NASA Contractor Report 3637

Study of Supersonic Wings Employing the Attainable Leading-Edge Thrust Concept

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Study of Supersonic Wings Employing the Attainable Leading-Edge Thrust Concept

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2.0 INTRODUCTION

Attempts to design highly swept supersonic wings having low drag-due-to-lift have usually resulted in an optimized wing shape with moderate twist and camber having a design lift coefficient (C_L) lower than the desired operating C_L. This approach has been adopted because of failures to produce efficient wing designs at higher design C_L and because of difficulties in integrating more severe wing camber shapes into practical configuration layouts.

The wing design process precludes attaining significant leading-edge thrust at the design point through the loadings used. Nevertheless, some development of leading-edge thrust is possible at the supersonic operating C_L through the incremental wing angle of attack required by the difference between the design C_L and the operating C_L. The leading-edge thrust is usually small, however, due to relatively high normal Mach numbers and rather sharp leading-edge radii.

Recent developments in supersonic wing research have led to a review of leading-edge thrust in supersonic wing design and a consideration of wings designed to exploit "attainable" leading-edge thrust. One of these developments (ref. 1) involved tests of a supersonic wing configuration that produced high leading-edge thrust values. This was accompanied by concurrent development of two improvements in wing theory methodology: one, a reliable method of calculating theoretical leading-edge thrust on supersonic wings of arbitrary planform (ref. 2); the other, a method for estimating the experimentally attainable portion of the theoretical thrust as a function of wing geometry and flight condition (ref. 3).

The result of these developments, suggested in Reference 7, has been to encourage the definition of supersonic wing geometries having significant leading-edge thrust at cruise. The benefit of such designs would be to achieve high aerodynamic efficiency at the supersonic cruise condition with a wing of moderate camber surface shape and to achieve improved efficiency at off-design operating points through attainment of increased overall leading-edge thrust.

The attainable leading-edge thrust concept study reported here involved a series of wing planforms having desirable leading-edge thrust characteristics as analyzed by attainable thrust methodology. Wind tunnel models having both flat and twisted and cambered meanlines were then defined to permit an experimental check on the theoretical methods and the technical approach used.

3.0 SYMBOLS

b	wing span
c	local wing chord
$\bar{c}$	mean aerodynamic chord
c_{avg}	average wing chord, S/b
c_t	theoretical section thrust coefficient, dt/dy qc
c_t*	attainable section thrust coefficient, dt*/dy qc
C_A	axial or chord force coefficient
C_A	increment of axial force coefficient due to leading-edge thrust
C_D	drag coefficient
C_{DF}	friction drag coefficient
C_{DL}	drag-due-to-lift
C_{DW}	wave drag coefficient
C_L	lift coefficient
C_N	normal force coefficient
ΔC_N	increment of normal force coefficient due to rotation of leading-edge suction vector
C_p	pressure coefficient
$C_{p,lim}$	limiting pressure coefficient used in definition of attainable thrust
C_T	theoretical wing thrust coefficient
C_T*	attainable wing thrust coefficient
K_T	fraction of theoretical thrust actually attainable, c_t*/c_t
M	freestream Mach number
M_e	equivalent Mach number used in definition of K_T
q	dynamic pressure
r, LER	leading-edge radius
R	freestream Reynolds number, based on $\bar{c}$ unless otherwise noted
S	wing area
T_o	total temperature
t	theoretical section leading-edge thrust
t*	attainable section leading-edge thrust

x,y,z	Cartesian coordinate system
α	angle of attack, degrees
β	$\sqrt{M^2 - 1}$
δ	angle between tangent to local camber surface and wing-chord plane
η	location of maximum wing section thickness as fraction of chord
γ	ratio of specific heats
Λ_{LE}	leading-edge sweep angle, degrees
Λ_{TE}	trailing-edge sweep angle, degrees
τ	maximum wing section thickness

Subscripts:

i	= 1, 2, 3, 4, . . .
n	quantities pertaining to wing section normal to leading edge with maximum thickness at midchord (see fig. 5)

4.0 DISCUSSION

The existence of leading-edge thrust on highly swept wings in supersonic flow (i.e., on wings with a subsonic leading-edge condition) has long been recognized. Qualitative relationships have been developed to estimate the approximate fraction of theoretical leading-edge thrust that would be obtained under real flow conditions. One such relationship, shown in Figure 1, illustrates the powerful influence of sweepback on the

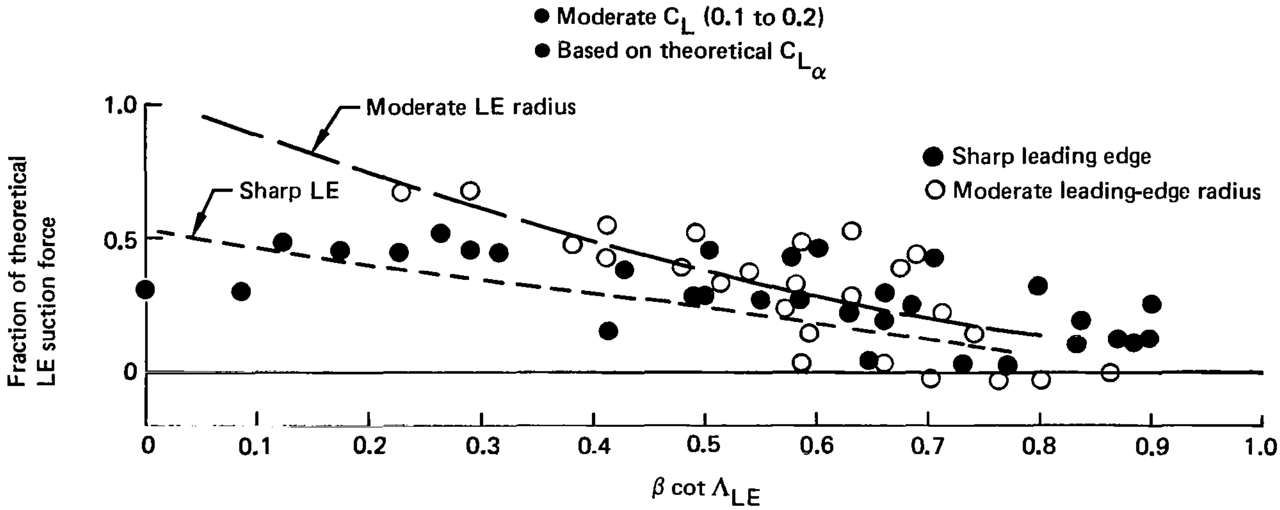


Figure 1. Leading-Edge Suction—Slender, Uncambered Wings

fraction of theoretical leading-edge thrust obtained. However, because the typical supersonic wing at its design point has a relatively high sweepback-Mach line parameter ($\beta \cot \Lambda_{LE}$), the actual thrust coefficient achieved tends to be small—the product of a relatively low theoretical thrust coefficient and a small fraction obtained. Hence, the effects of leading-edge thrust at supersonic speeds have often been ignored in supersonic design and analysis.

The concept of designing a class of supersonic wings to maximize the benefits of attainable leading-edge thrust was suggested in Reference 7, based upon the computer methods of References 3 through 6. A brief description of the attainable thrust concept follows.

4.1 ATTAINABLE THRUST

The attainable thrust definition (ref. 3) makes use of a factor, K_T, which identifies the fraction of the theoretical wing leading-edge suction force that is actually obtained as an airfoil nose force acting in a thrust sense. The remainder of the suction force is realized as a vortex lift acting normal to the planform. In the case of fully attached flow ($K_T = 1.0$), the entire theoretical suction force acts as a thrust on the airfoil nose. In the case of separated leading-edge flow (e.g., that obtained with a sharp leading edge, where $K_T = 0$), an incremental lift equal to the leading-edge suction force acts normal to the planform. The method is thus consistent with the Polhamus leading-edge suction analogy for fully detached vortex flow. In addition, the factor K_T provides a transitional relationship between leading-edge thrust and vortex lift for intermediate conditions between attached flow and fully detached vortex flow. K_T is principally sensitive to airfoil geometry, normal Mach number, and angle of attack and usually varies substantially along the span of the wing. The attainable thrust method is thus a much more sophisticated form of the qualitative relationship shown in Figure 1, in which additional basic data describing the wing and flow situation are included.

Leading-edge thrust component definitions are illustrated in Figures 2 through 4 for wings of flat and cambered meanlines. The attached flow nose force component acting on a

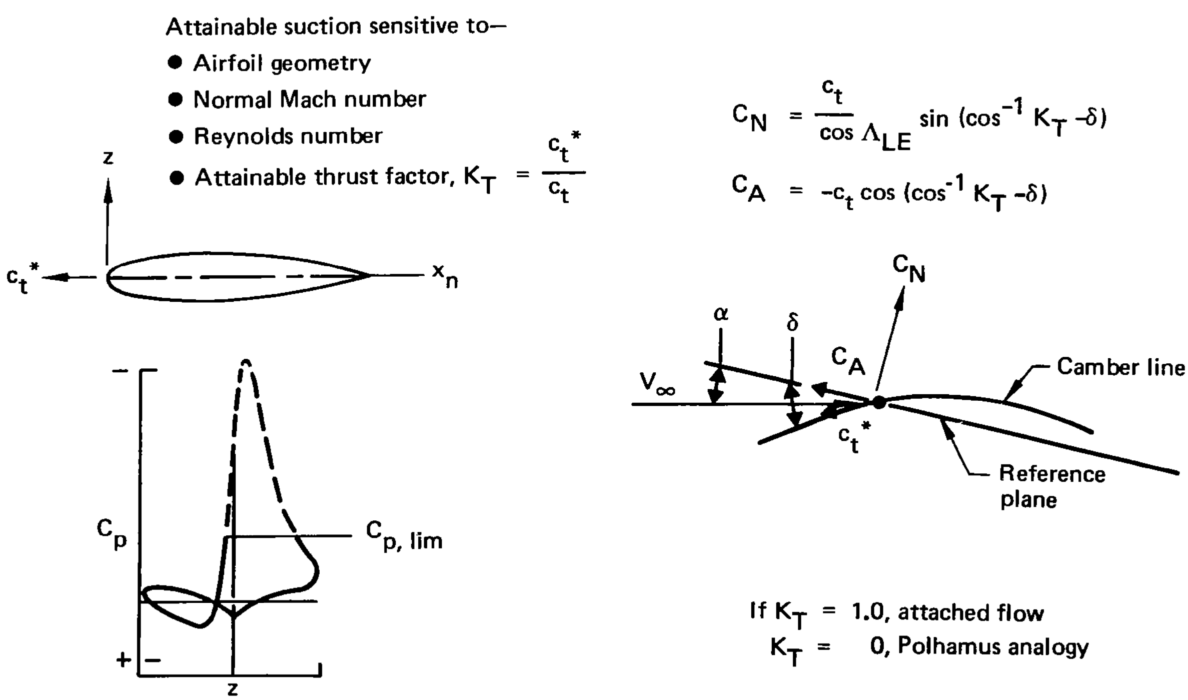


Figure 2. Attainable Leading-Edge Suction (Carlson)

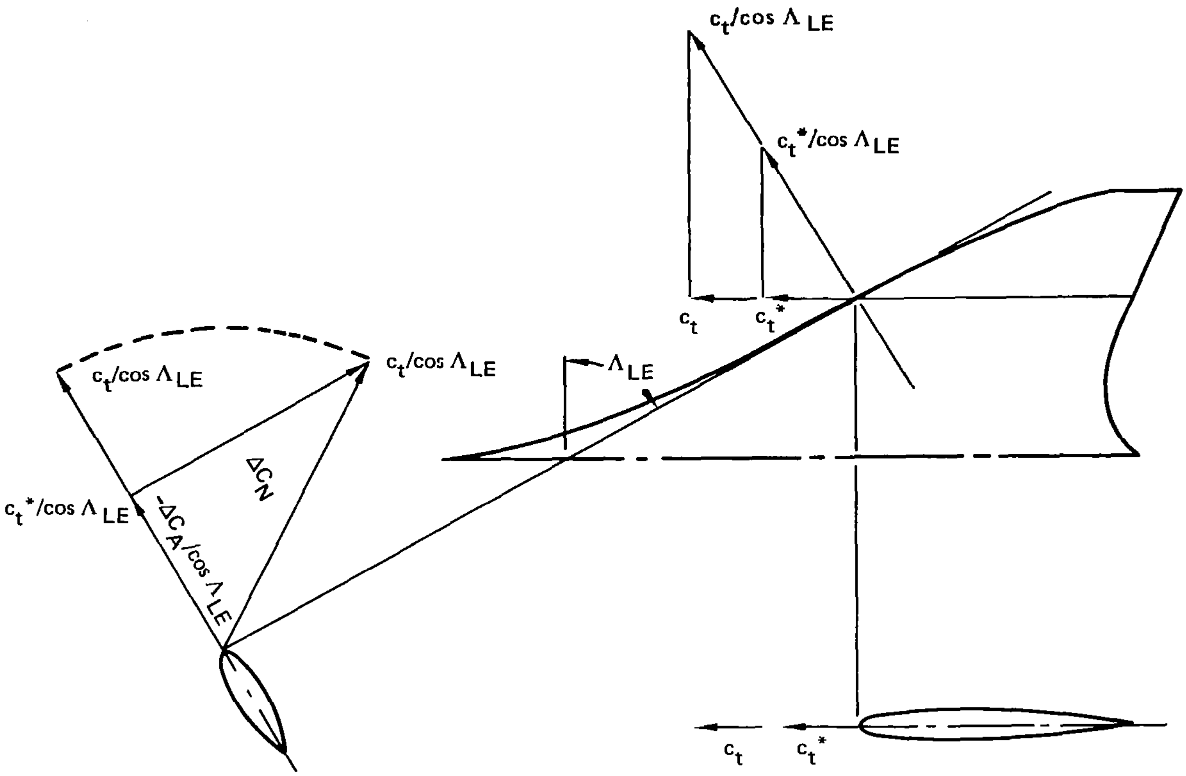


Figure 3. Incremental Section Normal Force Associated With Thrust Loss for Flat Wing

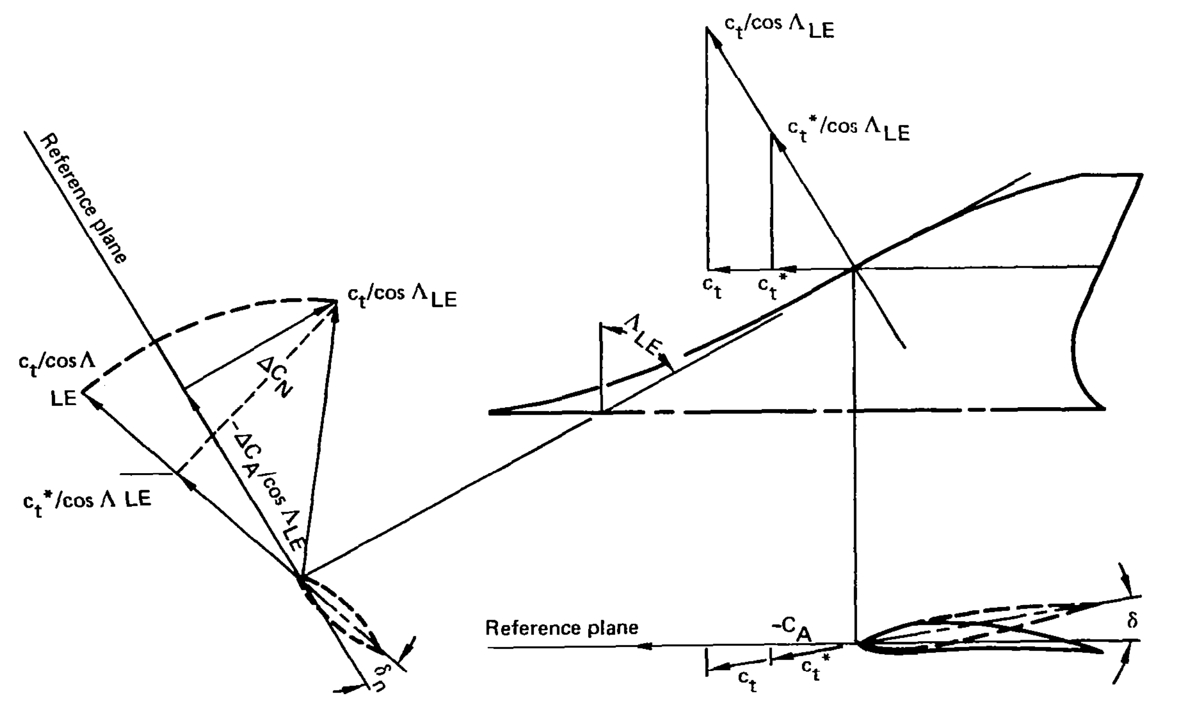


Figure 4. Incremental Section Normal Force Associated With Thrust Loss for Cambered Wing

typical airfoil section is $K_T\, c_t = c_t^*$, with line of action along the nose slope. As defined in Reference 3, the attached flow component is produced by the theoretical leading-edge suction force inclined to produce c_t^* as shown. An associated lifting force is also generated if fully attached flow is not obtained. If the wing leading-edge is sharp (where $K_T = 0$), $c_t^* \doteq 0$ and the theoretical suction force becomes vortex lift according to the Polhamus analogy.

K_T is calculated from airfoil geometry, normal Mach number, and Reynolds number according to the relationship:

$$K_T = \frac{2\,(1 - M_e^2)}{M_e} \left[\frac{\frac{\tau_n}{c_n}\left(\frac{r_n}{c_n}\right)^{0.4}}{c_{t,n}\sqrt{1 - M_n^2}} \right]^{0.6} \quad \text{but not greater than 1.0} \tag{1}$$

where
$$M_e = \frac{-\sqrt{2}}{\gamma C_{p,lim}\sqrt{1 - M_n^2}} \sqrt{\sqrt{1 + \left(\gamma C_{p,lim}\sqrt{1 - M_n^2}\right)^2} - 1}$$

$$C_{p,lim} = \frac{-2}{\gamma M_n^2} \left[\frac{R_n \times 10^{-6}}{R_n \times 10^{-6} + 10^{(4-3M_n)}} \right]^{0.05+0.35(1-M_n)^2}$$

$$R_n = R\frac{c_n}{\bar{c}}\cos\Lambda_{LE}$$

$$M_n = M\cos\Lambda_{LE}$$

$$c_{t,n} = c_t\,\frac{c}{c_n}\,\frac{1}{\cos^2\Lambda_{LE}}$$

The defining airfoil parameters are those for a section taken normal to the local leading edge, as defined in the symbols and in Figure 5. In the case of a twisted and cambered wing, the vector orientation for the vortex lift component becomes approximate due to the spreading out of the vortex system. In this discussion it will be considered that the camber surface involves only small angles relative to the reference plane to minimize the uncertainty of vortex component orientation.

For a wing of generally defined thickness form and angle of attack, operating at a given Mach number and Reynolds number, the principal variables controlling K_T are local sweepback angle (which defines normal Mach number, M_n) and leading-edge radius.

$$M_n = M \cos \Lambda_{LE}$$

$$c_n = \frac{2\eta c}{\sin \Lambda_{LE}\left[(1-\eta)\tan \Lambda_{LE} + \eta \tan \Lambda_{TE}\right] + \cos \Lambda_{LE}}$$

$$\frac{\tau_n}{c_n} = \frac{\tau}{c}\,\frac{1}{2\eta \cos \Lambda_{LE}}$$

$$\frac{r_n}{c_n} = \frac{r}{c}\,\frac{1}{2\eta \cos^2 \Lambda_{LE}}$$

$$\frac{c_{t,n}}{c_t} = \frac{c}{c_n}\,\frac{1}{\cos^2 \Lambda_{LE}}$$

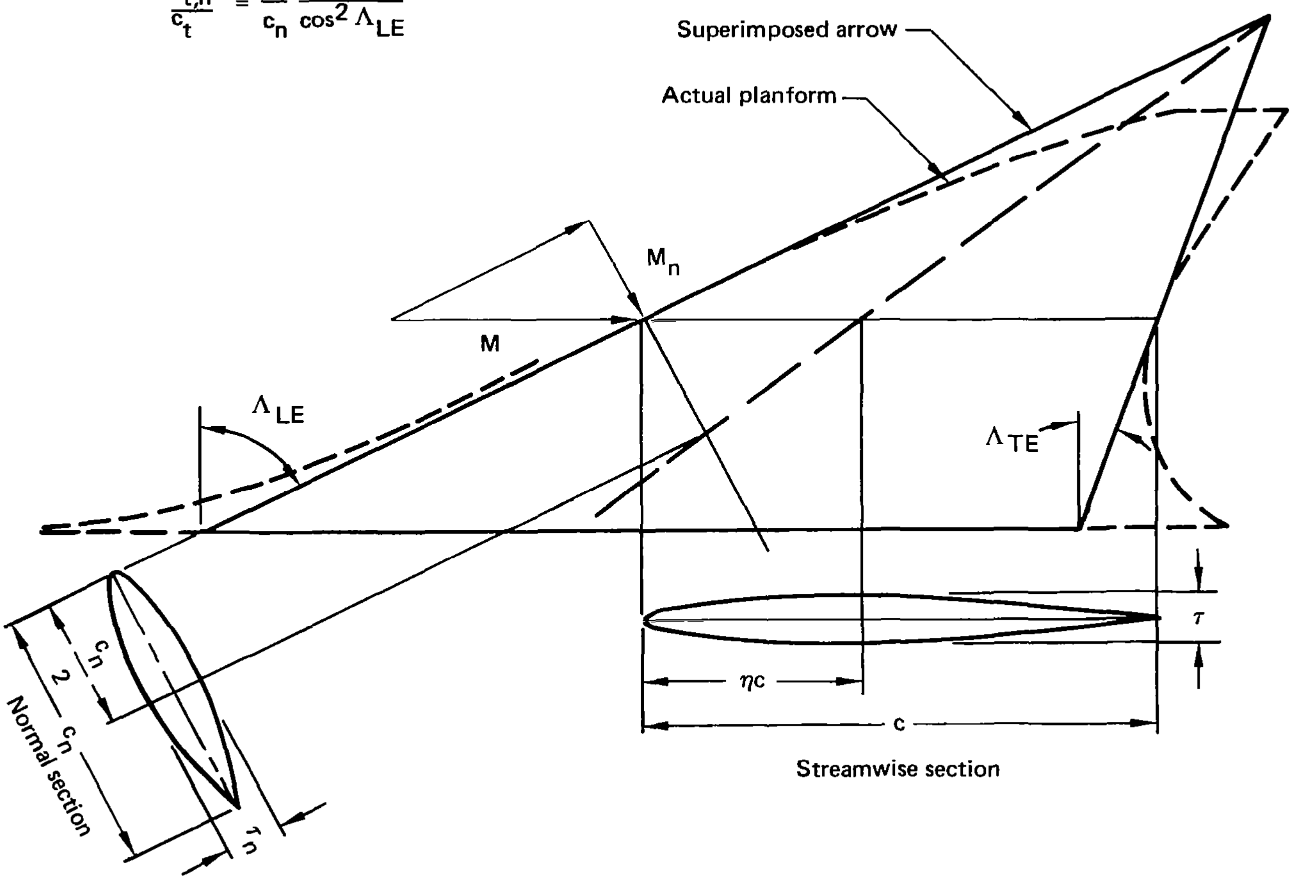


Figure 5. Relationship Between Streamwise and Normal Wing Sections

4.2 WING STUDY

Presentation of the wing study results is divided into three parts:

- Analysis of experimental data for the Reference 1 wing.
- Wing planform analyses, leading to selection of flat meanline wing.
- Development of cambered wing of the selected planform.

The analyses are based on the linear theory methods of References 4 to 6.

4.2.1 Experimental Data Comparison

Analyses of the Reference 1 wing, using the attainable thrust method, are presented in Figures 6 through 8. The wing is twisted and cambered, having a design C_L of 0.07, based on the reference trapezoidal area (0.06 based on gross area). The airfoil thickness form was NACA 65A004, having a leading-edge radius to chord ratio (LER/c) of approximately 0.001. The wing planform and sweepback parameter, $\beta \cot \Lambda_{LE}$ (at M = 1.8), are shown in Figure 6.

The spanwise leading-edge thrust distribution for the wing at $\alpha = 0$ deg is nominally zero, corresponding to the design point loading. The variation in leading-edge thrust distribution for $\alpha = 0$, 2, 4, and 6 deg relative to the design point and the associated K_T variations are shown in Figure 7.

A key feature of interest in this and subsequent wing analyses is the character of the K_T variation versus span at various angles of attack. A principal characteristic of this variation for the Reference 1 wing is the sharp breakaway of K_T from a value of 1.0 at all angles of attack shown. Flow separation and formation of a leading-edge vortex are indicated if $K_T < 1.0$. Oil flow data in Reference 1 show vortex flow origination in good agreement with the $K_T < 1.0$ point shown in Figure 1. The method also predicts the wingtip leading-edge separation associated with the tailored planform tip shape, as was intended (ref. 7).

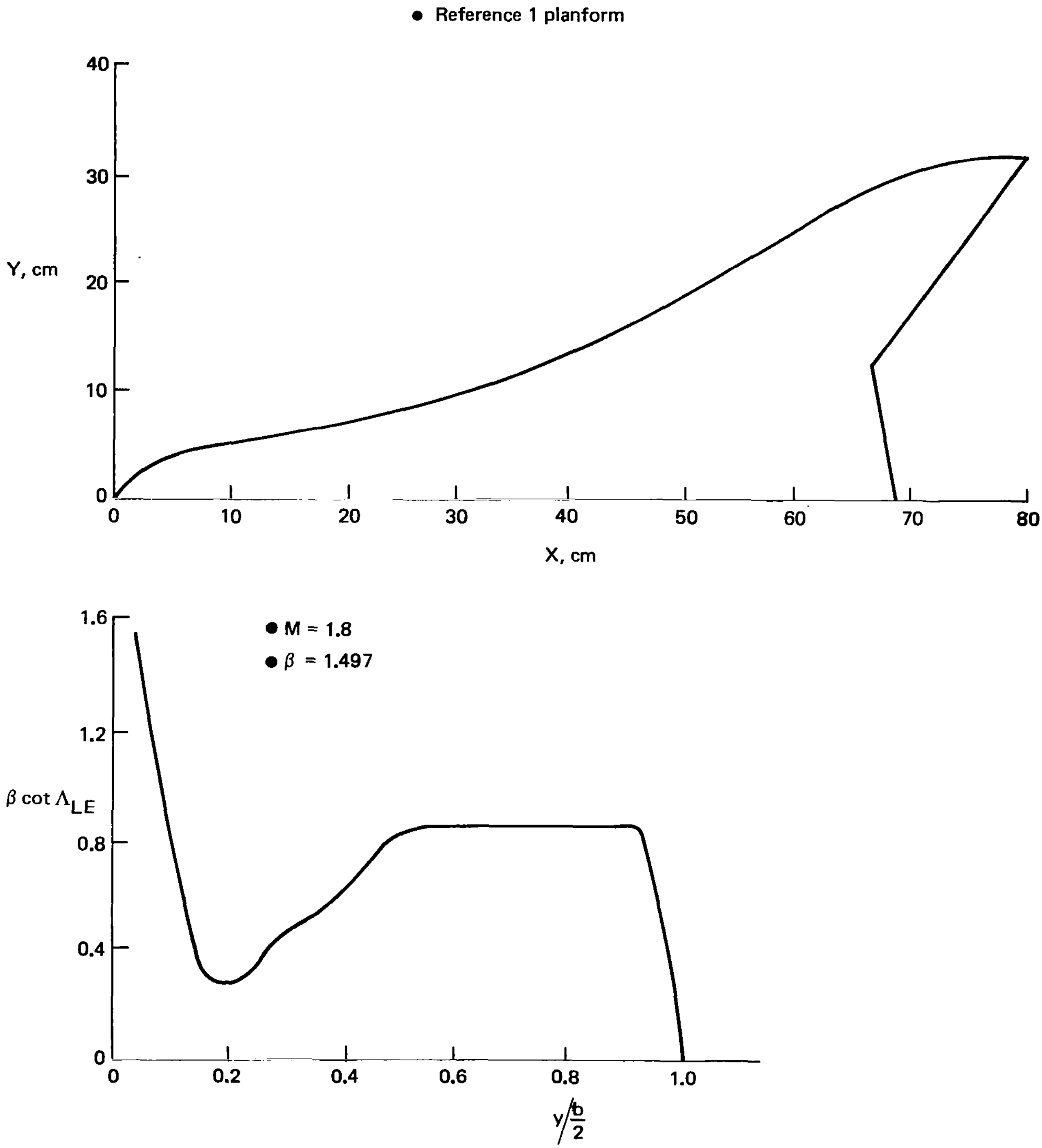
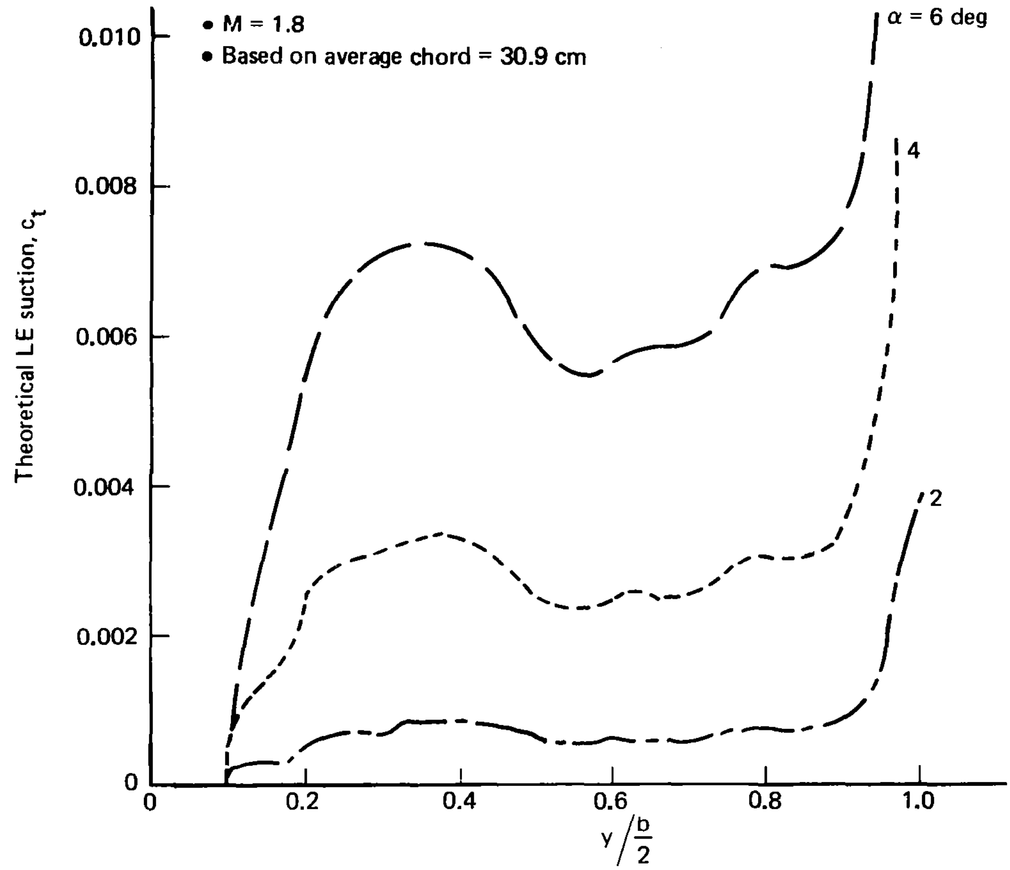


