0.4611 CL= 0.392 100CD=1.2202 CM=-0.1896
-2.00	S TURB S SEP 100CD UPPER 0.4998 0.0198 0.5070 LOWER 0.5719 0.0000 0.2268* TOTAL CL= 0.506 100CD=0.7338 CM=-0.1921	S TURB S SEP 100CD 1.0204 0.0283 0.9281 0.9642 0.2985 0.4165 CL= 0.494 100CD=1.3446 CM=-0.1925	S TURB S SEP 100CD 0.8168 0.0265 0.8282 0.9429 0.2966 0.4099 CL= 0.497 100CD=1.2381 CM=-0.1929
-1.00	S TURB S SEP 100CD UPPER 0.5167 0.0216 0.5463 LOWER 0.5680 0.0000 0.2162* TOTAL CL= 0.612 100CD=0.7625 CM=-0.1954	S TURB S SEP 100CD 1.0204 0.0310 0.9990 0.9642 0.2822 0.3783 CL= 0.599 100CD=1.3774 CM=-0.1956	S TURB S SEP 100CD 0.8475 0.0292 0.9052 0.8713 0.2724 0.3544 CL= 0.601 100CD=1.2596 CM=-0.1959
0.00	S TURB S SEP 100CD UPPER 0.5320 0.0235 0.5869 LOWER 0.5632 0.0000 0.2016* TOTAL CL= 0.718 100CD=0.7885 CM=-0.1986	S TURB S SEP 100CD 1.0204 0.0338 1.0756 0.9642 0.2641 0.3448 CL= 0.703 100CD=1.4204 CM=-0.1986	S TURB S SEP 100CD 0.8759 0.0322 0.9867 0.8021 0.0000 0.3042 CL= 0.705 100CD=1.2908 CM=-0.1957
1.00	S TURB S SEP 100CD UPPER 0.5455 0.0254 0.6284 LOWER 0.5577 0.0000 0.1868* TOTAL CL= 0.824 100CD=0.8152 CM=-0.2018	S TURB S SEP 100CD 1.0204 0.0369 1.1586 0.9642 0.0000 0.3131 CL= 0.806 100CD=1.4717 CM=-0.1978	S TURB S SEP 100CD 0.9038 0.0353 1.0761 0.6305 0.0000 0.2186 CL= 0.809 100CD=1.2947 CM=-0.1983
2.00	S TURB S SEP 100CD UPPER 0.5597 0.0275 0.6739 LOWER 0.5517 0.0000 0.1734* TOTAL CL= 0.929 100CD=0.8472 CM=-0.2048	S TURB S SEP 100CD 1.0204 0.0401 1.2487 0.9642 0.0000 0.2843 CL= 0.909 100CD=1.5330 CM=-0.2003	S TURB S SEP 100CD 0.9301 0.0387 1.1738 0.6204 0.0000 0.2017 CL= 0.911 100CD=1.3755 CM=-0.2008
3.00	S TURB S SEP 100CD UPPER 0.5733 0.0298 0.7222 LOWER 0.5456 0.0000 0.1618* TOTAL CL= 1.034 100CD=0.8840 CM=-0.2077	S TURB S SEP 100CD 1.0204 0.0436 1.3465 0.9642 0.0000 0.2630 CL= 1.011 100CD=1.6095 CM=-0.2027	S TURB S SEP 100CD 0.9549 0.0424 1.2821 0.6147 0.0000 0.1880 CL= 1.013 100CD=1.4701 CM=-0.2031

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
4.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.5850 0.0321 0.7713	1.0204 0.0474 1.4525	0.9783 0.0465 1.4026
	LOWER 0.5394 0.0000 0.1524*	0.9642 0.0000 0.2413	0.6100 0.0000 0.1755
	TOTAL CL= 1.138 100CD=0.9237	CL= 1.111 100CD=1.6937	CL= 1.113 100CD=1.5781
	CM=-0.2106	CM=-0.2048	CM=-0.2052
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.5948 0.0345 0.8230*	1.0204 0.0517 1.5668	0.9988 0.0511 1.5353
	LOWER 0.5331 0.0000 0.1418*	0.9642 0.0000 0.2219	0.6057 0.0000 0.1641
	TOTAL CL= 1.242 100CD=0.9648	CL= 1.211 100CD=1.7887	CL= 1.212 100CD=1.6994
	CM=-0.2133	CM=-0.2067	CM=-0.2069
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6025 0.0370 0.8736*	1.0204 0.0563 1.6909	1.0157 0.0562 1.6821
	LOWER 0.5268 0.0000 0.1349*	0.9642 0.0000 0.2042	0.6015 0.0000 0.1534
	TOTAL CL= 1.345 100CD=1.0085	CL= 1.309 100CD=1.8951	CL= 1.309 100CD=1.8356
	CM=-0.2159	CM=-0.2083	CM=-0.2084
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6187 0.0400 0.9430	1.0204 0.0613 1.8251	1.0280 0.0617 1.8431
	LOWER 0.5206 0.0000 0.1266*	0.9624 0.0000 0.1879	0.5972 0.0000 0.1438
	TOTAL CL= 1.447 100CD=1.0696	CL= 1.406 100CD=2.0130	CL= 1.406 100CD=1.9869
	CM=-0.2183	CM=-0.2097	CM=-0.2096
7.47			S TURB S SEP 100CD
	UPPER		1.0328 0.0643 1.9208
	LOWER		0.5951 0.0000 0.1392
	TOTAL		CL= 1.450 100CD=2.0600
			CM=-0.2101
7.66		S TURB S SEP 100CD	
	UPPER	1.0204 0.0649 1.9200	
	LOWER	0.9624 0.0000 0.1778	
	TOTAL	CL= 1.469 100CD=2.0978	
		CM=-0.2105	
8.00	S TURB S SEP 100CD		
	UPPER 0.7730 0.0521 1.3458		
	LOWER 0.5145 0.0000 0.1183*		
	TOTAL CL= 1.531 100CD=1.4640		
	CM=-0.2167		
8.60	S TURB S SEP 100CD		
	UPPER 0.8892 0.0617 1.6809		
	LOWER 0.5112 0.0000 0.1133*		
	TOTAL CL= 1.576 100CD=1.7942		
	CM=-0.2147		

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
-7.00	S TURB S SEP 100CD UPPER 0.4237 0.0093 0.3217 LOWER 1.0180 0.3522 0.7362* TOTAL CL=-0.027 100CD=1.0580 CM=-0.1766	S TURB S SEP 100CD 1.0157 0.0146 0.6065 1.0180 0.3522 0.7362* CL=-0.033 100CD=1.3427 CM=-0.1758	S TURB S SEP 100CD 0.7230 0.0134 0.5281 1.0180 0.3521 0.7374* CL=-0.031 100CD=1.2654 CM=-0.1760
-6.00	S TURB S SEP 100CD UPPER 0.4462 0.0109 0.3515 LOWER 1.0179 0.3409 0.6564* TOTAL CL= 0.080 100CD=1.0079 CM=-0.1803	S TURB S SEP 100CD 1.0157 0.0167 0.6517 1.0179 0.3409 0.6564* CL= 0.074 100CD=1.3081 CM=-0.1793	S TURB S SEP 100CD 0.7539 0.0154 0.5767 1.0179 0.3409 0.6562* CL= 0.075 100CD=1.2329 CM=-0.1795
-5.00	S TURB S SEP 100CD UPPER 0.4671 0.0125 0.3824 LOWER 1.0175 0.3293 0.5707* TOTAL CL= 0.188 100CD=0.9532 CM=-0.1839	S TURB S SEP 100CD 1.0157 0.0188 0.7005 1.0175 0.3293 0.5707* CL= 0.181 100CD=1.2713 CM=-0.1828	S TURB S SEP 100CD 0.7822 0.0175 0.6272 1.0175 0.3293 0.5706* CL= 0.182 100CD=1.1978 CM=-0.1830
-4.00	S TURB S SEP 100CD UPPER 0.4869 0.0141 0.4150 LOWER 0.5781 0.0000 0.2273* TOTAL CL= 0.295 100CD=0.6423 CM=-0.1860	S TURB S SEP 100CD 1.0204 0.0210 0.7532 0.9642 0.3106 0.4705 CL= 0.287 100CD=1.2237 CM=-0.1862	S TURB S SEP 100CD 0.8084 0.0197 0.6816 0.9966 0.3149 0.4921 CL= 0.288 100CD=1.1737 CM=-0.1865
-3.00	S TURB S SEP 100CD UPPER 0.5051 0.0159 0.4486 LOWER 0.5752 0.0000 0.2177* TOTAL CL= 0.402 100CD=0.6663 CM=-0.1894	S TURB S SEP 100CD 1.0204 0.0233 0.8099 0.9642 0.2973 0.4282 CL= 0.393 100CD=1.2381 CM=-0.1896	S TURB S SEP 100CD 0.8358 0.0221 0.7406 0.9797 0.2991 0.4353 CL= 0.394 100CD=1.1760 CM=-0.1898
-2.00	S TURB S SEP 100CD UPPER 0.5216 0.0176 0.4832 LOWER 0.5719 0.0000 0.2067* TOTAL CL= 0.509 100CD=0.6900 CM=-0.1928	S TURB S SEP 100CD 1.0204 0.0257 0.8713 0.9642 0.2820 0.3896 CL= 0.498 100CD=1.2608 CM=-0.1928	S TURB S SEP 100CD 0.8601 0.0245 0.8032 0.9601 0.2816 0.3883 CL= 0.500 100CD=1.1916 CM=-0.1931
-1.00	S TURB S SEP 100CD UPPER 0.5365 0.0194 0.5188 LOWER 0.5680 0.0000 0.1941* TOTAL CL= 0.615 100CD=0.7130 CM=-0.1961	S TURB S SEP 100CD 1.0204 0.0283 0.9375 0.9642 0.2643 0.3549 CL= 0.603 100CD=1.2924 CM=-0.1960	S TURB S SEP 100CD 0.8850 0.0271 0.8722 0.9175 0.2599 0.3445 CL= 0.604 100CD=1.2168 CM=-0.1962
0.00	S TURB S SEP 100CD UPPER 0.5498 0.0212 0.5552 LOWER 0.5632 0.0000 0.1819* TOTAL CL= 0.721 100CD=0.7370 CM=-0.1994	S TURB S SEP 100CD 1.0204 0.0311 1.0091 0.9642 0.0000 0.3243 CL= 0.707 100CD=1.3334 CM=-0.1960	S TURB S SEP 100CD 0.9088 0.0300 0.9469 0.8607 0.0000 0.3010 CL= 0.709 100CD=1.2479 CM=-0.1964
1.00	S TURB S SEP 100CD UPPER 0.5614 0.0231 0.5922 LOWER 0.5577 0.0000 0.1691* TOTAL CL= 0.827 100CD=0.7613 CM=-0.2026	S TURB S SEP 100CD 1.0204 0.0341 1.0864 0.9642 0.0000 0.2943 CL= 0.810 100CD=1.3808 CM=-0.1987	S TURB S SEP 100CD 0.9317 0.0330 1.0285 0.8096 0.0000 0.2637 CL= 0.812 100CD=1.2922 CM=-0.1991
2.00	S TURB S SEP 100CD UPPER 0.5718 0.0251 0.6301 LOWER 0.5517 0.0000 0.1572* TOTAL CL= 0.933 100CD=0.7874 CM=-0.2057	S TURB S SEP 100CD 1.0204 0.0372 1.1701 0.9642 0.0000 0.2675 CL= 0.913 100CD=1.4375 CM=-0.2013	S TURB S SEP 100CD 0.9536 0.0362 1.1182 0.6429 0.0000 0.1965 CL= 0.915 100CD=1.3147 CM=-0.2017
3.00	S TURB S SEP 100CD UPPER 0.5812 0.0271 0.6692 LOWER 0.5456 0.0000 0.1463* TOTAL CL= 1.038 100CD=0.8155 CM=-0.2088	S TURB S SEP 100CD 1.0204 0.0405 1.2585 0.9642 0.0000 0.2478 CL= 1.016 100CD=1.5063 CM=-0.2038	S TURB S SEP 100CD 0.9738 0.0398 1.2173 0.6297 0.0000 0.1800 CL= 1.017 100CD=1.3973 CM=-0.2041

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
4.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.5904 0.0292 0.7106	1.0204 0.0441 1.3563	0.9930 0.0436 1.3276
LOWER	0.5394 0.0000 0.1370*	0.9642 0.0000 0.2287	0.6228 0.0000 0.1673
TOTAL	CL= 1.143 100CD=0.8477	CL= 1.117 100CD=1.5850	CL= 1.118 100CD=1.4949
	CM=-0.2117	CM=-0.2060	CM=-0.2062
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.6004 0.0315 0.7564	1.0204 0.0480 1.4622	1.0098 0.0477 1.4471
LOWER	0.5331 0.0000 0.1289*	0.9642 0.0000 0.2104	0.6177 0.0000 0.1561
TOTAL	CL= 1.247 100CD=0.8853	CL= 1.217 100CD=1.6726	CL= 1.218 100CD=1.6032
	CM=-0.2145	CM=-0.2081	CM=-0.2082
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.6149 0.0342 0.8145	1.0204 0.0524 1.5763	1.0229 0.0525 1.5807
LOWER	0.5268 0.0000 0.1211*	0.9642 0.0000 0.1936	0.6131 0.0000 0.1463
TOTAL	CL= 1.350 100CD=0.9355	CL= 1.316 100CD=1.7699	CL= 1.316 100CD=1.7271
	CM=-0.2171	CM=-0.2098	CM=-0.2098
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.6612 0.0383 0.9349	1.0204 0.0571 1.6993	1.0335 0.0577 1.7300
LOWER	0.5206 0.0000 0.1141*	0.9624 0.0000 0.1782	0.6087 0.0000 0.1366
TOTAL	CL= 1.450 100CD=1.0490	CL= 1.414 100CD=1.8775	CL= 1.413 100CD=1.8666
	CM=-0.2190	CM=-0.2114	CM=-0.2111
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.8702 0.0538 1.4554	1.0204 0.0622 1.8321	1.0414 0.0635 1.8968
LOWER	0.5145 0.0000 0.1068*	0.9624 0.0000 0.1640	0.6042 0.0000 0.1274
TOTAL	CL= 1.527 100CD=1.5622	CL= 1.511 100CD=1.9961	CL= 1.508 100CD=2.0242
	CM=-0.2160	CM=-0.2126	CM=-0.2121
8.13			S TURB S SEP 100CD
UPPER			1.0423 0.0643 1.9197
LOWER			0.6036 0.0000 0.1262
TOTAL			CL= 1.520 100CD=2.0459
			CM=-0.2122
8.58		S TURB S SEP 100CD	
UPPER		1.0204 0.0655 1.9193*	
LOWER		0.9624 0.0000 0.1569	
TOTAL		CL= 1.566 100CD=2.0762	
		CM=-0.2132	
8.60	S TURB S SEP 100CD		
UPPER	0.9370 0.0604 1.6795		
LOWER	0.5112 0.0000 0.1024*		
TOTAL	CL= 1.578 100CD=1.7819		
	CM=-0.2153		

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
-7.00	S TURB S SEP 100CD UPPER 0.4450 0.0078 0.3157 LOWER 1.0180 0.3427 0.7135* TOTAL CL=-0.026 100CD=1.0293 CM=-0.1768	S TURB S SEP 100CD 1.0157 0.0129 0.5800 1.0180 0.3427 0.7135* CL=-0.031 100CD=1.2935 CM=-0.1760	S TURB S SEP 100CD 0.7654 0.0120 0.5233 1.0180 0.3427 0.7132* CL=-0.030 100CD=1.2365 CM=-0.1762
-6.00	S TURB S SEP 100CD UPPER 0.4664 0.0094 0.3441 LOWER 1.0179 0.3318 0.6234* TOTAL CL= 0.082 100CD=0.9675 CM=-0.1804	S TURB S SEP 100CD 1.0157 0.0149 0.6233 1.0179 0.3318 0.6234* CL= 0.076 100CD=1.2467 CM=-0.1796	S TURB S SEP 100CD 0.7919 0.0140 0.5682 1.0179 0.3318 0.6232* CL= 0.077 100CD=1.1914 CM=-0.1797
-5.00	S TURB S SEP 100CD UPPER 0.4862 0.0110 0.3736 LOWER 1.0175 0.3197 0.5441* TOTAL CL= 0.190 100CD=0.9177 CM=-0.1841	S TURB S SEP 100CD 1.0157 0.0170 0.6698 1.0175 0.3197 0.5441* CL= 0.183 100CD=1.2140 CM=-0.1831	S TURB S SEP 100CD 0.8159 0.0161 0.6153 1.0175 0.3197 0.5440* CL= 0.184 100CD=1.1593 CM=-0.1832
-4.00	S TURB S SEP 100CD UPPER 0.5047 0.0127 0.4043 LOWER 0.5781 0.0000 0.2151* TOTAL CL= 0.297 100CD=0.6194 CM=-0.1865	S TURB S SEP 100CD 1.0204 0.0192 0.7202 0.9642 0.2999 0.4484 CL= 0.289 100CD=1.1686 CM=-0.1865	S TURB S SEP 100CD 0.8392 0.0183 0.6662 0.9996 0.3047 0.4713 CL= 0.290 100CD=1.1375 CM=-0.1867
-3.00	S TURB S SEP 100CD UPPER 0.5214 0.0144 0.4358 LOWER 0.5752 0.0000 0.2030* TOTAL CL= 0.404 100CD=0.6388 CM=-0.1899	S TURB S SEP 100CD 1.0204 0.0215 0.7746 0.9642 0.2857 0.4085 CL= 0.395 100CD=1.1832 CM=-0.1898	S TURB S SEP 100CD 0.8634 0.0206 0.7218 0.9844 0.2881 0.4174 CL= 0.396 100CD=1.1393 CM=-0.1900
-2.00	S TURB S SEP 100CD UPPER 0.5365 0.0161 0.4682 LOWER 0.5719 0.0000 0.1919* TOTAL CL= 0.511 100CD=0.6601 CM=-0.1933	S TURB S SEP 100CD 1.0204 0.0239 0.8329 0.9642 0.2693 0.3720 CL= 0.500 100CD=1.2049 CM=-0.1931	S TURB S SEP 100CD 0.8850 0.0229 0.7809 0.9670 0.2698 0.3734 CL= 0.502 100CD=1.1543 CM=-0.1933
-1.00	S TURB S SEP 100CD UPPER 0.5498 0.0179 0.5012 LOWER 0.5680 0.0000 0.1809* TOTAL CL= 0.617 100CD=0.6820 CM=-0.1966	S TURB S SEP 100CD 1.0204 0.0264 0.8944 0.9642 0.0000 0.3386 CL= 0.605 100CD=1.2330 CM=-0.1938	S TURB S SEP 100CD 0.9067 0.0255 0.8456 0.9381 0.0000 0.3330 CL= 0.607 100CD=1.1786 CM=-0.1941
0.00	S TURB S SEP 100CD UPPER 0.5616 0.0197 0.5347 LOWER 0.5632 0.0000 0.1700* TOTAL CL= 0.724 100CD=0.7048 CM=-0.1999	S TURB S SEP 100CD 1.0204 0.0291 0.9626 0.9642 0.0000 0.3098 CL= 0.710 100CD=1.2723 CM=-0.1967	S TURB S SEP 100CD 0.9277 0.0283 0.9161 0.8910 0.0000 0.2948 CL= 0.711 100CD=1.2109 CM=-0.1970
1.00	S TURB S SEP 100CD UPPER 0.5719 0.0215 0.5683 LOWER 0.5577 0.0000 0.1584* TOTAL CL= 0.830 100CD=0.7267 CM=-0.2032	S TURB S SEP 100CD 1.0204 0.0320 1.0360 0.9642 0.0000 0.2821 CL= 0.814 100CD=1.3181 CM=-0.1994	S TURB S SEP 100CD 0.9480 0.0312 0.9933 0.8466 0.0000 0.2605 CL= 0.815 100CD=1.2538 CM=-0.1997
2.00	S TURB S SEP 100CD UPPER 0.5812 0.0233 0.6034 LOWER 0.5517 0.0000 0.1475* TOTAL CL= 0.936 100CD=0.7509 CM=-0.2063	S TURB S SEP 100CD 1.0204 0.0351 1.1152 0.9642 0.0000 0.2565 CL= 0.917 100CD=1.3717 CM=-0.2021	S TURB S SEP 100CD 0.9673 0.0344 1.0780 0.8054 0.0000 0.2368 CL= 0.918 100CD=1.3147 CM=-0.2023
3.00	S TURB S SEP 100CD UPPER 0.5898 0.0253 0.6397 LOWER 0.5456 0.0000 0.1373* TOTAL CL= 1.041 100CD=0.7770 CM=-0.2094	S TURB S SEP 100CD 1.0204 0.0384 1.2014 0.9642 0.0000 0.2395 CL= 1.019 100CD=1.4408 CM=-0.2046	S TURB S SEP 100CD 0.9848 0.0378 1.1713 0.6503 0.0000 0.1790 CL= 1.020 100CD=1.3502 CM=-0.2048