Figure 6. Planform and Sweepback Parameter, Wing 1



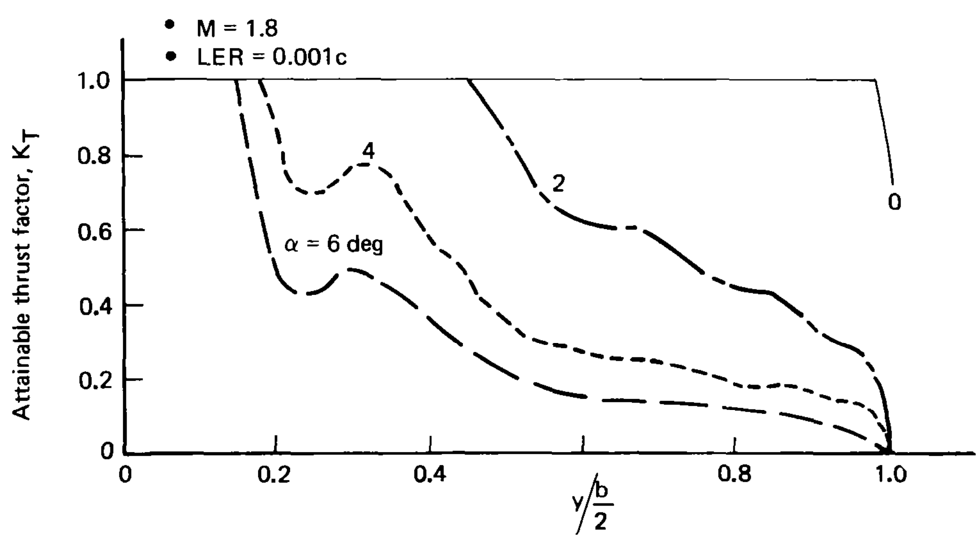


Figure 7. Theoretical Leading-Edge Suction Characteristics, Wing 1—Cambered

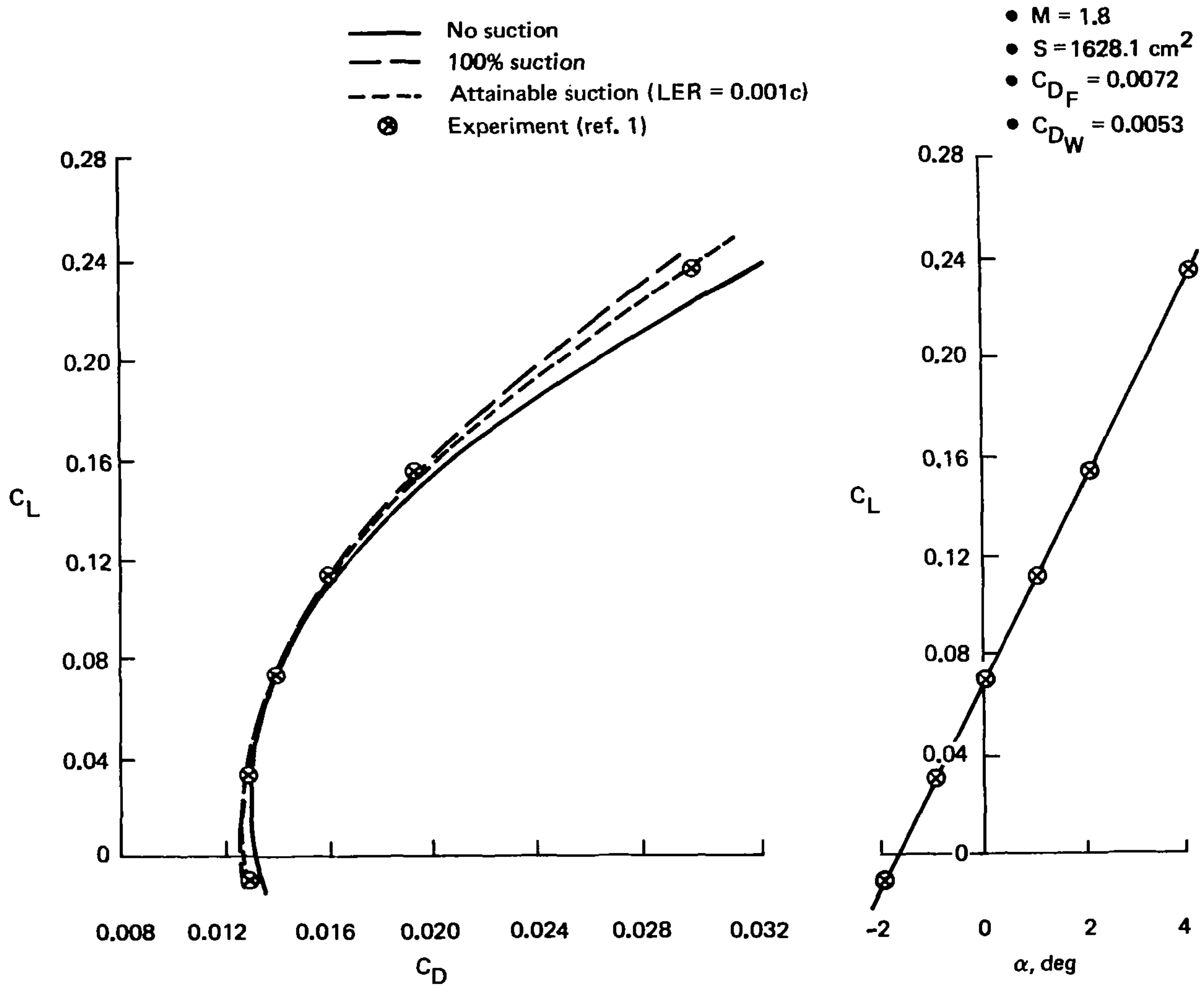


Figure 8. Test/Theory Comparison, Wing 1

Experimental and theoretical coefficients for the Reference 1 wing are compared in Figure 8; the theoretical data include drag-due-to-lift values corresponding to no leading-edge suction, full leading-edge suction, and attainable leading-edge suction based on the K_T values of Figure 7. The attainable suction solution compares quite well with the experimental data.

The philosophy of the wings designed for increased attainable suction stresses increased leading-edge bluntness in regions of high theoretical suction. The theoretical effect of increasing leading-edge radius on the airfoils of the Reference 1 wing is illustrated in Figure 9, showing K_T versus span for LER = 0.002c and 0.004c.

In terms of the initial point at which $K_T < 1.0$, there is an approximately 0.07 semispan outboard shift between LER = 0.001c and 0.004c at $\alpha = 2$ deg and a smaller shift at $\alpha = 4$ and 6 deg. There is also a double point for $K_T < 1.0$ at $\alpha = 4$ deg with LER = 0.004c, although the meaningful point is the inboard point.

Insight into the prediction of leading-edge separation for the Reference 1 wing is provided by Figure 10, showing the allowable values of c_t for $K_T = 1.0$ superimposed on the theoretical suction coefficients of Figure 7.

The allowable c_t values are obtained from equation 1, with $K_T = 1.0$:

$$K_T \, c_t^{\,0.6} = \frac{2(1-M_e^2)}{M_e} \left[\frac{\frac{r_n}{c_n}\left(\frac{r_n}{c_n}\right)^{0.4}}{\frac{c_{t,n}}{c_t}\sqrt{1-M_n^2}} \right]^{0.6} \tag{2}$$

For consistency the c_t values are based on average chord.

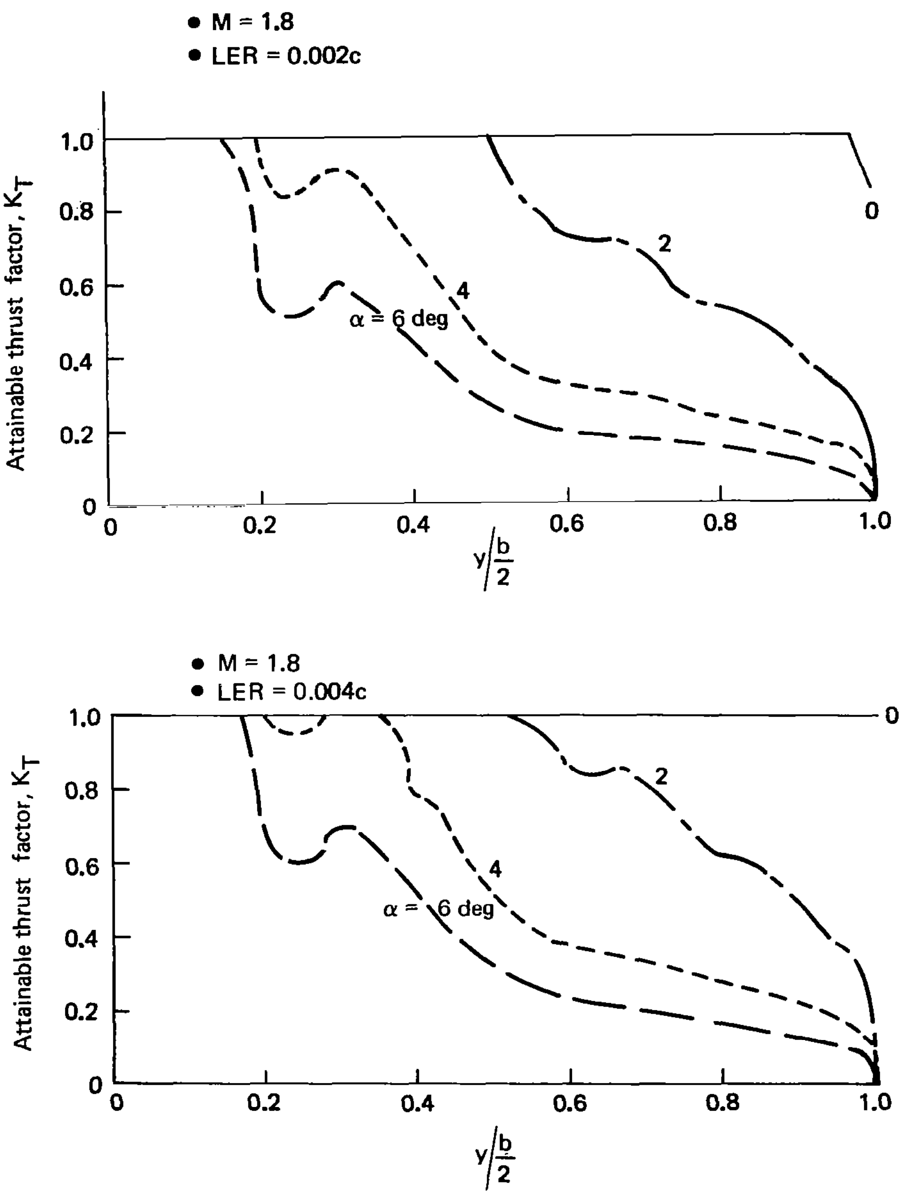


Figure 9. Theoretical Effect of Increasing Leading-Edge Radius, Wing 1—Cambered

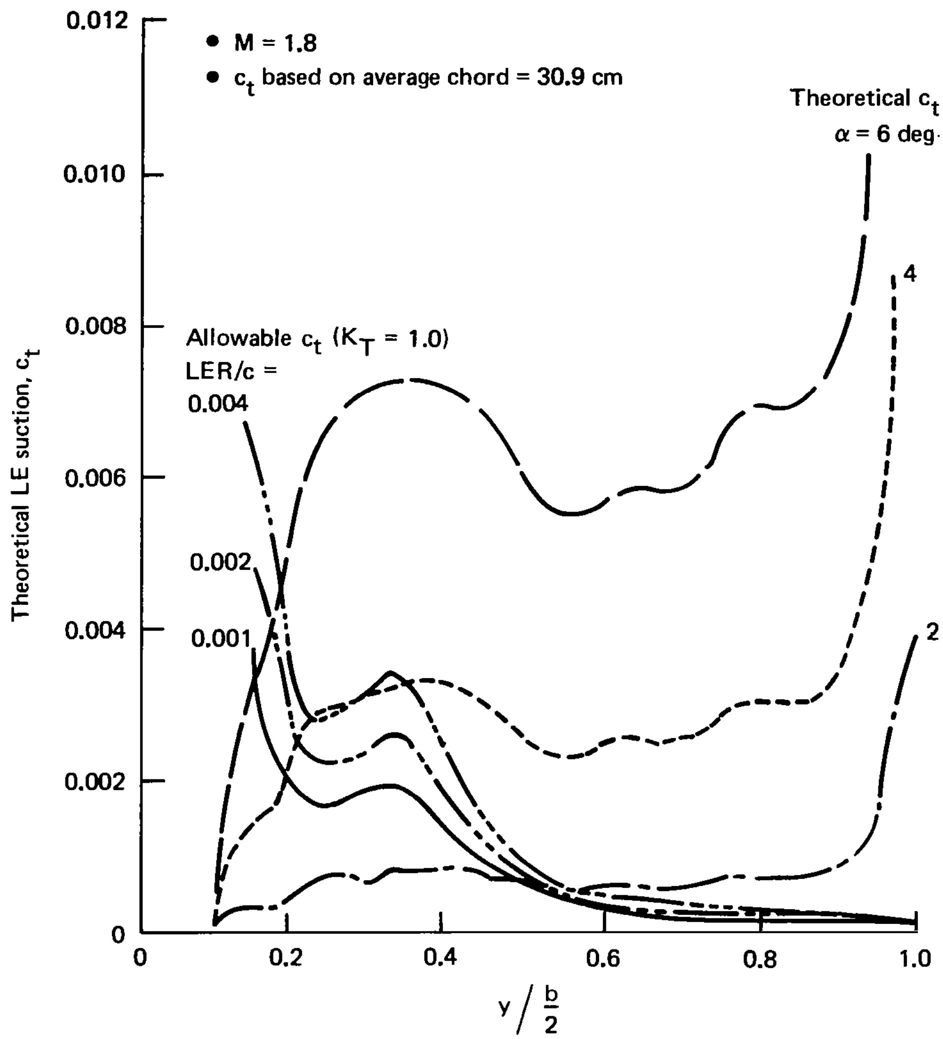


Figure 10. Separation Prediction Characteristics, Wing 1—Cambered

In Figure 10, the theoretical leading-edge suction coefficients for different angles of attack intercept the allowable c_t curves at the K_T = 1.0 breakaway points. The double point of $K_T < 1.0$ at α = 4 deg and LER = 0.004c is caused by the nearly parallel behavior of the two curves near the intercept points.

The separation prediction chart (fig. 10) is particularly illuminating because the allowable c_t curves define the upper limit of c_t achievable with attached flow for a given leading-edge radius. The total wing thrust coefficient, with attached flow, corresponds to the area bounded by the theoretical suction line on the left and the allowable c_t line above. The benefit in attached flow c_t derived from an increase in leading-edge radius may be seen from the different curves for allowable c_t.

The data of Figure 10, however, provide no guide to the underlying planform variables that produce the c_t characteristic curves and intercepts shown. In order to examine the characteristics of allowable and theoretical c_t functions for different leading-edge geometries, the planform study presented in the following section was conducted.

4.2.2 Wing Planform Analyses

An instructive application of the attainable thrust concept involves determination of the spanwise separation point for supersonic wings as a function of leading-edge geometry. To a large extent, the separation characteristics ($K_T < 1.0$) can be studied using flat meanline planforms and concentrating on angle-of-attack sensitivity.

A series of wing planforms was defined from variations in leading-edge sweepback parameter ($\beta \cot \Lambda_{LE}$) at M = 1.8. The general principles for the planforms were—

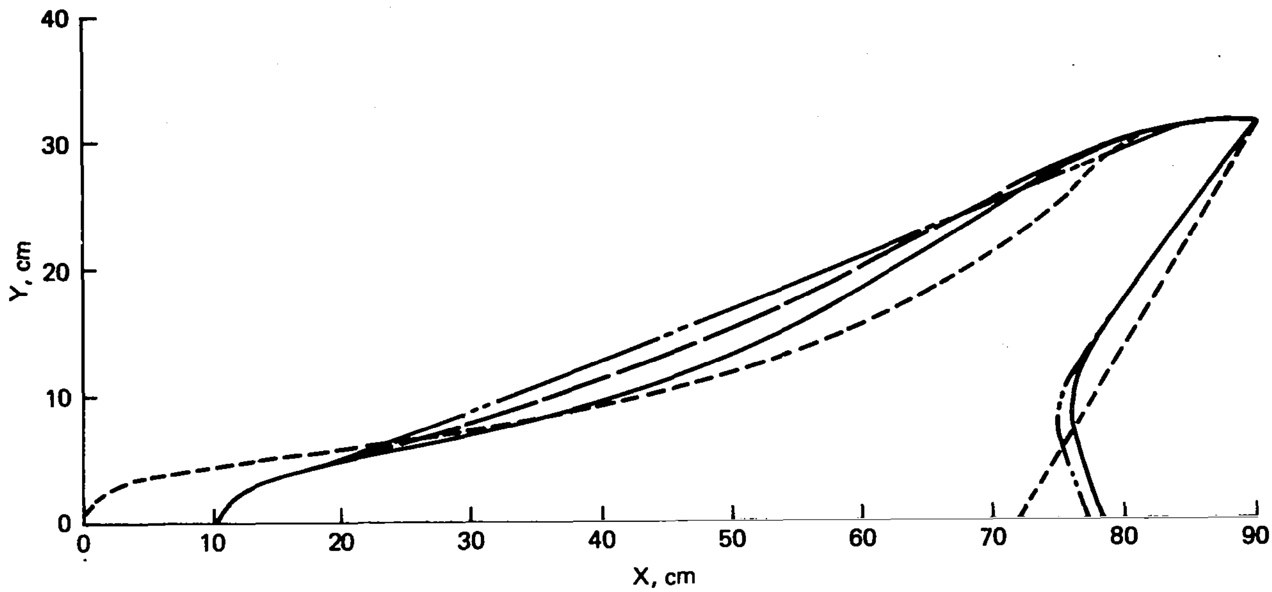
- Span = constant.
- Wing chord distribution ≈ constant.
- Basic airfoil characteristics = constant, except for modifications to nose shape and leading-edge radius.
- Leading-edge sweepback versus span distributions chosen to provide a wide variation in theoretical leading-edge thrust characteristics.

Representative planforms for the series are shown in Figure 11. The Reference 1 wing, identified as wing 1, is shown with the solid line. Other planforms include—

- Wing 2, which is the planform designated C in Reference 7, having a supersonic leading-edge condition ($\beta \cot \Lambda_{LE} > 1.0$) on the outboard wing.

- Two alternative leading-edge sweepback variations, having the same apex and wingtip geometry as wing 1, designated wings 3 and 4.

The associated sweepback parameter ($\beta \cot \Lambda_{LE}$) plots are shown in the lower part of Figure 11. The planforms have common inboard leading-edge and wingtip coordinates (with the exception of wing 2, which has an extended tip). The trailing-edge geometries are similar and not critical in the analyses. Leading-edge suction, K_T factors, and separation prediction characteristics for 4% $(t/c)_{max}$ wing thickness (assuming



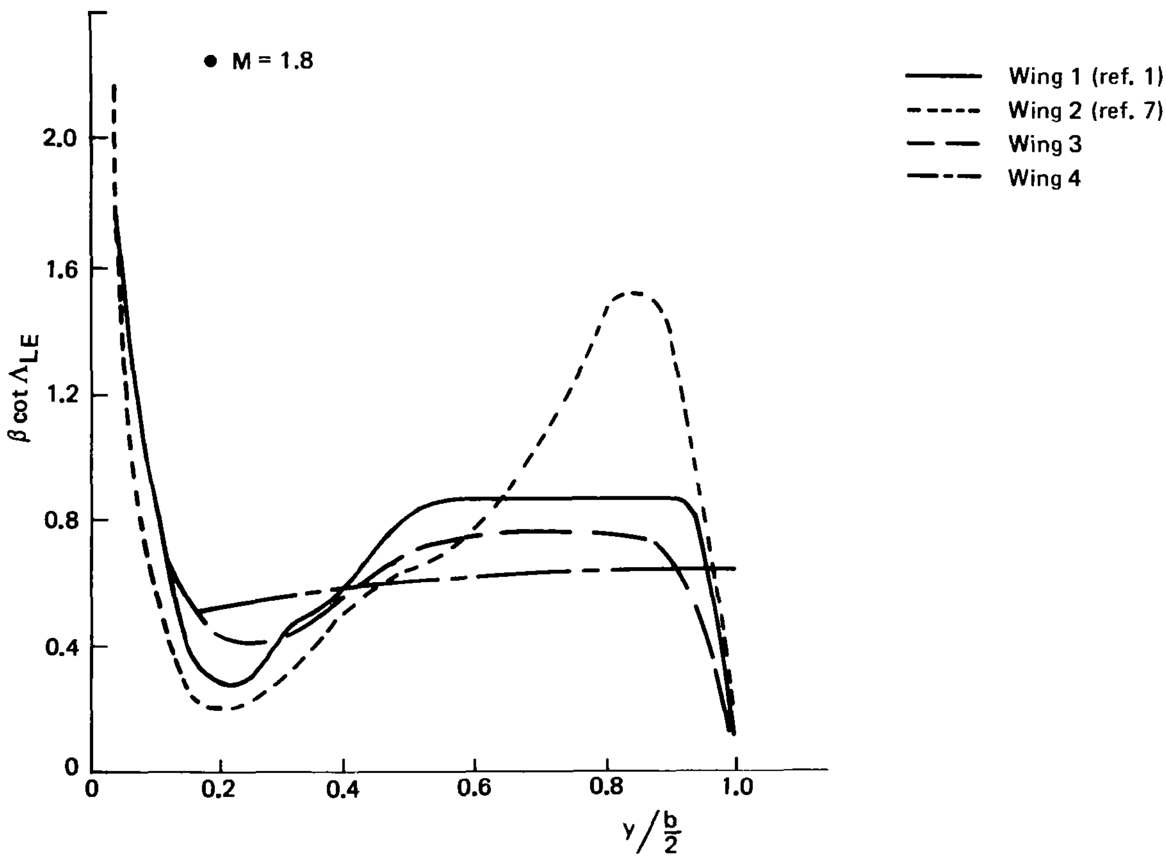


Figure 11. Alternative Planforms (M = 1.8)

LER = 0.001c, 0.002c, and 0.004c) are presented in Figures 12 through 23. The maximum leading-edge radius studied, 0.004c, was selected as the largest that could reasonably be incorporated into the NACA 65A004 nose shape without major alterations to the airfoil.