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
4.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.5989 0.0273 0.6789	1.0204 0.0418 1.2940	1.0016 0.0414 1.2732
	LOWER 0.5394 0.0000 0.1281*	0.9642 0.0000 0.2202	0.6346 0.0000 0.1632
	TOTAL CL= 1.146 100CD=0.8070	CL= 1.121 100CD=1.5142	CL= 1.122 100CD=1.4363
	CM=-0.2124	CM=-0.2069	CM=-0.2070
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6102 0.0297 0.7249	1.0204 0.0456 1.3943	1.0162 0.0455 1.3884
	LOWER 0.5331 0.0000 0.1207*	0.9642 0.0000 0.2026	0.6275 0.0000 0.1516
	TOTAL CL= 1.250 100CD=0.8456	CL= 1.222 100CD=1.5969	CL= 1.222 100CD=1.5400
	CM=-0.2153	CM=-0.2090	CM=-0.2091
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6315 0.0326 0.7927	1.0204 0.0497 1.5020	1.0274 0.0499 1.5145
	LOWER 0.5268 0.0000 0.1126*	0.9642 0.0000 0.1864	0.6222 0.0000 0.1418
	TOTAL CL= 1.353 100CD=0.9053	CL= 1.321 100CD=1.6884	CL= 1.321 100CD=1.6563
	CM=-0.2177	CM=-0.2109	CM=-0.2108
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.7734 0.0424 1.1103	1.0204 0.0543 1.6183	1.0370 0.0550 1.6567
	LOWER 0.5206 0.0000 0.1067*	0.9624 0.0000 0.1715	0.6175 0.0000 0.1323
	TOTAL CL= 1.442 100CD=1.2169	CL= 1.420 100CD=1.7899	CL= 1.418 100CD=1.7890
	CM=-0.2173	CM=-0.2125	CM=-0.2122
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9110 0.0532 1.4733	1.0204 0.0591 1.7437	1.0439 0.0605 1.8146
	LOWER 0.5145 0.0000 0.1000*	0.9624 0.0000 0.1581	0.6130 0.0000 0.1233
	TOTAL CL= 1.529 100CD=1.5733	CL= 1.517 100CD=1.9017	CL= 1.514 100CD=1.9380
	CM=-0.2163	CM=-0.2139	CM=-0.2133
8.61			S TURB S SEP 100CD
	UPPER		1.0469 0.0642 1.9193
	LOWER		0.6102 0.0000 0.1181
	TOTAL		CL= 1.572 100CD=2.0374
			CM=-0.2138
8.91	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0300 0.0651 1.9217*	1.0300 0.0651 1.9217*	
	LOWER 0.5096 0.0000 0.0938*	0.9624 0.0000 0.1470	
	TOTAL CL= 1.602 100CD=2.0156	CL= 1.602 100CD=2.0687	
	CM=-0.2144	CM=-0.2144	

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
-7.00	S TURB S SEP 100CD UPPER 0.4749 0.0055 0.3085 LOWER 1.0180 0.3295 0.6628* TOTAL CL=-0.023 100CD=0.9713 CM=-0.1771	S TURB S SEP 100CD 1.0157 0.0104 0.5443 1.0180 0.3295 0.6628* CL=-0.028 100CD=1.2071 CM=-0.1763	S TURB S SEP 100CD 0.8130 0.0098 0.5081 1.0180 0.3295 0.6620* CL=-0.028 100CD=1.1701 CM=-0.1764
-6.00	S TURB S SEP 100CD UPPER 0.4945 0.0073 0.3350 LOWER 1.0179 0.3180 0.5801* TOTAL CL= 0.084 100CD=0.9150 CM=-0.1808	S TURB S SEP 100CD 1.0157 0.0123 0.5849 1.0179 0.3180 0.5801* CL= 0.079 100CD=1.1650 CM=-0.1799	S TURB S SEP 100CD 0.8348 0.0117 0.5490 1.0179 0.3180 0.5796* CL= 0.080 100CD=1.1286 CM=-0.1800
-5.00	S TURB S SEP 100CD UPPER 0.5123 0.0090 0.3621 LOWER 1.0175 0.3050 0.5089* TOTAL CL= 0.192 100CD=0.8710 CM=-0.1844	S TURB S SEP 100CD 1.0157 0.0144 0.6286 1.0175 0.3050 0.5089* CL= 0.186 100CD=1.1375 CM=-0.1834	S TURB S SEP 100CD 0.8549 0.0138 0.5925 1.0175 0.3050 0.5086* CL= 0.186 100CD=1.1010 CM=-0.1836
-4.00	S TURB S SEP 100CD UPPER 0.5286 0.0106 0.3902 LOWER 0.5814 0.0000 0.1976 TOTAL CL= 0.300 100CD=0.5879 CM=-0.1871	S TURB S SEP 100CD 1.0204 0.0166 0.6748 0.9642 0.2835 0.4200 CL= 0.292 100CD=1.0949 CM=-0.1869	S TURB S SEP 100CD 0.8751 0.0160 0.6396 1.0033 0.2892 0.4436 CL= 0.293 100CD=1.0832 CM=-0.1870
-3.00	S TURB S SEP 100CD UPPER 0.5431 0.0122 0.4189 LOWER 0.5752 0.0000 0.1849* TOTAL CL= 0.407 100CD=0.6037 CM=-0.1905	S TURB S SEP 100CD 1.0204 0.0189 0.7268 0.9642 0.2679 0.3830 CL= 0.398 100CD=1.1098 CM=-0.1902	S TURB S SEP 100CD 0.8949 0.0182 0.6907 0.9900 0.2711 0.3934 CL= 0.399 100CD=1.0841 CM=-0.1904
-2.00	S TURB S SEP 100CD UPPER 0.5559 0.0139 0.4479 LOWER 0.5719 0.0000 0.1741* TOTAL CL= 0.514 100CD=0.6220 CM=-0.1940	S TURB S SEP 100CD 1.0204 0.0212 0.7801 0.9642 0.2500 0.3491 CL= 0.504 100CD=1.1293 CM=-0.1935	S TURB S SEP 100CD 0.9140 0.0206 0.7457 0.9745 0.2513 0.3522 CL= 0.505 100CD=1.0979 CM=-0.1936
-1.00	S TURB S SEP 100CD UPPER 0.5670 0.0156 0.4774 LOWER 0.5680 0.0000 0.1647* TOTAL CL= 0.621 100CD=0.6421 CM=-0.1974	S TURB S SEP 100CD 1.0204 0.0237 0.8388 0.9642 0.0000 0.3182 CL= 0.609 100CD=1.1570 CM=-0.1947	S TURB S SEP 100CD 0.9321 0.0231 0.8056 0.9565 0.0000 0.3160 CL= 0.610 100CD=1.1216 CM=-0.1949
0.00	S TURB S SEP 100CD UPPER 0.5769 0.0174 0.5074 LOWER 0.5632 0.0000 0.1554* TOTAL CL= 0.727 100CD=0.6629 CM=-0.2007	S TURB S SEP 100CD 1.0204 0.0263 0.9025 0.9642 0.0000 0.2909 CL= 0.714 100CD=1.1934 CM=-0.1976	S TURB S SEP 100CD 0.9499 0.0257 0.8709 0.9242 0.0000 0.2839 CL= 0.715 100CD=1.1549 CM=-0.1978
1.00	S TURB S SEP 100CD UPPER 0.5856 0.0191 0.5379 LOWER 0.5577 0.0000 0.1451* TOTAL CL= 0.833 100CD=0.6830 CM=-0.2040	S TURB S SEP 100CD 1.0204 0.0291 0.9709 0.9642 0.0000 0.2647 CL= 0.818 100CD=1.2357 CM=-0.2005	S TURB S SEP 100CD 0.9668 0.0286 0.9424 0.8867 0.0000 0.2525 CL= 0.819 100CD=1.1949 CM=-0.2007
2.00	S TURB S SEP 100CD UPPER 0.5937 0.0210 0.5695 LOWER 0.5517 0.0000 0.1352* TOTAL CL= 0.939 100CD=0.7047 CM=-0.2072	S TURB S SEP 100CD 1.0204 0.0321 1.0448 0.9642 0.0000 0.2414 CL= 0.922 100CD=1.2862 CM=-0.2032	S TURB S SEP 100CD 0.9828 0.0316 1.0190 0.8517 0.0000 0.2320 CL= 0.922 100CD=1.2510 CM=-0.2033
3.00	S TURB S SEP 100CD UPPER 0.6020 0.0229 0.6034 LOWER 0.5456 0.0000 0.1262* TOTAL CL= 1.045 100CD=0.7296 CM=-0.2104	S TURB S SEP 100CD 1.0204 0.0352 1.1243 0.9642 0.0000 0.2266 CL= 1.025 100CD=1.3509 CM=-0.2057	S TURB S SEP 100CD 0.9978 0.0348 1.1051 0.8193 0.0000 0.2107 CL= 1.025 100CD=1.3158 CM=-0.2059

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
4.00	S TURB S SEP 100CD UPPER 0.6125 0.0249 0.6426 LOWER 0.5394 0.0000 0.1183 TOTAL CL= 1.150 100CD=0.7610 CM=-0.2134	S TURB S SEP 100CD 1.0204 0.0386 1.2108 0.9642 0.0000 0.2087 CL= 1.127 100CD=1.4195 CM=-0.2081	S TURB S SEP 100CD 1.0118 0.0384 1.2016 0.7910 0.0000 0.1918 CL= 1.127 100CD=1.3934 CM=-0.2082
5.00	S TURB S SEP 100CD UPPER 0.6302 0.0275 0.6963 LOWER 0.5331 0.0000 0.1106 TOTAL CL= 1.254 100CD=0.8069 CM=-0.2161	S TURB S SEP 100CD 1.0204 0.0421 1.3035 0.9642 0.0000 0.1923 CL= 1.228 100CD=1.4958 CM=-0.2103	S TURB S SEP 100CD 1.0234 0.0422 1.3075 0.6483 0.0000 0.1481 CL= 1.228 100CD=1.4556 CM=-0.2103
6.00	S TURB S SEP 100CD UPPER 0.7201 0.0334 0.8755 LOWER 0.5268 0.0000 0.1035* TOTAL CL= 1.352 100CD=0.9790 CM=-0.2174	S TURB S SEP 100CD 1.0204 0.0460 1.4037 0.9642 0.0000 0.1770 CL= 1.328 100CD=1.5807 CM=-0.2124	S TURB S SEP 100CD 1.0332 0.0464 1.4261 0.6378 0.0000 0.1369 CL= 1.328 100CD=1.5630 CM=-0.2122
7.00	S TURB S SEP 100CD UPPER 0.8625 0.0432 1.1957 LOWER 0.5206 0.0000 0.0975* TOTAL CL= 1.441 100CD=1.2933 CM=-0.2169	S TURB S SEP 100CD 1.0204 0.0502 1.5111 0.9624 0.0000 0.1627 CL= 1.428 100CD=1.6738 CM=-0.2141	S TURB S SEP 100CD 1.0412 0.0511 1.5581 0.6314 0.0000 0.1272 CL= 1.426 100CD=1.6853 CM=-0.2137
8.00	S TURB S SEP 100CD UPPER 0.9487 0.0510 1.4498 LOWER 0.5145 0.0000 0.0917* TOTAL CL= 1.533 100CD=1.5414 CM=-0.2172	S TURB S SEP 100CD 1.0204 0.0548 1.6265 0.9624 0.0000 0.1503 CL= 1.525 100CD=1.7768 CM=-0.2156	S TURB S SEP 100CD 1.0469 0.0564 1.7049 0.6263 0.0000 0.1184 CL= 1.522 100CD=1.8233 CM=-0.2150
9.00	S TURB S SEP 100CD UPPER 1.0327 0.0611 1.8178* LOWER 0.5091 0.0000 0.0856* TOTAL CL= 1.619 100CD=1.9034 CM=-0.2163	S TURB S SEP 100CD 1.0327 0.0611 1.8178* 0.9624 0.0000 0.1385 CL= 1.619 100CD=1.9562 CM=-0.2163	S TURB S SEP 100CD 1.0504 0.0621 1.8667 0.6216 0.0000 0.1103 CL= 1.617 100CD=1.9770 CM=-0.2159
9.31	UPPER LOWER TOTAL		S TURB S SEP 100CD 1.0512 0.0640 1.9199 0.6202 0.0000 0.1079 CL= 1.646 100CD=2.0278 CM=-0.2161
9.39	S TURB S SEP 100CD UPPER 1.0431 0.0642 1.9190* LOWER 0.5072 0.0000 0.0833* TOTAL CL= 1.654 100CD=2.0023 CM=-0.2163	S TURB S SEP 100CD 1.0431 0.0642 1.9190* 0.9341 0.0000 0.1340 CL= 1.654 100CD=2.0529 CM=-0.2163	

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 9000000 MU= 300	R= 9000000 MU= 100	R= 9000000 MU= 900
-7.00	S TURB S SEP 100CD UPPER 0.5042 0.0020 0.3024 LOWER 1.0180 0.3144 0.6047* TOTAL CL=-0.020 100CD=0.9071 CM=-0.1776	S TURB S SEP 100CD 1.0157 0.0077 0.5101 1.0180 0.3144 0.6047* CL=-0.026 100CD=1.1149 CM=-0.1767	S TURB S SEP 100CD 0.8501 0.0073 0.4868 1.0180 0.3143 0.6039* CL=-0.025 100CD=1.0907 CM=-0.1768
-6.00	S TURB S SEP 100CD UPPER 0.5214 0.0049 0.3267 LOWER 1.0179 0.3023 0.5359* TOTAL CL= 0.087 100CD=0.8626 CM=-0.1812	S TURB S SEP 100CD 1.0157 0.0097 0.5482 1.0179 0.3023 0.5359* CL= 0.082 100CD=1.0840 CM=-0.1803	S TURB S SEP 100CD 0.8684 0.0093 0.5245 1.0179 0.3022 0.5354* CL= 0.082 100CD=1.0599 CM=-0.1804
-5.00	S TURB S SEP 100CD UPPER 0.5369 0.0067 0.3516 LOWER 1.0175 0.2888 0.4760* TOTAL CL= 0.195 100CD=0.8276 CM=-0.1848	S TURB S SEP 100CD 1.0157 0.0117 0.5883 1.0175 0.2888 0.4760* CL= 0.189 100CD=1.0643 CM=-0.1839	S TURB S SEP 100CD 0.8865 0.0113 0.5653 1.0175 0.2887 0.4756* CL= 0.189 100CD=1.0409 CM=-0.1839
-4.00	S TURB S SEP 100CD UPPER 0.5507 0.0084 0.3770 LOWER 0.5953 0.0000 0.1913 TOTAL CL= 0.302 100CD=0.5683 CM=-0.1877	S TURB S SEP 100CD 1.0204 0.0138 0.6323 0.9642 0.2650 0.3929 CL= 0.296 100CD=1.0252 CM=-0.1873	S TURB S SEP 100CD 0.9036 0.0134 0.6090 1.0063 0.2719 0.4175 CL= 0.296 100CD=1.0265 CM=-0.1874
-3.00	S TURB S SEP 100CD UPPER 0.5627 0.0100 0.4027 LOWER 0.5791 0.0000 0.1724 TOTAL CL= 0.410 100CD=0.5751 CM=-0.1912	S TURB S SEP 100CD 1.0204 0.0161 0.6797 0.9642 0.2479 0.3586 CL= 0.402 100CD=1.0383 CM=-0.1907	S TURB S SEP 100CD 0.9205 0.0156 0.6564 0.9949 0.2523 0.3706 CL= 0.402 100CD=1.0270 CM=-0.1908
-2.00	S TURB S SEP 100CD UPPER 0.5733 0.0116 0.4288 LOWER 0.5740 0.0000 0.1617 TOTAL CL= 0.517 100CD=0.5905 CM=-0.1947	S TURB S SEP 100CD 1.0204 0.0184 0.7308 0.9642 0.0000 0.3272 CL= 0.508 100CD=1.0580 CM=-0.1925	S TURB S SEP 100CD 0.9369 0.0180 0.7080 0.9812 0.0000 0.3321 CL= 0.508 100CD=1.0401 CM=-0.1927
-1.00	S TURB S SEP 100CD UPPER 0.5825 0.0133 0.4552 LOWER 0.5699 0.0000 0.1523 TOTAL CL= 0.624 100CD=0.6075 CM=-0.1981	S TURB S SEP 100CD 1.0204 0.0208 0.7859 0.9642 0.0000 0.2985 CL= 0.613 100CD=1.0843 CM=-0.1956	S TURB S SEP 100CD 0.9526 0.0204 0.7634 0.9674 0.0000 0.2992 CL= 0.614 100CD=1.0625 CM=-0.1958
0.00	S TURB S SEP 100CD UPPER 0.5907 0.0150 0.4821 LOWER 0.5657 0.0000 0.1434 TOTAL CL= 0.731 100CD=0.6256 CM=-0.2015	S TURB S SEP 100CD 1.0204 0.0234 0.8450 0.9642 0.0000 0.2720 CL= 0.718 100CD=1.1170 CM=-0.1986	S TURB S SEP 100CD 0.9677 0.0230 0.8227 0.9457 0.0000 0.2702 CL= 0.719 100CD=1.0930 CM=-0.1988
1.00	S TURB S SEP 100CD UPPER 0.5982 0.0167 0.5099 LOWER 0.5610 0.0000 0.1347 TOTAL CL= 0.837 100CD=0.6445 CM=-0.2049	S TURB S SEP 100CD 1.0204 0.0261 0.9089 0.9642 0.0000 0.2492 CL= 0.823 100CD=1.1581 CM=-0.2015	S TURB S SEP 100CD 0.9820 0.0257 0.8891 0.9167 0.0000 0.2425 CL= 0.823 100CD=1.1316 CM=-0.2017
2.00	S TURB S SEP 100CD UPPER 0.6063 0.0186 0.5398 LOWER 0.5558 0.0000 0.1264 TOTAL CL= 0.943 100CD=0.6662 CM=-0.2081	S TURB S SEP 100CD 1.0204 0.0290 0.9784 0.9642 0.0000 0.2334 CL= 0.927 100CD=1.2118 CM=-0.2043	S TURB S SEP 100CD 0.9955 0.0287 0.9625 0.8863 0.0000 0.2246 CL= 0.927 100CD=1.1871 CM=-0.2044
3.00	S TURB S SEP 100CD UPPER 0.6163 0.0205 0.5741 LOWER 0.5501 0.0000 0.1189 TOTAL CL= 1.049 100CD=0.6930 CM=-0.2113	S TURB S SEP 100CD 1.0204 0.0320 1.0525 0.9642 0.0000 0.2151 CL= 1.030 100CD=1.2676 CM=-0.2069	S TURB S SEP 100CD 1.0084 0.0319 1.0429 0.8592 0.0000 0.2049 CL= 1.030 100CD=1.2478 CM=-0.2070

B.L.SUMMARY AIRFOIL S830 21% ALPHA0= 6.838 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 9000000 MU= 300	R= 9000000 MU= 100	R= 9000000 MU= 900
4.00	S TURB S SEP 100CD UPPER 0.6328 0.0228 0.6203 LOWER 0.5440 0.0000 0.1112 TOTAL CL= 1.154 100CD=0.7315 CM=-0.2142	S TURB S SEP 100CD 1.0204 0.0353 1.1326 0.9642 0.0000 0.1978 CL= 1.132 100CD=1.3304 CM=-0.2094	S TURB S SEP 100CD 1.0198 0.0353 1.1320 0.8318 0.0000 0.1870 CL= 1.132 100CD=1.3189 CM=-0.2094
5.00	S TURB S SEP 100CD UPPER 0.6948 0.0273 0.7414 LOWER 0.5374 0.0000 0.1039 TOTAL CL= 1.254 100CD=0.8452 CM=-0.2162	S TURB S SEP 100CD 1.0204 0.0387 1.2189 0.9642 0.0000 0.1821 CL= 1.234 100CD=1.4010 CM=-0.2117	S TURB S SEP 100CD 1.0293 0.0389 1.2305 0.8066 0.0000 0.1708 CL= 1.234 100CD=1.4014 CM=-0.2116
6.00	S TURB S SEP 100CD UPPER 0.8243 0.0347 0.9797 LOWER 0.5305 0.0000 0.0969 TOTAL CL= 1.349 100CD=1.0766 CM=-0.2169	S TURB S SEP 100CD 1.0204 0.0423 1.3115 0.9642 0.0000 0.1676 CL= 1.335 100CD=1.4791 CM=-0.2138	S TURB S SEP 100CD 1.0381 0.0429 1.3412 0.7782 0.0000 0.1558 CL= 1.334 100CD=1.4969 CM=-0.2136
7.00	S TURB S SEP 100CD UPPER 0.9161 0.0419 1.2080 LOWER 0.5233 0.0000 0.0903 TOTAL CL= 1.443 100CD=1.2983 CM=-0.2175	S TURB S SEP 100CD 1.0204 0.0462 1.4109 0.9624 0.0000 0.1543 CL= 1.435 100CD=1.5652 CM=-0.2157	S TURB S SEP 100CD 1.0448 0.0472 1.4644 0.6522 0.0000 0.1244 CL= 1.433 100CD=1.5888 CM=-0.2153
8.00	S TURB S SEP 100CD UPPER 0.9734 0.0481 1.4038 LOWER 0.5160 0.0000 0.0845* TOTAL CL= 1.539 100CD=1.4883 CM=-0.2184	S TURB S SEP 100CD 1.0204 0.0505 1.5176 0.9624 0.0000 0.1429 CL= 1.534 100CD=1.6604 CM=-0.2174	S TURB S SEP 100CD 1.0495 0.0522 1.6015 0.6424 0.0000 0.1147 CL= 1.531 100CD=1.7162 CM=-0.2167
9.00	S TURB S SEP 100CD UPPER 1.0327 0.0564 1.6894* LOWER 0.5091 0.0000 0.0787* TOTAL CL= 1.629 100CD=1.7682 CM=-0.2183	S TURB S SEP 100CD 1.0327 0.0564 1.6894* 0.9624 0.0000 0.1313 CL= 1.629 100CD=1.8207 CM=-0.2183	S TURB S SEP 100CD 1.0523 0.0576 1.7517 0.6363 0.0000 0.1064 CL= 1.627 100CD=1.8582 CM=-0.2178
10.00	S TURB S SEP 100CD UPPER 1.0505 0.0633 1.9093* LOWER 0.5042 0.0000 0.0737* TOTAL CL= 1.721 100CD=1.9830 CM=-0.2185	S TURB S SEP 100CD 1.0505 0.0633 1.9093* 0.9341 0.0000 0.1208 CL= 1.721 100CD=2.0301 CM=-0.2185	S TURB S SEP 100CD 1.0541 0.0635 1.9183 0.6312 0.0000 0.0990 CL= 1.721 100CD=2.0173 CM=-0.2185
10.01	UPPER LOWER TOTAL		S TURB S SEP 100CD 1.0541 0.0636 1.9201 0.6311 0.0000 0.0989 CL= 1.722 100CD=2.0190 CM=-0.2185
10.05	S TURB S SEP 100CD UPPER 1.0508 0.0637 1.9207* LOWER 0.5039 0.0000 0.0734* TOTAL CL= 1.726 100CD=1.9941 CM=-0.2185	S TURB S SEP 100CD 1.0508 0.0637 1.9207* 0.9341 0.0000 0.1203 CL= 1.726 100CD=2.0409 CM=-0.2185	

APPENDIX B

PRESSURE DISTRIBUTIONS, TRANSITION AND SEPARATION LOCATIONS, AND SECTION CHARACTERISTICS OF S831 AIRFOIL

AIRFOIL S831 18%				-7.00	-6.00	-5.00	-4.00	-3.00	-2.00	-1.00	0.00	1.00
N	X	Y	NU	CP(X) FOR THE ABOVE ALPHA REL. CHORD LINE								
1	1.00000	0.00000	0.00	0.403	0.403	0.404	0.404	0.406	0.407	0.409	0.411	0.414
2	0.99614	0.00105	1.00	0.393	0.392	0.392	0.391	0.391	0.392	0.393	0.394	0.396
3	0.98514	0.00481	2.00	0.333	0.331	0.329	0.327	0.326	0.326	0.325	0.326	0.326
4	0.96834	0.01157	3.00	0.232	0.228	0.224	0.221	0.218	0.216	0.214	0.213	0.212
5	0.94699	0.02083	4.00	0.105	0.098	0.092	0.087	0.082	0.078	0.074	0.071	0.068
6	0.92180	0.03167	5.00	-0.024	-0.033	-0.042	-0.050	-0.058	-0.065	-0.071	-0.077	-0.082
7	0.89294	0.04327	6.00	-0.116	-0.129	-0.141	-0.152	-0.162	-0.172	-0.181	-0.190	-0.198
8	0.86035	0.05544	7.00	-0.180	-0.196	-0.211	-0.225	-0.239	-0.252	-0.264	-0.275	-0.286
9	0.82460	0.06818	8.00	-0.255	-0.274	-0.293	-0.311	-0.328	-0.345	-0.360	-0.376	-0.390
10	0.78632	0.08116	9.00	-0.339	-0.362	-0.385	-0.407	-0.429	-0.450	-0.470	-0.490	-0.508
11	0.74609	0.09394	10.00	-0.430	-0.459	-0.487	-0.514	-0.541	-0.567	-0.592	-0.617	-0.640
12	0.70445	0.10608	11.00	-0.527	-0.562	-0.596	-0.629	-0.662	-0.694	-0.725	-0.755	-0.785
13	0.66185	0.11707	12.00	-0.628	-0.669	-0.709	-0.750	-0.789	-0.828	-0.866	-0.904	-0.940
14	0.61871	0.12640	13.00	-0.724	-0.773	-0.821	-0.869	-0.916	-0.963	-1.009	-1.055	-1.099
15	0.57522	0.13349	14.00	-0.786	-0.842	-0.898	-0.954	-1.009	-1.064	-1.118	-1.172	-1.224
16	0.53137	0.13799	15.00	-0.795	-0.858	-0.921	-0.984	-1.046	-1.108	-1.170	-1.232	-1.292
17	0.48707	0.13978	16.00	-0.741	-0.808	-0.877	-0.945	-1.013	-1.081	-1.149	-1.216	-1.284
18	0.44223	0.13917	17.00	-0.652	-0.724	-0.796	-0.869	-0.942	-1.015	-1.088	-1.161	-1.234
19	0.39728	0.13659	18.00	-0.563	-0.639	-0.715	-0.793	-0.871	-0.949	-1.028	-1.107	-1.186
20	0.35269	0.13226	19.00	-0.472	-0.552	-0.633	-0.715	-0.798	-0.882	-0.967	-1.053	-1.139
21	0.30899	0.12638	20.00	-0.377	-0.461	-0.547	-0.635	-0.724	-0.814	-0.906	-0.998	-1.091
22	0.26663	0.11912	21.00	-0.278	-0.367	-0.458	-0.551	-0.646	-0.743	-0.842	-0.942	-1.044
23	0.22608	0.11064	22.00	-0.172	-0.266	-0.363	-0.462	-0.564	-0.668	-0.775	-0.884	-0.995
24	0.18776	0.10113	23.00	-0.059	-0.157	-0.260	-0.366	-0.475	-0.587	-0.703	-0.822	-0.944
25	0.15212	0.09077	24.00	0.065	-0.038	-0.146	-0.259	-0.377	-0.499	-0.625	-0.755	-0.889
26	0.11951	0.07975	25.00	0.202	0.095	-0.020	-0.140	-0.266	-0.398	-0.536	-0.679	-0.828
27	0.09031	0.06828	26.00	0.355	0.244	0.125	-0.003	-0.138	-0.282	-0.433	-0.592	-0.758
28	0.06483	0.05655	27.00	0.528	0.416	0.294	0.160	0.015	-0.141	-0.307	-0.484	-0.671
29	0.04333	0.04479	28.00	0.716	0.611	0.491	0.355	0.203	0.035	-0.148	-0.345	-0.558
30	0.02606	0.03319	29.00	0.901	0.821	0.718	0.591	0.441	0.268	0.072	-0.146	-0.387
31	0.01307	0.02201	30.00	1.000	0.986	0.935	0.848	0.724	0.564	0.368	0.137	-0.131
32	0.00449	0.01168	31.00	0.695	0.859	0.961	1.000	0.975	0.888	0.738	0.526	0.251
33	0.00036	0.00277	32.00	-1.411	-0.689	-0.094	0.373	0.711	0.920	0.999	0.949	0.770
34	0.00004	0.00088	32.25	-2.824	-1.795	-0.925	-0.216	0.331	0.716	0.939	0.999	0.895
35	0.00004	-0.00080	32.50	-5.104	-3.613	-2.328	-1.251	-0.382	0.276	0.724	0.960	0.984
36	0.00017	-0.00155	32.63	-6.764	-4.951	-3.376	-2.040	-0.946	-0.094	0.515	0.880	1.000
37	0.00041	-0.00221	32.75	-8.944	-6.721	-4.775	-3.108	-1.722	-0.619	0.200	0.733	0.981
38	0.00080	-0.00281	32.88	-7.509	-5.684	-4.076	-2.686	-1.517	-0.568	0.158	0.660	0.938
39	0.00134	-0.00340	33.00	-6.447	-4.913	-3.553	-2.368	-1.359	-0.528	0.124	0.596	0.888
40	0.00280	-0.00458	33.25	-4.998	-3.853	-2.826	-1.920	-1.134	-0.470	0.071	0.489	0.784
41	0.00966	-0.00795	34.00	-2.950	-2.333	-1.766	-1.251	-0.787	-0.376	-0.018	0.287	0.538
42	0.02422	-0.01170	35.00	-1.715	-1.375	-1.056	-0.759	-0.484	-0.232	-0.002	0.204	0.387
43	0.04525	-0.01480	36.00	-1.075	-0.859	-0.653	-0.459	-0.276	-0.105	0.055	0.202	0.338
44	0.07229	-0.01796	37.00	-0.783	-0.625	-0.474	-0.329	-0.190	-0.059	0.066	0.183	0.292
45	0.10441	-0.02131	38.00	-0.632	-0.507	-0.386	-0.269	-0.157	-0.049	0.055	0.153	0.247
46	0.14105	-0.02479	39.00	-0.542	-0.438	-0.337	-0.239	-0.144	-0.052	0.037	0.122	0.204
47	0.18146	-0.02831	40.00	-0.487	-0.398	-0.311	-0.227	-0.144	-0.064	0.014	0.090	0.163
48	0.22509	-0.03171	41.00	-0.451	-0.374	-0.298	-0.224	-0.151	-0.080	-0.010	0.058	0.124
49	0.27122	-0.03485	42.00	-0.430	-0.362	-0.295	-0.228	-0.163	-0.099	-0.036	0.026	0.086
50	0.31929	-0.03752	43.00	-0.417	-0.356	-0.296	-0.237	-0.178	-0.120	-0.063	-0.006	0.049
51	0.36859	-0.03951	44.00	-0.411	-0.357	-0.302	-0.249	-0.195	-0.142	-0.090	-0.038	0.013
52	0.41855	-0.04054	45.00	-0.410	-0.361	-0.312	-0.263	-0.214	-0.166	-0.118	-0.070	-0.022
53	0.46850	-0.04013	46.00	-0.401	-0.357	-0.313	-0.269	-0.225	-0.181	-0.137	-0.093	-0.050
54	0.51847	-0.03767	47.00	-0.341	-0.303	-0.265	-0.226	-0.188	-0.149	-0.111	-0.072	-0.034
55	0.56861	-0.03326	48.00	-0.251	-0.219	-0.187	-0.154	-0.122	-0.089	-0.056	-0.023	0.010
56	0.61888	-0.02718	49.00	-0.140	-0.114	-0.088	-0.061	-0.034	-0.007	0.021	0.048	0.076
57	0.66924	-0.01993	50.00	-0.021	-0.001	0.020	0.042	0.064	0.086	0.108	0.131	0.154
58	0.71934	-0.01226	51.00	0.092	0.108	0.125	0.142	0.159	0.177	0.195	0.213	0.232
59	0.76865	-0.00492	52.00	0.196	0.208	0.221	0.235	0.248	0.263	0.277	0.292	0.306
60	0.81639	0.00118	53.00	0.282	0.291	0.301	0.312	0.323	0.334	0.345	0.357	0.369
61	0.86130	0.00530	54.00	0.347	0.354	0.362	0.370	0.379	0.388	0.397	0.406	0.416
62	0.90193	0.00707	55.00	0.388	0.394	0.400	0.407	0.414	0.421	0.428	0.436	0.444
63	0.93666	0.00668	56.00	0.408	0.412	0.417	0.423	0.428	0.434	0.440	0.446	0.453
64	0.96429	0.00489	57.00	0.413	0.416	0.420	0.424	0.428	0.433	0.438	0.444	0.449
65	0.98416	0.00263	58.00	0.409	0.412	0.414	0.417	0.421	0.424	0.428	0.433	0.437
66	0.99606	0.00077	59.00	0.404	0.405	0.407	0.409	0.411	0.414	0.417	0.420	0.424
67	1.00000	0.00000	60.00	0.403	0.403	0.404	0.404	0.406	0.407	0.409	0.411	0.414

ALPHA= 6.88 DEGREES CM0=-0.1713 ETA= 1.132

AIRFOIL S831 18%			2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
N	X	Y	NU	CP(X)	FOR THE ABOVE ALPHA	REL. CHORD LINE					
1	1.00000	0.00000	0.00	0.417	0.420	0.424	0.428	0.433	0.437	0.442	0.448
2	0.99614	0.00105	1.00	0.398	0.400	0.403	0.406	0.409	0.413	0.417	0.422
3	0.98514	0.00481	2.00	0.327	0.328	0.330	0.332	0.335	0.338	0.341	0.345
4	0.96834	0.01157	3.00	0.212	0.212	0.213	0.214	0.216	0.218	0.220	0.223
5	0.94699	0.02083	4.00	0.066	0.065	0.064	0.063	0.064	0.064	0.066	0.068
6	0.92180	0.03167	5.00	-0.086	-0.090	-0.093	-0.095	-0.097	-0.098	-0.099	-0.098
7	0.89294	0.04327	6.00	-0.205	-0.211	-0.217	-0.222	-0.226	-0.229	-0.232	-0.234
8	0.86035	0.05544	7.00	-0.296	-0.306	-0.314	-0.322	-0.329	-0.335	-0.341	-0.345
9	0.82460	0.06818	8.00	-0.404	-0.416	-0.429	-0.440	-0.450	-0.460	-0.468	-0.476
10	0.78632	0.08116	9.00	-0.526	-0.543	-0.559	-0.575	-0.589	-0.602	-0.615	-0.627
11	0.74609	0.09394	10.00	-0.663	-0.685	-0.706	-0.726	-0.746	-0.764	-0.781	-0.798
12	0.70445	0.10608	11.00	-0.814	-0.842	-0.868	-0.895	-0.920	-0.944	-0.967	-0.988
13	0.66185	0.11707	12.00	-0.976	-1.011	-1.045	-1.078	-1.110	-1.141	-1.170	-1.199
14	0.61871	0.12640	13.00	-1.143	-1.186	-1.228	-1.269	-1.309	-1.348	-1.386	-1.423
15	0.57522	0.13349	14.00	-1.277	-1.328	-1.379	-1.428	-1.477	-1.525	-1.571	-1.617
16	0.53137	0.13799	15.00	-1.353	-1.412	-1.471	-1.529	-1.586	-1.642	-1.698	-1.752
17	0.48707	0.13978	16.00	-1.351	-1.417	-1.483	-1.548	-1.613	-1.677	-1.740	-1.801
18	0.44223	0.13917	17.00	-1.307	-1.380	-1.452	-1.524	-1.595	-1.666	-1.736	-1.806
19	0.39728	0.13659	18.00	-1.265	-1.345	-1.424	-1.503	-1.582	-1.661	-1.739	-1.816
20	0.35269	0.13226	19.00	-1.225	-1.312	-1.399	-1.486	-1.573	-1.660	-1.747	-1.833
21	0.30899	0.12638	20.00	-1.186	-1.281	-1.376	-1.472	-1.568	-1.665	-1.762	-1.859
22	0.26663	0.11912	21.00	-1.147	-1.251	-1.356	-1.462	-1.569	-1.677	-1.785	-1.893
23	0.22608	0.11064	22.00	-1.108	-1.222	-1.339	-1.456	-1.576	-1.696	-1.818	-1.940
24	0.18776	0.10113	23.00	-1.068	-1.195	-1.324	-1.455	-1.589	-1.725	-1.862	-2.001
25	0.15212	0.09077	24.00	-1.026	-1.168	-1.312	-1.460	-1.611	-1.765	-1.921	-2.080
26	0.11951	0.07975	25.00	-0.981	-1.140	-1.303	-1.471	-1.644	-1.820	-2.001	-2.185
27	0.09031	0.06828	26.00	-0.931	-1.111	-1.298	-1.491	-1.691	-1.896	-2.107	-2.324
28	0.06483	0.05655	27.00	-0.868	-1.075	-1.291	-1.517	-1.752	-1.995	-2.247	-2.507
29	0.04333	0.04479	28.00	-0.785	-1.027	-1.282	-1.552	-1.834	-2.130	-2.438	-2.759
30	0.02606	0.03319	29.00	-0.650	-0.934	-1.240	-1.567	-1.914	-2.282	-2.669	-3.075
31	0.01307	0.02201	30.00	-0.433	-0.771	-1.142	-1.548	-1.988	-2.460	-2.965	-3.501
32	0.00449	0.01168	31.00	-0.085	-0.484	-0.943	-1.463	-2.043	-2.682	-3.379	-4.134
33	0.00036	0.00277	32.00	0.462	0.025	-0.540	-1.233	-2.052	-2.997	-4.067	-5.260
34	0.00004	0.00088	32.25	0.629	0.200	-0.391	-1.143	-2.056	-3.128	-4.358	-5.745
35	0.00004	-0.00080	32.50	0.797	0.398	-0.212	-1.032	-2.061	-3.298	-4.742	-6.391
36	0.00017	-0.00155	32.63	0.875	0.506	-0.108	-0.965	-2.064	-3.404	-4.984	-6.802
37	0.00041	-0.00221	32.75	0.942	0.618	0.007	-0.888	-2.067	-3.529	-5.272	-7.293
38	0.00080	-0.00281	32.88	0.992	0.822	0.427	-0.191	-1.033	-2.096	-3.381	-4.884
39	0.00134	-0.00340	33.00	0.999	0.929	0.679	0.248	-0.362	-1.152	-2.119	-3.264
40	0.00280	-0.00458	33.25	0.953	0.999	0.920	0.717	0.389	-0.062	-0.637	-1.333
41	0.00966	-0.00795	34.00	0.735	0.878	0.966	1.000	0.979	0.903	0.773	0.588
42	0.02422	-0.01170	35.00	0.547	0.683	0.794	0.882	0.946	0.985	1.000	0.990
43	0.04525	-0.01480	36.00	0.461	0.572	0.671	0.756	0.829	0.889	0.937	0.971
44	0.07229	-0.01796	37.00	0.395	0.489	0.576	0.655	0.726	0.789	0.844	0.891
45	0.10441	-0.02131	38.00	0.335	0.418	0.497	0.569	0.637	0.698	0.755	0.805
46	0.14105	-0.02479	39.00	0.283	0.357	0.428	0.495	0.559	0.618	0.673	0.724
47	0.18146	-0.02831	40.00	0.234	0.302	0.367	0.429	0.489	0.545	0.598	0.649
48	0.22509	-0.03171	41.00	0.188	0.251	0.311	0.369	0.425	0.479	0.530	0.579
49	0.27122	-0.03485	42.00	0.145	0.203	0.259	0.313	0.366	0.417	0.466	0.513
50	0.31929	-0.03752	43.00	0.104	0.157	0.209	0.260	0.310	0.359	0.406	0.451
51	0.36859	-0.03951	44.00	0.064	0.113	0.162	0.210	0.257	0.303	0.348	0.392
52	0.41855	-0.04054	45.00	0.024	0.071	0.117	0.162	0.206	0.250	0.293	0.335
53	0.46850	-0.04013	46.00	-0.006	0.037	0.079	0.122	0.163	0.205	0.245	0.285
54	0.51847	-0.03767	47.00	0.005	0.043	0.081	0.119	0.157	0.194	0.231	0.268
55	0.56861	-0.03326	48.00	0.044	0.077	0.110	0.143	0.176	0.209	0.242	0.274
56	0.61888	-0.02718	49.00	0.104	0.132	0.160	0.189	0.217	0.245	0.273	0.301
57	0.66924	-0.01993	50.00	0.177	0.200	0.223	0.247	0.271	0.294	0.318	0.342
58	0.71934	-0.01226	51.00	0.251	0.270	0.289	0.308	0.328	0.347	0.367	0.387
59	0.76865	-0.00492	52.00	0.322	0.337	0.353	0.369	0.385	0.401	0.417	0.434
60	0.81639	0.00118	53.00	0.381	0.394	0.407	0.420	0.433	0.446	0.460	0.473
61	0.86130	0.00530	54.00	0.426	0.436	0.447	0.458	0.469	0.480	0.491	0.503
62	0.90193	0.00707	55.00	0.453	0.461	0.470	0.479	0.488	0.498	0.508	0.518
63	0.93666	0.00668	56.00	0.460	0.468	0.475	0.483	0.491	0.500	0.508	0.517
64	0.96429	0.00489	57.00	0.455	0.461	0.468	0.475	0.482	0.489	0.497	0.505
65	0.98416	0.00263	58.00	0.442	0.448	0.453	0.459	0.466	0.472	0.479	0.486
66	0.99606	0.00077	59.00	0.428	0.432	0.437	0.442	0.447	0.453	0.459	0.465
67	1.00000	0.00000	60.00	0.417	0.420	0.424	0.428	0.433	0.437	0.442	0.448