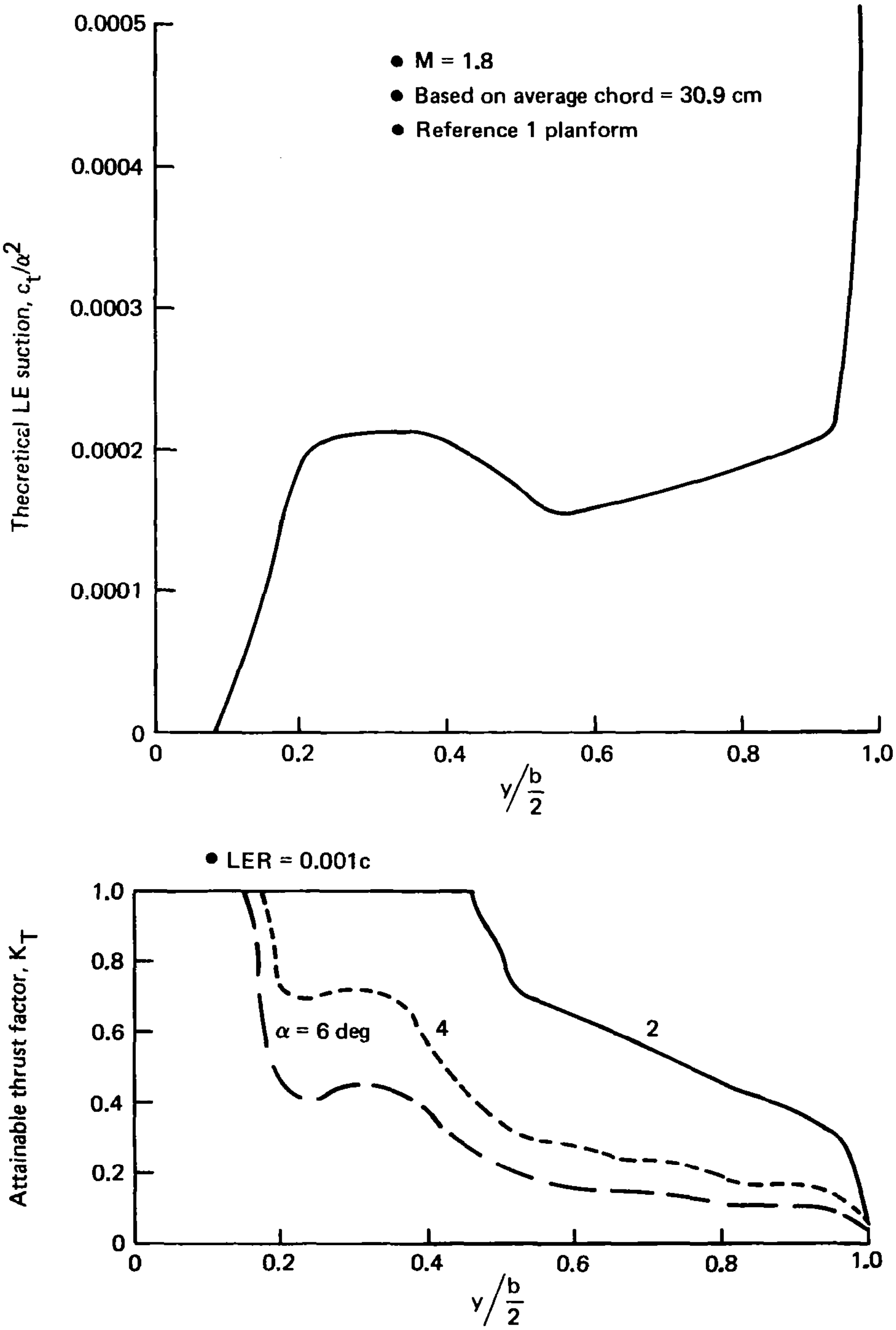


Figure 12. Leading-Edge Suction Characteristics, Wing 1—Flat Meanline Wing

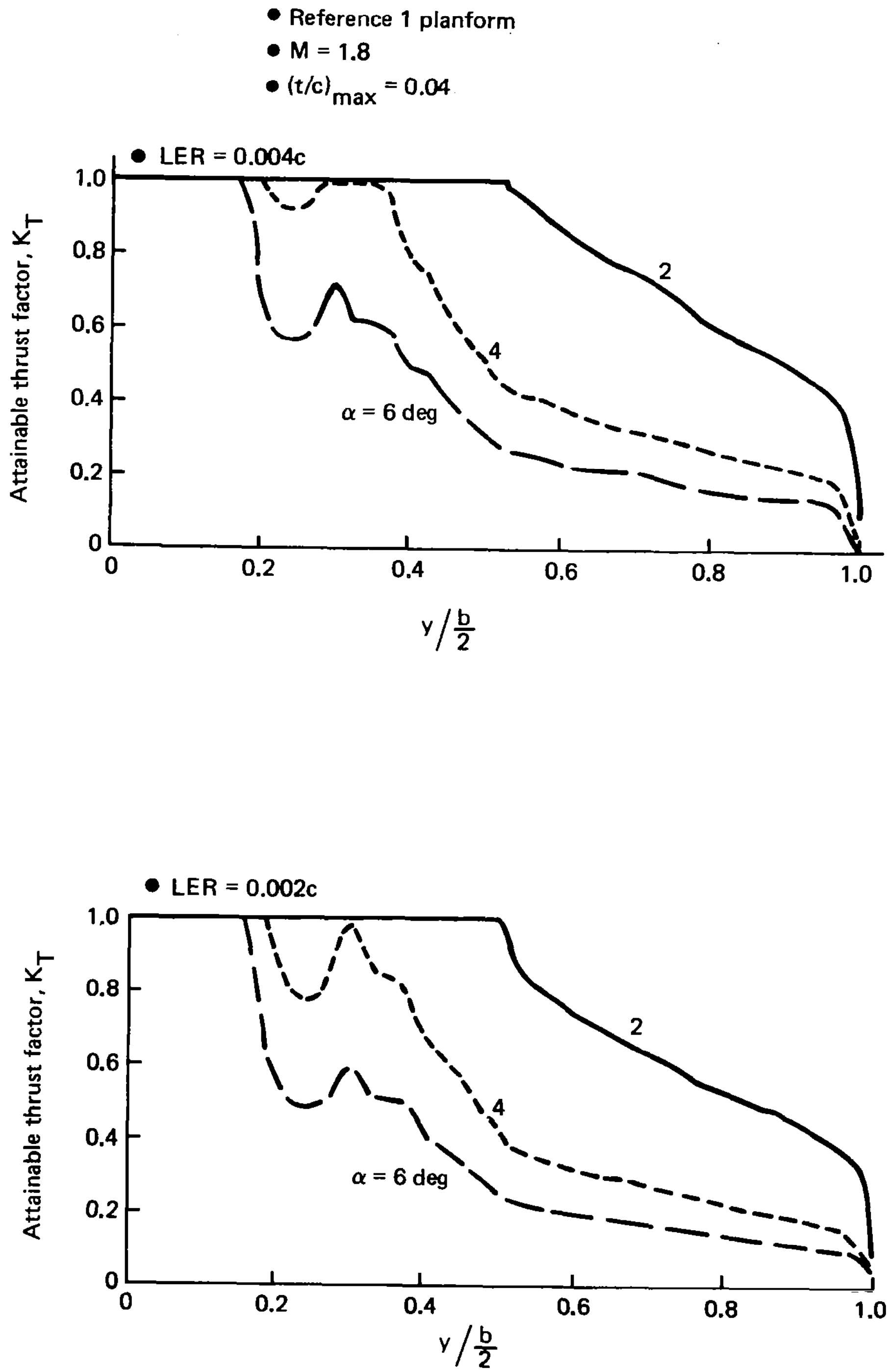


Figure 13. Effect of Increased Leading-Edge Radius, Wing, 1—Flat Meanline Wing

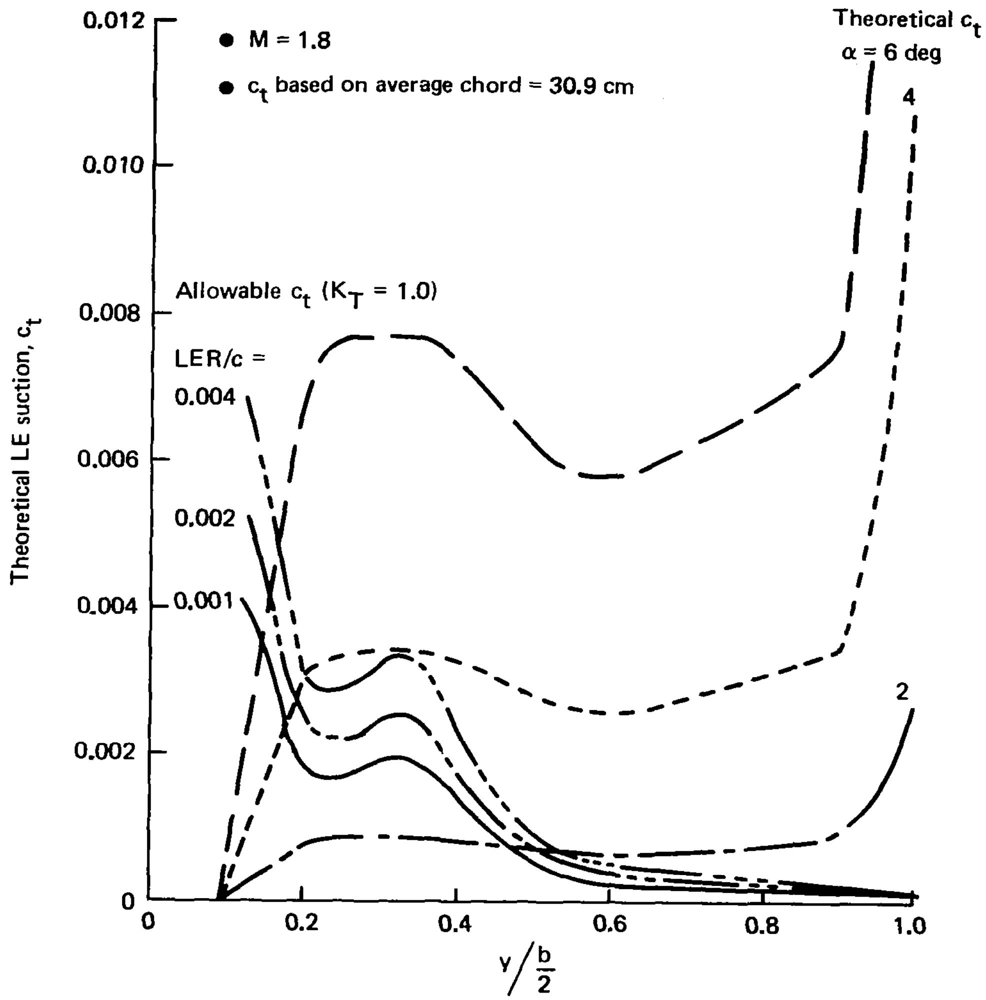
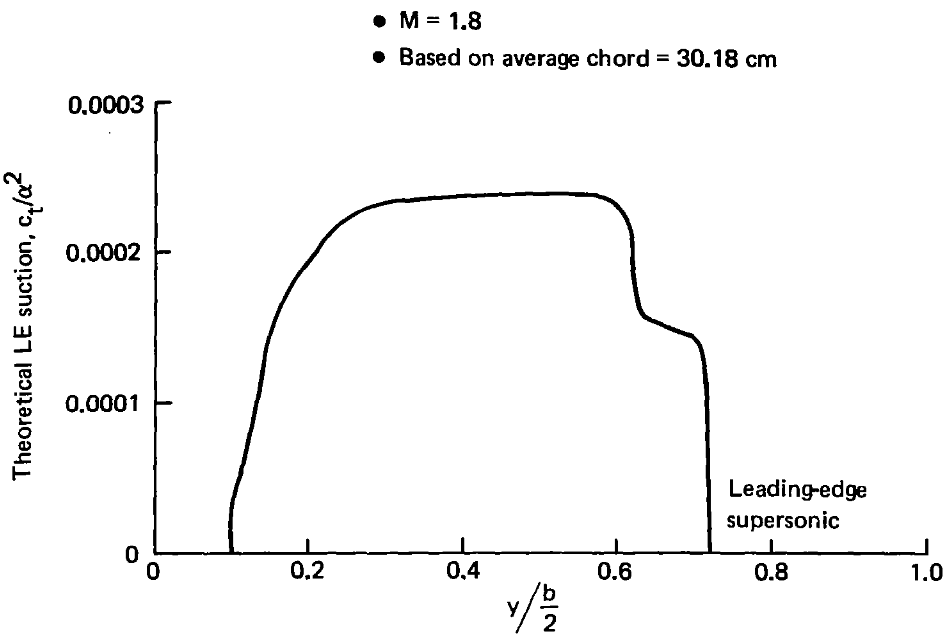


Figure 14. Separation Prediction Characteristics, Wing 1—Flat Meanline Planform



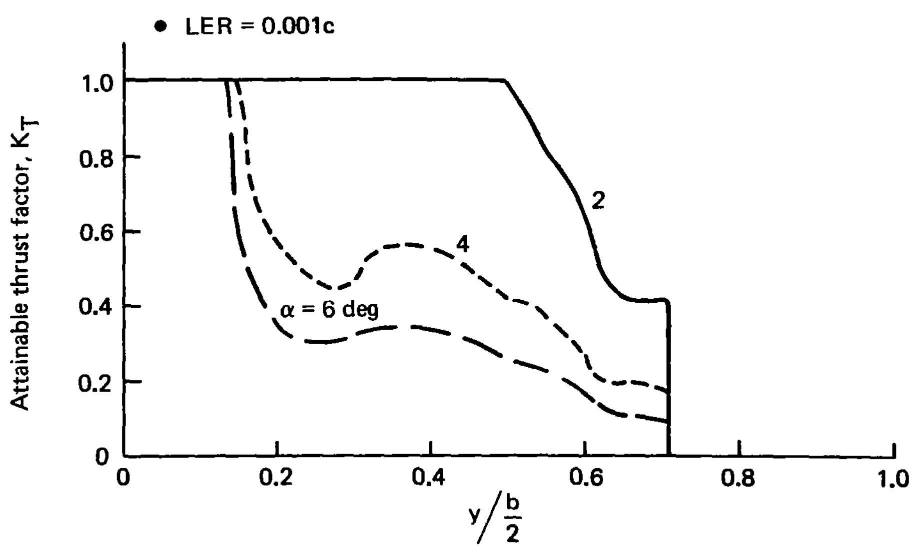


Figure 15. Leading-Edge Suction Characteristics, Wing 2—Flat Meanline Wing

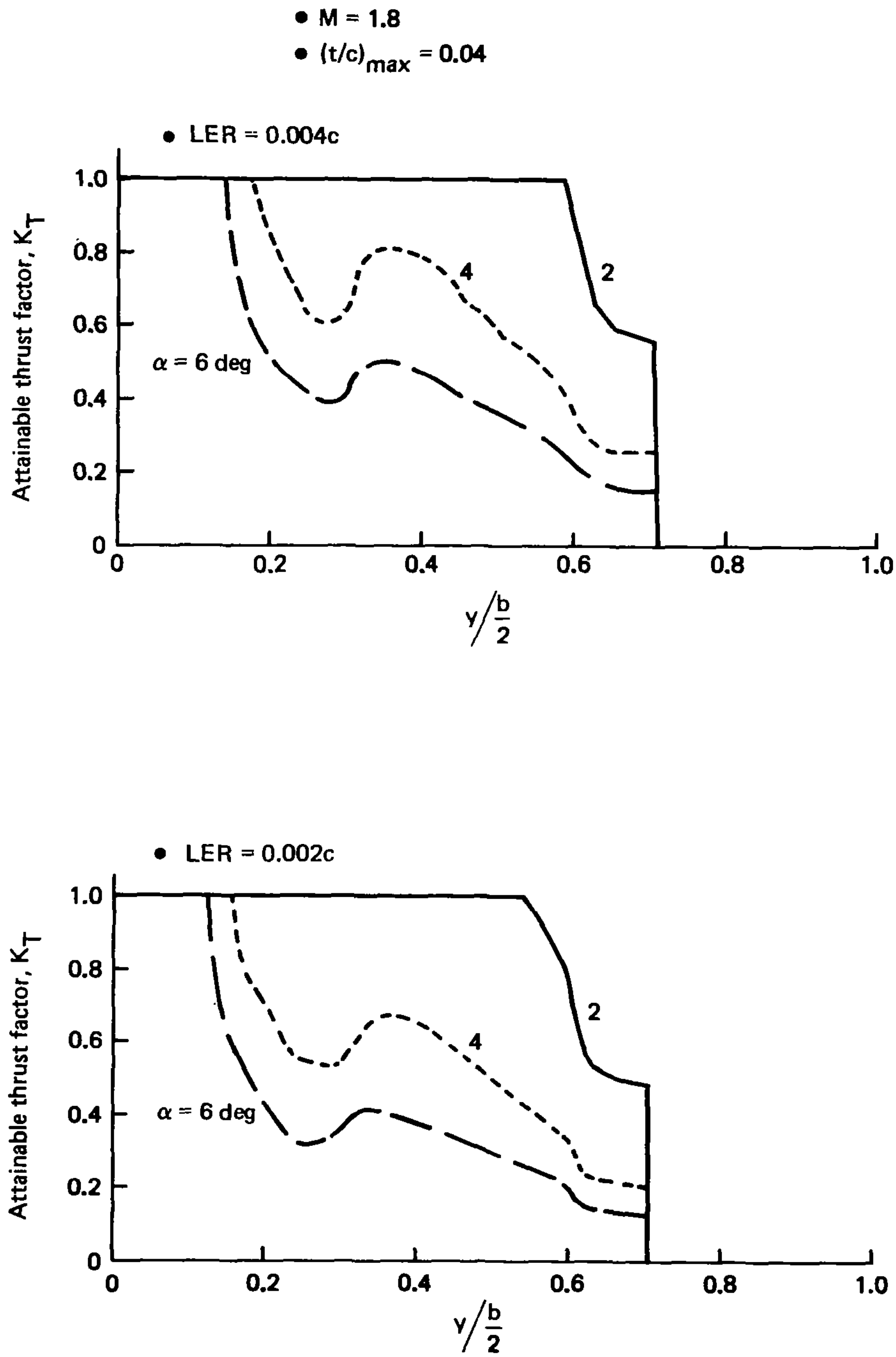


Figure 16. Effect of Increased Leading-Edge Radius, Wing 2—Flat Meanline Wing

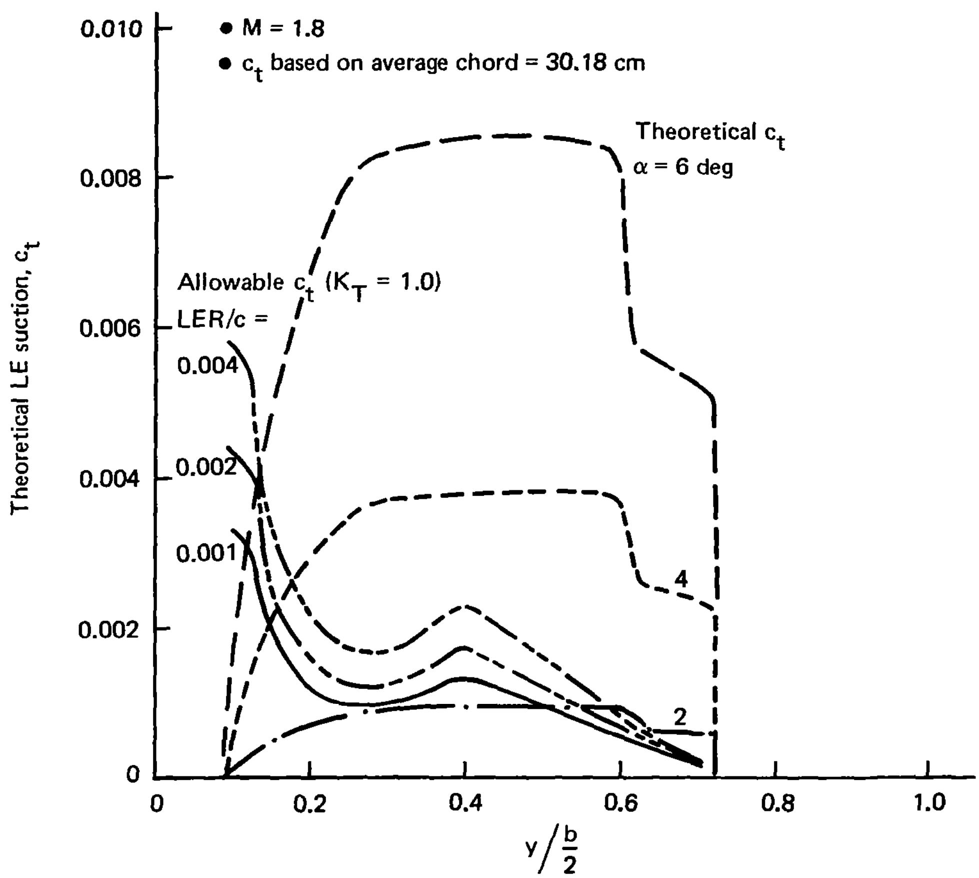
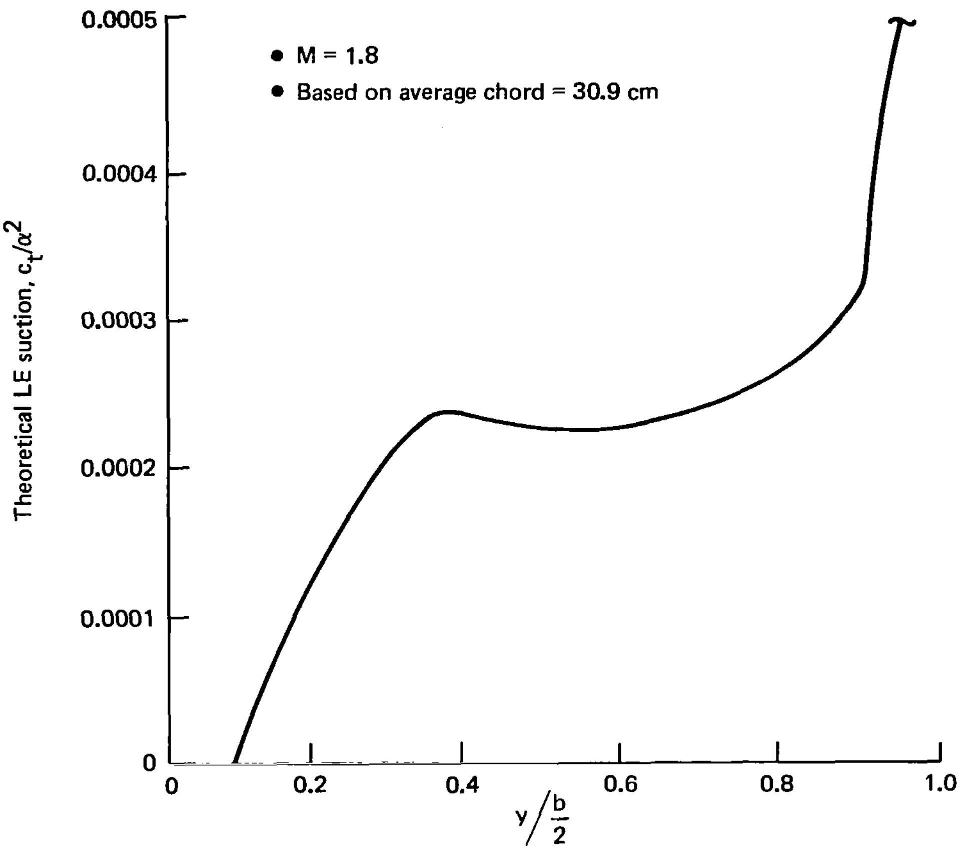