ALPHA0= 6.88 DEGREES CM0=-0.1713 ETA= 1.132

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
-4.23	S TURB S SEP 100CD UPPER 0.3950 0.0205 0.3703* LOWER 1.0060 0.0000 0.4753* TOTAL CL= 0.270 100CD=0.8456 CM=-0.1765	S TURB S SEP 100CD 1.0219 0.0404 0.7965 1.0060 0.0000 0.4753* CL= 0.248 100CD=1.2718 CM=-0.1716	S TURB S SEP 100CD 0.7571 0.0373 0.7021 1.0060 0.0000 0.4753* CL= 0.252 100CD=1.1774 CM=-0.1724
-4.00	S TURB S SEP 100CD UPPER 0.3962 0.0211 0.3752* LOWER 1.0059 0.0000 0.4707* TOTAL CL= 0.295 100CD=0.8459 CM=-0.1773	S TURB S SEP 100CD 1.0219 0.0413 0.8101 1.0059 0.0000 0.4707* CL= 0.272 100CD=1.2808 CM=-0.1722	S TURB S SEP 100CD 0.7649 0.0382 0.7167 1.0059 0.0000 0.4707* CL= 0.276 100CD=1.1875 CM=-0.1730
-3.00	S TURB S SEP 100CD UPPER 0.4016 0.0235 0.3976* LOWER 0.9938 0.0000 0.4201* TOTAL CL= 0.401 100CD=0.8177 CM=-0.1804	S TURB S SEP 100CD 1.0219 0.0450 0.8722 0.9938 0.0000 0.4201* CL= 0.376 100CD=1.2923 CM=-0.1748	S TURB S SEP 100CD 0.7968 0.0422 0.7825 0.9938 0.0000 0.4109* CL= 0.379 100CD=1.1934 CM=-0.1755
-2.00	S TURB S SEP 100CD UPPER 0.4074 0.0261 0.4218* LOWER 0.4483 0.0000 0.1834* TOTAL CL= 0.506 100CD=0.6052 CM=-0.1835	S TURB S SEP 100CD 1.0219 0.0489 0.9394 0.9543 0.0000 0.3619 CL= 0.478 100CD=1.3013 CM=-0.1774	S TURB S SEP 100CD 0.8296 0.0464 0.8547 0.9753 0.0000 0.3683 CL= 0.481 100CD=1.2230 CM=-0.1780
-1.00	S TURB S SEP 100CD UPPER 0.4124 0.0287 0.4461* LOWER 0.4407 0.0000 0.1713* TOTAL CL= 0.611 100CD=0.6175 CM=-0.1866	S TURB S SEP 100CD 1.0219 0.0531 1.0123 0.9543 0.0000 0.3345 CL= 0.580 100CD=1.3468 CM=-0.1798	S TURB S SEP 100CD 0.8593 0.0507 0.9312 0.9552 0.0000 0.3347 CL= 0.583 100CD=1.2659 CM=-0.1804
0.00	S TURB S SEP 100CD UPPER 0.4171 0.0314 0.4715* LOWER 0.4329 0.0000 0.1601* TOTAL CL= 0.716 100CD=0.6316 CM=-0.1897	S TURB S SEP 100CD 1.0219 0.0574 1.0899 0.9543 0.0000 0.3092 CL= 0.680 100CD=1.3991 CM=-0.1820	S TURB S SEP 100CD 0.8885 0.0554 1.0148 0.8980 0.0000 0.2991 CL= 0.683 100CD=1.3140 CM=-0.1826
1.00	S TURB S SEP 100CD UPPER 0.4217 0.0342 0.4954* LOWER 0.4252 0.0000 0.1499* TOTAL CL= 0.820 100CD=0.6453 CM=-0.1927	S TURB S SEP 100CD 1.0219 0.0619 1.1737 0.9543 0.0000 0.2859 CL= 0.780 100CD=1.4596 CM=-0.1841	S TURB S SEP 100CD 0.9151 0.0602 1.1039 0.8267 0.0000 0.2658 CL= 0.782 100CD=1.3697 CM=-0.1846
2.00	S TURB S SEP 100CD UPPER 0.4262 0.0376 0.5270* LOWER 0.4175 0.0000 0.1418* TOTAL CL= 0.923 100CD=0.6688 CM=-0.1954	S TURB S SEP 100CD 1.0219 0.0666 1.2641 0.9543 0.0000 0.2643 CL= 0.879 100CD=1.5284 CM=-0.1861	S TURB S SEP 100CD 0.9393 0.0651 1.2004 0.7645 0.0000 0.2367 CL= 0.881 100CD=1.4371 CM=-0.1865
3.00	S TURB S SEP 100CD UPPER 0.4307 0.0407 0.5559* LOWER 0.4098 0.0000 0.1329* TOTAL CL= 1.026 100CD=0.6887 CM=-0.1982	S TURB S SEP 100CD 1.0219 0.0717 1.3634 0.9543 0.0000 0.2444 CL= 0.976 100CD=1.6078 CM=-0.1878	S TURB S SEP 100CD 0.9622 0.0704 1.3081 0.7063 0.0000 0.2103 CL= 0.978 100CD=1.5184 CM=-0.1882
4.00	S TURB S SEP 100CD UPPER 0.4355 0.0436 0.5832* LOWER 0.4019 0.0000 0.1239* TOTAL CL= 1.129 100CD=0.7071 CM=-0.2010	S TURB S SEP 100CD 1.0219 0.0774 1.4686 0.9543 0.0000 0.2260 CL= 1.072 100CD=1.6946 CM=-0.1893	S TURB S SEP 100CD 0.9806 0.0763 1.4215 0.6500 0.0000 0.1869 CL= 1.074 100CD=1.6085 CM=-0.1897
5.00	S TURB S SEP 100CD UPPER 0.4405 0.0464 0.6083* LOWER 0.3935 0.0000 0.1161* TOTAL CL= 1.232 100CD=0.7244 CM=-0.2038	S TURB S SEP 100CD 1.0219 0.0840 1.5817 0.9543 0.0000 0.2095 CL= 1.166 100CD=1.7912 CM=-0.1906	S TURB S SEP 100CD 0.9988 0.0832 1.5492 0.5875 0.0000 0.1636 CL= 1.167 100CD=1.7128 CM=-0.1909

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4575 0.0502 0.6615	1.0219 0.0914 1.7035	1.0161 0.0911 1.6931
	LOWER 0.3846 0.0000 0.1079*	0.9543 0.0000 0.1936	0.5343 0.0000 0.1430
	TOTAL CL= 1.333 100CD=0.7695	CL= 1.258 100CD=1.8971	CL= 1.259 100CD=1.8361
	CM=-0.2062	CM=-0.1917	CM=-0.1917
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6970 0.0764 1.1729	1.0219 0.0995 1.8342	1.0312 0.1000 1.8556
	LOWER 0.3753 0.0000 0.1003*	0.9543 0.0000 0.1790	0.5156 0.0000 0.1314
	TOTAL CL= 1.390 100CD=1.2732	CL= 1.348 100CD=2.0132	CL= 1.347 100CD=1.9870
	CM=-0.1999	CM=-0.1924	CM=-0.1922
7.37			S TURB S SEP 100CD
	UPPER		1.0358 0.1036 1.9205
	LOWER		0.5111 0.0000 0.1278
	TOTAL		CL= 1.380 100CD=2.0482
			CM=-0.1923
7.62		S TURB S SEP 100CD	
	UPPER	1.0219 0.1050 1.9201	
	LOWER	0.9543 0.0000 0.1708	
	TOTAL	CL= 1.403 100CD=2.0909	
		CM=-0.1926	
8.00	S TURB S SEP 100CD		
	UPPER 0.8954 0.0993 1.6608		
	LOWER 0.3662 0.0000 0.0942*		
	TOTAL CL= 1.453 100CD=1.7550		
	CM=-0.1956		
8.15	S TURB S SEP 100CD		
	UPPER 0.9129 0.1018 1.7158		
	LOWER 0.3648 0.0000 0.0932*		
	TOTAL CL= 1.464 100CD=1.8090		
	CM=-0.1953		

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
-4.59	S TURB S SEP 100CD UPPER 0.3931 0.0152 0.3233* LOWER 1.0060 0.0000 0.4682* TOTAL CL= 0.237 100CD=0.7915 CM=-0.1765	S TURB S SEP 100CD 1.0220 0.0357 0.7289 1.0060 0.0000 0.4682* CL= 0.215 100CD=1.1971 CM=-0.1715	S TURB S SEP 100CD 0.8010 0.0336 0.6653 1.0060 0.0000 0.4683* CL= 0.217 100CD=1.1335 CM=-0.1720
-4.00	S TURB S SEP 100CD UPPER 0.3962 0.0166 0.3342* LOWER 1.0059 0.0000 0.4457* TOTAL CL= 0.300 100CD=0.7799 CM=-0.1784	S TURB S SEP 100CD 1.0219 0.0378 0.7612 1.0059 0.0000 0.4457* CL= 0.276 100CD=1.2069 CM=-0.1731	S TURB S SEP 100CD 0.8168 0.0358 0.6985 1.0059 0.0000 0.4457* CL= 0.278 100CD=1.1441 CM=-0.1736
-3.00	S TURB S SEP 100CD UPPER 0.4016 0.0189 0.3535* LOWER 0.9938 0.0000 0.3962* TOTAL CL= 0.406 100CD=0.7497 CM=-0.1817	S TURB S SEP 100CD 1.0219 0.0413 0.8190 0.9938 0.0000 0.3962* CL= 0.380 100CD=1.2152 CM=-0.1758	S TURB S SEP 100CD 0.8433 0.0395 0.7580 0.9938 0.0000 0.3877* CL= 0.382 100CD=1.1456 CM=-0.1762
-2.00	S TURB S SEP 100CD UPPER 0.4074 0.0212 0.3739* LOWER 0.4483 0.0000 0.1633* TOTAL CL= 0.512 100CD=0.5371 CM=-0.1849	S TURB S SEP 100CD 1.0219 0.0450 0.8818 0.9543 0.0000 0.3412 CL= 0.483 100CD=1.2230 CM=-0.1784	S TURB S SEP 100CD 0.8698 0.0433 0.8231 0.9799 0.0000 0.3492 CL= 0.485 100CD=1.1722 CM=-0.1788
-1.00	S TURB S SEP 100CD UPPER 0.4124 0.0235 0.3939* LOWER 0.4407 0.0000 0.1534* TOTAL CL= 0.618 100CD=0.5473 CM=-0.1881	S TURB S SEP 100CD 1.0219 0.0489 0.9493 0.9543 0.0000 0.3157 CL= 0.585 100CD=1.2651 CM=-0.1809	S TURB S SEP 100CD 0.8939 0.0474 0.8924 0.9632 0.0000 0.3177 CL= 0.587 100CD=1.2101 CM=-0.1814
0.00	S TURB S SEP 100CD UPPER 0.4171 0.0259 0.4144* LOWER 0.4329 0.0000 0.1439* TOTAL CL= 0.723 100CD=0.5583 CM=-0.1914	S TURB S SEP 100CD 1.0219 0.0531 1.0227 0.9543 0.0000 0.2922 CL= 0.687 100CD=1.3149 CM=-0.1833	S TURB S SEP 100CD 0.9179 0.0517 0.9691 0.9300 0.0000 0.2879 CL= 0.688 100CD=1.2570 CM=-0.1837
1.00	S TURB S SEP 100CD UPPER 0.4221 0.0284 0.4370* LOWER 0.4252 0.0000 0.1346* TOTAL CL= 0.828 100CD=0.5716 CM=-0.1945	S TURB S SEP 100CD 1.0219 0.0575 1.1009 0.9543 0.0000 0.2702 CL= 0.787 100CD=1.3711 CM=-0.1855	S TURB S SEP 100CD 0.9392 0.0563 1.0506 0.8738 0.0000 0.2582 CL= 0.789 100CD=1.3088 CM=-0.1859
2.00	S TURB S SEP 100CD UPPER 0.4278 0.0309 0.4601* LOWER 0.4175 0.0000 0.1262* TOTAL CL= 0.933 100CD=0.5863 CM=-0.1976	S TURB S SEP 100CD 1.0219 0.0619 1.1847 0.9543 0.0000 0.2500 CL= 0.886 100CD=1.4347 CM=-0.1876	S TURB S SEP 100CD 0.9592 0.0608 1.1387 0.8227 0.0000 0.2332 CL= 0.888 100CD=1.3719 CM=-0.1879
3.00	S TURB S SEP 100CD UPPER 0.4340 0.0342 0.4898 LOWER 0.4098 0.0000 0.1192* TOTAL CL= 1.036 100CD=0.6089 CM=-0.2004	S TURB S SEP 100CD 1.0219 0.0666 1.2772 0.9543 0.0000 0.2313 CL= 0.984 100CD=1.5085 CM=-0.1895	S TURB S SEP 100CD 0.9769 0.0657 1.2366 0.7761 0.0000 0.2105 CL= 0.986 100CD=1.4472 CM=-0.1898
4.00	S TURB S SEP 100CD UPPER 0.4423 0.0373 0.5214 LOWER 0.4019 0.0000 0.1115* TOTAL CL= 1.139 100CD=0.6329 CM=-0.2032	S TURB S SEP 100CD 1.0219 0.0716 1.3745 0.9543 0.0000 0.2140 CL= 1.082 100CD=1.5885 CM=-0.1913	S TURB S SEP 100CD 0.9931 0.0709 1.3424 0.7313 0.0000 0.1901 CL= 1.083 100CD=1.5325 CM=-0.1915
5.00	S TURB S SEP 100CD UPPER 0.4557 0.0409 0.5641 LOWER 0.3935 0.0000 0.1045* TOTAL CL= 1.241 100CD=0.6686 CM=-0.2058	S TURB S SEP 100CD 1.0219 0.0772 1.4792 0.9543 0.0000 0.1979 CL= 1.177 100CD=1.6771 CM=-0.1928	S TURB S SEP 100CD 1.0090 0.0768 1.4613 0.6861 0.0000 0.1710 CL= 1.178 100CD=1.6323 CM=-0.1929

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.5392 0.0520 0.7404	1.0219 0.0838 1.5919	1.0240 0.0838 1.5956
	LOWER 0.3846 0.0000 0.0975*	0.9543 0.0000 0.1835	0.6399 0.0000 0.1537
	TOTAL CL= 1.330 100CD=0.8379	CL= 1.271 100CD=1.7754	CL= 1.271 100CD=1.7493
	CM=-0.2056	CM=-0.1940	CM=-0.1940
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.8232 0.0793 1.3140	1.0219 0.0909 1.7125	1.0367 0.0917 1.7465
	LOWER 0.3753 0.0000 0.0907*	0.9543 0.0000 0.1696	0.5897 0.0000 0.1364
	TOTAL CL= 1.385 100CD=1.4047	CL= 1.364 100CD=1.8822	CL= 1.362 100CD=1.8829
	CM=-0.1989	CM=-0.1950	CM=-0.1948
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9327 0.0930 1.6205	1.0219 0.0989 1.8418	1.0452 0.1005 1.9119
	LOWER 0.3662 0.0000 0.0846	0.9543 0.0000 0.1571	0.5442 0.0000 0.1208
	TOTAL CL= 1.465 100CD=1.7051	CL= 1.454 100CD=1.9989	CL= 1.451 100CD=2.0328
	CM=-0.1976	CM=-0.1957	CM=-0.1952
8.05			S TURB S SEP 100CD
	UPPER		1.0455 0.1010 1.9205
	LOWER		0.5423 0.0000 0.1201
	TOTAL		CL= 1.455 100CD=2.0406
			CM=-0.1952
8.43	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0255 0.1031 1.9220*	1.0255 0.1031 1.9220*	
	LOWER 0.3622 0.0000 0.0823*	0.9542 0.0000 0.1519	
	TOTAL CL= 1.490 100CD=2.0043	CL= 1.490 100CD=2.0738	
	CM=-0.1957	CM=-0.1957	

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
-4.74	S TURB S SEP 100CD UPPER 0.3960 0.0123 0.3016 LOWER 1.0060 0.0000 0.4481* TOTAL CL= 0.223 100CD=0.7497 CM=-0.1766	S TURB S SEP 100CD 1.0219 0.0327 0.6894 1.0060 0.0000 0.4481* CL= 0.202 100CD=1.1374 CM=-0.1717	S TURB S SEP 100CD 0.8286 0.0310 0.6412 1.0060 0.0000 0.4484* CL= 0.204 100CD=1.0896 CM=-0.1720
-4.00	S TURB S SEP 100CD UPPER 0.4003 0.0139 0.3144 LOWER 1.0059 0.0000 0.4238* TOTAL CL= 0.302 100CD=0.7382 CM=-0.1791	S TURB S SEP 100CD 1.0219 0.0352 0.7279 1.0059 0.0000 0.4238* CL= 0.279 100CD=1.1516 CM=-0.1737	S TURB S SEP 100CD 0.8462 0.0337 0.6802 1.0059 0.0000 0.4238* CL= 0.281 100CD=1.1040 CM=-0.1741
-3.00	S TURB S SEP 100CD UPPER 0.4060 0.0162 0.3322 LOWER 0.9938 0.0000 0.3801* TOTAL CL= 0.409 100CD=0.7124 CM=-0.1824	S TURB S SEP 100CD 1.0219 0.0387 0.7834 0.9938 0.0000 0.3801* CL= 0.383 100CD=1.1635 CM=-0.1764	S TURB S SEP 100CD 0.8695 0.0373 0.7365 0.9941 0.0000 0.3722* CL= 0.385 100CD=1.1088 CM=-0.1768
-2.00	S TURB S SEP 100CD UPPER 0.4123 0.0185 0.3517 LOWER 0.4567 0.0000 0.1555 TOTAL CL= 0.515 100CD=0.5071 CM=-0.1857	S TURB S SEP 100CD 1.0219 0.0423 0.8428 0.9543 0.0000 0.3274 CL= 0.486 100CD=1.1702 CM=-0.1791	S TURB S SEP 100CD 0.8928 0.0410 0.7974 0.9828 0.0000 0.3363 CL= 0.488 100CD=1.1337 CM=-0.1795
-1.00	S TURB S SEP 100CD UPPER 0.4178 0.0208 0.3711 LOWER 0.4444 0.0000 0.1442 TOTAL CL= 0.621 100CD=0.5153 CM=-0.1889	S TURB S SEP 100CD 1.0219 0.0460 0.9072 0.9543 0.0000 0.3031 CL= 0.589 100CD=1.2103 CM=-0.1817	S TURB S SEP 100CD 0.9137 0.0448 0.8627 0.9673 0.0000 0.3060 CL= 0.590 100CD=1.1687 CM=-0.1820
0.00	S TURB S SEP 100CD UPPER 0.4232 0.0232 0.3914 LOWER 0.4354 0.0000 0.1348 TOTAL CL= 0.727 100CD=0.5262 CM=-0.1922	S TURB S SEP 100CD 1.0219 0.0501 0.9773 0.9543 0.0000 0.2806 CL= 0.691 100CD=1.2579 CM=-0.1842	S TURB S SEP 100CD 0.9345 0.0489 0.9342 0.9443 0.0000 0.2789 CL= 0.692 100CD=1.2131 CM=-0.1845
1.00	S TURB S SEP 100CD UPPER 0.4287 0.0256 0.4129 LOWER 0.4266 0.0000 0.1262 TOTAL CL= 0.832 100CD=0.5391 CM=-0.1954	S TURB S SEP 100CD 1.0219 0.0543 1.0518 0.9543 0.0000 0.2597 CL= 0.792 100CD=1.3115 CM=-0.1865	S TURB S SEP 100CD 0.9533 0.0533 1.0118 0.8985 0.0000 0.2518 CL= 0.793 100CD=1.2636 CM=-0.1869
2.00	S TURB S SEP 100CD UPPER 0.4346 0.0281 0.4360 LOWER 0.4178 0.0000 0.1181 TOTAL CL= 0.937 100CD=0.5541 CM=-0.1985	S TURB S SEP 100CD 1.0219 0.0586 1.1313 0.9543 0.0000 0.2404 CL= 0.891 100CD=1.3717 CM=-0.1887	S TURB S SEP 100CD 0.9707 0.0578 1.0952 0.8543 0.0000 0.2287 CL= 0.893 100CD=1.3239 CM=-0.1890
3.00	S TURB S SEP 100CD UPPER 0.4418 0.0314 0.4655 LOWER 0.4098 0.0000 0.1108 TOTAL CL= 1.040 100CD=0.5763 CM=-0.2013	S TURB S SEP 100CD 1.0219 0.0631 1.2191 0.9543 0.0000 0.2225 CL= 0.990 100CD=1.4416 CM=-0.1907	S TURB S SEP 100CD 0.9858 0.0624 1.1876 0.8126 0.0000 0.2075 CL= 0.991 100CD=1.3951 CM=-0.1909
4.00	S TURB S SEP 100CD UPPER 0.4522 0.0346 0.4987 LOWER 0.4019 0.0000 0.1040* TOTAL CL= 1.143 100CD=0.6027 CM=-0.2042	S TURB S SEP 100CD 1.0219 0.0678 1.3114 0.9543 0.0000 0.2059 CL= 1.088 100CD=1.5172 CM=-0.1926	S TURB S SEP 100CD 1.0008 0.0673 1.2885 0.7741 0.0000 0.1887 CL= 1.089 100CD=1.4772 CM=-0.1928
5.00	S TURB S SEP 100CD UPPER 0.4748 0.0391 0.5546 LOWER 0.3935 0.0000 0.0974 TOTAL CL= 1.244 100CD=0.6520 CM=-0.2064	S TURB S SEP 100CD 1.0219 0.0729 1.4107 0.9543 0.0000 0.1904 CL= 1.185 100CD=1.6011 CM=-0.1943	S TURB S SEP 100CD 1.0153 0.0727 1.4017 0.7353 0.0000 0.1714 CL= 1.186 100CD=1.5731 CM=-0.1943

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.7161 0.0633 0.9981	1.0219 0.0787 1.5173	1.0288 0.0790 1.5294
	LOWER 0.3846 0.0000 0.0910	0.9543 0.0000 0.1766	0.6961 0.0000 0.1557
	TOTAL CL= 1.309 100CD=1.0891	CL= 1.280 100CD=1.6939	CL= 1.280 100CD=1.6852
	CM=-0.2013	CM=-0.1957	CM=-0.1956
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.8716 0.0773 1.3329	1.0219 0.0853 1.6313	1.0400 0.0862 1.6723
	LOWER 0.3753 0.0000 0.0850	0.9543 0.0000 0.1636	0.6560 0.0000 0.1405
	TOTAL CL= 1.388 100CD=1.4179	CL= 1.374 100CD=1.7949	CL= 1.372 100CD=1.8128
	CM=-0.1995	CM=-0.1969	CM=-0.1966
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9517 0.0882 1.5798	1.0219 0.0926 1.7533	1.0470 0.0943 1.8285
	LOWER 0.3662 0.0000 0.0794	0.9543 0.0000 0.1512	0.6149 0.0000 0.1267
	TOTAL CL= 1.473 100CD=1.6592	CL= 1.465 100CD=1.9046	CL= 1.462 100CD=1.9552
	CM=-0.1992	CM=-0.1978	CM=-0.1972
8.55	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 1.0465 0.0991 1.9189*	1.0465 0.0991 1.9189*	1.0494 0.0991 1.9197
	LOWER 0.3611 0.0000 0.0765	0.9544 0.0000 0.1448	0.5894 0.0000 0.1188
	TOTAL CL= 1.510 100CD=1.9954	CL= 1.510 100CD=2.0637	CL= 1.510 100CD=2.0385
	CM=-0.1974	CM=-0.1974	CM=-0.1974

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
-5.56	S TURB S SEP 100CD UPPER 0.4017 0.0076 0.2705 LOWER 1.0061 0.0000 0.4550* TOTAL CL= 0.138 100CD=0.7255 CM=-0.1746	S TURB S SEP 100CD 1.0139 0.0263 0.6091 1.0061 0.0000 0.4550* CL= 0.120 100CD=1.0641 CM=-0.1702	S TURB S SEP 100CD 0.8473 0.0247 0.5725 1.0061 0.0000 0.4557* CL= 0.121 100CD=1.0283 CM=-0.1706
-5.00	S TURB S SEP 100CD UPPER 0.4049 0.0088 0.2791 LOWER 1.0060 0.0000 0.4431* TOTAL CL= 0.198 100CD=0.7222 CM=-0.1765	S TURB S SEP 100CD 1.0139 0.0281 0.6347 1.0060 0.0000 0.4431* CL= 0.178 100CD=1.0778 CM=-0.1718	S TURB S SEP 100CD 0.8592 0.0270 0.6022 1.0060 0.0000 0.4431* CL= 0.180 100CD=1.0452 CM=-0.1720
-4.00	S TURB S SEP 100CD UPPER 0.4105 0.0109 0.2948 LOWER 1.0059 0.0000 0.3995* TOTAL CL= 0.306 100CD=0.6943 CM=-0.1799	S TURB S SEP 100CD 1.0219 0.0315 0.6830 1.0059 0.0000 0.3995* CL= 0.283 100CD=1.0825 CM=-0.1746	S TURB S SEP 100CD 0.8800 0.0305 0.6506 1.0059 0.0000 0.3995* CL= 0.284 100CD=1.0501 CM=-0.1749
-3.00	S TURB S SEP 100CD UPPER 0.4159 0.0130 0.3112 LOWER 0.9938 0.0000 0.3586* TOTAL CL= 0.413 100CD=0.6698 CM=-0.1833	S TURB S SEP 100CD 1.0219 0.0349 0.7351 0.9938 0.0000 0.3586* CL= 0.387 100CD=1.0937 CM=-0.1774	S TURB S SEP 100CD 0.8998 0.0340 0.7028 0.9963 0.0000 0.3524* CL= 0.388 100CD=1.0552 CM=-0.1777
-2.00	S TURB S SEP 100CD UPPER 0.4222 0.0153 0.3293 LOWER 0.4714 0.0000 0.1478 TOTAL CL= 0.519 100CD=0.4771 CM=-0.1866	S TURB S SEP 100CD 1.0219 0.0384 0.7910 0.9543 0.0000 0.3090 CL= 0.491 100CD=1.0999 CM=-0.1801	S TURB S SEP 100CD 0.9189 0.0376 0.7591 0.9863 0.0000 0.3190 CL= 0.492 100CD=1.0781 CM=-0.1804
-1.00	S TURB S SEP 100CD UPPER 0.4276 0.0176 0.3473 LOWER 0.4559 0.0000 0.1361 TOTAL CL= 0.625 100CD=0.4834 CM=-0.1899	S TURB S SEP 100CD 1.0219 0.0420 0.8511 0.9543 0.0000 0.2863 CL= 0.594 100CD=1.1373 CM=-0.1828	S TURB S SEP 100CD 0.9366 0.0412 0.8197 0.9726 0.0000 0.2904 CL= 0.595 100CD=1.1100 CM=-0.1831
0.00	S TURB S SEP 100CD UPPER 0.4331 0.0199 0.3662 LOWER 0.4470 0.0000 0.1273 TOTAL CL= 0.731 100CD=0.4935 CM=-0.1932	S TURB S SEP 100CD 1.0219 0.0457 0.9154 0.9543 0.0000 0.2652 CL= 0.697 100CD=1.1806 CM=-0.1854	S TURB S SEP 100CD 0.9541 0.0450 0.8854 0.9570 0.0000 0.2657 CL= 0.698 100CD=1.1511 CM=-0.1856
1.00	S TURB S SEP 100CD UPPER 0.4388 0.0223 0.3864 LOWER 0.4385 0.0000 0.1193 TOTAL CL= 0.837 100CD=0.5057 CM=-0.1965	S TURB S SEP 100CD 1.0219 0.0497 0.9856 0.9543 0.0000 0.2457 CL= 0.798 100CD=1.2313 CM=-0.1879	S TURB S SEP 100CD 0.9698 0.0491 0.9576 0.9254 0.0000 0.2418 CL= 0.799 100CD=1.1994 CM=-0.1881
2.00	S TURB S SEP 100CD UPPER 0.4459 0.0248 0.4092 LOWER 0.4300 0.0000 0.1118 TOTAL CL= 0.942 100CD=0.5211 CM=-0.1996	S TURB S SEP 100CD 1.0219 0.0539 1.0603 0.9543 0.0000 0.2276 CL= 0.899 100CD=1.2879 CM=-0.1903	S TURB S SEP 100CD 0.9838 0.0533 1.0348 0.8875 0.0000 0.2201 CL= 0.900 100CD=1.2549 CM=-0.1905
3.00	S TURB S SEP 100CD UPPER 0.4558 0.0282 0.4405 LOWER 0.4211 0.0000 0.1047 TOTAL CL= 1.045 100CD=0.5452 CM=-0.2024	S TURB S SEP 100CD 1.0219 0.0582 1.1400 0.9543 0.0000 0.2107 CL= 0.999 100CD=1.3507 CM=-0.1924	S TURB S SEP 100CD 0.9971 0.0577 1.1194 0.8532 0.0000 0.2013 CL= 0.999 100CD=1.3208 CM=-0.1925
4.00	S TURB S SEP 100CD UPPER 0.4758 0.0323 0.4862 LOWER 0.4122 0.0000 0.0980 TOTAL CL= 1.147 100CD=0.5841 CM=-0.2050	S TURB S SEP 100CD 1.0219 0.0626 1.2272 0.9543 0.0000 0.1950 CL= 1.097 100CD=1.4223 CM=-0.1944	S TURB S SEP 100CD 1.0103 0.0624 1.2150 0.8203 0.0000 0.1841 CL= 1.098 100CD=1.3991 CM=-0.1945

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6661 0.0512 0.8039	1.0219 0.0673 1.3190	1.0229 0.0673 1.3204
	LOWER 0.4032 0.0000 0.0916	0.9543 0.0000 0.1809	0.7882 0.0000 0.1685
	TOTAL CL= 1.224 100CD=0.8956	CL= 1.195 100CD=1.5000	CL= 1.195 100CD=1.4889
	CM=-0.2022	CM=-0.1963	CM=-0.1963
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.8225 0.0642 1.0917	1.0219 0.0723 1.4178	1.0345 0.0727 1.4392
	LOWER 0.3940 0.0000 0.0856	0.9543 0.0000 0.1673	0.7563 0.0000 0.1544
	TOTAL CL= 1.307 100CD=1.1774	CL= 1.292 100CD=1.5851	CL= 1.291 100CD=1.5936
	CM=-0.2009	CM=-0.1980	CM=-0.1978
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9158 0.0731 1.3164	1.0219 0.0779 1.5234	1.0438 0.0789 1.5720
	LOWER 0.3844 0.0000 0.0799	0.9543 0.0000 0.1551	0.7234 0.0000 0.1409
	TOTAL CL= 1.396 100CD=1.3963	CL= 1.387 100CD=1.6785	CL= 1.385 100CD=1.7130
	CM=-0.2011	CM=-0.1993	CM=-0.1990
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9712 0.0815 1.5124	1.0219 0.0844 1.6361	1.0493 0.0861 1.7166
	LOWER 0.3746 0.0000 0.0745	0.9543 0.0000 0.1434	0.6903 0.0000 0.1287
	TOTAL CL= 1.486 100CD=1.5869	CL= 1.480 100CD=1.7795	CL= 1.477 100CD=1.8452
	CM=-0.2015	CM=-0.2005	CM=-0.1999
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 1.0550 0.0949 1.9120*	1.0550 0.0949 1.9120*	1.0550 0.0945 1.8928*
	LOWER 0.3645 0.0000 0.0693	0.9543 0.0000 0.1327	0.6564 0.0000 0.1168
	TOTAL CL= 1.565 100CD=1.9813	CL= 1.565 100CD=2.0446	CL= 1.566 100CD=2.0096
	CM=-0.2002	CM=-0.2002	CM=-0.2003
9.12	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0555 0.0957 1.9202*	1.0555 0.0957 1.9202*	
	LOWER 0.3633 0.0000 0.0688	0.9319 0.0000 0.1314	
	TOTAL CL= 1.576 100CD=1.9889	CL= 1.576 100CD=2.0516	
	CM=-0.2003	CM=-0.2003	
9.16			S TURB S SEP 100CD
	UPPER		1.0556 0.0959 1.9196*
	LOWER		0.6511 0.0000 0.1151
	TOTAL		CL= 1.580 100CD=2.0347
			CM=-0.2004

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.) R= 9000000 MU= 300	R= 9000000 MU= 100	R= 9000000 MU= 900
-6.14		S TURB S SEP 100CD
UPPER		0.8683 0.0196 0.5224
LOWER		1.0061 0.0000 0.4554*
TOTAL		CL= 0.063 100CD=0.9777
		CM=-0.1696
-6.13 S TURB S SEP 100CD	S TURB S SEP 100CD	
UPPER 0.4093 0.0007 0.2478	1.0139 0.0204 0.5442	
LOWER 1.0061 0.0000 0.4554*	1.0061 0.0000 0.4554*	
TOTAL CL= 0.082 100CD=0.7032	CL= 0.064 100CD=0.9996	
CM=-0.1740	CM=-0.1695	
-6.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4101 0.0013 0.2496	1.0139 0.0208 0.5495	0.8712 0.0201 0.5281
LOWER 1.0061 0.0000 0.4587*	1.0061 0.0000 0.4587*	1.0061 0.0000 0.4589*
TOTAL CL= 0.096 100CD=0.7083	CL= 0.077 100CD=1.0082	CL= 0.078 100CD=0.9869
CM=-0.1744	CM=-0.1698	CM=-0.1700
-5.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4156 0.0056 0.2636	1.0139 0.0244 0.5952	0.8894 0.0232 0.5696
LOWER 1.0060 0.0000 0.4195*	1.0060 0.0000 0.4195*	1.0060 0.0000 0.4194*
TOTAL CL= 0.202 100CD=0.6831	CL= 0.182 100CD=1.0146	CL= 0.184 100CD=0.9890
CM=-0.1773	CM=-0.1727	CM=-0.1730
-4.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4209 0.0079 0.2783	1.0219 0.0277 0.6406	0.9070 0.0270 0.6185
LOWER 1.0059 0.0000 0.3765*	1.0059 0.0000 0.3765*	1.0059 0.0000 0.3765*
TOTAL CL= 0.309 100CD=0.6547	CL= 0.287 100CD=1.0171	CL= 0.288 100CD=0.9950
CM=-0.1807	CM=-0.1756	CM=-0.1758
-3.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4262 0.0101 0.2935	1.0219 0.0310 0.6892	0.9239 0.0304 0.6670
LOWER 0.9938 0.0000 0.3385*	0.9938 0.0000 0.3385*	0.9981 0.0000 0.3340
TOTAL CL= 0.416 100CD=0.6320	CL= 0.392 100CD=1.0277	CL= 0.393 100CD=1.0010
CM=-0.1841	CM=-0.1784	CM=-0.1786
-2.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4327 0.0123 0.3107	1.0219 0.0345 0.7416	0.9400 0.0339 0.7194
LOWER 0.4925 0.0000 0.1439	0.9543 0.0000 0.2917	0.9895 0.0000 0.3027
TOTAL CL= 0.523 100CD=0.4546	CL= 0.496 100CD=1.0333	CL= 0.497 100CD=1.0220
CM=-0.1875	CM=-0.1812	CM=-0.1814
-1.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4381 0.0145 0.3276	1.0219 0.0379 0.7977	0.9555 0.0374 0.7760
LOWER 0.4684 0.0000 0.1296	0.9543 0.0000 0.2706	0.9776 0.0000 0.2758
TOTAL CL= 0.629 100CD=0.4572	CL= 0.599 100CD=1.0683	CL= 0.600 100CD=1.0517
CM=-0.1908	CM=-0.1840	CM=-0.1841
0.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4439 0.0169 0.3457	1.0219 0.0415 0.8580	0.9700 0.0410 0.8372
LOWER 0.4589 0.0000 0.1211	0.9543 0.0000 0.2508	0.9646 0.0000 0.2525
TOTAL CL= 0.735 100CD=0.4668	CL= 0.702 100CD=1.1088	CL= 0.703 100CD=1.0897
CM=-0.1942	CM=-0.1867	CM=-0.1868
1.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4510 0.0193 0.3662	1.0219 0.0452 0.9224	0.9828 0.0447 0.9030
LOWER 0.4507 0.0000 0.1138	0.9543 0.0000 0.2326	0.9433 0.0000 0.2312
TOTAL CL= 0.841 100CD=0.4800	CL= 0.805 100CD=1.1550	CL= 0.805 100CD=1.1342
CM=-0.1974	CM=-0.1893	CM=-0.1894
2.00 S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER 0.4611 0.0221 0.3916	1.0219 0.0491 0.9928	0.9950 0.0488 0.9759
LOWER 0.4426 0.0000 0.1068	0.9543 0.0000 0.2155	0.9136 0.0000 0.2113
TOTAL CL= 0.946 100CD=0.4984	CL= 0.906 100CD=1.2083	CL= 0.907 100CD=1.1872
CM=-0.2005	CM=-0.1918	CM=-0.1919