Figure 17. Separation Prediction Characteristics, Wing 2—Flat Meanline Planform



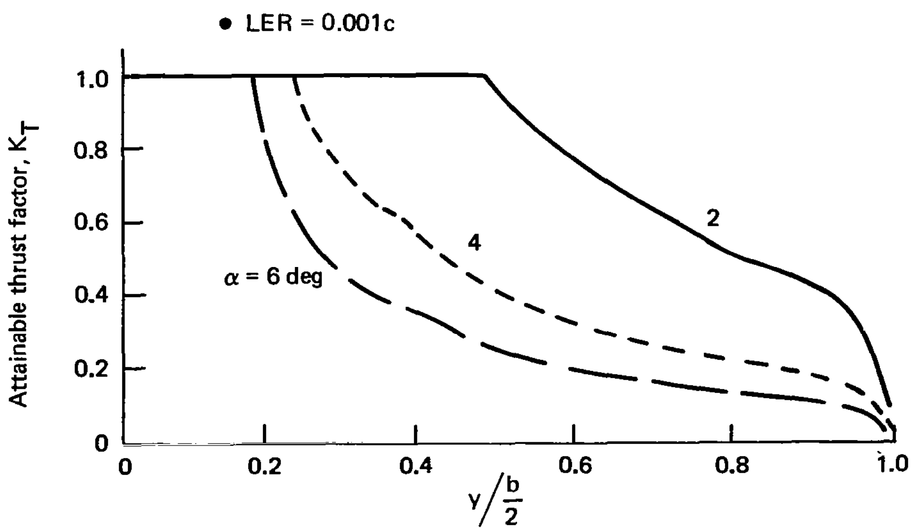


Figure 18. Leading-Edge Suction Characteristics, Wing 3—Flat Meanline Wing

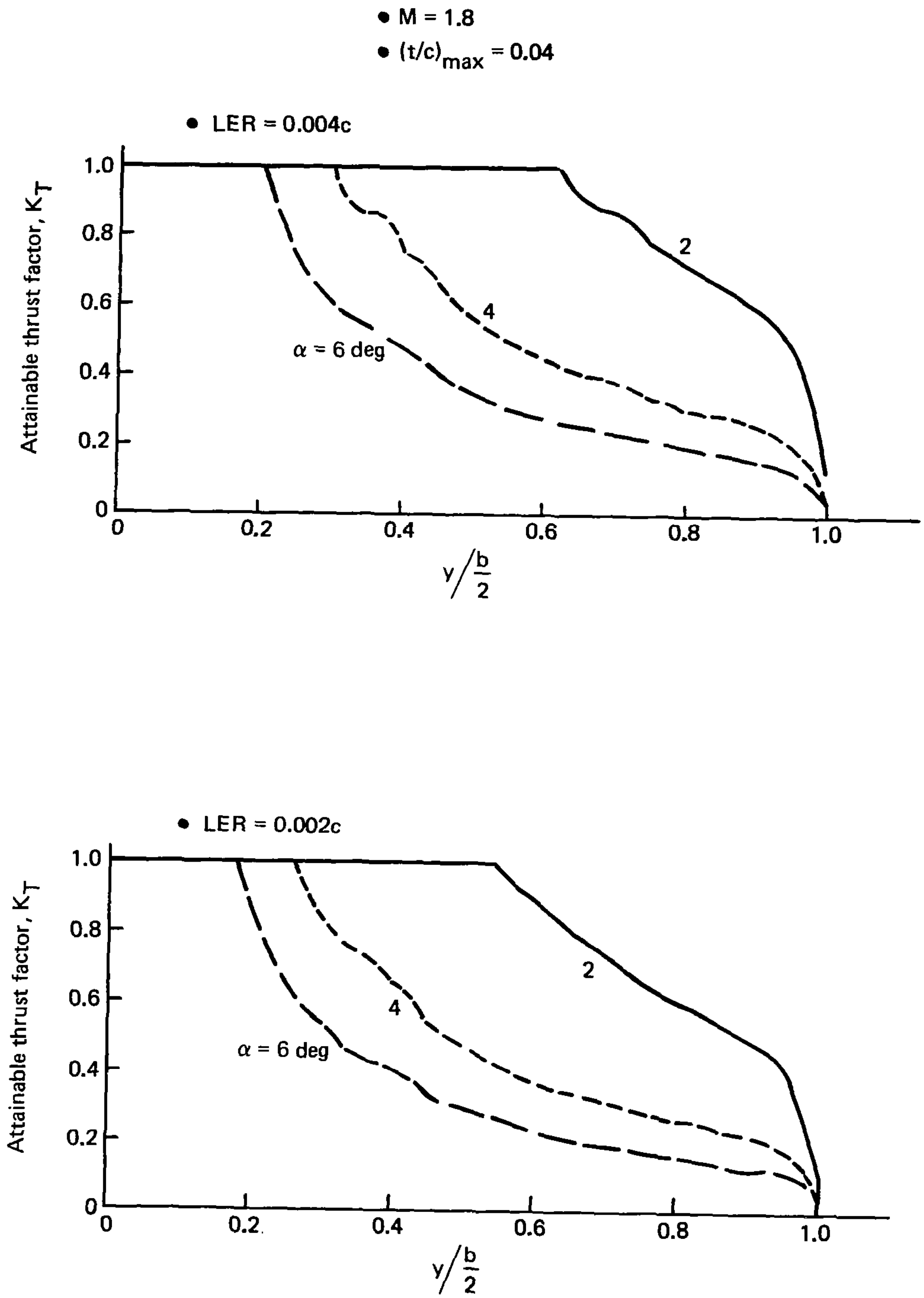


Figure 19. Effect of Increased Leading-Edge Radius, Wing 3—Flat Meanline Wing

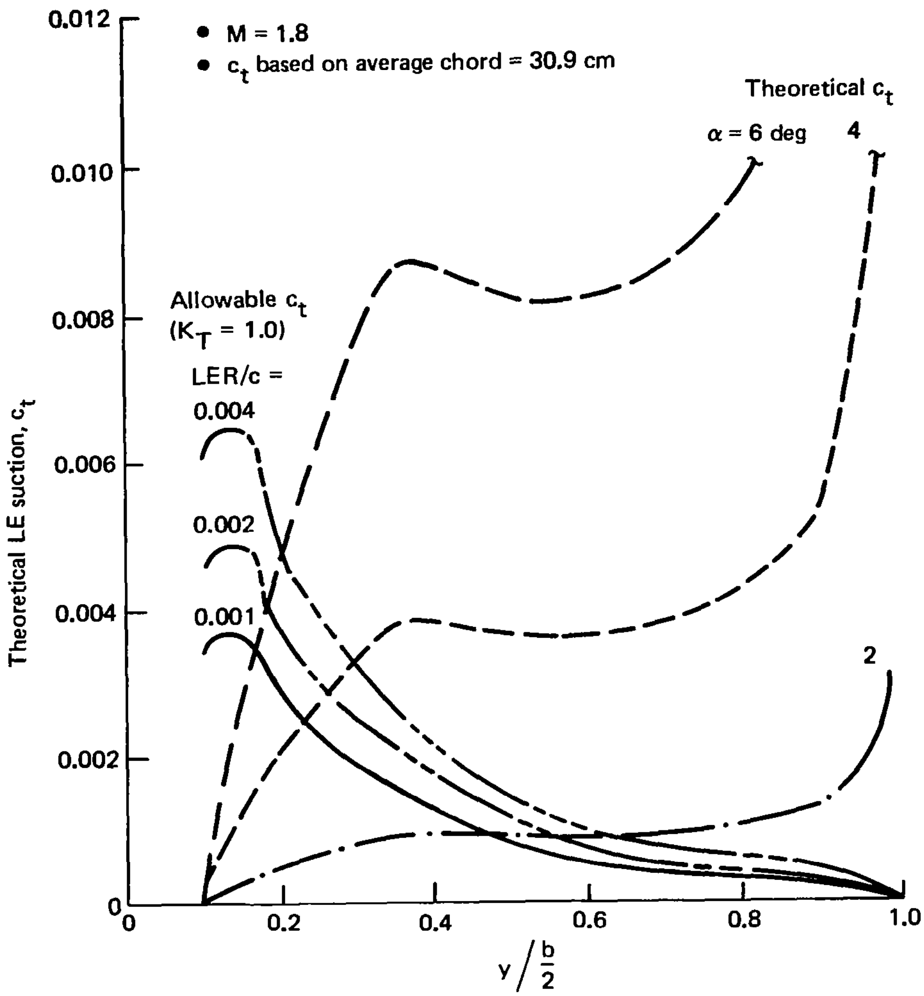


Figure 20. Separation Prediction Characteristics, Wing 3—Flat Meanline Planform

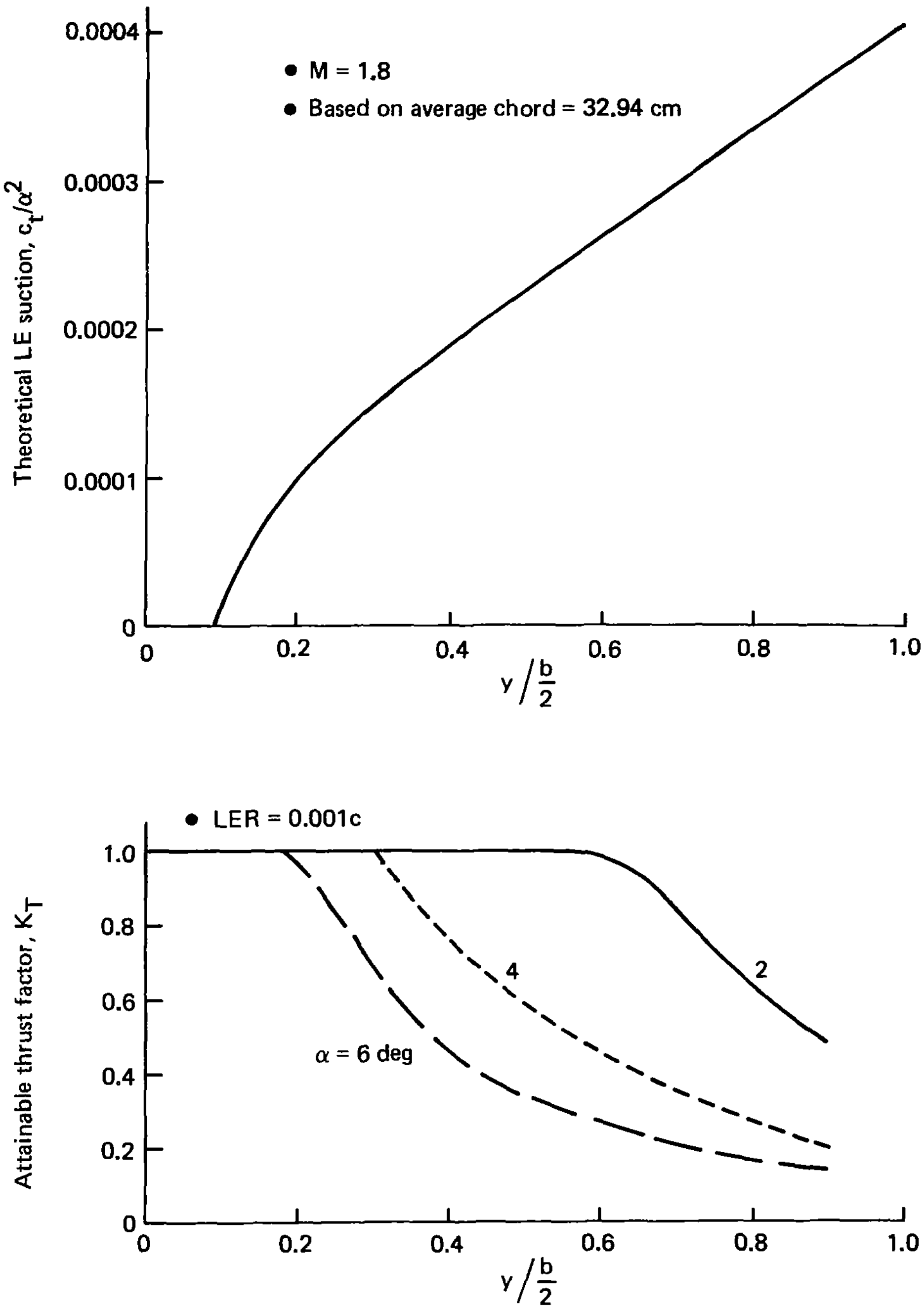


Figure 21. Leading-Edge Suction Characteristics, Wing 4—Flat Meanline Wing

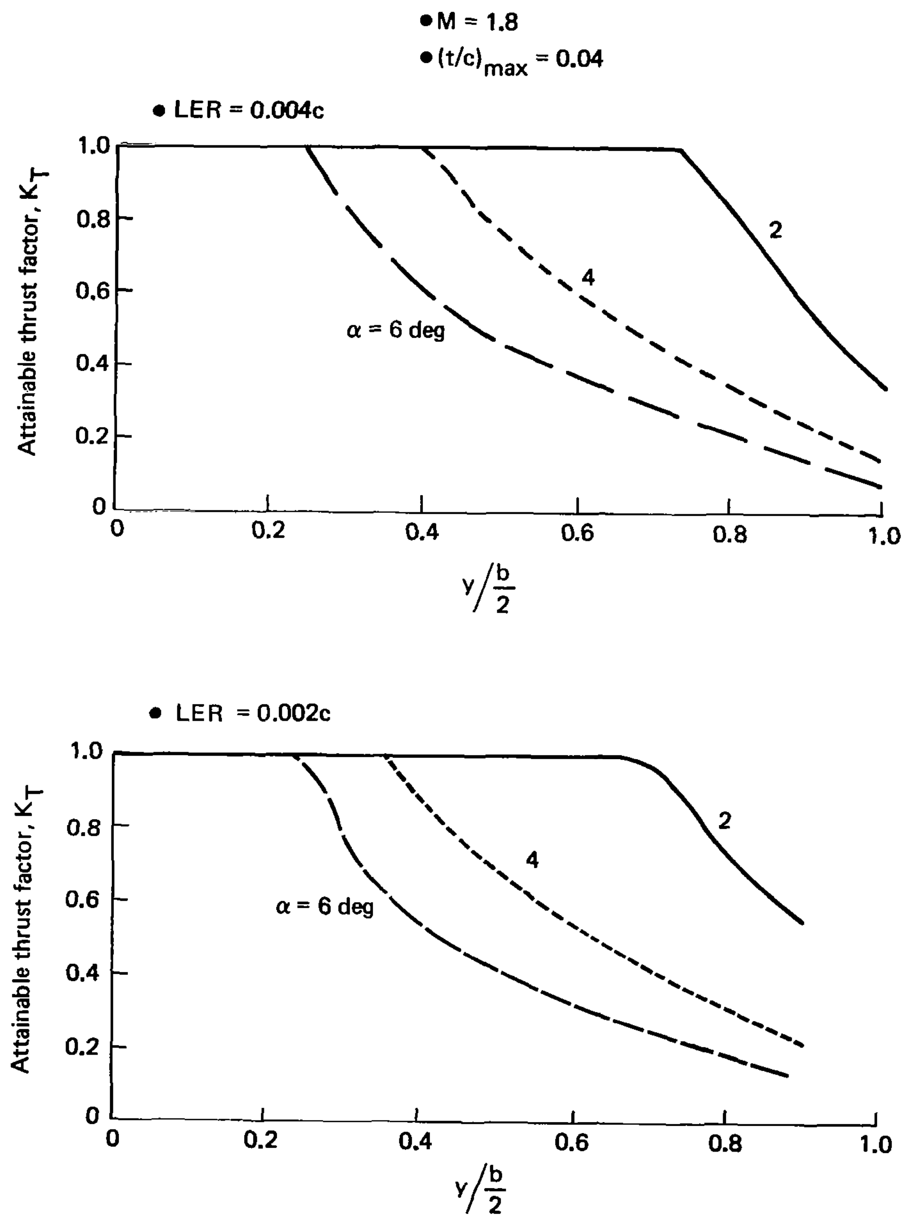


Figure 22. Effect of Increased Leading-Edge Radius, Wing 4—Flat Meanline Wing

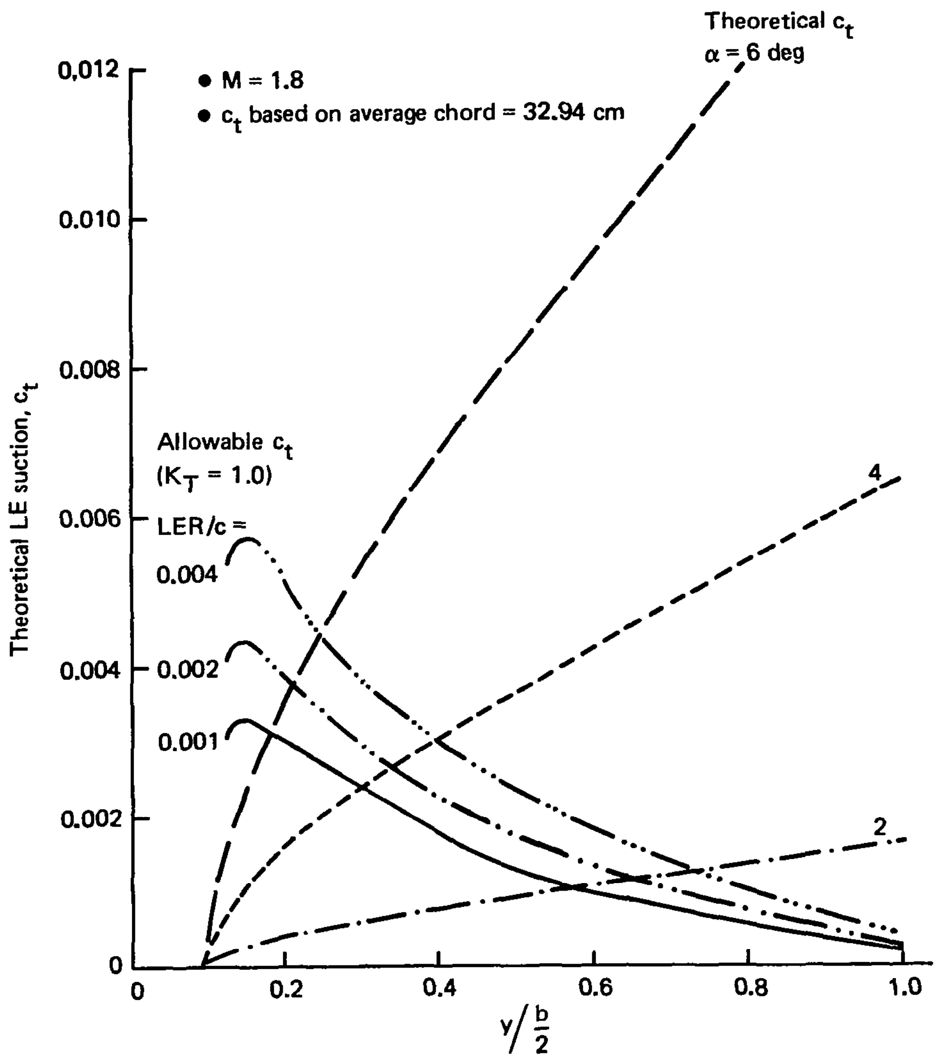


Figure 23. Separation Prediction Characteristics, Wing 4—Flat Meanline Planform

The leading-edge sweepback variations of the wings affect both theoretical and allowable suction coefficient data. Using the LER = 0.004c data, a summary chart of these characteristics, segregated into theoretical and allowable coefficients, is presented in Figure 24 to allow a comparison of the separation predictions. The highly sweptback wing 2 is significantly more sensitive to inboard wing separation at $\alpha = 4$ and 6 deg. In general, it appears that the gradual sweepback variation (e.g., wing 4) benefits from more gradual theoretical suction buildup and higher allowable c_t for attached flow (if the 0.004c leading-edge radius is tolerable from a wave drag standpoint, as discussed in the following section).

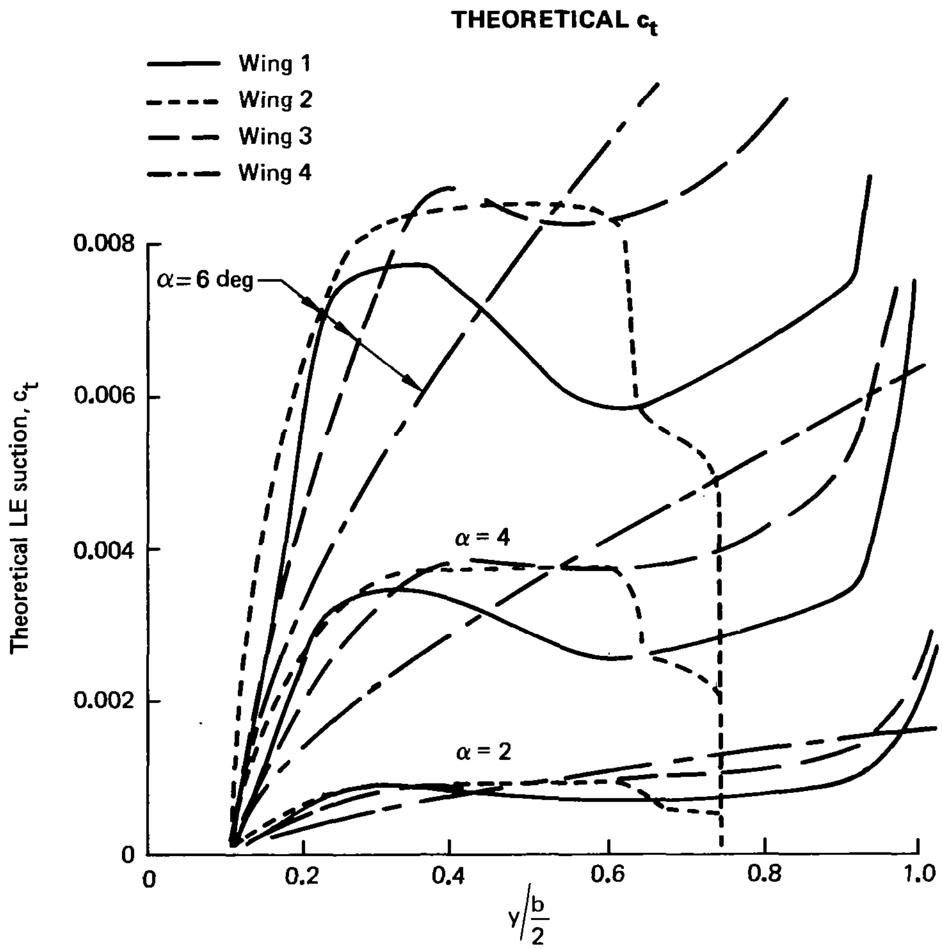
Another presentation of the separation prediction is given in Figure 25, showing the wing suction coefficient normal to the leading edge, c_s (rather than the streamwise component, c_t). Symbols on the suction coefficient plots indicate the spanwise location of the K_T breakaway point for angles of attack of 2, 4, and 6 deg using the LER = 0.004c data. These data are pertinent since they illustrate the normal section characteristics that are addressed in the attainable suction analysis. The magnitude of the normal section thrust coefficients for highly swept wings is not apparent from streamwise component data.

The conclusion reached from these data was that the high local leading-edge upwash angles associated with high sweepback (reflected in the rapid rise in suction coefficients) produced early leading-edge separation at $\alpha = 4$ and 6 deg, even with the LER = 0.004c airfoils.

4.2.2.1 Wave Drag Considerations

A principal consideration in the separation predictions of the wings involves the leading-edge bluntness and the associated wave drag. The effect of local nose-shape variations of the type employed here to assist in maintaining attached flow, is of critical importance, but difficult to assess. Linear theory provides poor estimates of the effects of airfoil nose bluntness due to local slenderness violations. Applicable experimental data are scarce.

Crude boundaries of allowable airfoil nose bluntness as a function of sweepback parameter, extracted from wind tunnel data, are presented in Figure 26. The boundaries are based on a small zero lift drag increase due to bluntness over a corresponding sharp nose airfoil. Within the boundaries, a line of assumed allowable nose radius is shown,



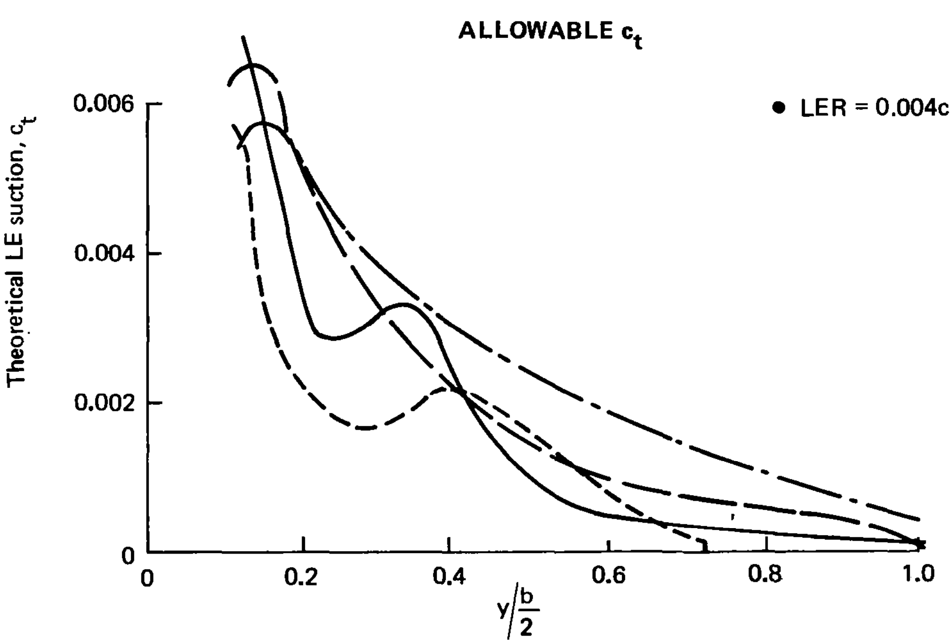


Figure 24. Theoretical and Allowable c_t Characteristics—Flat Meanline Planforms (M = 1.8)

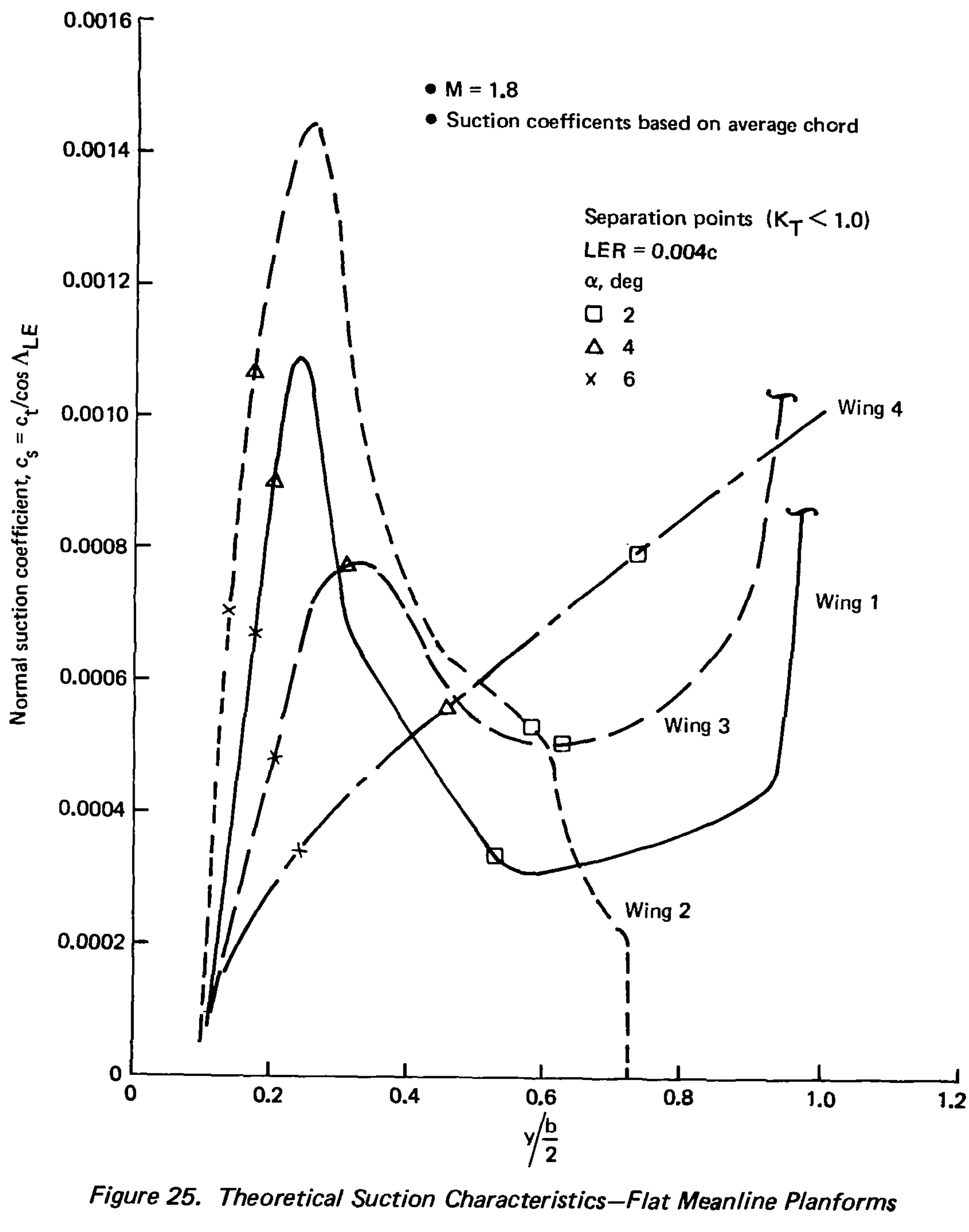


Figure 25. Theoretical Suction Characteristics—Flat Meanline Planforms

which favors the upper bound of allowable bluntness. This line was used in subsequent wing analyses.

If the assumed allowable nose radius of Figure 26 is used, rather than LER = 0.004c, the separation characteristics summary of wings 1 to 4 is changed as shown in Figure 27. The general conclusions reached earlier, based on LER = 0.004c, are unchanged. However, because of the importance of the wave drag and nose bluntness question, wind tunnel models have been recommended that allow wing leading-edge bluntness variations (sec. 5.0).

4.2.2.2 Additional Planforms

As a result of the initial planform analyses, which favored wing 4 on the basis of leading-edge separation predictions, additional planforms were introduced having sweepback variations similar to those of wings 3 and 4. The objective for introducing these planforms was to delay leading-edge separation (defined by K_T breakaway) as far outboard as possible while maintaining overall subsonic leading-edge conditions and favoring inboard leading-edge sweepback. For consistency, a common spanwise wing chord distribution (wing 4) was used. Data for wings of the series (wings 5 to 9) are presented in

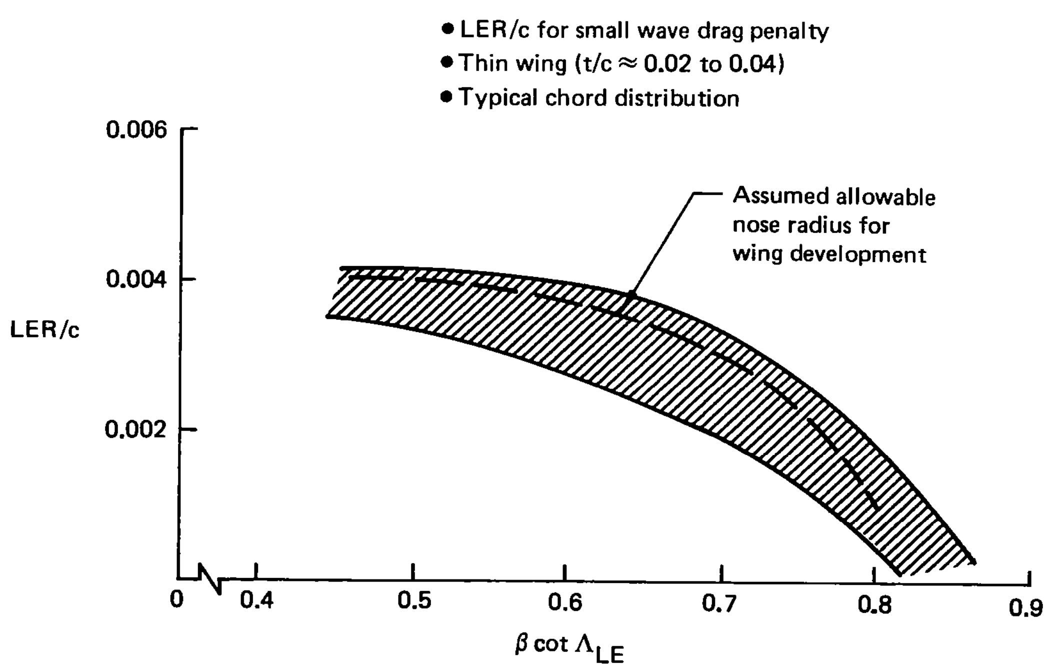


Figure 26. Allowable Nose Radius Boundaries

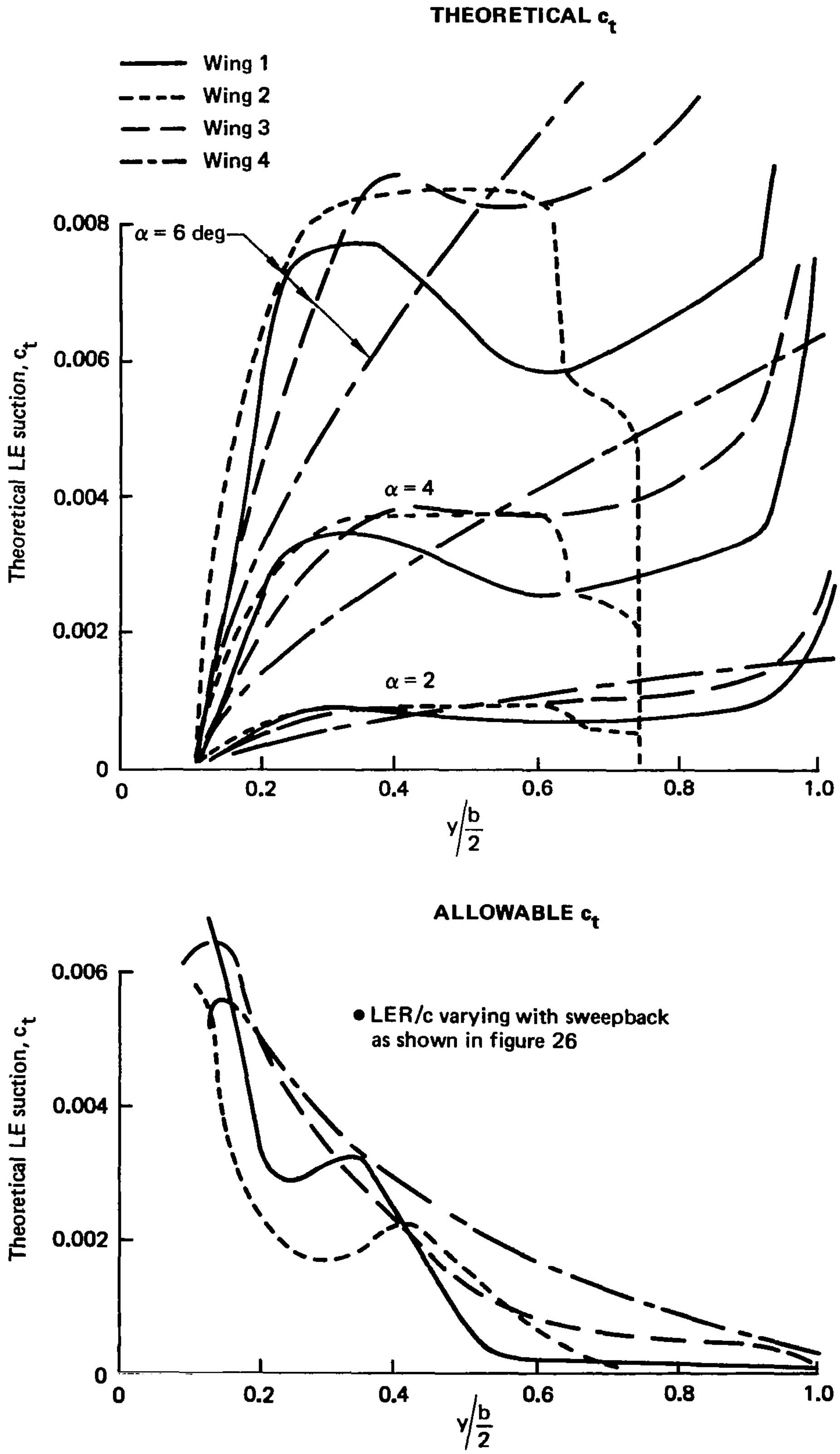


Figure 27. Theoretical and Allowable c_t Characteristics—Flat Meanline Planforms (M = 1.8)

Figures 28 through 42. Normal leading-edge suction data are presented in Figure 43. These wings generally showed more moderate variations in separation characteristics than wings 1 to 4.