B.L.SUMMARY AIRFOIL S831 18% ALPHA0= 6.885 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 9000000 MU= 300	R= 9000000 MU= 100	R= 9000000 MU= 900
3.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4821 0.0264 0.4363	1.0219 0.0532 1.0672	1.0069 0.0530 1.0554
	LOWER 0.4342 0.0000 0.1001	0.9543 0.0000 0.1996	0.8835 0.0000 0.1934
	TOTAL CL= 1.048 100CD=0.5364	CL= 1.007 100CD=1.2668	CL= 1.007 100CD=1.2488
	CM=-0.2031	CM=-0.1941	CM=-0.1942
4.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.6507 0.0424 0.6894	1.0219 0.0575 1.1483	1.0183 0.0575 1.1448
	LOWER 0.4254 0.0000 0.0938	0.9543 0.0000 0.1848	0.8563 0.0000 0.1780
	TOTAL CL= 1.131 100CD=0.7832	CL= 1.106 100CD=1.3331	CL= 1.106 100CD=1.3227
	CM=-0.2014	CM=-0.1962	CM=-0.1962
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.7884 0.0536 0.9161	1.0219 0.0619 1.2334	1.0294 0.0621 1.2429
	LOWER 0.4165 0.0000 0.0876	0.9543 0.0000 0.1711	0.8283 0.0000 0.1634
	TOTAL CL= 1.220 100CD=1.0037	CL= 1.205 100CD=1.4044	CL= 1.205 100CD=1.4063
	CM=-0.2013	CM=-0.1982	CM=-0.1982
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.8826 0.0616 1.1060	1.0219 0.0664 1.3246	1.0393 0.0669 1.3531
	LOWER 0.4074 0.0000 0.0819	0.9543 0.0000 0.1586	0.8006 0.0000 0.1503
	TOTAL CL= 1.312 100CD=1.1878	CL= 1.303 100CD=1.4832	CL= 1.302 100CD=1.5034
	CM=-0.2019	CM=-0.2001	CM=-0.1999
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9456 0.0683 1.2767	1.0219 0.0713 1.4224	1.0470 0.0723 1.4765
	LOWER 0.3981 0.0000 0.0765	0.9543 0.0000 0.1469	0.7737 0.0000 0.1381
	TOTAL CL= 1.405 100CD=1.3532	CL= 1.400 100CD=1.5693	CL= 1.398 100CD=1.6145
	CM=-0.2029	CM=-0.2018	CM=-0.2014
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9864 0.0750 1.4417	1.0219 0.0768 1.5267	1.0513 0.0784 1.6108
	LOWER 0.3886 0.0000 0.0713	0.9543 0.0000 0.1360	0.7458 0.0000 0.1268
	TOTAL CL= 1.498 100CD=1.5130	CL= 1.495 100CD=1.6626	CL= 1.491 100CD=1.7376
	CM=-0.2038	CM=-0.2031	CM=-0.2025
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 1.0550 0.0858 1.7691*	1.0550 0.0858 1.7691*	1.0550 0.0857 1.7648*
	LOWER 0.3788 0.0000 0.0664	0.9543 0.0000 0.1258	0.7166 0.0000 0.1162
	TOTAL CL= 1.583 100CD=1.8355	CL= 1.583 100CD=1.8949	CL= 1.583 100CD=1.8810
	CM=-0.2033	CM=-0.2033	CM=-0.2034
9.86	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0570 0.0929 1.9206*	1.0570 0.0929 1.9206*	
	LOWER 0.3700 0.0000 0.0624	0.9319 0.0000 0.1176	
	TOTAL CL= 1.659 100CD=1.9830	CL= 1.659 100CD=2.0382	
	CM=-0.2036	CM=-0.2036	
9.89			S TURB S SEP 100CD
	UPPER		1.0571 0.0931 1.9194*
	LOWER		0.6916 0.0000 0.1075
	TOTAL		CL= 1.662 100CD=2.0269
			CM=-0.2037

APPENDIX C

PRESSURE DISTRIBUTIONS, TRANSITION AND SEPARATION LOCATIONS, AND SECTION CHARACTERISTICS OF S832 AIRFOIL

AIRFOIL S832 15%				-4.00	-3.00	-2.00	-1.00	0.00	1.00	2.00	3.00
N	X	Y	NU	CP(X) FOR THE ABOVE ALPHA REL. CHORD LINE							
1	1.00000	0.00000	0.00	0.376	0.377	0.378	0.380	0.381	0.384	0.386	0.389
2	0.99619	0.00069	1.00	0.371	0.371	0.371	0.371	0.372	0.373	0.375	0.377
3	0.98514	0.00333	2.00	0.329	0.327	0.326	0.325	0.324	0.324	0.325	0.326
4	0.96785	0.00839	3.00	0.256	0.252	0.250	0.247	0.245	0.244	0.243	0.243
5	0.94539	0.01576	4.00	0.163	0.158	0.153	0.149	0.145	0.142	0.139	0.137
6	0.91858	0.02488	5.00	0.065	0.057	0.050	0.044	0.038	0.033	0.028	0.024
7	0.88788	0.03517	6.00	-0.017	-0.027	-0.037	-0.046	-0.055	-0.063	-0.070	-0.076
8	0.85352	0.04638	7.00	-0.088	-0.102	-0.114	-0.126	-0.138	-0.148	-0.158	-0.168
9	0.81614	0.05839	8.00	-0.172	-0.188	-0.204	-0.220	-0.235	-0.249	-0.262	-0.275
10	0.77642	0.07079	9.00	-0.266	-0.287	-0.307	-0.327	-0.345	-0.364	-0.381	-0.398
11	0.73496	0.08312	10.00	-0.370	-0.395	-0.421	-0.445	-0.469	-0.492	-0.514	-0.536
12	0.69229	0.09486	11.00	-0.481	-0.513	-0.544	-0.574	-0.603	-0.632	-0.660	-0.688
13	0.64882	0.10544	12.00	-0.590	-0.628	-0.666	-0.703	-0.739	-0.774	-0.809	-0.843
14	0.60480	0.11436	13.00	-0.683	-0.728	-0.772	-0.816	-0.859	-0.902	-0.944	-0.986
15	0.56040	0.12129	14.00	-0.750	-0.802	-0.853	-0.905	-0.956	-1.006	-1.056	-1.105
16	0.51577	0.12599	15.00	-0.786	-0.845	-0.904	-0.963	-1.021	-1.079	-1.137	-1.194
17	0.47106	0.12830	16.00	-0.782	-0.848	-0.913	-0.979	-1.045	-1.110	-1.175	-1.240
18	0.42629	0.12824	17.00	-0.730	-0.801	-0.872	-0.944	-1.016	-1.087	-1.159	-1.231
19	0.38161	0.12614	18.00	-0.662	-0.738	-0.815	-0.892	-0.970	-1.048	-1.126	-1.204
20	0.33747	0.12233	19.00	-0.592	-0.673	-0.756	-0.839	-0.923	-1.008	-1.094	-1.180
21	0.29436	0.11701	20.00	-0.518	-0.605	-0.694	-0.784	-0.876	-0.968	-1.062	-1.156
22	0.25274	0.11037	21.00	-0.440	-0.533	-0.629	-0.727	-0.826	-0.927	-1.030	-1.134
23	0.21310	0.10256	22.00	-0.355	-0.456	-0.559	-0.665	-0.774	-0.884	-0.997	-1.112
24	0.17583	0.09376	23.00	-0.261	-0.370	-0.482	-0.597	-0.716	-0.838	-0.963	-1.091
25	0.14137	0.08415	24.00	-0.156	-0.273	-0.395	-0.521	-0.652	-0.787	-0.926	-1.069
26	0.11007	0.07390	25.00	-0.036	-0.161	-0.294	-0.432	-0.577	-0.727	-0.884	-1.045
27	0.08228	0.06320	26.00	0.106	-0.030	-0.173	-0.326	-0.487	-0.656	-0.833	-1.019
28	0.05831	0.05217	27.00	0.280	0.138	-0.017	-0.184	-0.363	-0.553	-0.755	-0.968
29	0.03830	0.04102	28.00	0.492	0.347	0.185	0.006	-0.191	-0.405	-0.635	-0.882
30	0.02242	0.03000	29.00	0.735	0.602	0.444	0.259	0.048	-0.189	-0.451	-0.738
31	0.01071	0.01942	30.00	0.956	0.873	0.748	0.582	0.373	0.122	-0.169	-0.502
32	0.00328	0.00973	31.00	0.910	0.989	0.993	0.922	0.776	0.557	0.263	-0.105
33	0.00011	0.00150	32.00	-0.642	-0.001	0.483	0.809	0.976	0.984	0.834	0.525
34	0.00000	0.00028	32.18	-1.432	-0.572	0.103	0.590	0.889	0.999	0.922	0.656
35	0.00010	-0.00126	32.43	-3.183	-1.876	-0.811	0.009	0.584	0.914	0.997	0.834
36	0.00026	-0.00194	32.55	-4.495	-2.873	-1.532	-0.474	0.301	0.790	0.994	0.911
37	0.00053	-0.00252	32.68	-6.254	-4.225	-2.526	-1.158	-0.124	0.577	0.942	0.971
38	0.00094	-0.00303	32.80	-5.172	-3.533	-2.143	-1.006	-0.122	0.507	0.881	1.000
39	0.00150	-0.00353	32.93	-4.394	-3.030	-1.862	-0.892	-0.121	0.450	0.820	0.989
40	0.00188	-0.00380	33.00	-4.041	-2.800	-1.732	-0.838	-0.120	0.421	0.786	0.973
41	0.00298	-0.00448	33.18	-3.360	-2.354	-1.478	-0.732	-0.119	0.361	0.708	0.921
42	0.01074	-0.00728	34.00	-1.876	-1.362	-0.897	-0.481	-0.117	0.197	0.460	0.671
43	0.02577	-0.00958	35.00	-1.071	-0.781	-0.512	-0.265	-0.039	0.166	0.349	0.509
44	0.04734	-0.01088	36.00	-0.633	-0.446	-0.270	-0.105	0.050	0.193	0.325	0.446
45	0.07510	-0.01192	37.00	-0.427	-0.290	-0.159	-0.034	0.084	0.196	0.300	0.398
46	0.10825	-0.01295	38.00	-0.316	-0.207	-0.102	-0.002	0.095	0.187	0.274	0.357
47	0.14628	-0.01404	39.00	-0.247	-0.157	-0.070	0.014	0.095	0.174	0.249	0.321
48	0.18846	-0.01522	40.00	-0.204	-0.127	-0.053	0.020	0.090	0.159	0.225	0.289
49	0.23423	-0.01649	41.00	-0.175	-0.108	-0.043	0.020	0.082	0.143	0.202	0.259
50	0.28287	-0.01779	42.00	-0.155	-0.097	-0.040	0.017	0.072	0.126	0.180	0.232
51	0.33377	-0.01907	43.00	-0.142	-0.091	-0.040	0.011	0.061	0.110	0.158	0.205
52	0.38622	-0.02025	44.00	-0.134	-0.088	-0.042	0.003	0.048	0.093	0.137	0.180
53	0.43959	-0.02122	45.00	-0.129	-0.088	-0.046	-0.005	0.036	0.076	0.116	0.156
54	0.49317	-0.02188	46.00	-0.127	-0.090	-0.052	-0.015	0.022	0.059	0.096	0.133
55	0.54634	-0.02208	47.00	-0.127	-0.093	-0.059	-0.026	0.008	0.042	0.076	0.110
56	0.59843	-0.02158	48.00	-0.125	-0.095	-0.065	-0.034	-0.003	0.028	0.059	0.090
57	0.64911	-0.02005	49.00	-0.104	-0.077	-0.050	-0.023	0.004	0.032	0.060	0.088
58	0.69821	-0.01745	50.00	-0.063	-0.040	-0.017	0.007	0.031	0.055	0.079	0.104
59	0.74555	-0.01394	51.00	-0.004	0.015	0.035	0.055	0.075	0.096	0.117	0.138
60	0.79090	-0.00991	52.00	0.066	0.082	0.098	0.115	0.132	0.149	0.167	0.184
61	0.83384	-0.00585	53.00	0.140	0.153	0.166	0.179	0.193	0.207	0.222	0.237
62	0.87378	-0.00234	54.00	0.208	0.218	0.229	0.239	0.250	0.262	0.274	0.286
63	0.90980	0.00013	55.00	0.262	0.270	0.278	0.286	0.295	0.305	0.314	0.324
64	0.94089	0.00144	56.00	0.304	0.310	0.316	0.323	0.330	0.337	0.345	0.354
65	0.96613	0.00169	57.00	0.335	0.340	0.345	0.350	0.355	0.361	0.368	0.374
66	0.98476	0.00118	58.00	0.358	0.361	0.364	0.368	0.372	0.377	0.382	0.387
67	0.99616	0.00041	59.00	0.371	0.373	0.375	0.378	0.381	0.385	0.388	0.392
68	1.00000	0.00000	60.00	0.376	0.377	0.378	0.380	0.381	0.384	0.386	0.389

ALPHA0= 5.45 DEGREES CM0=-0.1209 ETA= 1.116

AIRFOIL S832 15%			4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00
N	X	Y	NU	CP(X) FOR THE ABOVE ALPHA REL. CHORD LINE						
1	1.00000	0.00000	0.00	0.393	0.396	0.400	0.405	0.410	0.415	0.420
2	0.99619	0.00069	1.00	0.379	0.381	0.384	0.388	0.392	0.396	0.400
3	0.98514	0.00333	2.00	0.327	0.328	0.330	0.333	0.336	0.339	0.343
4	0.96785	0.00839	3.00	0.243	0.243	0.244	0.245	0.247	0.249	0.252
5	0.94539	0.01576	4.00	0.136	0.134	0.134	0.134	0.134	0.135	0.137
6	0.91858	0.02488	5.00	0.020	0.017	0.015	0.013	0.011	0.011	0.011
7	0.88788	0.03517	6.00	-0.082	-0.088	-0.092	-0.097	-0.100	-0.103	-0.105
8	0.85352	0.04638	7.00	-0.177	-0.185	-0.192	-0.199	-0.204	-0.210	-0.214
9	0.81614	0.05839	8.00	-0.287	-0.298	-0.309	-0.319	-0.328	-0.336	-0.343
10	0.77642	0.07079	9.00	-0.414	-0.429	-0.444	-0.457	-0.470	-0.482	-0.493
11	0.73496	0.08312	10.00	-0.557	-0.576	-0.596	-0.614	-0.631	-0.648	-0.663
12	0.69229	0.09486	11.00	-0.714	-0.740	-0.765	-0.789	-0.811	-0.833	-0.854
13	0.64882	0.10544	12.00	-0.876	-0.908	-0.940	-0.970	-1.000	-1.028	-1.056
14	0.60480	0.11436	13.00	-1.026	-1.066	-1.104	-1.142	-1.179	-1.215	-1.250
15	0.56040	0.12129	14.00	-1.153	-1.201	-1.248	-1.293	-1.338	-1.382	-1.425
16	0.51577	0.12599	15.00	-1.250	-1.306	-1.361	-1.415	-1.469	-1.521	-1.573
17	0.47106	0.12830	16.00	-1.304	-1.368	-1.431	-1.494	-1.556	-1.617	-1.677
18	0.42629	0.12824	17.00	-1.302	-1.373	-1.444	-1.514	-1.584	-1.653	-1.721
19	0.38161	0.12614	18.00	-1.283	-1.361	-1.440	-1.518	-1.595	-1.673	-1.749
20	0.33747	0.12233	19.00	-1.266	-1.352	-1.439	-1.526	-1.613	-1.699	-1.786
21	0.29436	0.11701	20.00	-1.251	-1.347	-1.444	-1.540	-1.637	-1.735	-1.832
22	0.25274	0.11037	21.00	-1.239	-1.345	-1.453	-1.561	-1.670	-1.780	-1.890
23	0.21310	0.10256	22.00	-1.229	-1.348	-1.468	-1.590	-1.713	-1.837	-1.962
24	0.17583	0.09376	23.00	-1.222	-1.355	-1.490	-1.628	-1.768	-1.910	-2.053
25	0.14137	0.08415	24.00	-1.216	-1.367	-1.521	-1.679	-1.839	-2.003	-2.169
26	0.11007	0.07390	25.00	-1.213	-1.385	-1.563	-1.745	-1.931	-2.122	-2.317
27	0.08228	0.06320	26.00	-1.211	-1.411	-1.619	-1.833	-2.054	-2.281	-2.514
28	0.05831	0.05217	27.00	-1.192	-1.426	-1.671	-1.927	-2.191	-2.466	-2.749
29	0.03830	0.04102	28.00	-1.145	-1.424	-1.718	-2.028	-2.352	-2.690	-3.043
30	0.02242	0.03000	29.00	-1.050	-1.386	-1.747	-2.131	-2.538	-2.967	-3.419
31	0.01071	0.01942	30.00	-0.875	-1.288	-1.741	-2.233	-2.764	-3.332	-3.938
32	0.00328	0.00973	31.00	-0.546	-1.060	-1.646	-2.304	-3.032	-3.830	-4.697
33	0.00011	0.00150	32.00	0.058	-0.567	-1.349	-2.286	-3.379	-4.625	-6.022
34	0.00000	0.00028	32.18	0.202	-0.440	-1.268	-2.282	-3.480	-4.861	-6.423
35	0.00010	-0.00126	32.43	0.424	-0.230	-1.130	-2.273	-3.659	-5.285	-7.150
36	0.00026	-0.00194	32.55	0.544	-0.109	-1.047	-2.268	-3.771	-5.553	-7.614
37	0.00053	-0.00252	32.68	0.665	0.024	-0.952	-2.262	-3.903	-5.874	-8.172
38	0.00094	-0.00303	32.80	0.862	0.469	-0.179	-1.082	-2.238	-3.646	-5.304
39	0.00150	-0.00353	32.93	0.956	0.722	0.287	-0.349	-1.185	-2.219	-3.451
40	0.00188	-0.00380	33.00	0.982	0.814	0.468	-0.055	-0.754	-1.629	-2.679
41	0.00298	-0.00448	33.18	0.999	0.944	0.755	0.431	-0.025	-0.615	-1.337
42	0.01074	-0.00728	34.00	0.830	0.937	0.992	0.995	0.945	0.844	0.690
43	0.02577	-0.00958	35.00	0.647	0.762	0.855	0.925	0.972	0.996	0.998
44	0.04734	-0.01088	36.00	0.555	0.652	0.738	0.812	0.873	0.923	0.960
45	0.07510	-0.01192	37.00	0.489	0.573	0.649	0.718	0.780	0.834	0.881
46	0.10825	-0.01295	38.00	0.435	0.509	0.578	0.641	0.700	0.754	0.802
47	0.14628	-0.01404	39.00	0.390	0.456	0.518	0.577	0.632	0.683	0.731
48	0.18846	-0.01522	40.00	0.351	0.410	0.467	0.521	0.572	0.621	0.667
49	0.23423	-0.01649	41.00	0.315	0.369	0.421	0.471	0.520	0.566	0.610
50	0.28287	-0.01779	42.00	0.282	0.332	0.380	0.427	0.472	0.515	0.557
51	0.33377	-0.01907	43.00	0.252	0.298	0.342	0.386	0.428	0.469	0.509
52	0.38622	-0.02025	44.00	0.223	0.265	0.307	0.347	0.387	0.426	0.464
53	0.43959	-0.02122	45.00	0.196	0.235	0.273	0.311	0.349	0.385	0.421
54	0.49317	-0.02188	46.00	0.170	0.206	0.242	0.277	0.312	0.347	0.381
55	0.54634	-0.02208	47.00	0.144	0.178	0.211	0.244	0.277	0.310	0.342
56	0.59843	-0.02158	48.00	0.121	0.152	0.183	0.214	0.245	0.276	0.307
57	0.64911	-0.02005	49.00	0.116	0.144	0.173	0.201	0.229	0.258	0.286
58	0.69821	-0.01745	50.00	0.129	0.154	0.179	0.205	0.230	0.256	0.281
59	0.74555	-0.01394	51.00	0.160	0.181	0.203	0.225	0.248	0.270	0.293
60	0.79090	-0.00991	52.00	0.203	0.221	0.240	0.259	0.278	0.298	0.317
61	0.83384	-0.00585	53.00	0.252	0.267	0.283	0.299	0.315	0.332	0.349
62	0.87378	-0.00234	54.00	0.299	0.312	0.325	0.338	0.352	0.366	0.380
63	0.90980	0.00013	55.00	0.335	0.346	0.357	0.368	0.380	0.391	0.404
64	0.94089	0.00144	56.00	0.362	0.371	0.380	0.390	0.400	0.410	0.420
65	0.96613	0.00169	57.00	0.381	0.389	0.397	0.405	0.413	0.421	0.430
66	0.98476	0.00118	58.00	0.393	0.399	0.405	0.412	0.419	0.426	0.434
67	0.99616	0.00041	59.00	0.397	0.402	0.407	0.412	0.418	0.424	0.431
68	1.00000	0.00000	60.00	0.393	0.396	0.400	0.405	0.410	0.415	0.420

ALPHA= 5.45 DEGREES CM0=-0.1209 ETA= 1.116

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 1000000 MU= 300	R= 1000000 MU= 100	R= 1000000 MU= 900
-1.74	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4204 0.0300 0.4548*	1.0149 0.0576 0.8945	0.7345 0.0499 0.7558
	LOWER 1.0014 0.0000 0.4574*	1.0014 0.0000 0.4574*	1.0014 0.0000 0.4574*
	TOTAL CL= 0.383 100CD=0.9122	CL= 0.358 100CD=1.3519	CL= 0.366 100CD=1.2132
	CM=-0.1269	CM=-0.1216	CM=-0.1232
-1.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4262 0.0338 0.4795*	1.0148 0.0624 0.9477	0.7666 0.0556 0.8174
	LOWER 0.9794 0.0000 0.4230*	0.9794 0.0000 0.4230*	0.9794 0.0000 0.4107*
	TOTAL CL= 0.459 100CD=0.9025	CL= 0.432 100CD=1.3707	CL= 0.439 100CD=1.2281
	CM=-0.1283	CM=-0.1224	CM=-0.1240
0.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4339 0.0393 0.5159*	1.0149 0.0692 1.0248	0.8077 0.0634 0.9054
	LOWER 0.2737 0.0000 0.1765*	0.9511 0.0000 0.3689	0.9500 0.0000 0.3687
	TOTAL CL= 0.562 100CD=0.6924	CL= 0.530 100CD=1.3937	CL= 0.537 100CD=1.2740
	CM=-0.1300	CM=-0.1234	CM=-0.1248
1.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4409 0.0449 0.5475*	1.0149 0.0766 1.1084	0.8452 0.0714 0.9989
	LOWER 0.2657 0.0000 0.1653*	0.9511 0.0000 0.3415	0.8790 0.0000 0.3291
	TOTAL CL= 0.664 100CD=0.7128	CL= 0.627 100CD=1.4499	CL= 0.634 100CD=1.3280
	CM=-0.1317	CM=-0.1242	CM=-0.1254
2.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4485 0.0508 0.5867*	1.0149 0.0849 1.1992	0.8784 0.0800 1.0982
	LOWER 0.2577 0.0000 0.1543*	0.9511 0.0000 0.3165	0.7836 0.0000 0.2903
	TOTAL CL= 0.765 100CD=0.7410	CL= 0.722 100CD=1.5156	CL= 0.729 100CD=1.3885
	CM=-0.1333	CM=-0.1247	CM=-0.1259
3.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4561 0.0568 0.6254*	1.0149 0.0941 1.2975	0.9069 0.0896 1.2038
	LOWER 0.2497 0.0000 0.1437*	0.9511 0.0000 0.2934	0.7014 0.0000 0.2577
	TOTAL CL= 0.865 100CD=0.7692	CL= 0.815 100CD=1.5910	CL= 0.821 100CD=1.4616
	CM=-0.1348	CM=-0.1250	CM=-0.1261
4.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4638 0.0616 0.6580*	1.0149 0.1042 1.4038	0.9311 0.1001 1.3169
	LOWER 0.2420 0.0000 0.1347*	0.9511 0.0000 0.2723	0.6226 0.0000 0.2282
	TOTAL CL= 0.965 100CD=0.7927	CL= 0.906 100CD=1.6760	CL= 0.912 100CD=1.5451
	CM=-0.1363	CM=-0.1251	CM=-0.1261
5.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4714 0.0687 0.7045*	1.0149 0.1150 1.5196	0.9542 0.1115 1.4429
	LOWER 0.2343 0.0000 0.1252*	0.9511 0.0000 0.2527	0.5402 0.0000 0.2000
	TOTAL CL= 1.061 100CD=0.8297	CL= 0.995 100CD=1.7722	CL= 1.000 100CD=1.6428
	CM=-0.1372	CM=-0.1250	CM=-0.1258
6.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4792 0.0765 0.7542*	1.0149 0.1271 1.6452	0.9762 0.1243 1.5848
	LOWER 0.2266 0.0000 0.1172*	0.9511 0.0000 0.2345	0.4455 0.0000 0.1700
	TOTAL CL= 1.156 100CD=0.8714	CL= 1.081 100CD=1.8797	CL= 1.085 100CD=1.7548
	CM=-0.1378	CM=-0.1246	CM=-0.1252
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.4914 0.0823 0.7952*	1.0149 0.1396 1.7816	0.9970 0.1382 1.7463
	LOWER 0.2185 0.0000 0.1100*	0.9511 0.0000 0.2178	0.3737 0.0000 0.1457
	TOTAL CL= 1.252 100CD=0.9053	CL= 1.164 100CD=1.9994	CL= 1.166 100CD=1.8921
	CM=-0.1389	CM=-0.1241	CM=-0.1244
7.93		S TURB S SEP 100CD	
	UPPER	1.0149 0.1506 1.9193	
	LOWER	0.9511 0.0000 0.2033	
	TOTAL	CL= 1.242 100CD=2.1225	
		CM=-0.1238	

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 1000000 MU= 300	R= 1000000 MU= 100	R= 1000000 MU= 900
7.95			S TURB S SEP 100CD
UPPER			1.0142 0.1508 1.9207
LOWER			0.3495 0.0000 0.1337
TOTAL			CL= 1.244 100CD=2.0545
			CM=-0.1238
8.00	S TURB S SEP 100CD		
UPPER	0.6934 0.1128 1.2294		
LOWER	0.2099 0.0000 0.1027*		
TOTAL	CL= 1.308 100CD=1.3321		
	CM=-0.1330		
8.65	S TURB S SEP 100CD		
UPPER	0.8339 0.1396 1.5766		
LOWER	0.2042 0.0000 0.0980*		
TOTAL	CL= 1.333 100CD=1.6745		
	CM=-0.1280		

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
-2.18	S TURB S SEP 100CD UPPER 0.4169 0.0125 0.3501* LOWER 1.0015 0.0000 0.4326* TOTAL CL= 0.349 100CD=0.7827 CM=-0.1290	S TURB S SEP 100CD 1.0149 0.0457 0.7769 1.0015 0.0000 0.4326* CL= 0.322 100CD=1.2094 CM=-0.1228	S TURB S SEP 100CD 0.8149 0.0417 0.7010 1.0015 0.0000 0.4326* CL= 0.325 100CD=1.1335 CM=-0.1235
-2.00	S TURB S SEP 100CD UPPER 0.4184 0.0133 0.3543* LOWER 1.0015 0.0000 0.4290* TOTAL CL= 0.368 100CD=0.7833 CM=-0.1294	S TURB S SEP 100CD 1.0149 0.0467 0.7878 1.0015 0.0000 0.4290* CL= 0.340 100CD=1.2168 CM=-0.1230	S TURB S SEP 100CD 0.8203 0.0429 0.7124 1.0015 0.0000 0.4290* CL= 0.344 100CD=1.1414 CM=-0.1237
-1.00	S TURB S SEP 100CD UPPER 0.4262 0.0180 0.3797* LOWER 0.9794 0.0000 0.3758* TOTAL CL= 0.473 100CD=0.7555 CM=-0.1315	S TURB S SEP 100CD 1.0148 0.0528 0.8512 0.9794 0.0000 0.3758* CL= 0.442 100CD=1.2270 CM=-0.1246	S TURB S SEP 100CD 0.8493 0.0492 0.7790 0.9803 0.0000 0.3685* CL= 0.445 100CD=1.1475 CM=-0.1253
0.00	S TURB S SEP 100CD UPPER 0.4339 0.0223 0.4042* LOWER 0.2737 0.0000 0.1363* TOTAL CL= 0.578 100CD=0.5405 CM=-0.1337	S TURB S SEP 100CD 1.0149 0.0591 0.9201 0.9511 0.0000 0.3326 CL= 0.542 100CD=1.2527 CM=-0.1258	S TURB S SEP 100CD 0.8770 0.0559 0.8513 0.9626 0.0000 0.3353 CL= 0.546 100CD=1.1865 CM=-0.1266
1.00	S TURB S SEP 100CD UPPER 0.4409 0.0266 0.4297* LOWER 0.2657 0.0000 0.1273* TOTAL CL= 0.683 100CD=0.5571 CM=-0.1359	S TURB S SEP 100CD 1.0149 0.0657 0.9942 0.9511 0.0000 0.3086 CL= 0.641 100CD=1.3028 CM=-0.1269	S TURB S SEP 100CD 0.9016 0.0628 0.9286 0.9317 0.0000 0.3053 CL= 0.644 100CD=1.2339 CM=-0.1276
2.00	S TURB S SEP 100CD UPPER 0.4485 0.0306 0.4541* LOWER 0.2577 0.0000 0.1193* TOTAL CL= 0.787 100CD=0.5733 CM=-0.1381	S TURB S SEP 100CD 1.0149 0.0726 1.0745 0.9511 0.0000 0.2866 CL= 0.738 100CD=1.3611 CM=-0.1278	S TURB S SEP 100CD 0.9220 0.0698 1.0102 0.8714 0.0000 0.2752 CL= 0.742 100CD=1.2853 CM=-0.1285
3.00	S TURB S SEP 100CD UPPER 0.4561 0.0353 0.4835* LOWER 0.2497 0.0000 0.1126* TOTAL CL= 0.890 100CD=0.5962 CM=-0.1401	S TURB S SEP 100CD 1.0149 0.0801 1.1615 0.9511 0.0000 0.2662 CL= 0.834 100CD=1.4277 CM=-0.1285	S TURB S SEP 100CD 0.9417 0.0775 1.1006 0.8133 0.0000 0.2489 CL= 0.837 100CD=1.3495 CM=-0.1292
4.00	S TURB S SEP 100CD UPPER 0.4638 0.0402 0.5151* LOWER 0.2420 0.0000 0.1057* TOTAL CL= 0.992 100CD=0.6208 CM=-0.1420	S TURB S SEP 100CD 1.0149 0.0886 1.2552 0.9511 0.0000 0.2473 CL= 0.928 100CD=1.5025 CM=-0.1290	S TURB S SEP 100CD 0.9607 0.0863 1.2003 0.7595 0.0000 0.2259 CL= 0.931 100CD=1.4262 CM=-0.1296
5.00	S TURB S SEP 100CD UPPER 0.4768 0.0457 0.5561 LOWER 0.2343 0.0000 0.0990* TOTAL CL= 1.093 100CD=0.6552 CM=-0.1437	S TURB S SEP 100CD 1.0149 0.0980 1.3565 0.9511 0.0000 0.2297 CL= 1.019 100CD=1.5863 CM=-0.1292	S TURB S SEP 100CD 0.9787 0.0960 1.3113 0.7068 0.0000 0.2049 CL= 1.022 100CD=1.5163 CM=-0.1297
6.00	S TURB S SEP 100CD UPPER 0.5013 0.0532 0.6206 LOWER 0.2266 0.0000 0.0929 TOTAL CL= 1.191 100CD=0.7135 CM=-0.1449	S TURB S SEP 100CD 1.0149 0.1080 1.4659 0.9511 0.0000 0.2134 CL= 1.108 100CD=1.6794 CM=-0.1292	S TURB S SEP 100CD 0.9961 0.1068 1.4368 0.6538 0.0000 0.1856 CL= 1.110 100CD=1.6224 CM=-0.1295
7.00	S TURB S SEP 100CD UPPER 0.6822 0.0836 0.9727 LOWER 0.2185 0.0000 0.0871 TOTAL CL= 1.250 100CD=1.0598 CM=-0.1385	S TURB S SEP 100CD 1.0149 0.1190 1.5845 0.9511 0.0000 0.1983 CL= 1.195 100CD=1.7827 CM=-0.1289	S TURB S SEP 100CD 1.0121 0.1188 1.5791 0.5994 0.0000 0.1674 CL= 1.196 100CD=1.7464 CM=-0.1290

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 2000000 MU= 300	R= 2000000 MU= 100	R= 2000000 MU= 900
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.8448 0.1121 1.3365	1.0149 0.1310 1.7123	1.0256 0.1321 1.7396
LOWER	0.2099 0.0000 0.0816	0.9511 0.0000 0.1843	0.5418 0.0000 0.1499
TOTAL	CL= 1.309 100CD=1.4181	CL= 1.280 100CD=1.8966	CL= 1.278 100CD=1.8895
	CM=-0.1332	CM=-0.1285	CM=-0.1282
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.9910 0.1407 1.7884*	1.0149 0.1434 1.8568*	1.0356 0.1457 1.9200
LOWER	0.2011 0.0000 0.0762	0.9511 0.0000 0.1712	0.4807 0.0000 0.1327
TOTAL	CL= 1.366 100CD=1.8646	CL= 1.362 100CD=2.0279	CL= 1.358 100CD=2.0527
	CM=-0.1285	CM=-0.1279	CM=-0.1274
9.22	S TURB S SEP 100CD	S TURB S SEP 100CD	
UPPER	1.0212 0.1471 1.9217*	1.0212 0.1471 1.9217*	
LOWER	0.1992 0.0000 0.0751	0.9511 0.0000 0.1684	
TOTAL	CL= 1.378 100CD=1.9968	CL= 1.378 100CD=2.0901	
	CM=-0.1275	CM=-0.1275	

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
-2.40	S TURB S SEP 100CD UPPER 0.4199 0.0053 0.3126 LOWER 1.0016 0.0000 0.4118* TOTAL CL= 0.331 100CD=0.7244 CM=-0.1297	S TURB S SEP 100CD 1.0149 0.0393 0.7172 1.0016 0.0000 0.4118* CL= 0.304 100CD=1.1291 CM=-0.1233	S TURB S SEP 100CD 0.8493 0.0364 0.6633 1.0016 0.0000 0.4119* CL= 0.306 100CD=1.0752 CM=-0.1238
-2.00	S TURB S SEP 100CD UPPER 0.4234 0.0072 0.3208 LOWER 1.0015 0.0000 0.3993* TOTAL CL= 0.373 100CD=0.7200 CM=-0.1306	S TURB S SEP 100CD 1.0149 0.0415 0.7397 1.0015 0.0000 0.3993* CL= 0.345 100CD=1.1390 CM=-0.1240	S TURB S SEP 100CD 0.8588 0.0387 0.6862 1.0015 0.0000 0.3993* CL= 0.347 100CD=1.0854 CM=-0.1245
-1.00	S TURB S SEP 100CD UPPER 0.4319 0.0113 0.3422 LOWER 0.9794 0.0000 0.3498* TOTAL CL= 0.479 100CD=0.6920 CM=-0.1329	S TURB S SEP 100CD 1.0148 0.0472 0.7991 0.9794 0.0000 0.3498* CL= 0.447 100CD=1.1489 CM=-0.1256	S TURB S SEP 100CD 0.8826 0.0447 0.7472 0.9835 0.0000 0.3485 CL= 0.450 100CD=1.0957 CM=-0.1261
0.00	S TURB S SEP 100CD UPPER 0.4404 0.0158 0.3667 LOWER 0.2814 0.0000 0.1233 TOTAL CL= 0.584 100CD=0.4899 CM=-0.1351	S TURB S SEP 100CD 1.0149 0.0532 0.8633 0.9511 0.0000 0.3134 CL= 0.549 100CD=1.1767 CM=-0.1272	S TURB S SEP 100CD 0.9047 0.0509 0.8129 0.9680 0.0000 0.3174 CL= 0.551 100CD=1.1303 CM=-0.1277
1.00	S TURB S SEP 100CD UPPER 0.4479 0.0199 0.3898 LOWER 0.2693 0.0000 0.1144 TOTAL CL= 0.689 100CD=0.5042 CM=-0.1374	S TURB S SEP 100CD 1.0149 0.0595 0.9327 0.9511 0.0000 0.2912 CL= 0.648 100CD=1.2239 CM=-0.1284	S TURB S SEP 100CD 0.9232 0.0573 0.8826 0.9472 0.0000 0.2905 CL= 0.651 100CD=1.1731 CM=-0.1290
2.00	S TURB S SEP 100CD UPPER 0.4563 0.0243 0.4157 LOWER 0.2594 0.0000 0.1069 TOTAL CL= 0.794 100CD=0.5226 CM=-0.1396	S TURB S SEP 100CD 1.0149 0.0660 1.0074 0.9511 0.0000 0.2706 CL= 0.747 100CD=1.2781 CM=-0.1295	S TURB S SEP 100CD 0.9409 0.0640 0.9587 0.9042 0.0000 0.2642 CL= 0.749 100CD=1.2229 CM=-0.1300
3.00	S TURB S SEP 100CD UPPER 0.4658 0.0288 0.4445 LOWER 0.2500 0.0000 0.1001 TOTAL CL= 0.897 100CD=0.5446 CM=-0.1417	S TURB S SEP 100CD 1.0149 0.0728 1.0882 0.9511 0.0000 0.2516 CL= 0.844 100CD=1.3398 CM=-0.1304	S TURB S SEP 100CD 0.9581 0.0710 1.0429 0.8560 0.0000 0.2405 CL= 0.846 100CD=1.2834 CM=-0.1309
4.00	S TURB S SEP 100CD UPPER 0.4780 0.0340 0.4792 LOWER 0.2420 0.0000 0.0940 TOTAL CL= 1.000 100CD=0.5732 CM=-0.1437	S TURB S SEP 100CD 1.0149 0.0803 1.1756 0.9511 0.0000 0.2339 CL= 0.939 100CD=1.4095 CM=-0.1311	S TURB S SEP 100CD 0.9746 0.0787 1.1360 0.8109 0.0000 0.2196 CL= 0.941 100CD=1.3556 CM=-0.1315
5.00	S TURB S SEP 100CD UPPER 0.4979 0.0403 0.5282 LOWER 0.2343 0.0000 0.0883 TOTAL CL= 1.100 100CD=0.6165 CM=-0.1452	S TURB S SEP 100CD 1.0149 0.0887 1.2695 0.9511 0.0000 0.2174 CL= 1.032 100CD=1.4869 CM=-0.1316	S TURB S SEP 100CD 0.9903 0.0875 1.2396 0.7677 0.0000 0.2009 CL= 1.034 100CD=1.4404 CM=-0.1319
6.00	S TURB S SEP 100CD UPPER 0.5978 0.0585 0.7119 LOWER 0.2266 0.0000 0.0830 TOTAL CL= 1.183 100CD=0.7948 CM=-0.1433	S TURB S SEP 100CD 1.0149 0.0979 1.3708 0.9511 0.0000 0.2021 CL= 1.124 100CD=1.5728 CM=-0.1318	S TURB S SEP 100CD 1.0053 0.0973 1.3562 0.7245 0.0000 0.1837 CL= 1.124 100CD=1.5399 CM=-0.1320
7.00	S TURB S SEP 100CD UPPER 0.7894 0.0870 1.0708 LOWER 0.2185 0.0000 0.0778 TOTAL CL= 1.245 100CD=1.1486 CM=-0.1375	S TURB S SEP 100CD 1.0149 0.1078 1.4800 0.9511 0.0000 0.1878 CL= 1.212 100CD=1.6677 CM=-0.1318	S TURB S SEP 100CD 1.0190 0.1081 1.4880 0.6813 0.0000 0.1678 CL= 1.212 100CD=1.6558 CM=-0.1317