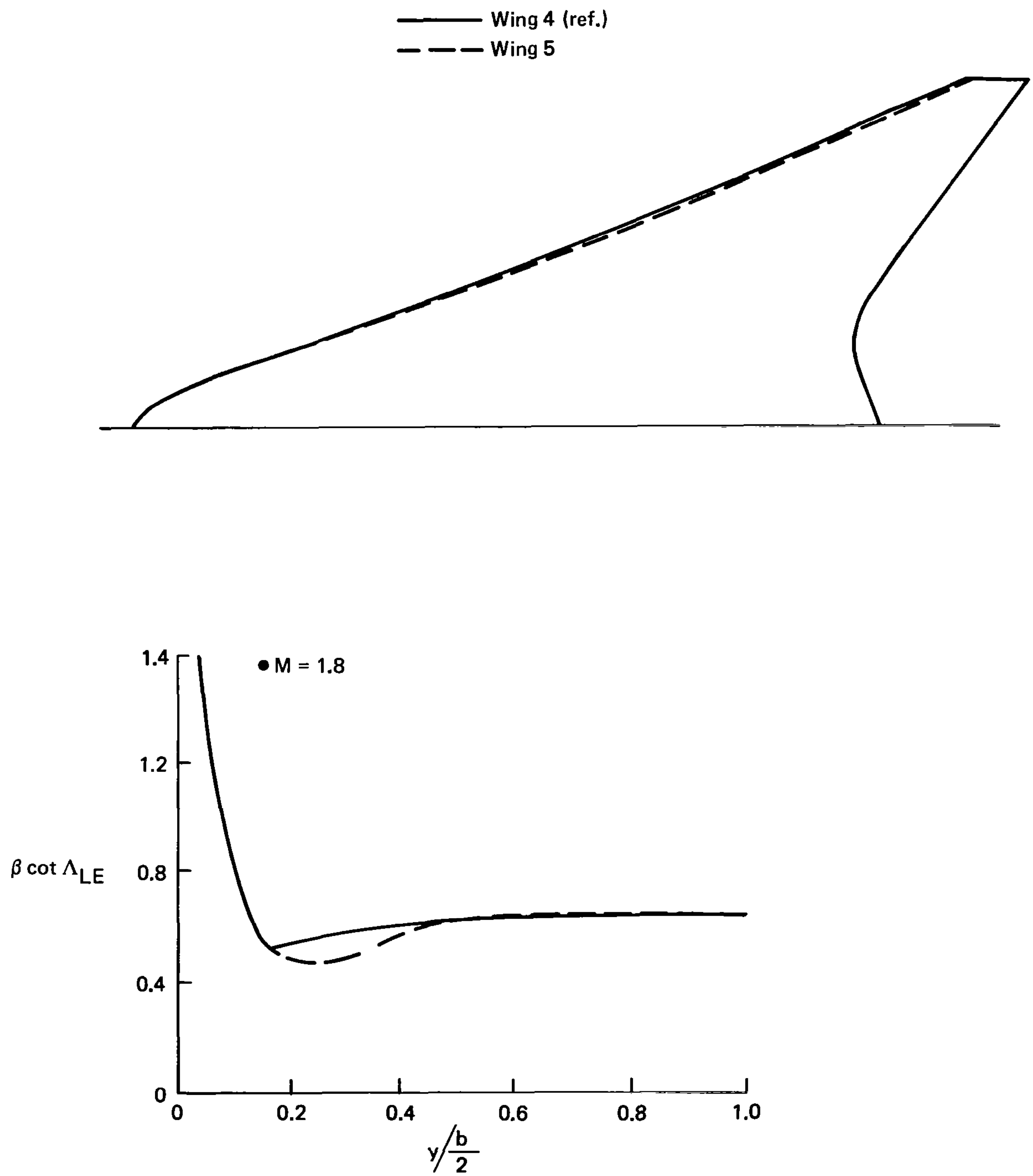


Figure 28. Planform Characteristics, Wing 5

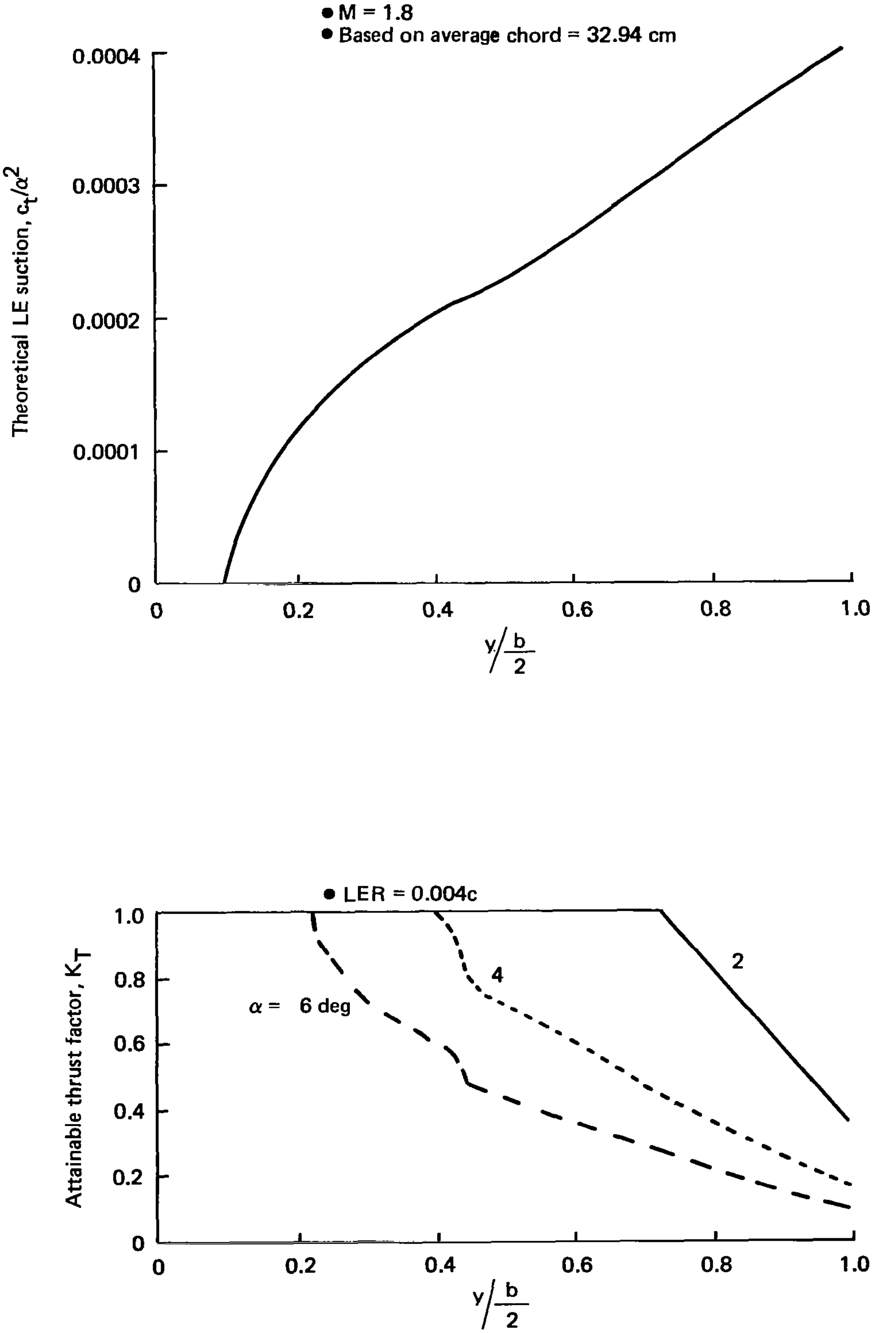


Figure 29. Leading-Edge Suction Characteristics, Wing 5—Flat Meanline Wing

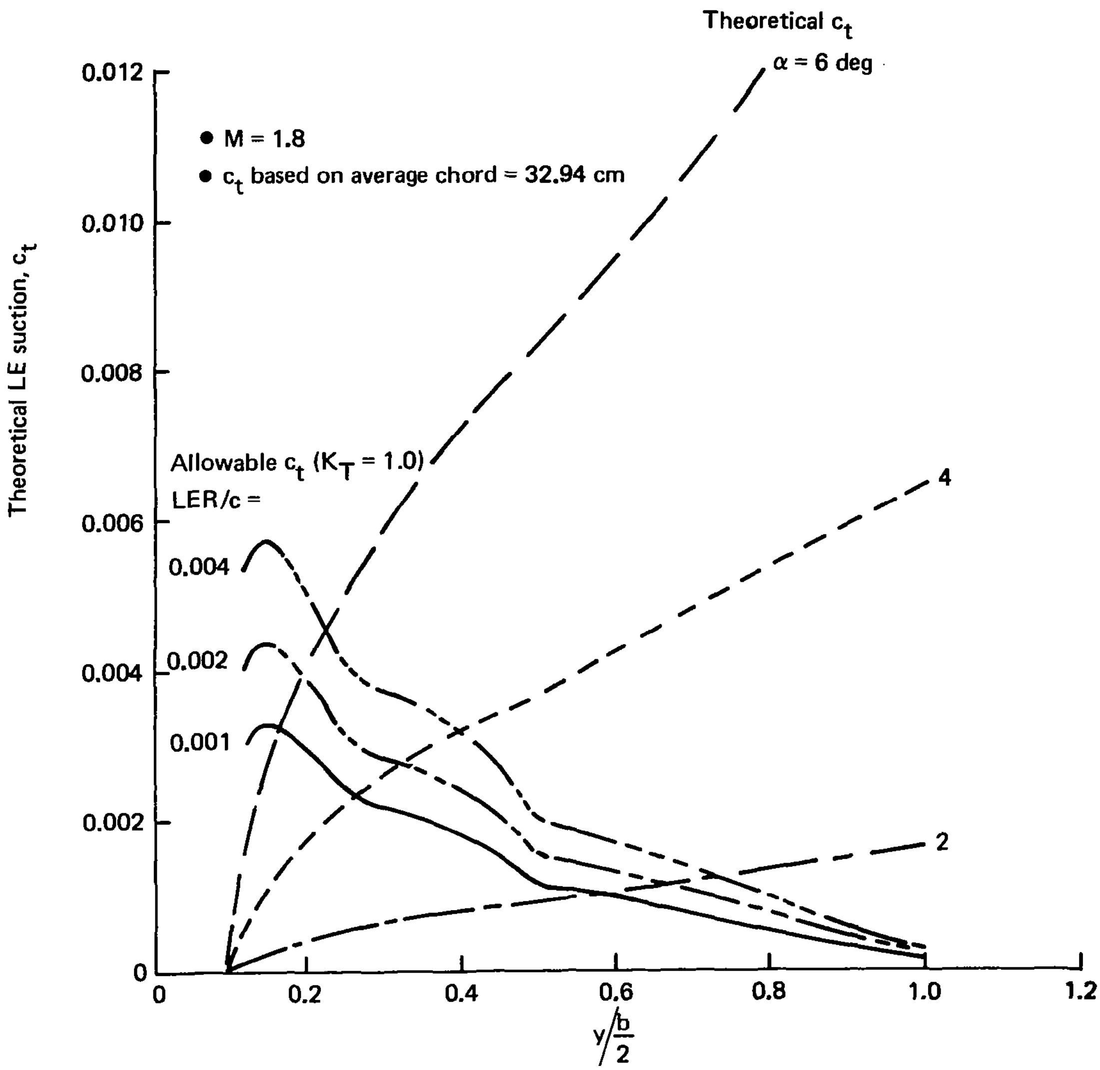


Figure 30. Separation Prediction Characteristics, Wing 5—Flat Meanline Planform

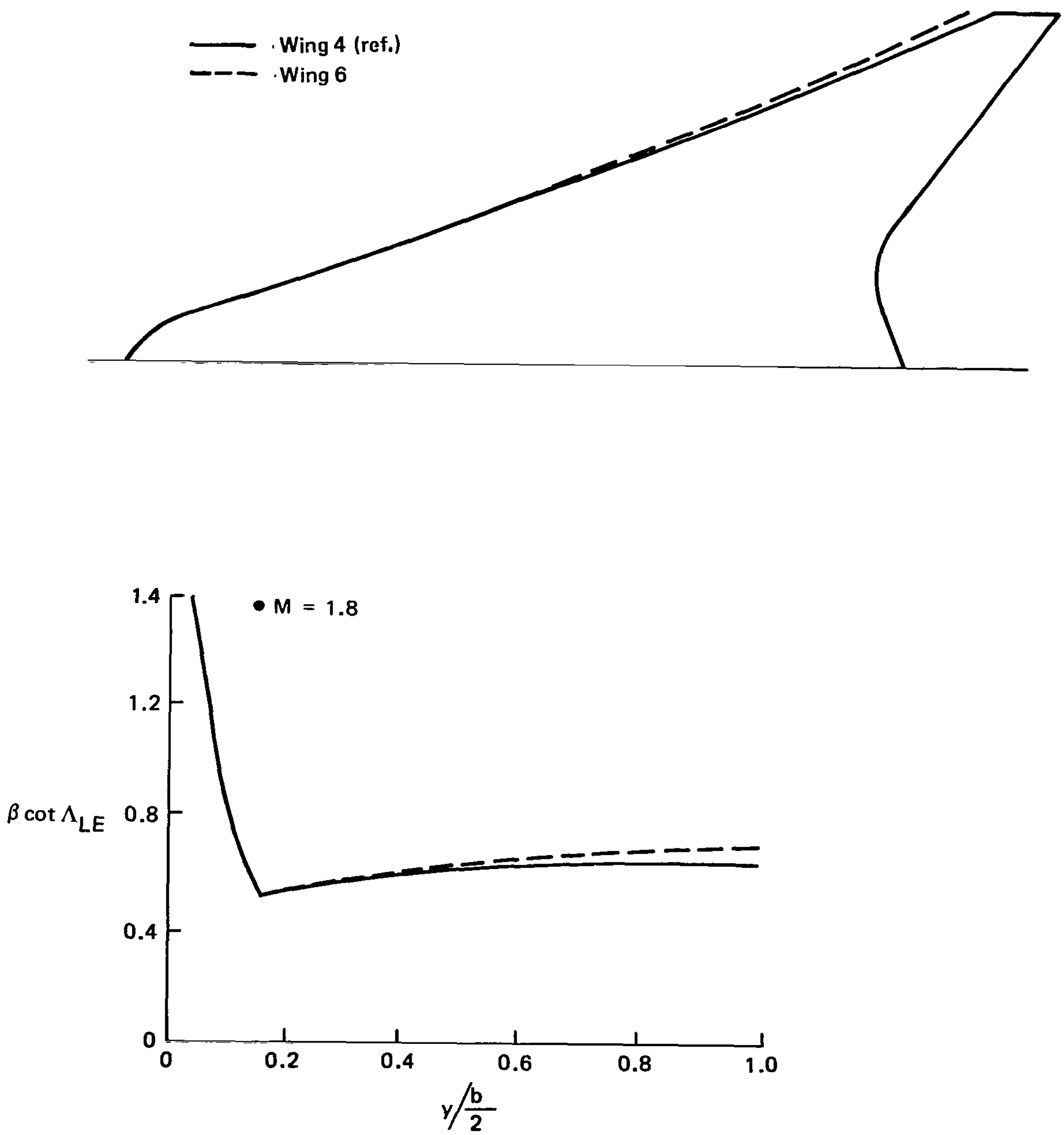


Figure 31. Planform Characteristics, Wing 6

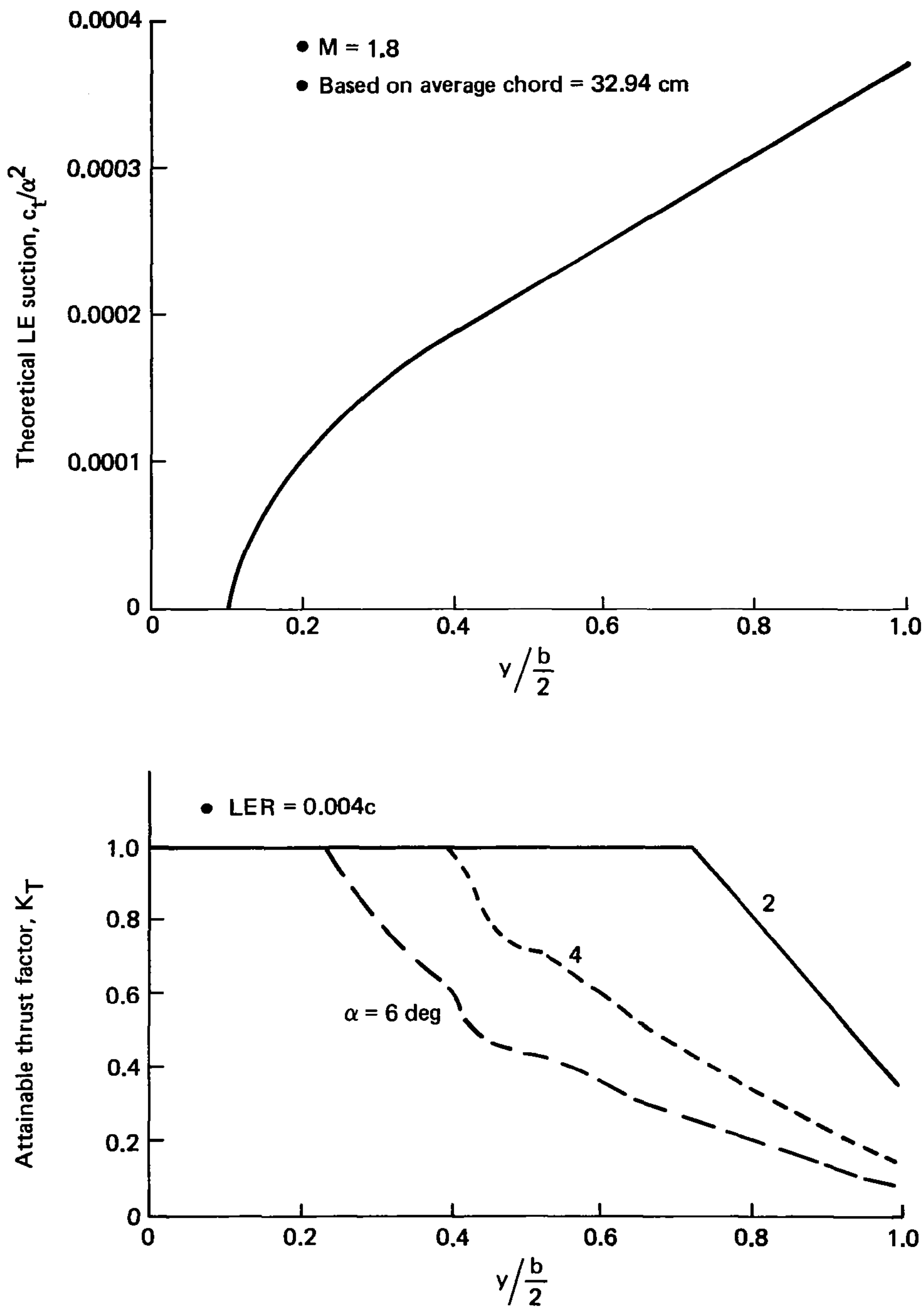


Figure 32. Leading-Edge Suction Characteristics, Wing 6—Flat Meanline Wing

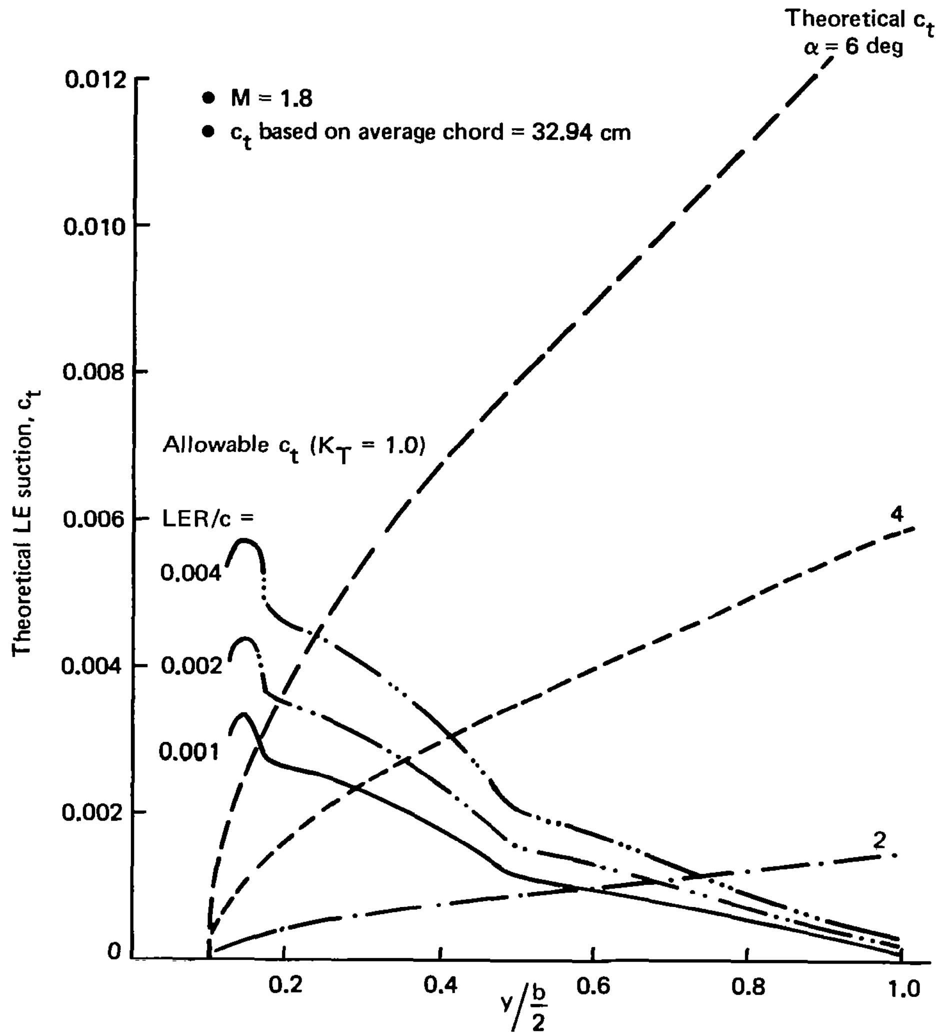
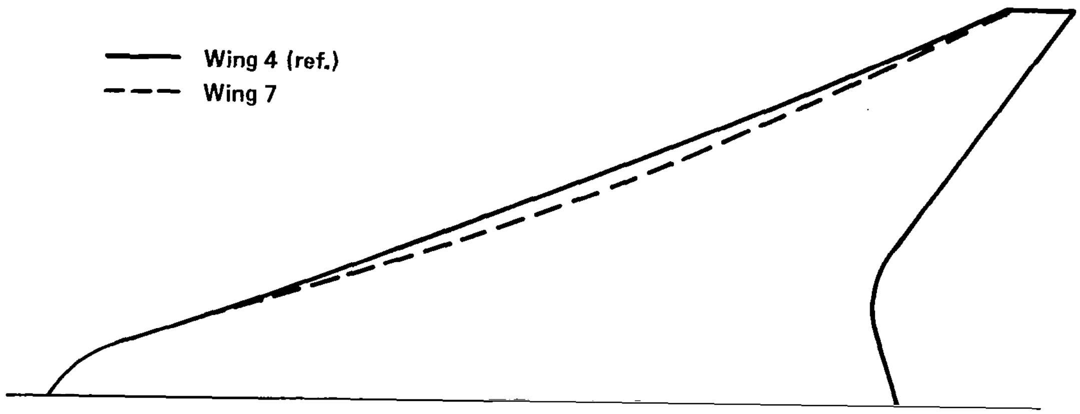


Figure 33. Separation Prediction Characteristics, Wing 6—Flat Meanline Planform



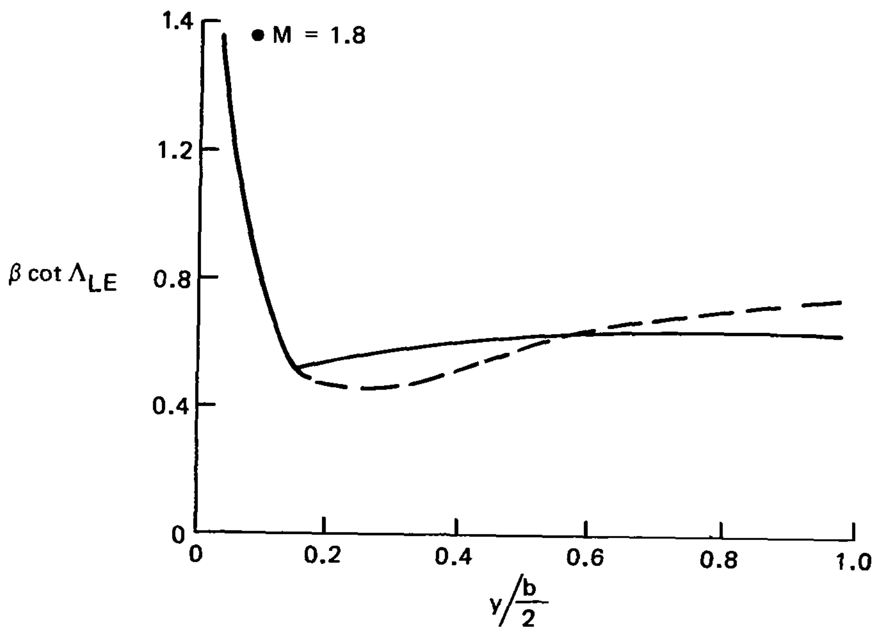


Figure 34. Planform Characteristics, Wing 7

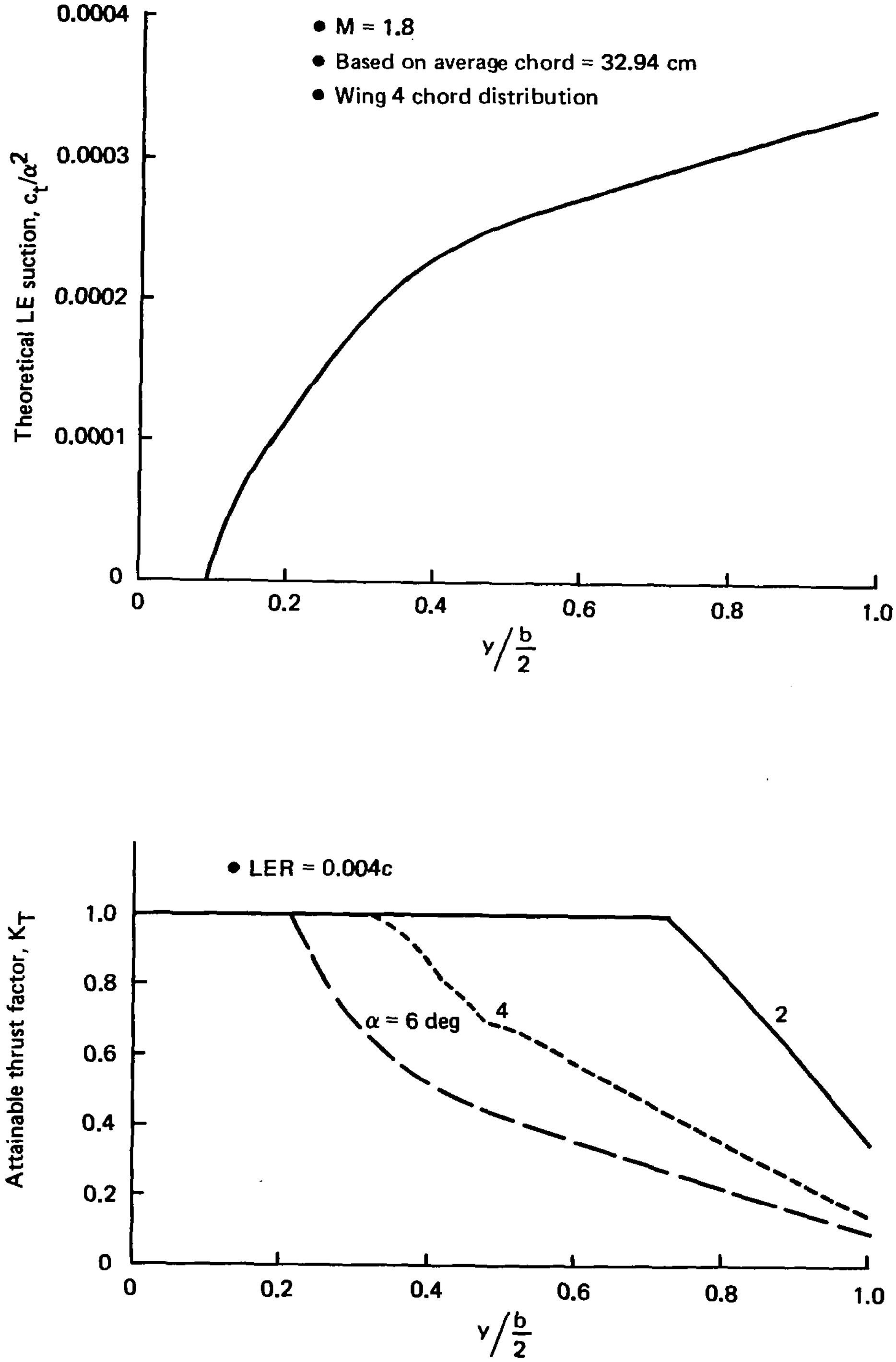


Figure 35. Leading-Edge Suction Characteristics, Wing 7—Flat Meanline Wing

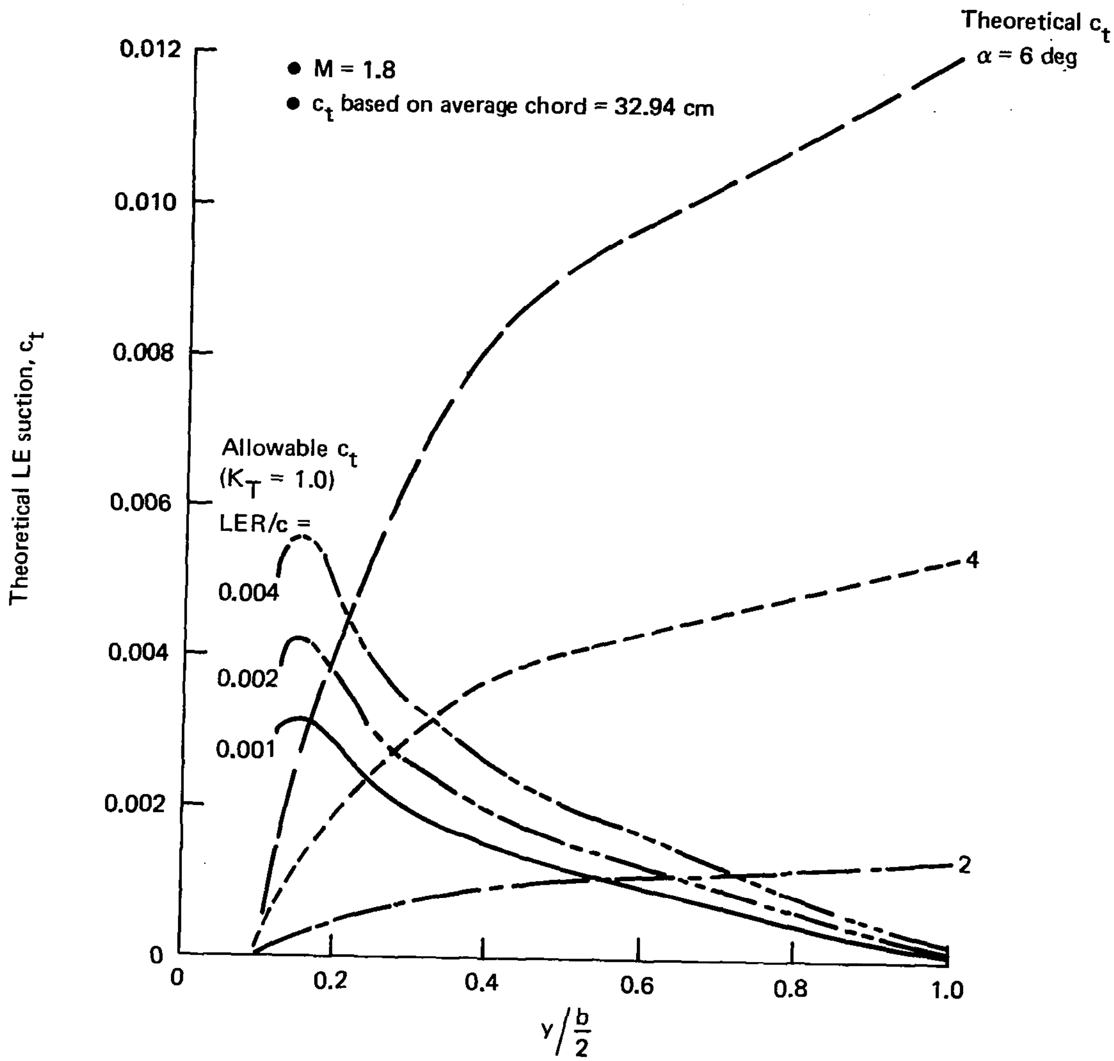


Figure 36. Separation Prediction Characteristics, Wing 7—Flat Meanline Planform

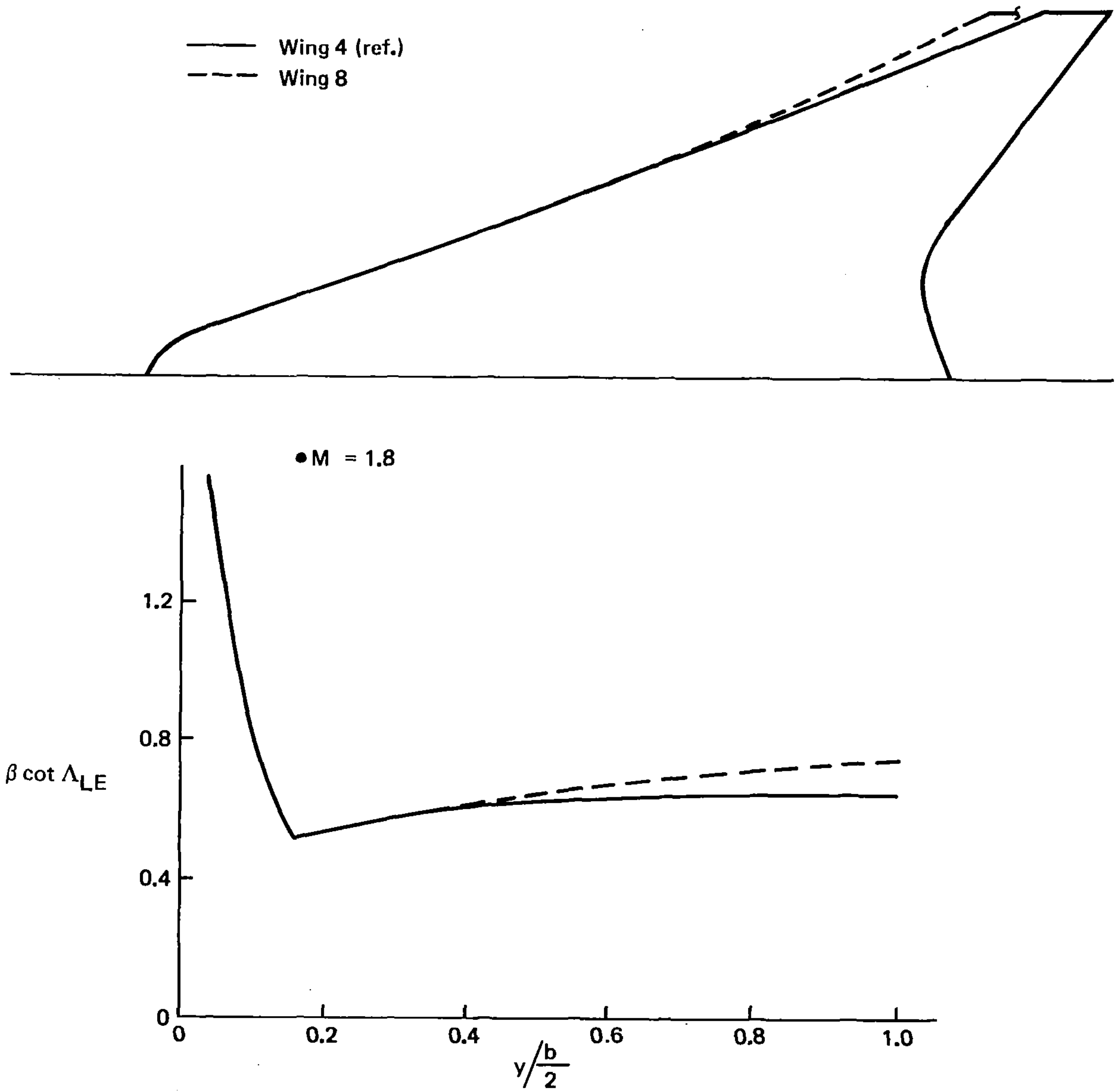
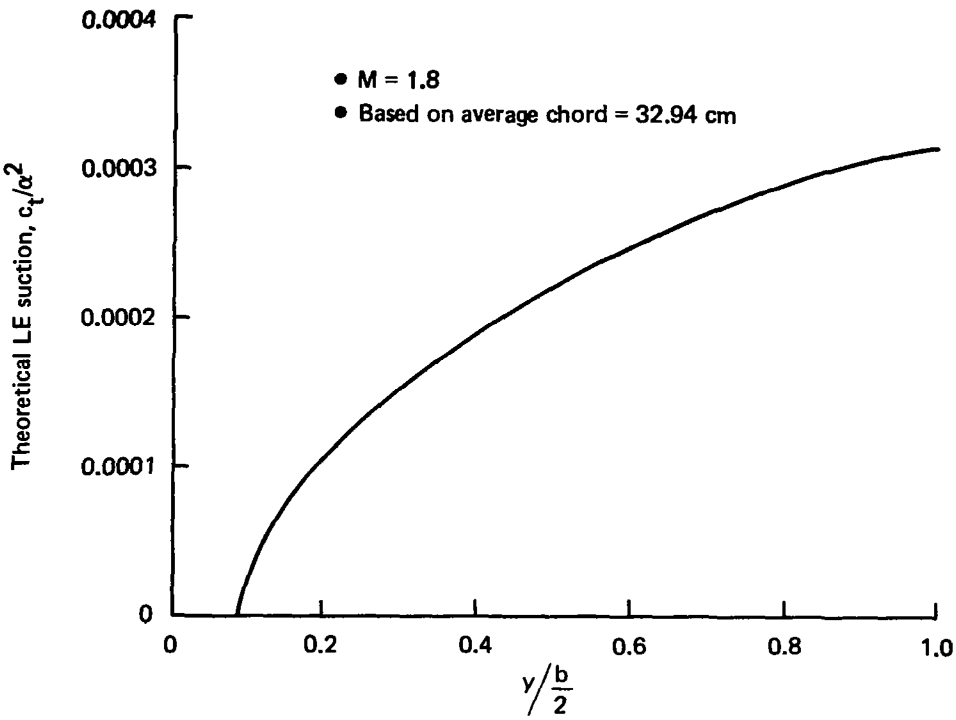


Figure 37. Planform Characteristics, Wing 8



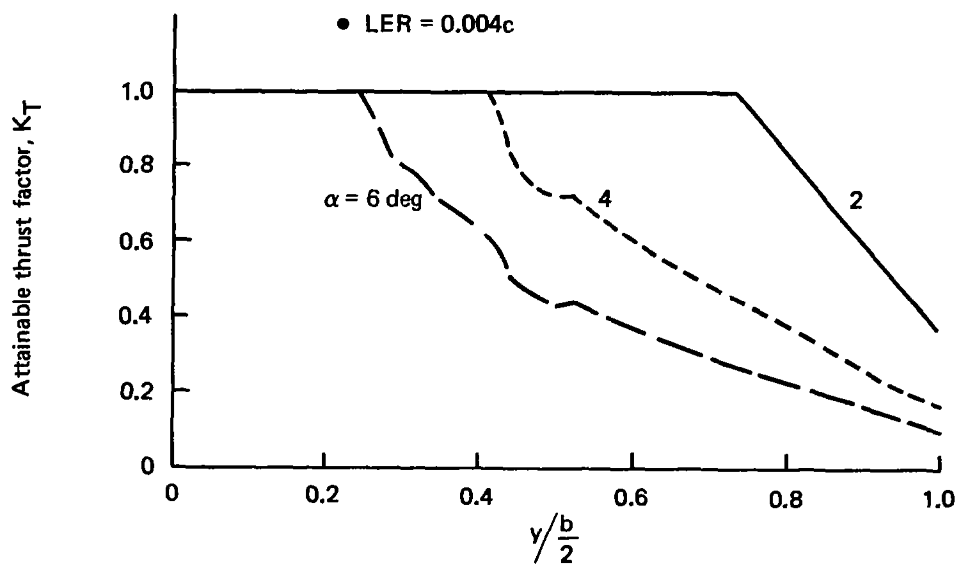


Figure 38. Leading-Edge Suction Characteristics, Wing 8—Flat Meanline Wing

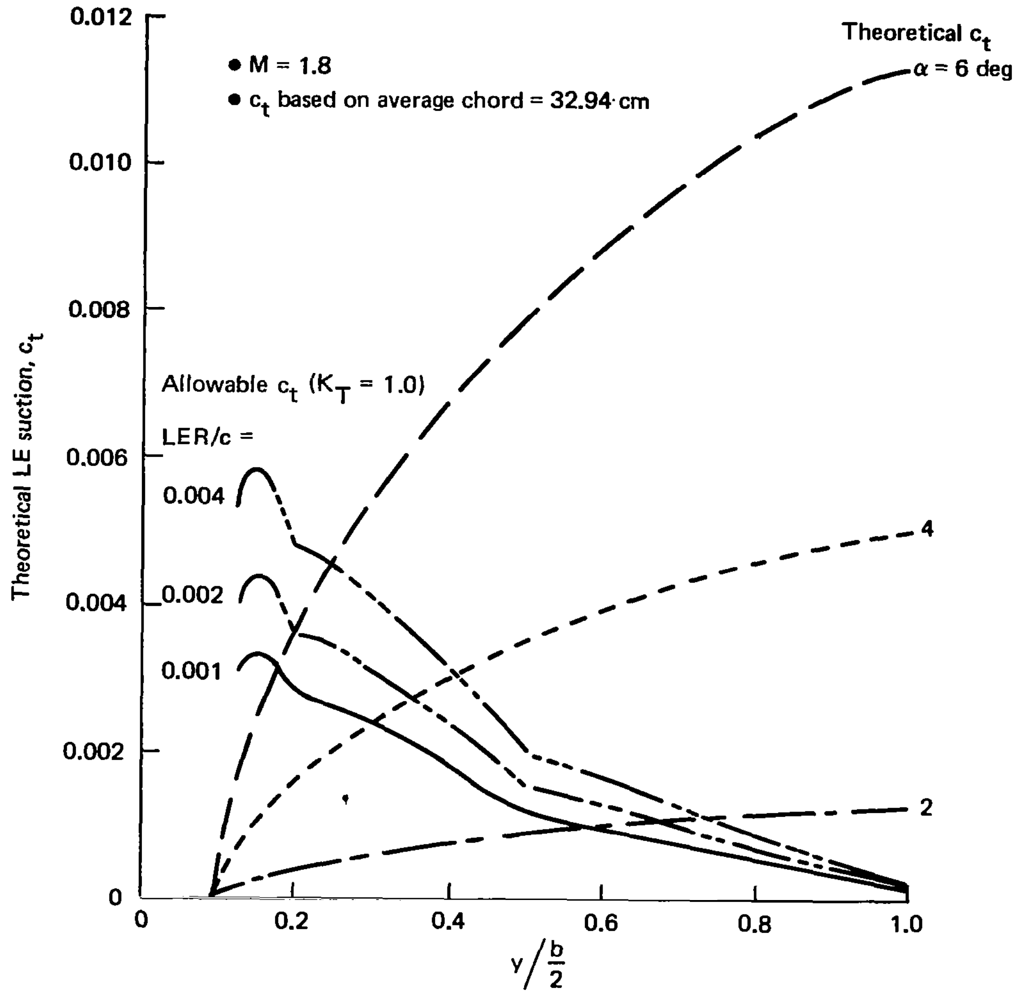
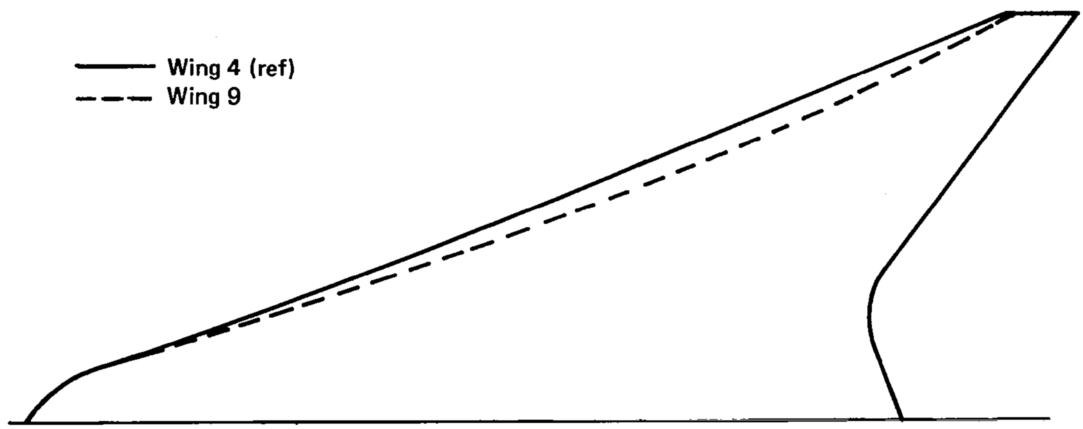


Figure 39. Separation Prediction Characteristics, Wing 8—Flat Meanline Planform



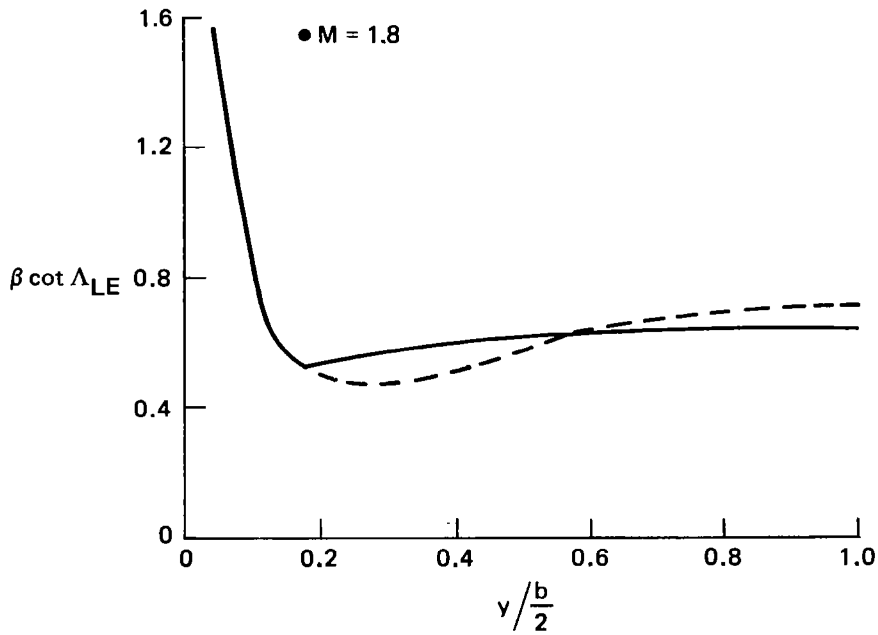


Figure 40. Planform Characteristics, Wing 9

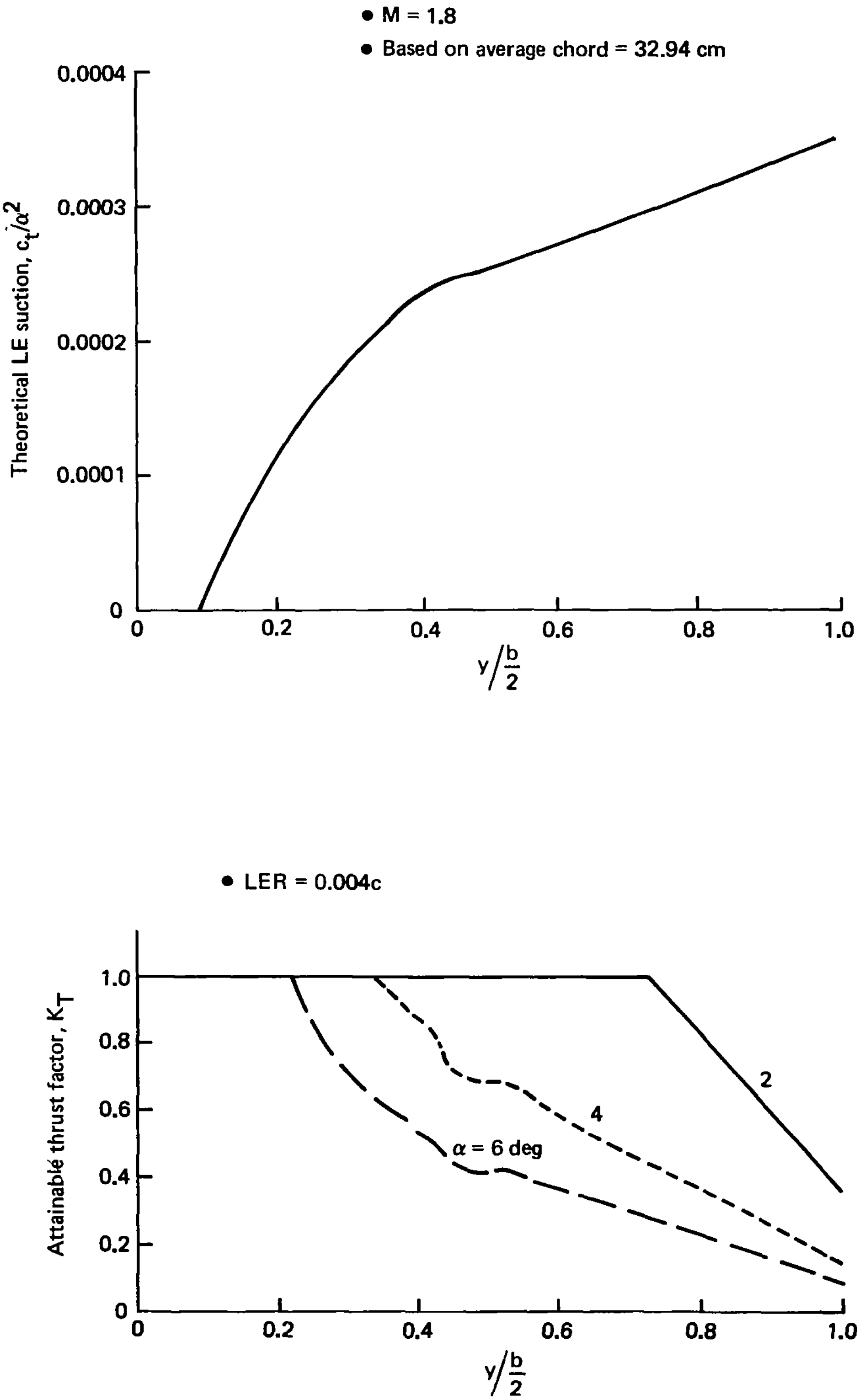


Figure 41. Leading-Edge Suction Characteristics, Wing 9—Flat Meanline Wing

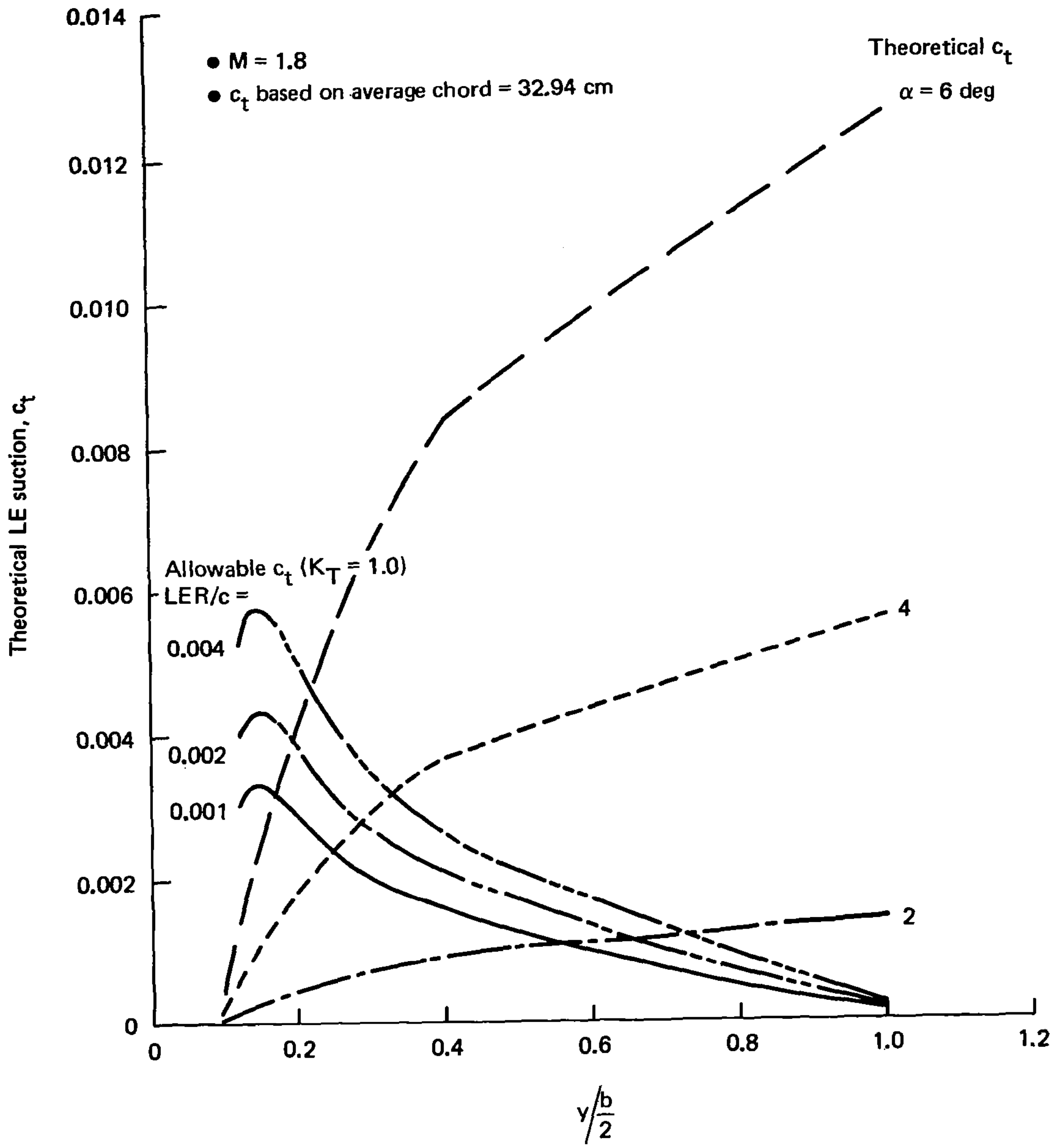


Figure 42. Separation Prediction Characteristics, Wing 9—Flat Meanline Planform

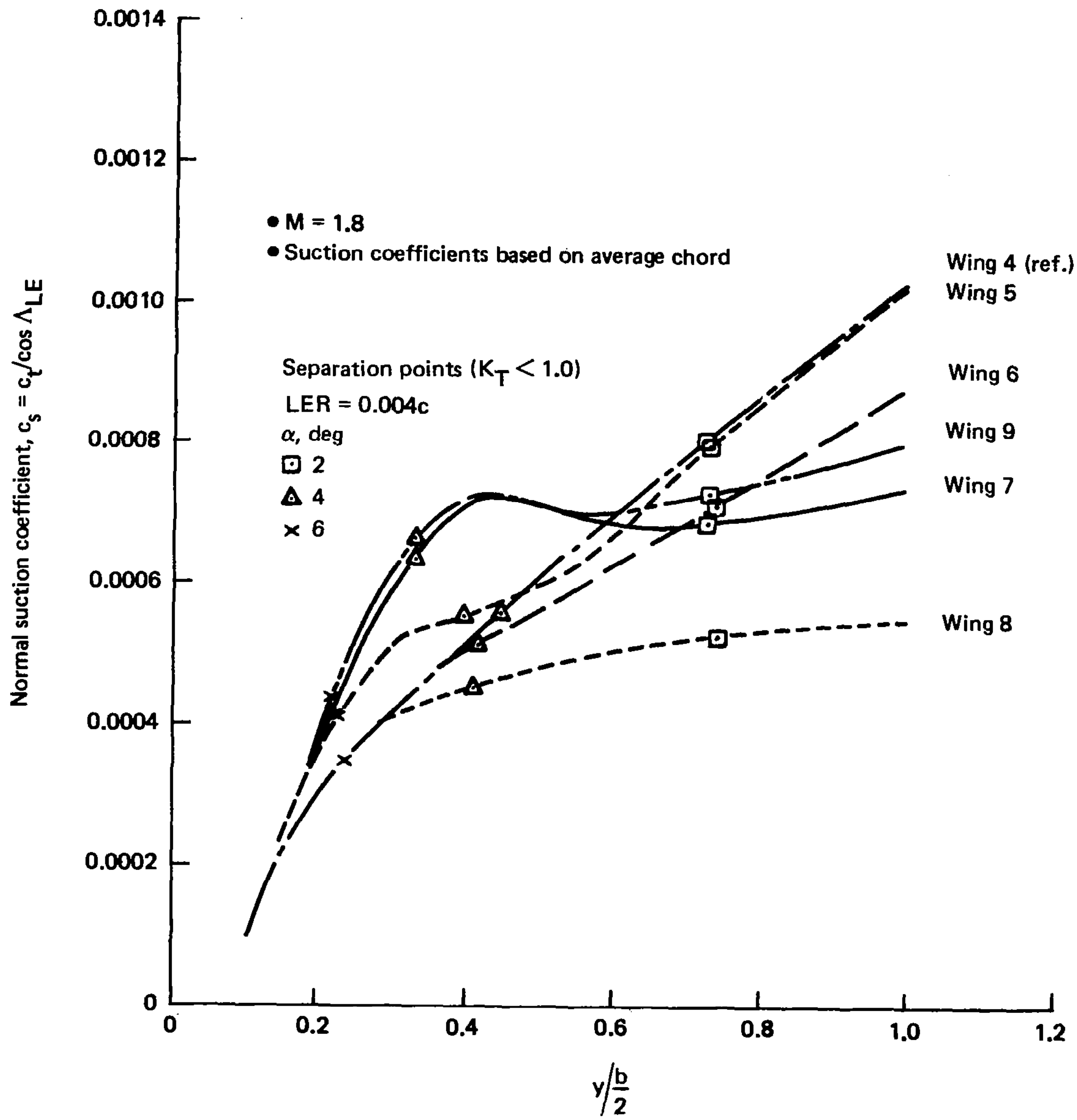


Figure 43. Theoretical Suction Characteristics—Flat Meanline Planforms

4.2.2.3 Wing Planform Selection

Aerodynamic considerations leading to a planform selection, in addition to the attainable suction characteristics, included friction drag, wave drag, and minimum drag-due-to-lift potential of the planform. A summary of these factors is presented in Table 1 for the flat meanline wings. Friction drag corresponded to the wind tunnel conditions for wing 1. Wave drag was calculated for 4% $(t/c)_{max}$ airfoils with a LER = 0.001c (where the small LER was used to minimize calculation uncertainty). Drag-due-to-lift was tabulated for $C_L = 0.20$ for no leading-edge, full leading-edge, and attainable leading-edge thrust conditions. For consistency, the reference area is the same as that of wing 1, with the gross wing area tabulated.

Table 1. Summary of Wing Characteristics

- Flat meanline wings
- M = 1.8
- $C_L = 0.20$
- $S = 1628.1\ cm^2$

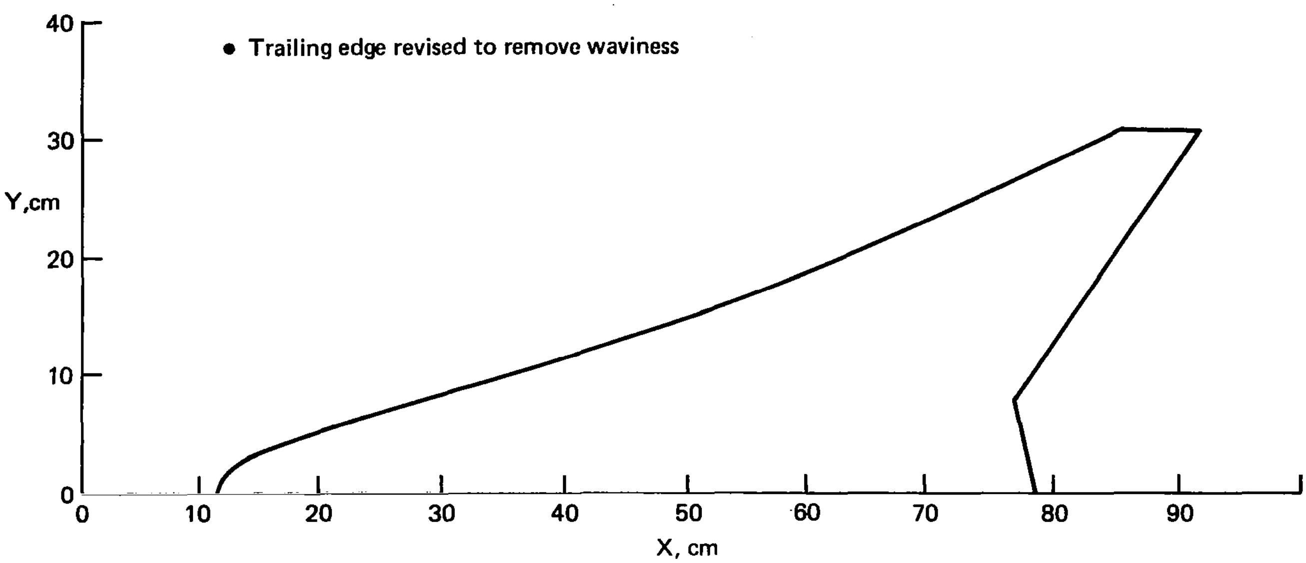
Wing	C_{D_F} [a]	C_{D_W} (LER = 0.001c)	C_{D_L} No suction	Full suction	Attainable suction (LER = 0.004c)	ΣC_D [b]	S_{gross}
1	0.0072	0.0053	0.0167	0.0120	0.0140	0.0265	1915
2	0.0070	0.0045	0.0190	0.0149	0.0160	0.0275	1870
3	0.0072	0.0052	0.0168	0.0108	0.0136	0.0260	1915
4	0.0077	0.0054	0.0157	0.0102	0.0124	0.0255	2040
5	0.0077	0.0053	0.0158	0.0103	0.0125	0.0255	2040
6	0.0077	0.0055	0.0155	0.0104	0.0124	0.0256	2040
7	0.0077	0.0052	0.0160	0.0104	0.0125	0.0254	2040
8	0.0077	0.0056	0.0154	0.0106	0.0124	0.0257	2040
9	0.0077	0.0052	0.0160	0.0103	0.0126	0.0255	2040

[a] Reynolds number = 6.56×10^6 per meter, model scale of ref. 1.
[b] $C_{D_F} + C_{D_W} + C_{D_L}$ attainable.

The drag summation, based on the attainable thrust drag-due-to-lift values, led to a choice between wings 4 to 9. Wing 7 was selected for further development because it represented a good compromise between wave drag, drag-due-to-lift potential, and leading-edge separation characteristics. The wing has a desirably low normal Mach number in the high sweepback region ($\beta \cot \Lambda_{LE} = 0.46$) to minimize wave drag associated with a relatively blunt leading-edge airfoil, and a reasonably high sweepback ($\beta \cot \Lambda_{LE} = 0.7$) for the outboard wing for low supersonic drag-due-to-lift.

4.2.2.4 Wing 7 Definition

The leading-edge geometry of wing 7 shown in Figure 44 was developed using the spanwise chord distribution of wing 4. The resulting wavy trailing edge, although satisfactory for estimating leading-edge separation characteristics, was replaced by the one shown in Figure 44 (patterned after those shown in fig. 11) for further development of wing 7.



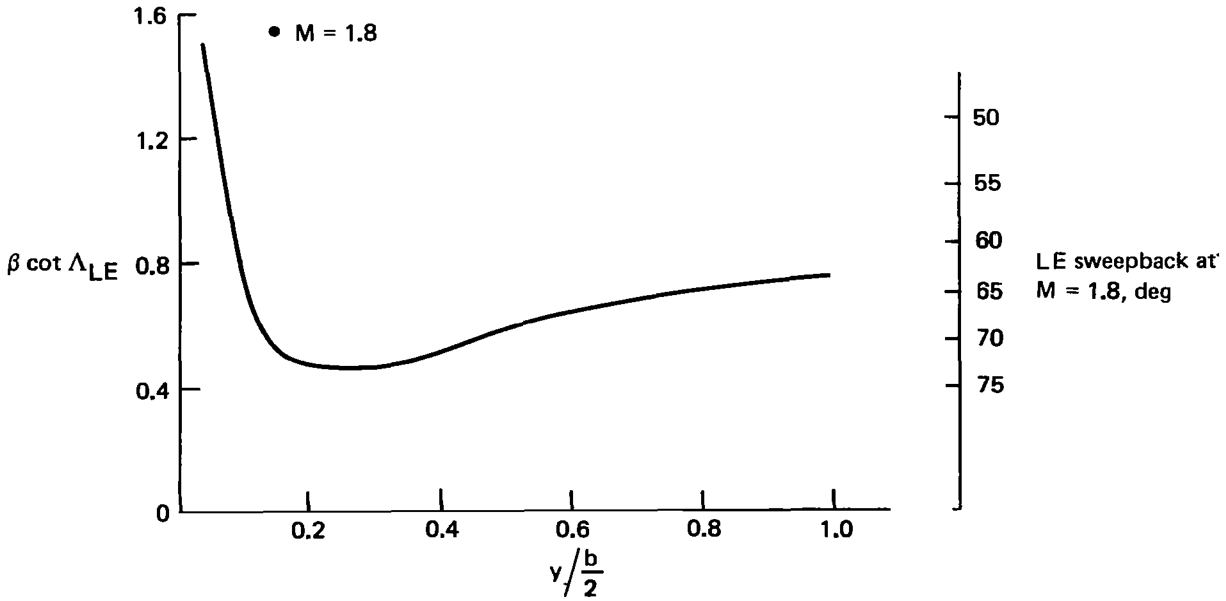


Figure 44. Planform Characteristics, Wing 7

The basic airfoil definition of wing 7 was the NACA 65A004 section used on wing 1, having LER = 0.001c. Two alternative leading-edge geometries (i.e., airfoil forward of 0.25c) were defined to investigate the effect of other airfoil nose shapes on wing wave drag and leading-edge separation. These nose shapes were—

- A sharp leading-edge airfoil, fairing smoothly into the basic airfoil shape at 0.25c.
- A blunt leading-edge airfoil with LER/c varying spanwise, fairing smoothly into the basic airfoil shape at 0.25c. The leading-edge radius corresponds to the wave drag boundary of Figure 26, as a function of the local sweepback angle of wing 7 at Mach 1.8.