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 3000000 MU= 300	R= 3000000 MU= 100	R= 3000000 MU= 900
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.8874 0.1056 1.3177	1.0149 0.1186 1.5979	1.0305 0.1202 1.6376
LOWER	0.2099 0.0000 0.0728	0.9511 0.0000 0.1745	0.6370 0.0000 0.1530
TOTAL	CL= 1.320 100CD=1.3904	CL= 1.299 100CD=1.7724	CL= 1.297 100CD=1.7906
	CM=-0.1350	CM=-0.1315	CM=-0.1311
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
UPPER	0.9910 0.1277 1.6600*	1.0149 0.1305 1.7263*	1.0386 0.1337 1.8044
LOWER	0.2011 0.0000 0.0680	0.9511 0.0000 0.1622	0.5913 0.0000 0.1390
TOTAL	CL= 1.388 100CD=1.7281	CL= 1.383 100CD=1.8884	CL= 1.378 100CD=1.9434
	CM=-0.1317	CM=-0.1310	CM=-0.1302
9.55	S TURB S SEP 100CD	S TURB S SEP 100CD	
UPPER	1.0415 0.1418 1.9190*	1.0415 0.1418 1.9190*	
LOWER	0.1963 0.0000 0.0655	0.9511 0.0000 0.1558	
TOTAL	CL= 1.421 100CD=1.9845	CL= 1.421 100CD=2.0748	
	CM=-0.1296	CM=-0.1296	
9.62			S TURB S SEP 100CD
UPPER			1.0425 0.1423 1.9208*
LOWER			0.5616 0.0000 0.1305
TOTAL			CL= 1.427 100CD=2.0513
			CM=-0.1296

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
-2.55	S TURB S SEP 100CD UPPER 0.4280 0.0000 0.2950 LOWER 1.0016 0.0000 0.3981* TOTAL CL= 0.319 100CD=0.6932 CM=-0.1303	S TURB S SEP 100CD 1.0149 0.0347 0.6775 1.0016 0.0000 0.3981* CL= 0.291 100CD=1.0757 CM=-0.1237	S TURB S SEP 100CD 0.8691 0.0325 0.6356 1.0016 0.0000 0.3982* CL= 0.293 100CD=1.0338 CM=-0.1241
-2.00	S TURB S SEP 100CD UPPER 0.4327 0.0021 0.3069 LOWER 1.0015 0.0000 0.3815* TOTAL CL= 0.377 100CD=0.6884 CM=-0.1316	S TURB S SEP 100CD 1.0149 0.0377 0.7072 1.0015 0.0000 0.3815* CL= 0.348 100CD=1.0887 CM=-0.1247	S TURB S SEP 100CD 0.8810 0.0356 0.6652 1.0015 0.0000 0.3815* CL= 0.350 100CD=1.0466 CM=-0.1251
-1.00	S TURB S SEP 100CD UPPER 0.4412 0.0082 0.3272 LOWER 0.9794 0.0000 0.3350* TOTAL CL= 0.482 100CD=0.6622 CM=-0.1336	S TURB S SEP 100CD 1.0148 0.0432 0.7637 0.9794 0.0000 0.3350* CL= 0.451 100CD=1.0987 CM=-0.1264	S TURB S SEP 100CD 0.9017 0.0413 0.7227 0.9857 0.0000 0.3352 CL= 0.453 100CD=1.0579 CM=-0.1268
0.00	S TURB S SEP 100CD UPPER 0.4495 0.0126 0.3504 LOWER 0.2927 0.0000 0.1180 TOTAL CL= 0.587 100CD=0.4683 CM=-0.1359	S TURB S SEP 100CD 1.0149 0.0490 0.8250 0.9511 0.0000 0.3006 CL= 0.553 100CD=1.1257 CM=-0.1280	S TURB S SEP 100CD 0.9199 0.0472 0.7840 0.9716 0.0000 0.3055 CL= 0.555 100CD=1.0895 CM=-0.1284
1.00	S TURB S SEP 100CD UPPER 0.4567 0.0166 0.3720 LOWER 0.2784 0.0000 0.1089 TOTAL CL= 0.693 100CD=0.4809 CM=-0.1382	S TURB S SEP 100CD 1.0149 0.0551 0.8911 0.9511 0.0000 0.2795 CL= 0.654 100CD=1.1706 CM=-0.1295	S TURB S SEP 100CD 0.9362 0.0533 0.8500 0.9540 0.0000 0.2800 CL= 0.656 100CD=1.1300 CM=-0.1299
2.00	S TURB S SEP 100CD UPPER 0.4655 0.0209 0.3969 LOWER 0.2684 0.0000 0.1017 TOTAL CL= 0.797 100CD=0.4987 CM=-0.1405	S TURB S SEP 100CD 1.0149 0.0614 0.9622 0.9511 0.0000 0.2600 CL= 0.753 100CD=1.2222 CM=-0.1307	S TURB S SEP 100CD 0.9527 0.0598 0.9231 0.9213 0.0000 0.2560 CL= 0.755 100CD=1.1790 CM=-0.1311
3.00	S TURB S SEP 100CD UPPER 0.4761 0.0255 0.4259 LOWER 0.2589 0.0000 0.0952 TOTAL CL= 0.901 100CD=0.5211 CM=-0.1426	S TURB S SEP 100CD 1.0149 0.0679 1.0391 0.9511 0.0000 0.2418 CL= 0.850 100CD=1.2808 CM=-0.1317	S TURB S SEP 100CD 0.9683 0.0665 1.0030 0.8791 0.0000 0.2337 CL= 0.852 100CD=1.2368 CM=-0.1321
4.00	S TURB S SEP 100CD UPPER 0.4916 0.0309 0.4634 LOWER 0.2496 0.0000 0.0892 TOTAL CL= 1.003 100CD=0.5526 CM=-0.1445	S TURB S SEP 100CD 1.0149 0.0748 1.1219 0.9511 0.0000 0.2249 CL= 0.947 100CD=1.3468 CM=-0.1326	S TURB S SEP 100CD 0.9831 0.0737 1.0915 0.8396 0.0000 0.2142 CL= 0.948 100CD=1.3057 CM=-0.1329
5.00	S TURB S SEP 100CD UPPER 0.5259 0.0392 0.5316 LOWER 0.2404 0.0000 0.0834 TOTAL CL= 1.101 100CD=0.6150 CM=-0.1455	S TURB S SEP 100CD 1.0149 0.0825 1.2111 0.9511 0.0000 0.2091 CL= 1.041 100CD=1.4202 CM=-0.1332	S TURB S SEP 100CD 0.9975 0.0817 1.1904 0.8010 0.0000 0.1966 CL= 1.042 100CD=1.3870 CM=-0.1335
6.00	S TURB S SEP 100CD UPPER 0.7105 0.0666 0.8398 LOWER 0.2313 0.0000 0.0780 TOTAL CL= 1.170 100CD=0.9178 CM=-0.1407	S TURB S SEP 100CD 1.0149 0.0910 1.3070 0.9511 0.0000 0.1944 CL= 1.134 100CD=1.5014 CM=-0.1336	S TURB S SEP 100CD 1.0111 0.0908 1.3013 0.7639 0.0000 0.1806 CL= 1.134 100CD=1.4819 CM=-0.1337
7.00	S TURB S SEP 100CD UPPER 0.8360 0.0851 1.0897 LOWER 0.2222 0.0000 0.0729 TOTAL CL= 1.248 100CD=1.1627 CM=-0.1381	S TURB S SEP 100CD 1.0149 0.1003 1.4103 0.9511 0.0000 0.1807 CL= 1.224 100CD=1.5910 CM=-0.1338	S TURB S SEP 100CD 1.0233 0.1010 1.4265 0.7257 0.0000 0.1658 CL= 1.223 100CD=1.5923 CM=-0.1336

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 4000000 MU= 300	R= 4000000 MU= 100	R= 4000000 MU= 900
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9088 0.1001 1.2905	1.0149 0.1103 1.5215	1.0335 0.1122 1.5684
	LOWER 0.2130 0.0000 0.0681	0.9511 0.0000 0.1679	0.6878 0.0000 0.1521
	TOTAL CL= 1.329 100CD=1.3585	CL= 1.312 100CD=1.6894	CL= 1.309 100CD=1.7205
	CM=-0.1365	CM=-0.1337	CM=-0.1332
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9910 0.1186 1.5762*	1.0149 0.1214 1.6420*	1.0405 0.1248 1.7265
	LOWER 0.2035 0.0000 0.0635	0.9511 0.0000 0.1561	0.6484 0.0000 0.1393
	TOTAL CL= 1.402 100CD=1.6396	CL= 1.398 100CD=1.7981	CL= 1.392 100CD=1.8658
	CM=-0.1341	CM=-0.1334	CM=-0.1325
9.94	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0449 0.1390 1.9204*	1.0449 0.1390 1.9204*	
	LOWER 0.1945 0.0000 0.0593	0.9510 0.0000 0.1457	
	TOTAL CL= 1.465 100CD=1.9797	CL= 1.465 100CD=2.0661	
	CM=-0.1312	CM=-0.1312	
10.00			S TURB S SEP 100CD
	UPPER		1.0452 0.1389 1.9089*
	LOWER		0.6080 0.0000 0.1272
	TOTAL		CL= 1.471 100CD=2.0361
			CM=-0.1314
10.05			S TURB S SEP 100CD
	UPPER		1.0455 0.1397 1.9198*
	LOWER		0.6059 0.0000 0.1267
	TOTAL		CL= 1.475 100CD=2.0465
			CM=-0.1313

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.

*-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
-3.21	S TURB S SEP 100CD UPPER 0.4364 0.0000 0.2713 LOWER 1.0016 0.0000 0.3981* TOTAL CL= 0.246 100CD=0.6694 CM=-0.1282	S TURB S SEP 100CD 1.0150 0.0259 0.6044 1.0016 0.0000 0.3981* CL= 0.226 100CD=1.0025 CM=-0.1235	S TURB S SEP 100CD 0.8843 0.0244 0.5749 1.0016 0.0000 0.3984* CL= 0.228 100CD=0.9734 CM=-0.1237
-3.00	S TURB S SEP 100CD UPPER 0.4381 0.0000 0.2740 LOWER 1.0016 0.0000 0.3982* TOTAL CL= 0.269 100CD=0.6722 CM=-0.1288	S TURB S SEP 100CD 1.0149 0.0270 0.6142 1.0016 0.0000 0.3982* CL= 0.248 100CD=1.0124 CM=-0.1239	S TURB S SEP 100CD 0.8883 0.0254 0.5847 1.0016 0.0000 0.3982* CL= 0.250 100CD=0.9829 CM=-0.1241
-2.00	S TURB S SEP 100CD UPPER 0.4465 0.0000 0.2882 LOWER 1.0015 0.0000 0.3588* TOTAL CL= 0.379 100CD=0.6470 CM=-0.1321	S TURB S SEP 100CD 1.0149 0.0323 0.6631 1.0015 0.0000 0.3588* CL= 0.353 100CD=1.0219 CM=-0.1257	S TURB S SEP 100CD 0.9065 0.0307 0.6335 1.0015 0.0000 0.3588* CL= 0.354 100CD=0.9923 CM=-0.1260
-1.00	S TURB S SEP 100CD UPPER 0.4547 0.0029 0.3095 LOWER 0.9794 0.0000 0.3156* TOTAL CL= 0.487 100CD=0.6251 CM=-0.1347	S TURB S SEP 100CD 1.0148 0.0377 0.7164 0.9794 0.0000 0.3156* CL= 0.456 100CD=1.0320 CM=-0.1275	S TURB S SEP 100CD 0.9231 0.0363 0.6864 0.9884 0.0000 0.3175 CL= 0.457 100CD=1.0039 CM=-0.1278
0.00	S TURB S SEP 100CD UPPER 0.4628 0.0086 0.3310 LOWER 0.3145 0.0000 0.1136 TOTAL CL= 0.591 100CD=0.4446 CM=-0.1368	S TURB S SEP 100CD 1.0149 0.0432 0.7735 0.9511 0.0000 0.2836 CL= 0.558 100CD=1.0571 CM=-0.1292	S TURB S SEP 100CD 0.9381 0.0418 0.7431 0.9760 0.0000 0.2895 CL= 0.560 100CD=1.0326 CM=-0.1295
1.00	S TURB S SEP 100CD UPPER 0.4701 0.0124 0.3515 LOWER 0.2932 0.0000 0.1029 TOTAL CL= 0.697 100CD=0.4544 CM=-0.1392	S TURB S SEP 100CD 1.0149 0.0489 0.8352 0.9511 0.0000 0.2640 CL= 0.660 100CD=1.0992 CM=-0.1309	S TURB S SEP 100CD 0.9529 0.0476 0.8053 0.9604 0.0000 0.2656 CL= 0.661 100CD=1.0709 CM=-0.1312
2.00	S TURB S SEP 100CD UPPER 0.4805 0.0168 0.3767 LOWER 0.2821 0.0000 0.0959 TOTAL CL= 0.802 100CD=0.4726 CM=-0.1415	S TURB S SEP 100CD 1.0149 0.0549 0.9017 0.9511 0.0000 0.2457 CL= 0.761 100CD=1.1475 CM=-0.1324	S TURB S SEP 100CD 0.9672 0.0537 0.8735 0.9387 0.0000 0.2441 CL= 0.762 100CD=1.1176 CM=-0.1327
3.00	S TURB S SEP 100CD UPPER 0.4952 0.0219 0.4090 LOWER 0.2724 0.0000 0.0898 TOTAL CL= 0.905 100CD=0.4987 CM=-0.1435	S TURB S SEP 100CD 1.0149 0.0611 0.9731 0.9511 0.0000 0.2287 CL= 0.859 100CD=1.2018 CM=-0.1336	S TURB S SEP 100CD 0.9808 0.0602 0.9483 0.9055 0.0000 0.2239 CL= 0.861 100CD=1.1722 CM=-0.1338
4.00	S TURB S SEP 100CD UPPER 0.5251 0.0291 0.4636 LOWER 0.2631 0.0000 0.0841 TOTAL CL= 1.005 100CD=0.5476 CM=-0.1449	S TURB S SEP 100CD 1.0149 0.0676 1.0502 0.9511 0.0000 0.2128 CL= 0.957 100CD=1.2630 CM=-0.1346	S TURB S SEP 100CD 0.9937 0.0669 1.0309 0.8718 0.0000 0.2058 CL= 0.958 100CD=1.2368 CM=-0.1348
5.00	S TURB S SEP 100CD UPPER 0.6792 0.0513 0.6955 LOWER 0.2538 0.0000 0.0787 TOTAL CL= 1.086 100CD=0.7742 CM=-0.1423	S TURB S SEP 100CD 1.0149 0.0744 1.1331 0.9511 0.0000 0.1979 CL= 1.053 100CD=1.3310 CM=-0.1355	S TURB S SEP 100CD 1.0063 0.0741 1.1232 0.8395 0.0000 0.1896 CL= 1.053 100CD=1.3129 CM=-0.1356
6.00	S TURB S SEP 100CD UPPER 0.8003 0.0675 0.9044 LOWER 0.2447 0.0000 0.0736 TOTAL CL= 1.169 100CD=0.9780 CM=-0.1405	S TURB S SEP 100CD 1.0149 0.0819 1.2220 0.9511 0.0000 0.1841 CL= 1.147 100CD=1.4061 CM=-0.1362	S TURB S SEP 100CD 1.0179 0.0821 1.2264 0.8077 0.0000 0.1749 CL= 1.147 100CD=1.4013 CM=-0.1361

B.L.SUMMARY AIRFOIL S832 15% ALPHA0= 5.447 DEG.
 *-WARNING 1998 ALPHA REL. CHORD LINE

ALPHA(DEG.)	R= 6000000 MU= 300	R= 6000000 MU= 100	R= 6000000 MU= 900
7.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.8804 0.0801 1.0821	1.0149 0.0903 1.3177	1.0285 0.0912 1.3432
	LOWER 0.2355 0.0000 0.0688	0.9511 0.0000 0.1712	0.7758 0.0000 0.1612
	TOTAL CL= 1.256 100CD=1.1509	CL= 1.240 100CD=1.4888	CL= 1.238 100CD=1.5044
	CM=-0.1396	CM=-0.1366	CM=-0.1363
8.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9323 0.0920 1.2438	1.0149 0.0994 1.4204	1.0371 0.1015 1.4752
	LOWER 0.2264 0.0000 0.0643	0.9511 0.0000 0.1591	0.7434 0.0000 0.1487
	TOTAL CL= 1.342 100CD=1.3080	CL= 1.330 100CD=1.5795	CL= 1.326 100CD=1.6239
	CM=-0.1389	CM=-0.1367	CM=-0.1361
9.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 0.9910 0.1067 1.4660*	1.0149 0.1093 1.5306	1.0426 0.1127 1.6213
	LOWER 0.2172 0.0000 0.0599	0.9511 0.0000 0.1479	0.7108 0.0000 0.1371
	TOTAL CL= 1.422 100CD=1.5259	CL= 1.418 100CD=1.6786	CL= 1.412 100CD=1.7584
	CM=-0.1374	CM=-0.1366	CM=-0.1357
10.00	S TURB S SEP 100CD	S TURB S SEP 100CD	S TURB S SEP 100CD
	UPPER 1.0452 0.1266 1.8067*	1.0452 0.1266 1.8067*	1.0457 0.1257 1.7851*
	LOWER 0.2078 0.0000 0.0558	0.9511 0.0000 0.1375	0.6777 0.0000 0.1263
	TOTAL CL= 1.492 100CD=1.8625	CL= 1.492 100CD=1.9441	CL= 1.493 100CD=1.9114
	CM=-0.1345	CM=-0.1345	CM=-0.1348
10.57	S TURB S SEP 100CD	S TURB S SEP 100CD	
	UPPER 1.0501 0.1351 1.9192*	1.0501 0.1351 1.9192*	
	LOWER 0.2023 0.0000 0.0535	0.9511 0.0000 0.1318	
	TOTAL CL= 1.536 100CD=1.9727	CL= 1.536 100CD=2.0510	
	CM=-0.1337	CM=-0.1337	
10.61			S TURB S SEP 100CD
	UPPER		1.0501 0.1354 1.9190*
	LOWER		0.6575 0.0000 0.1201
	TOTAL		CL= 1.539 100CD=2.0391
			CM=-0.1338

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE (DD-MM-YYYY) August 2005			2. REPORT TYPE Subcontract report		3. DATES COVERED (From - To) November 2001 - November 2002	
4. TITLE AND SUBTITLE The S830, S831, and S832 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-500-36339		
				5e. TASK NUMBER WER4.3110		
				5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Airfoils, Inc. 601 Cricklewood Dr. State College, PA 16083					8. PERFORMING ORGANIZATION REPORT NUMBER AAM-1-31212-01	
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-500-36339	
12. DISTRIBUTION AVAILABILITY STATEMENT National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, VA 22161						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT (Maximum 200 Words) A family of quiet, thick, natural-laminar-flow airfoils, the S830, S831, and S832, for 40 - 50-meter-diameter, variable-speed/variable-pitch, horizontal-axis wind turbines has been designed and analyzed theoretically. The two primary objectives of high maximum lift, relatively insensitive to roughness, and low profile drag have been achieved. The airfoils should exhibit docile stalls, which meet the design goal. The constraints on the pitching moment and the airfoils thicknesses have been satisfied.						
15. SUBJECT TERMS airfoils; horizontal-axis 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)
Prescribed by ANSI Std. Z39.18