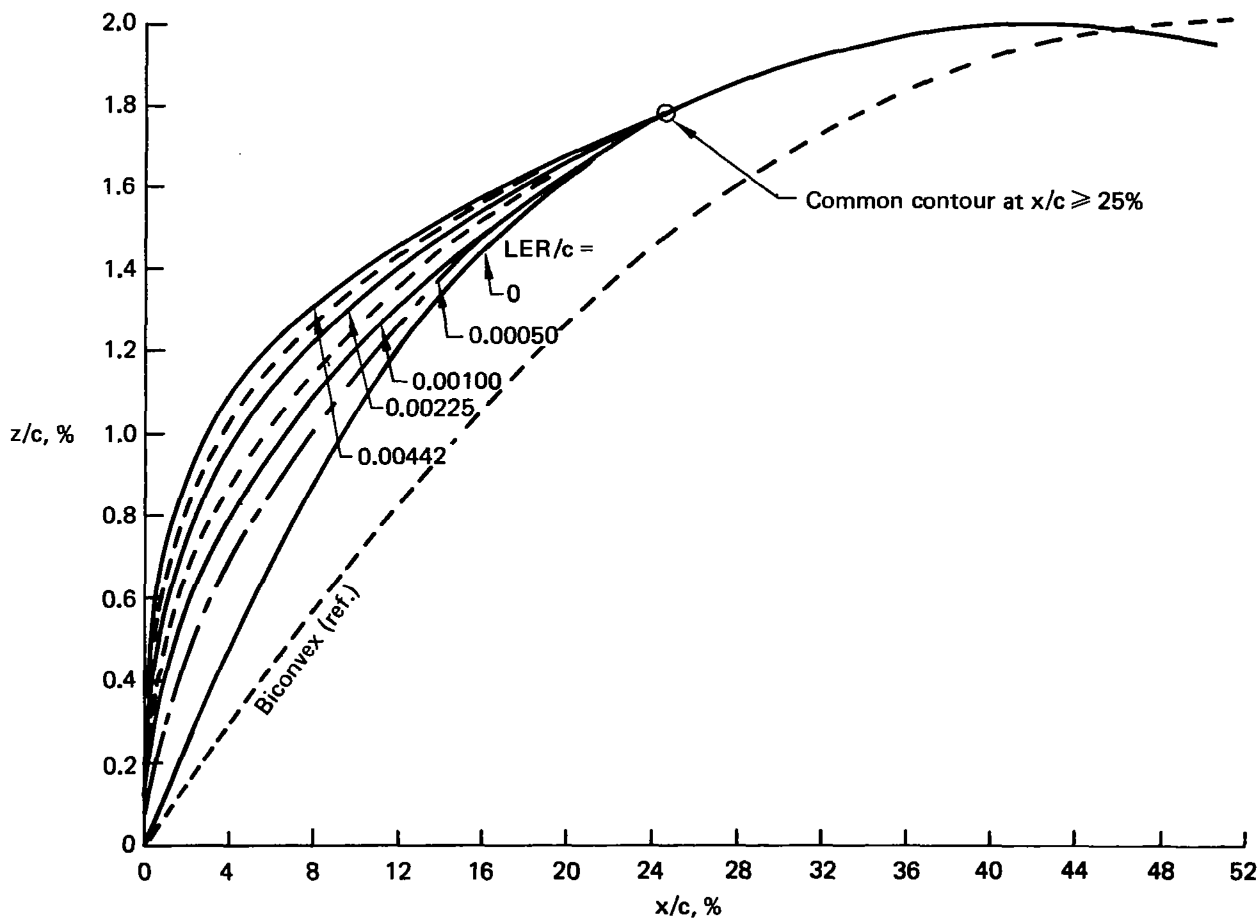


Figure 45. Airfoil Thickness

Detail definitions of the airfoil nose shapes as a function of leading-edge radius were obtained from the thickness parameter and airfoil data of Figures 45 and 46. The thickness parameter at x/c = 0 defines the leading-edge radius according to the equation

$$\text{LER}/c = 1/2\left(\frac{z/c}{\sqrt{x/c}}\right)^2_{x=0}$$

The airfoil nose shapes (forward of 0.25c) for the varying leading-edge radius wing were defined using thickness parameter data interpolated from Figure 46.

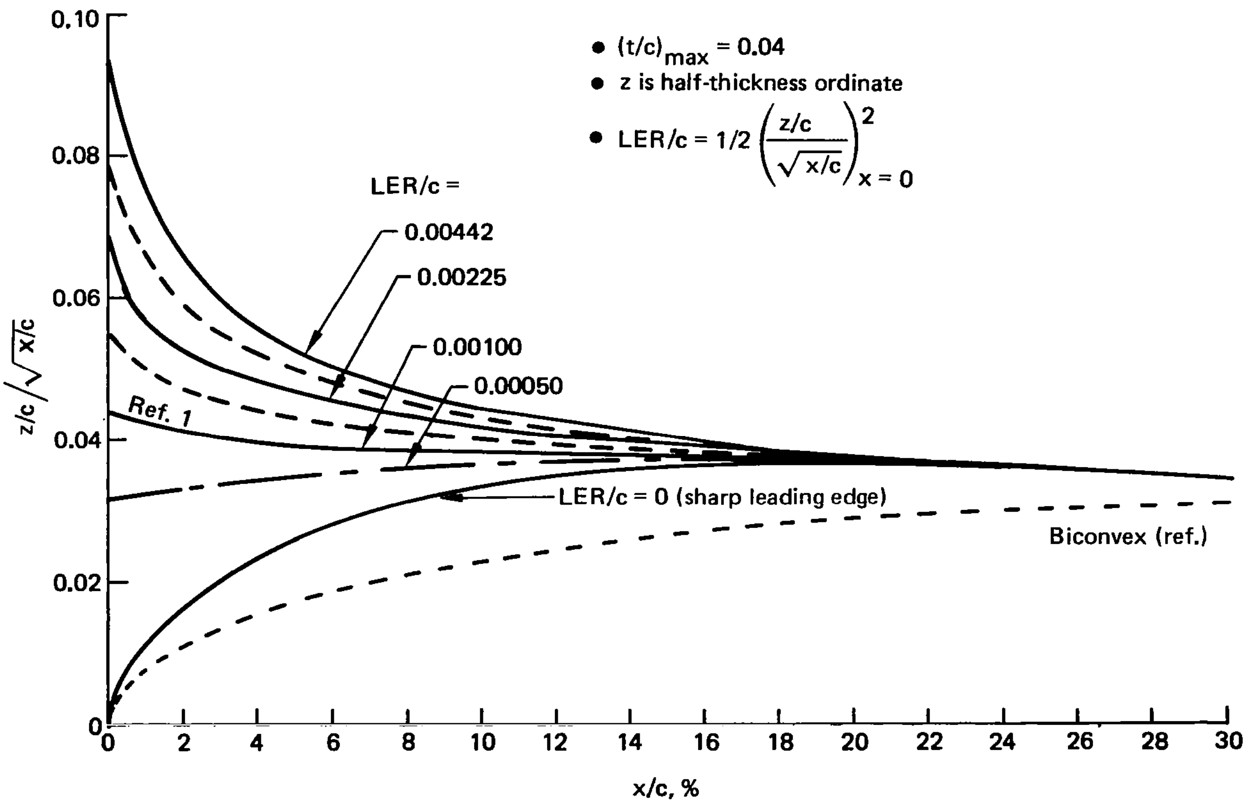


Figure 46. Airfoil Thickness Parameter

The leading-edge suction and K_T factor data for 0.001c and varying-radius leading-edge versions of wing 7 are presented in Figure 47. Predicted separation characteristics are shown in Figure 48. These data are essentially the same as the data from the corresponding planform selection of Figures 34 through 36, differing slightly due to the trailing-edge definition of wing 7 compared to the assumed chord distribution used earlier.

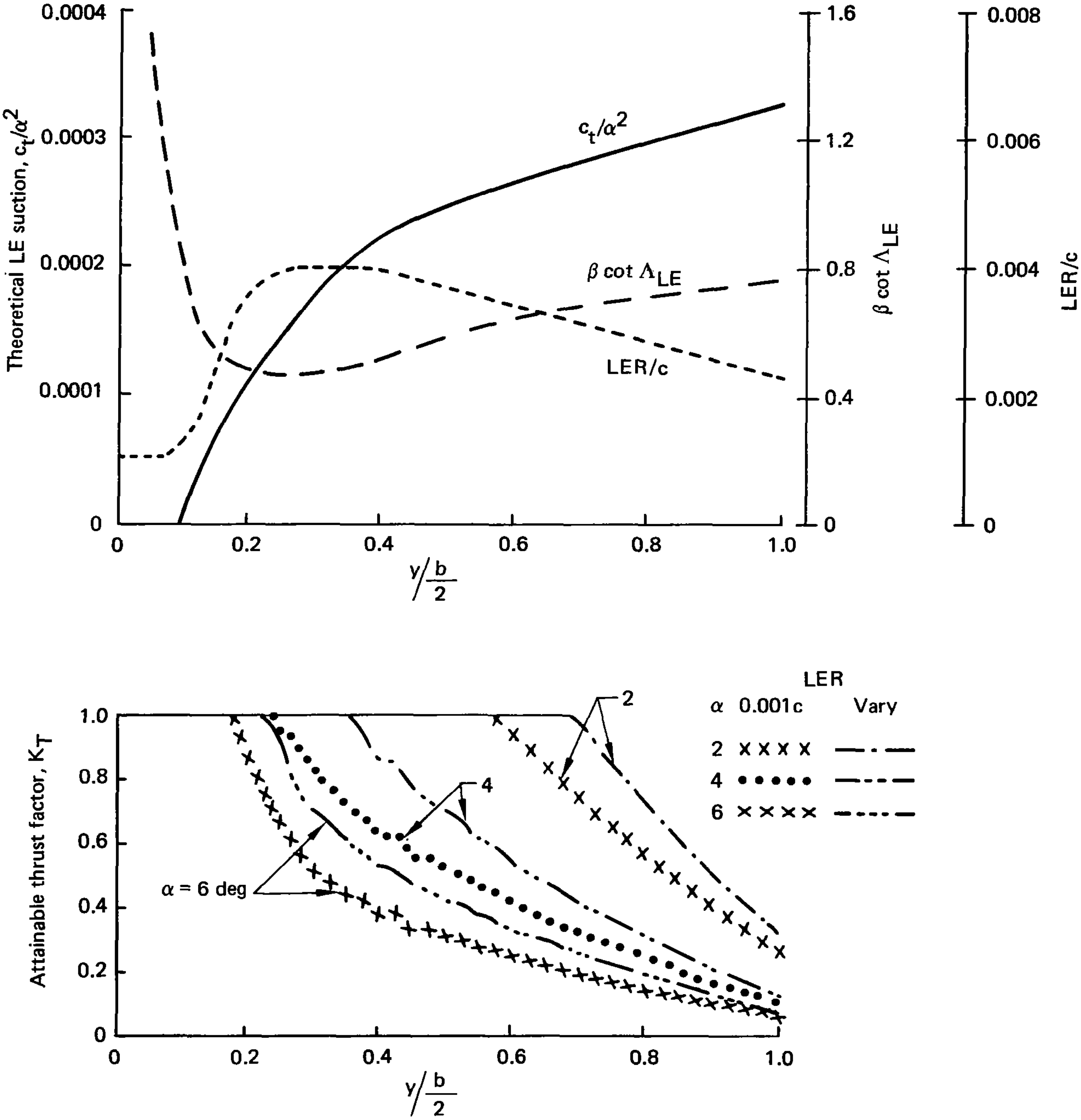


Figure 47. Leading-Edge Suction Characteristics, Wing 7—Flat Meanline Planform (M = 1.8)

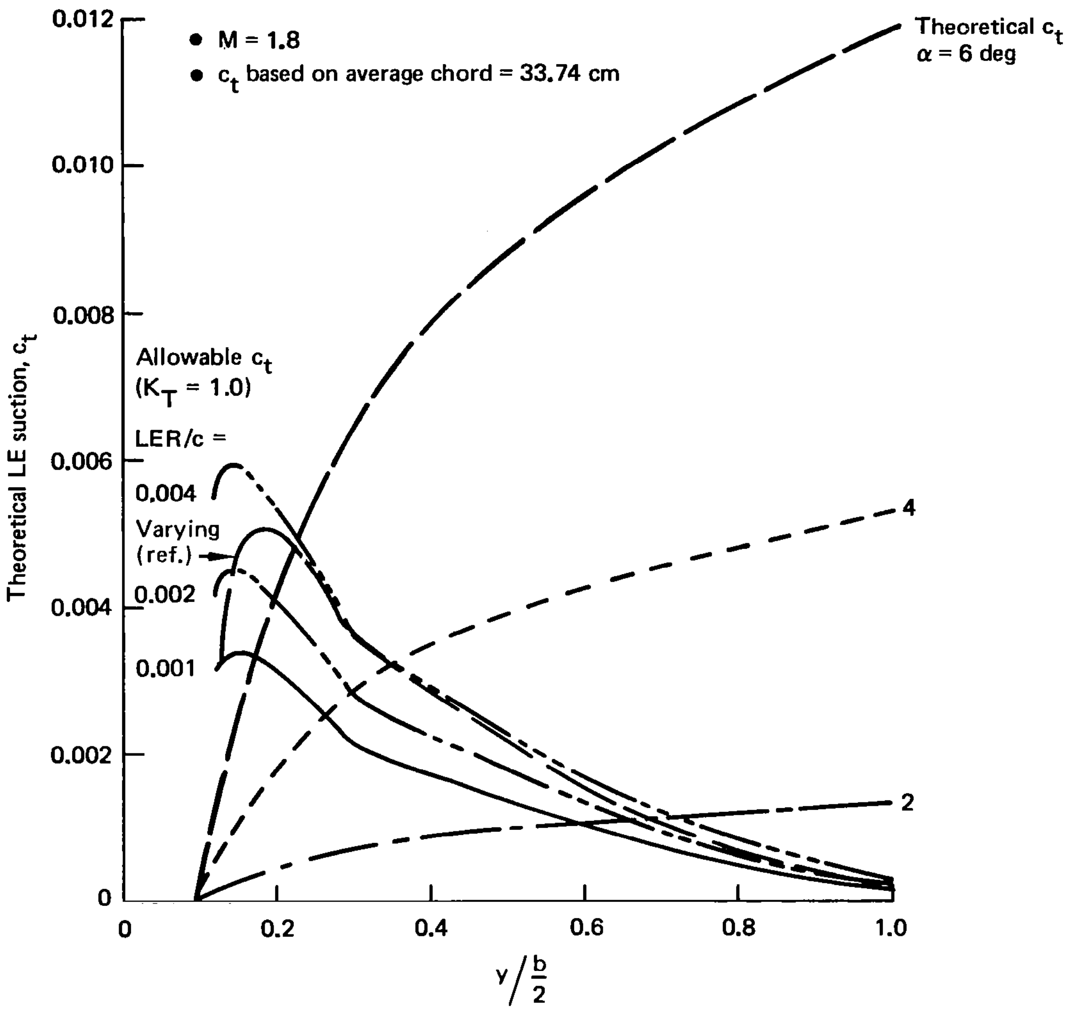


Figure 48. Separation Prediction Characteristics, Wing 7—Flat Meanline Planform

Theoretical drag-due-to-lift characteristics of the flat meanline wing 7 with sharp, 0.001c, and varying-radii leading edges are presented in Figure 49. Theoretical characteristics for no leading-edge suction and full leading-edge suction are included for reference. The wing reference area for these data and for subsequent wing 7 data was changed to the gross planform area.

Theoretical pressure data for wing 7 are presented in the appendix. Wind tunnel model recommendations and definitions are given in Section 5.0.

4.2.3 Cambered Wing Development

The objective of the cambered wing development was to use the attainable thrust approach in the design of an optimized wing shape and then to further define leading-edge geometries for improved wing characteristics at higher angles of attack.

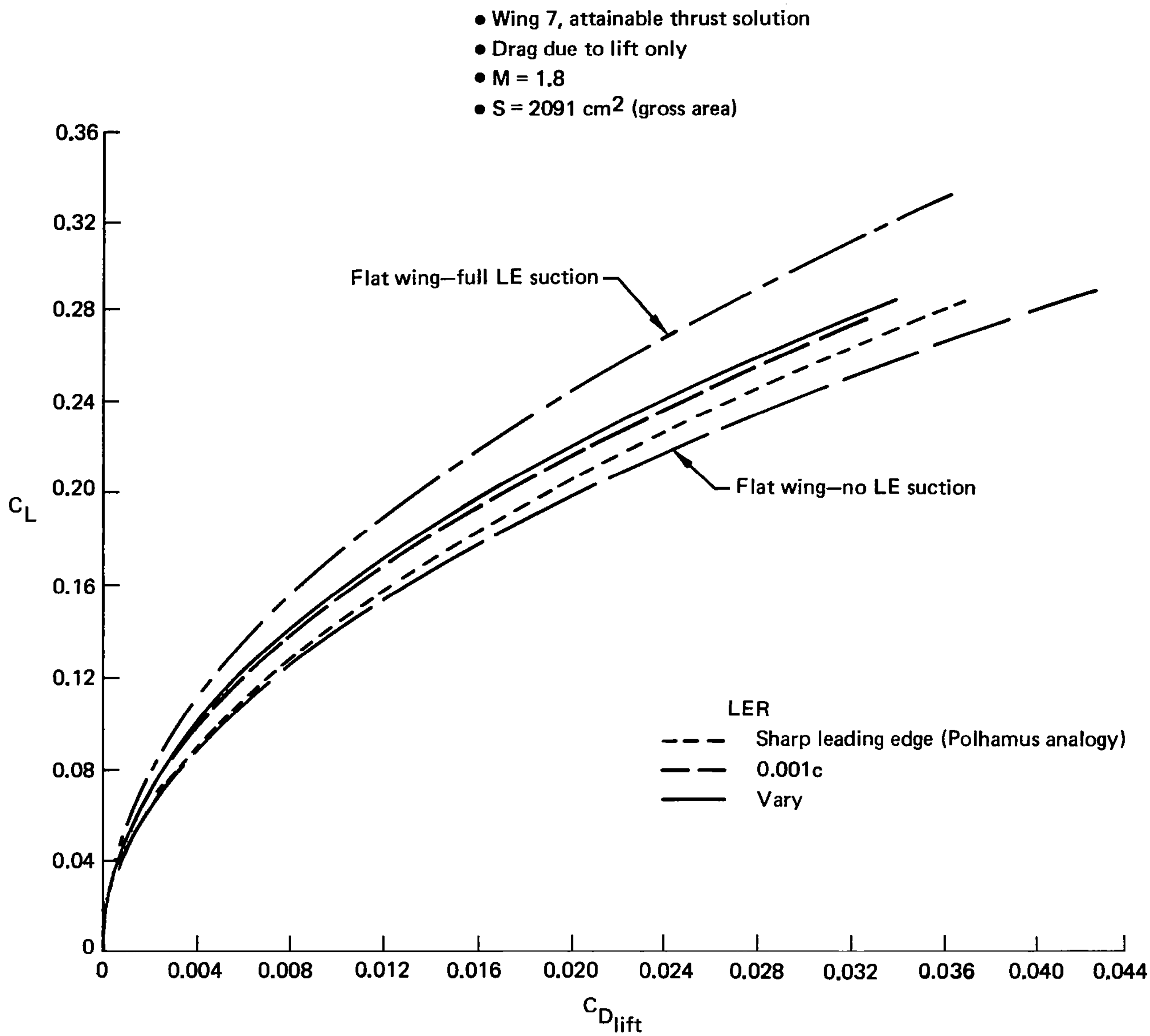


Figure 49. Theoretical Effect of Leading-Edge Radius—Flat Meanline Wing

4.2.3.1 Basic Wing Design

The design conditions for the basic cambered wing were Mach 1.8 and $C_L = 0.10$. A twisted and cambered meanline surface having low drag-due-to-lift, corresponding to the flat wing 7, was defined using the constrained linear theory methods of References 4 to 6. A feature of these methods is the capability of imposing limits on an allowable upper surface pressure coefficient level and/or gradient used in the loading optimization at the design lift condition. The attainable thrust solution was employed to define the allowable gradient by determining the leading-edge pressure gradient corresponding to the flat wing

K_T breakaway point at various spanwise stations. The design upper surface pressure coefficient constraints for the cambered wing 7 are shown in Figure 50.

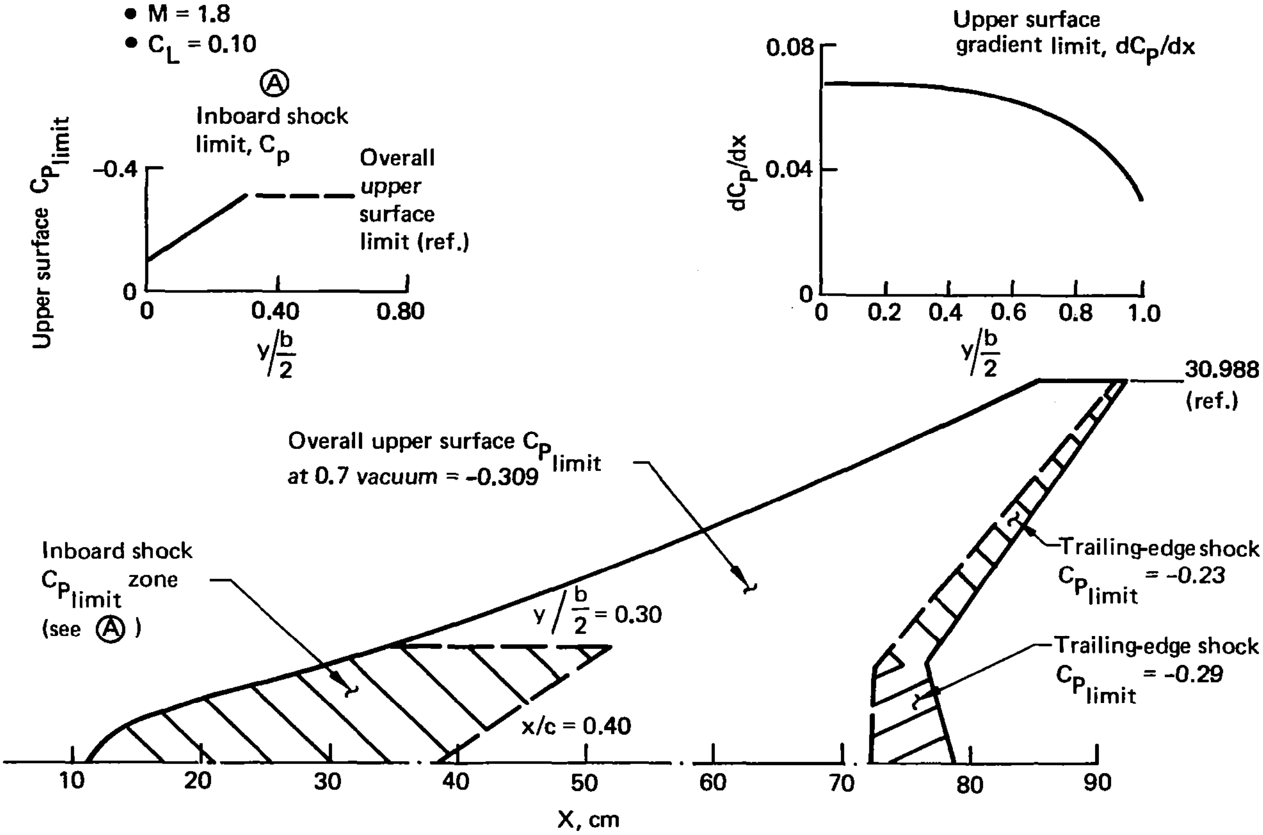


Figure 50. Design C_P Constraints, Wing 7—Cambered

The calculated camber surface obtained from the design program was smoothed to remove slope irregularities and sheared to produce a straight line of 8 deg anhedral along the 65% chord line of the wing. Representative cuts through the wing loft and lifting pressure distributions obtained from the lift analysis program are presented in the appendix.

The cambered wing, due to the lifting pressure distribution used in the optimization, develops very little leading-edge thrust at the design condition. By superposition, the incremental thrust coefficients relative to the design point for the cambered wing are the same as the flat wing relative to $\alpha = 0$. Thus, except for the effect of a higher average lifting pressure due to the design lift coefficient, the beneficial effects due to leading-edge radius in maintaining attached flow over an expanded angle-of-attack envelope for the flat wing should be applicable to the cambered wing, relative to its design point.

Leading-edge suction and separation prediction characteristics for the cambered wing 7 are presented in Figures 51 and 52 for the 0.001c and varying-radius leading edges. These characteristics are similar to those of the flat wing, but not directly comparable because of the different lift coefficients involved, as shown in the tabulation below.

	C_L			
	Angle of attack, deg			
	0	2	4	6
Flat wing	0	0.07	0.144	0.224
Cambered wing	0.108	0.179	0.255	0.337

An alternative presentation of leading-edge separation characteristics for the two wings that allows direct comparisons in terms of lift coefficient is shown in Figure 53. The attached-flow envelopes identify, as a function of C_L, the spanwise locations where K_T breaks away from 1.0 for the 0.001c and varying-radius leading edges. The varying-radius leading edge provides a significant improvement in envelope size for attached flow. The cambered wing essentially shifts the attached-flow envelope of the flat wing to the C_L level of the design lift coefficient.

The attached-flow envelopes correspond to the allowable c_t functions of the flat wing analyses and were calculated by determining the wing lift coefficients associated with the allowable c_t at various spanwise stations. These lift coefficient limits define a corresponding local angle-of-attack range, above and below local $\alpha = 0$, to preclude either upper surface or lower surface separation.

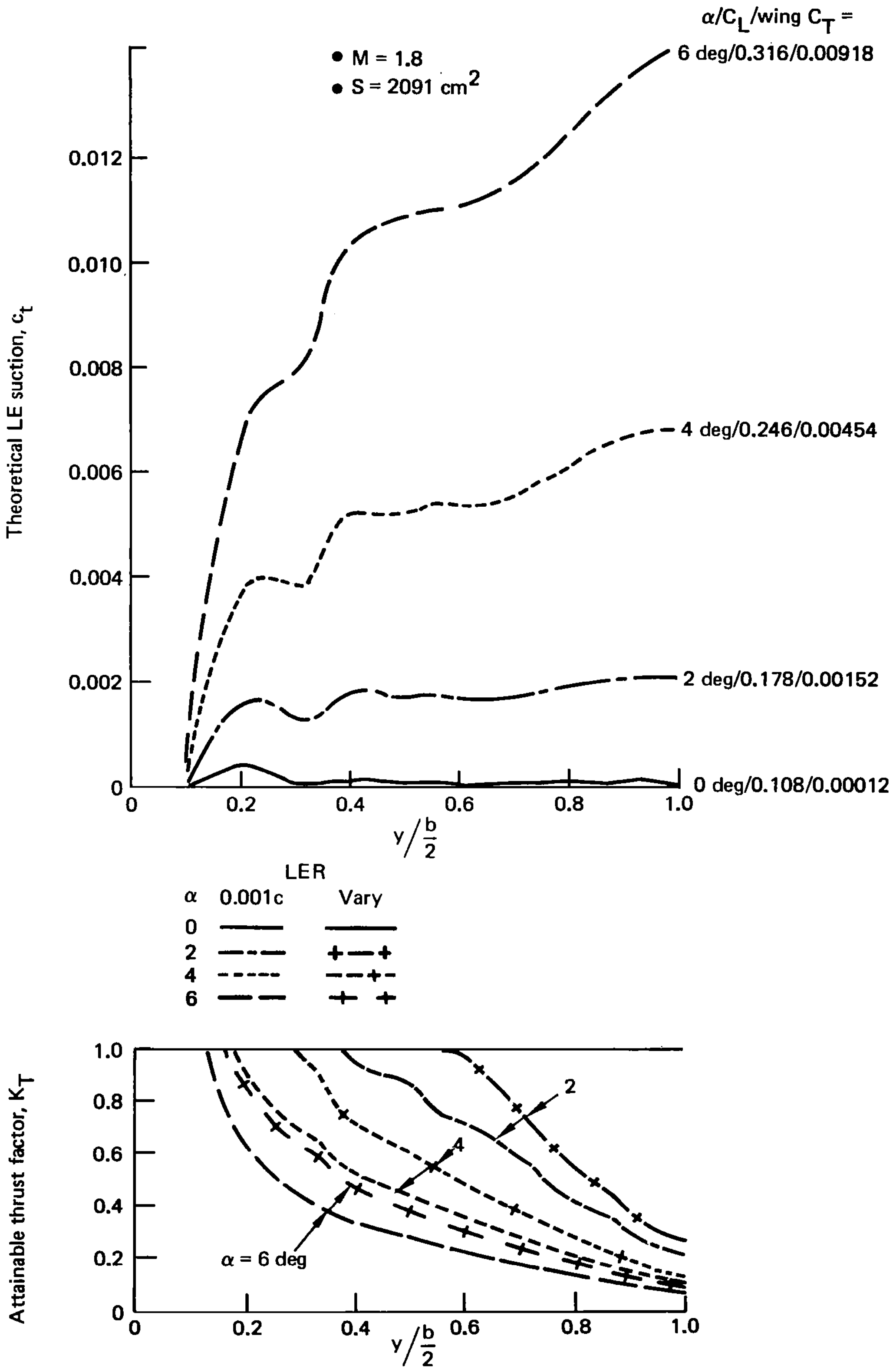


Figure 51. Leading-Edge Suction Characteristics, Wing 7—Cambered

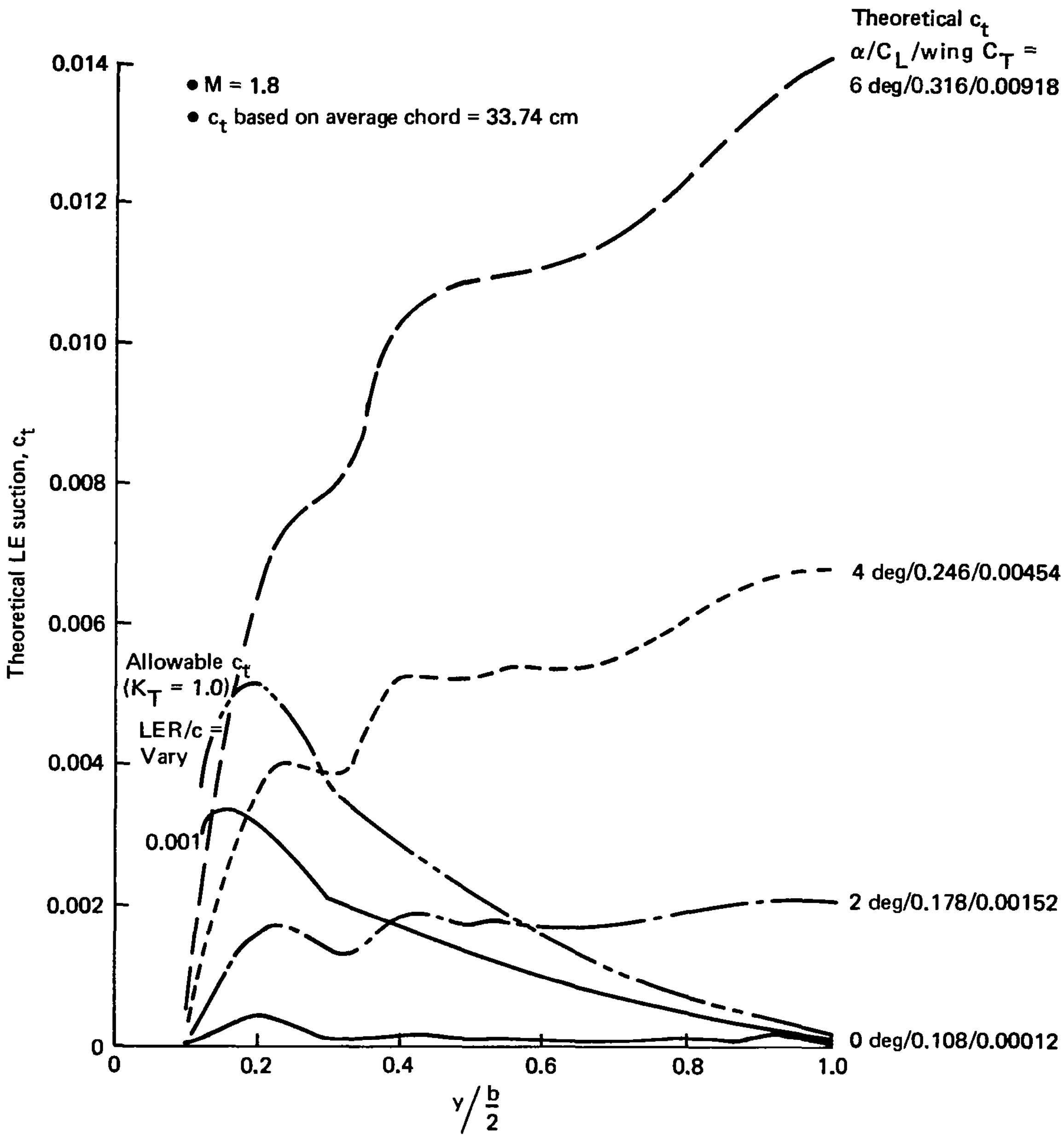


Figure 52. Separation Prediction Characteristics, Wing 7—Cambered

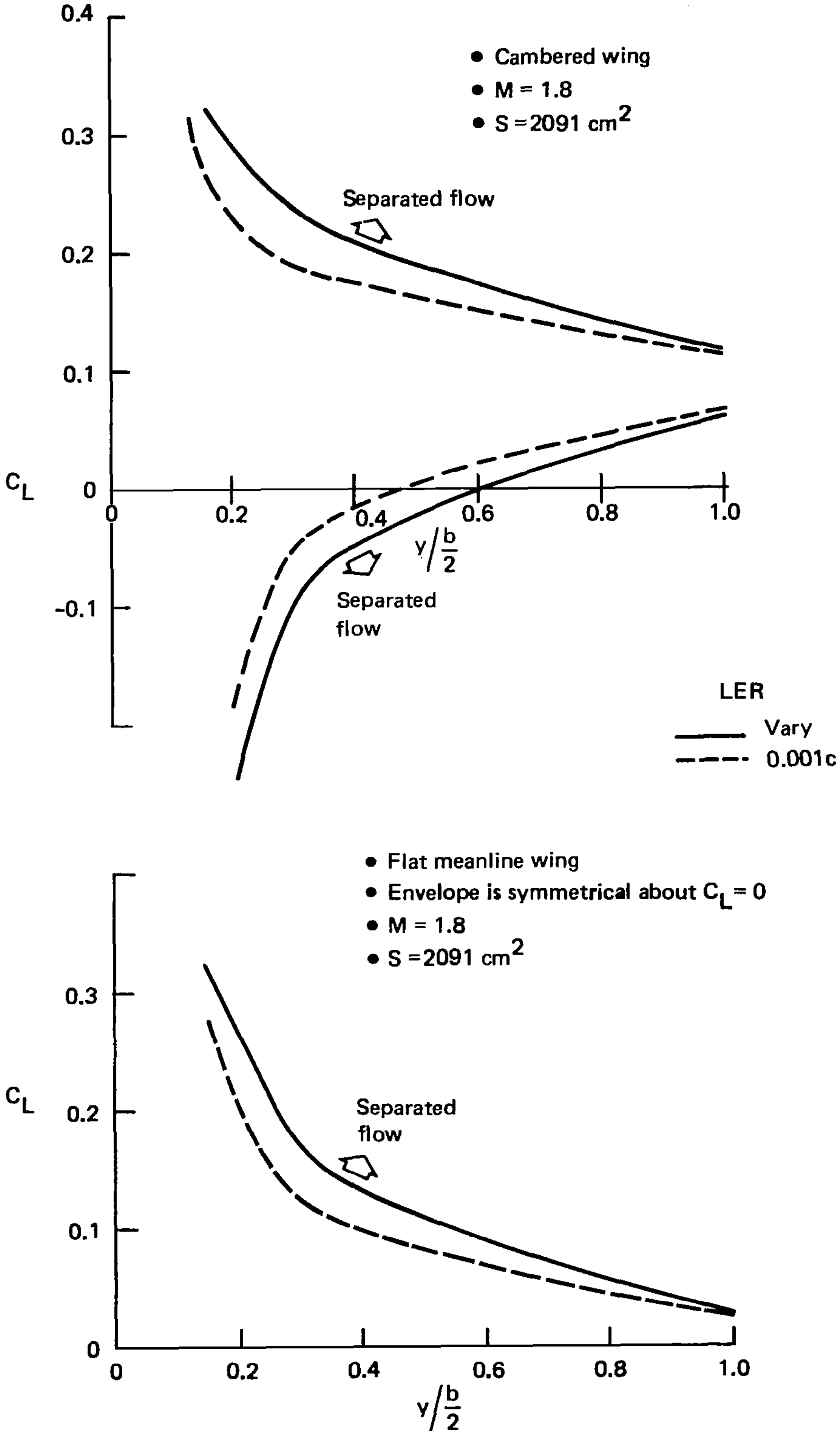


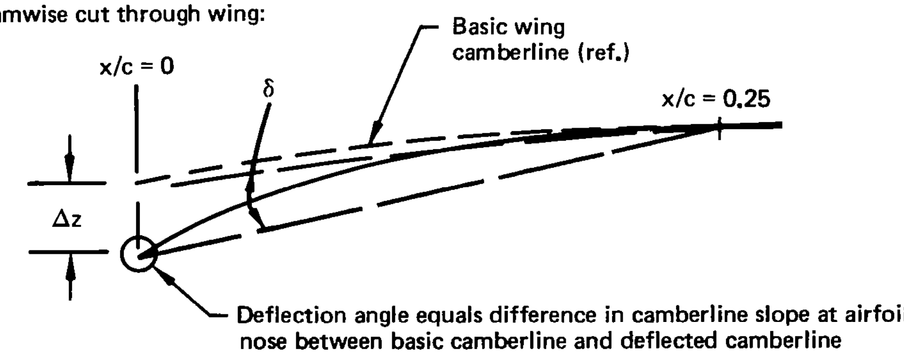
Figure 53. Attached-Flow Envelope, Wing 7

4.2.3.2 Wing Leading-Edge Deflections for Cambered Wing

As a further application of the attached-flow envelope for the cambered wing, it may be feasible to use the attainable thrust analysis to achieve attached leading-edge flow at specified angles of attack. The technique involves deflecting the wing leading edge to obtain leading-edge thrust coefficients less than the attached-flow limits. The solution requires iteration to identify the necessary deflections.

The required deflections were calculated for the cambered wing at several angles of attack above design. The wing leading edge, forward of 0.25 chord, was deflected smoothly from the basic cambered wing shape to a defined incremental angle at the leading edge, as shown in Figure 54. Spanwise deflection schedules for α = 2, 4, and 6 deg were obtained by solving for deflection angles giving $c_t \approx 0$ for the entire wing at each α. These schedules were then adjusted to approximate ones forming a "family" as a function of angle of attack, with c_t falling within the attached-flow limits for the varying-radius leading-edge wing. The resulting deflection angle schedules and attached-flow envelopes are presented in Figures 55 through 58. Some wingtip separation was allowed at $\alpha = 6$ deg, as shown, because the local deflection angles required to maintain attached flow were considered excessive.

- Streamwise cut through wing:



- Deflection angle = $\tan^{-1}\left(\frac{dz}{dx}\right)_{\text{nose, deflected LE}} - \tan^{-1}\left(\frac{dz}{dx}\right)_{\text{nose, basic wing}}$

- Fcr smooth arc from 0.25c to nose:

$$\Delta\left(\frac{z}{c}\right)_{\text{nose}} = 0.00962 \text{ per degree of deflection angle}$$

- Equivalent plain flap deflection angle:

$$\delta = \Delta\left(\frac{z}{c}\right)_{\text{nose}} \Big/ 0.25 = 0.55 \text{ per degree of deflection angle}$$

Figure 54. Flap Deflection Angle Definitions

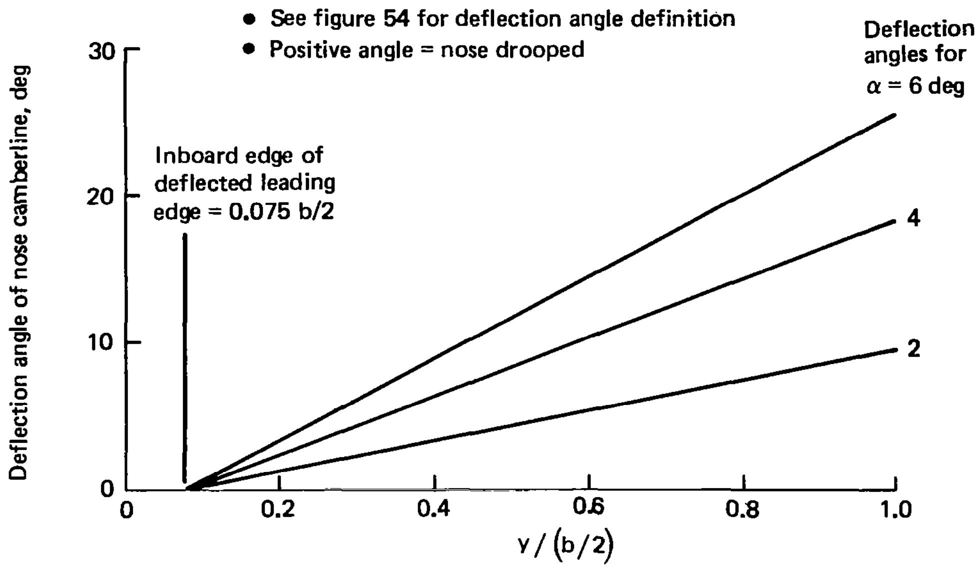


Figure 55. Leading-Edge Deflection Angles, Wing 7—Cambered

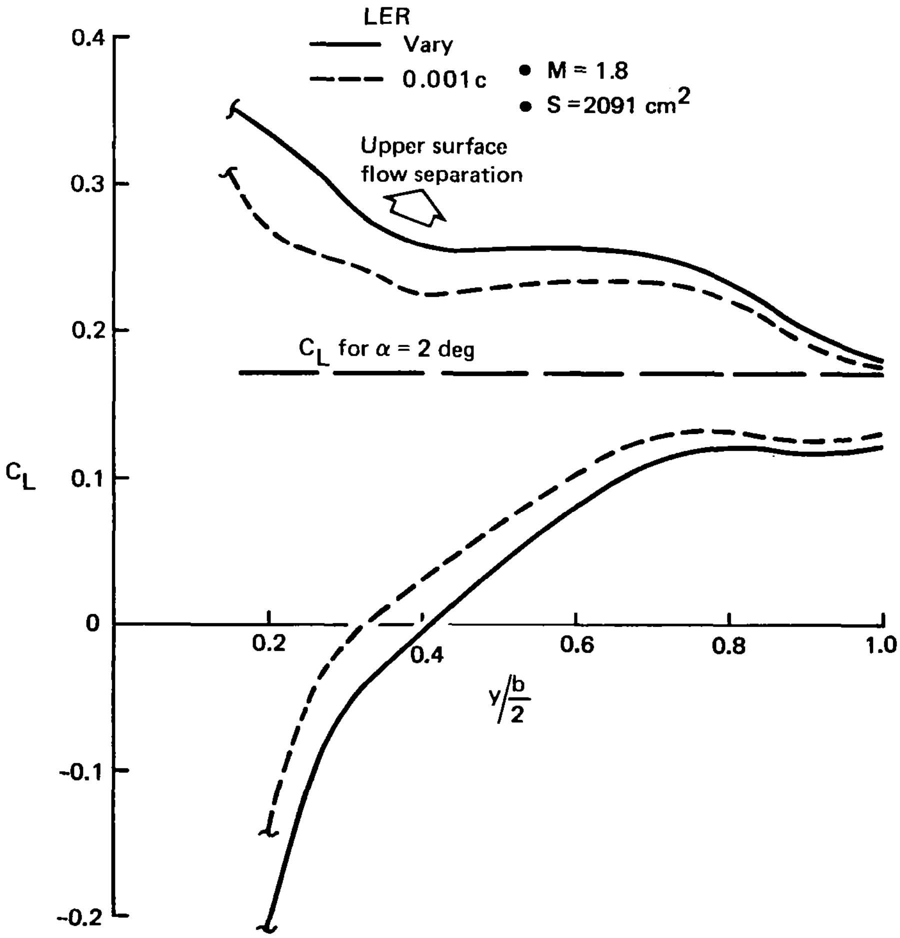


Figure 56. Attached-Flow Envelopes, Wing 7—Cambered, Leading Edge Drooped for α = 2 deg

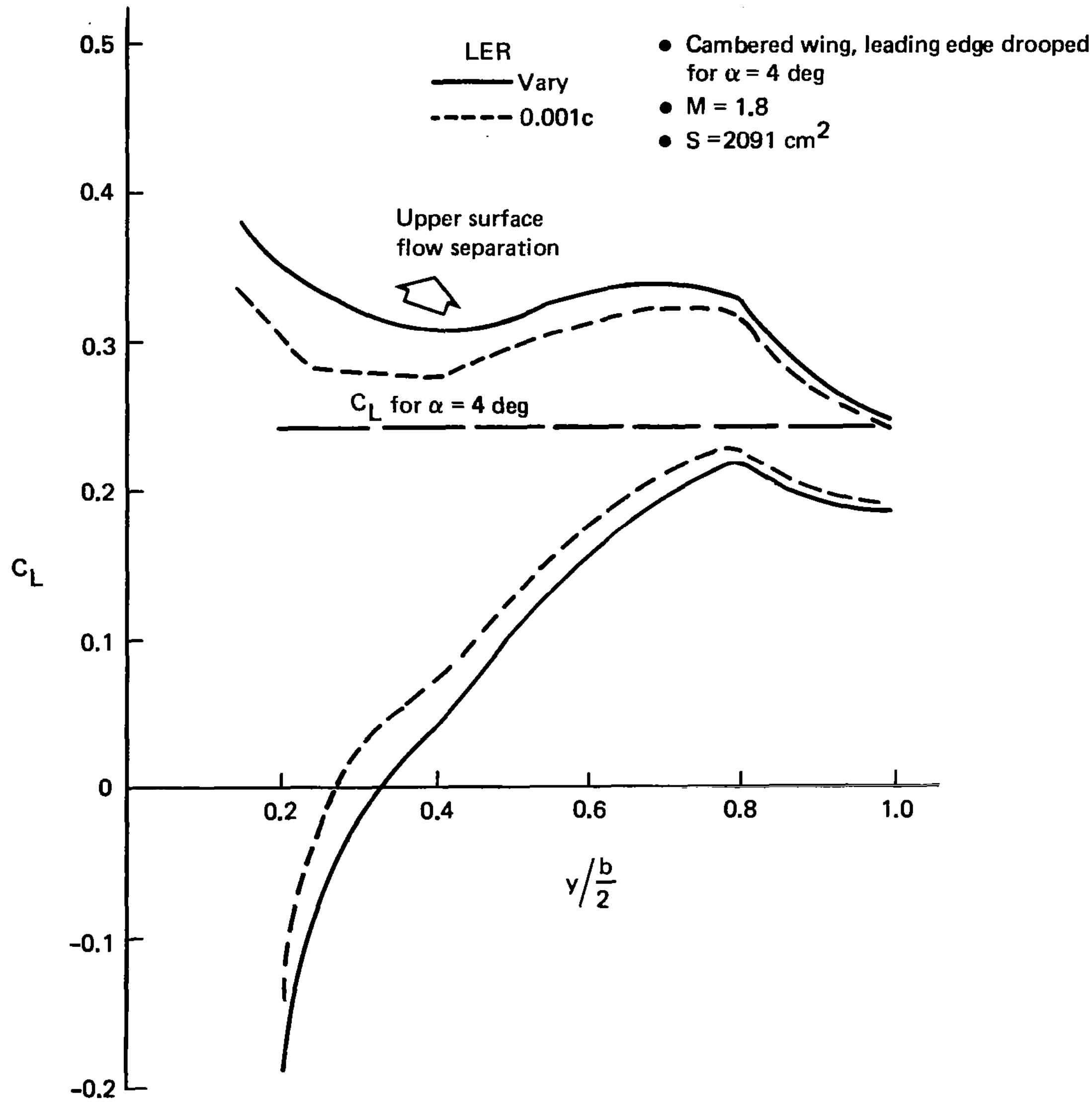


Figure 57. Attached-Flow Envelopes, Wing 7—Cambered, Leading Edge Drooped for α = 4 deg

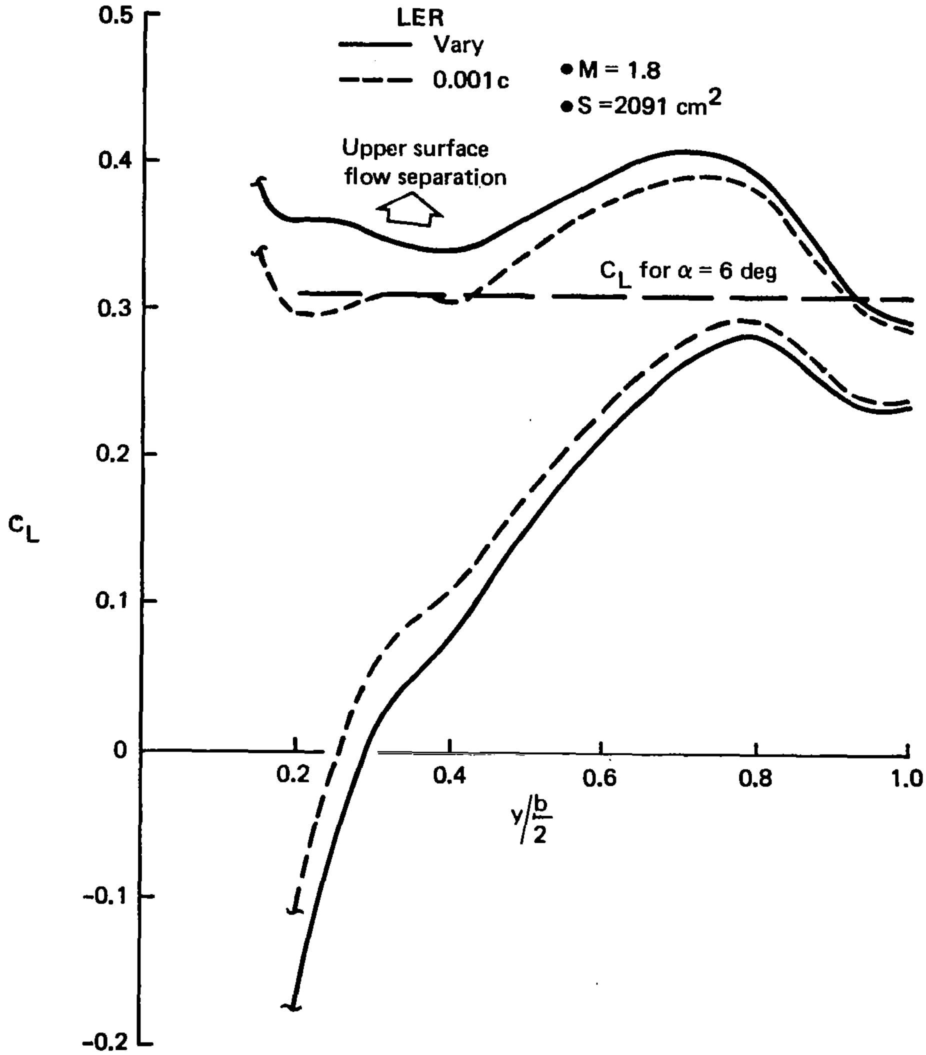


Figure 58. Attached-Flow Envelopes, Wing 7—Cambered, Leading Edge Drooped for $\alpha = 6$ deg

The attached-flow envelopes for the cambered wing illustrate several points:

- Inboard on the wing, where the leading-edge upwash is moderate and the leading-edge radius relatively large, there is substantial latitude for deflection angle selection. Outboard, where the situation is reversed, the selection is quite limited.

- One of the goals of the planform leading-edge definition was to moderate the spanwise rate of increase of leading-edge suction (local upwash). Nevertheless, the upwash angles, as defined by the deflection angle requirements, rapidly increased (to approximately 30 deg at $\alpha = 6$ deg near the wingtip). The linear theory solution is thus producing a requirement for deflection angles that violate linear theory assumptions at relatively low wing angles of attack.

- Avoiding large leading-edge deflection angles due to linear theory restrictions is not a meaningful prohibition because the leading edge otherwise experiences large local angles of attack.

- A conclusion resulting from these analyses is that the attainable thrust attached-flow envelope, used in conjunction with an upwash angle restriction, might allow the definition of a planform geometry that offers further attached-flow potential at higher wing angles of attack.

The estimated drag characteristics of the cambered wing, including the leading-edge deflection series, are shown in Figure 59. Symbols identify the design angle of attack and/or lift coefficient for the particular deflection schedule used. An interesting point is that the attached-flow drag-due-to-lift at the higher deflections does not necessarily give the lowest theoretical drag for the corresponding lift coefficient because the associated nose force vector has the direction of the drooped leading-edge angle. Somewhat lower drag occurs with some leading-edge separation because the vortex lift (acting normal to the drooped leading edge) then produces a better lift-to-drag ratio.

In the earlier discussion of the attainable thrust method, it was noted that the theoretical force characteristics for cambered wing solutions with separated leading-edge flow have to be considered approximate because of the assumptions made in the leading-edge suction vector orientation. The line of action of the vortex lift component is inaccurate for cambered wings due to the spreading out of the vortex force. This characteristic is exaggerated in the case of a drooped leading edge, so that the theoretical force characteristics, outside the range of the attached-flow envelope, need to be interpreted with caution.

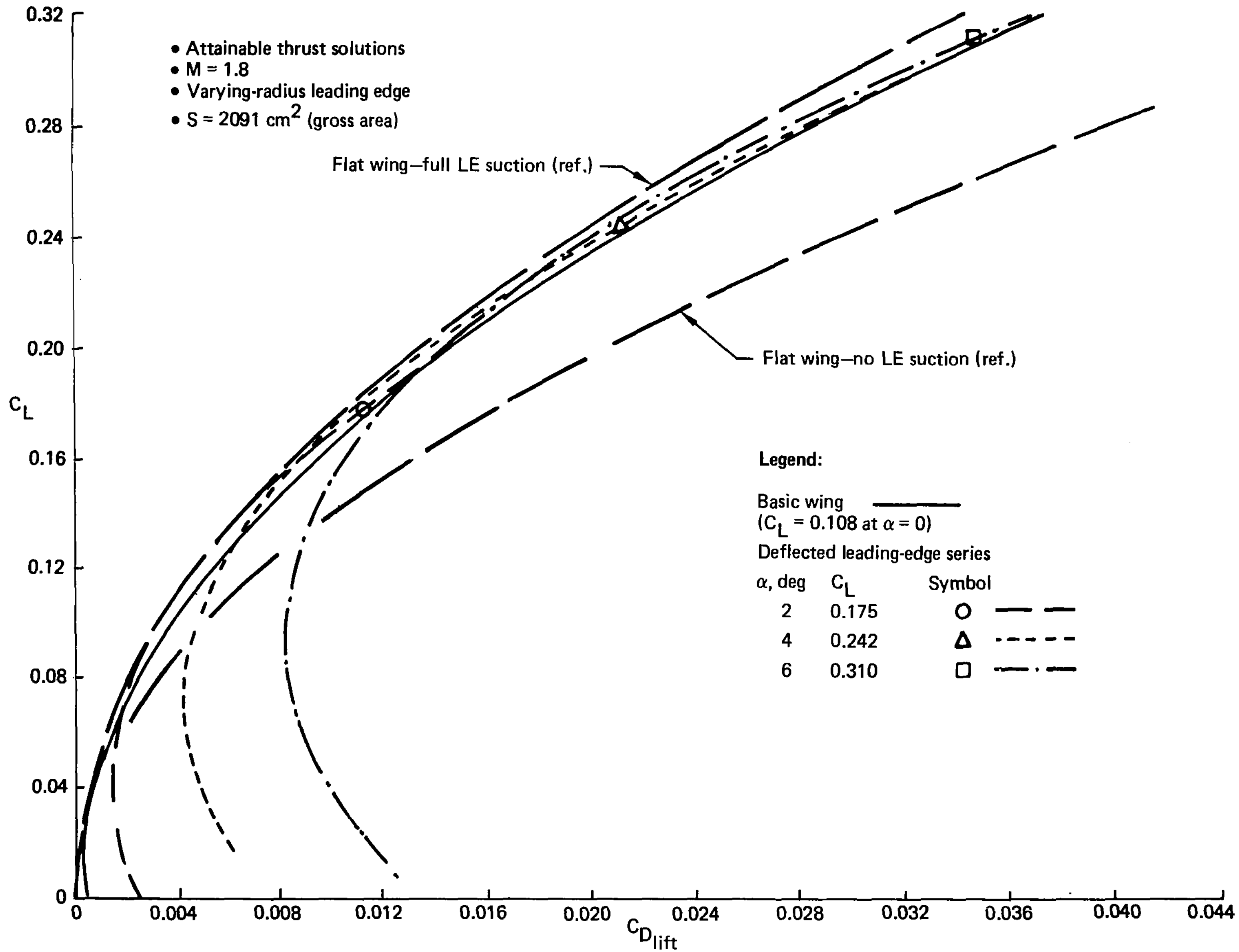


Figure 59. Theoretical Effect of Leading-Edge Deflection, Wing 7—Cambered

5.0 WIND TUNNEL MODEL RECOMMENDATIONS

Wind tunnel models to provide an experimental check on the theoretical estimates for wing 7 (flat and cambered meanlines) are described in this section. Principle points of interest are the tradeoff between wave drag and leading-edge suction characteristics for the flat meanline wing and the effect of leading-edge deflection on the force characteristics of the cambered wing.

It is recommended that two wings be constructed:

- A flat meanline model having interchangeable leading edges to allow different leading-edge radii: sharp, 0.001c, and the varying-radius leading-edge definition discussed in Section 4.2.2.

- A cambered meanline model having interchangeable leading-edge pieces to allow leading-edge deflections tailored for $\alpha = 0$ (basic leading edge), 2, 4, and 6 deg, as discussed in Section 4.2.3.

The overall model layout is illustrated in Figure 60. This layout uses the minimum fuselage arrangement used for the Reference 1 model and the same basic NACA 65A004 airfoil section (LER = 0.001c). The apex region remains fixed to provide attachment support for the removable leading edges and has the basic LER = 0.001c airfoil nose section. Spanwise, the sharp and varying-radius leading edges fair smoothly into the apex region, as shown in Figure 61. Chordwise, all leading edges fair into the basic airfoil geometry at 0.25 chord, which is somewhat forward of the removable leading-edge joint.

The wing definitions for the flat meanline wings are presented in the input format of Reference 5 in Tables 2 through 4.

The cambered wing definitions for the basic wing shape and deflected leading-edge versions are presented in Tables 5 through 9. The thickness definition of the wing is not repeated here; the planform definition in Table 5 shows the basic wing shear, which produces a straight line of 8 deg anhedral along the 65% chord line of the wing.

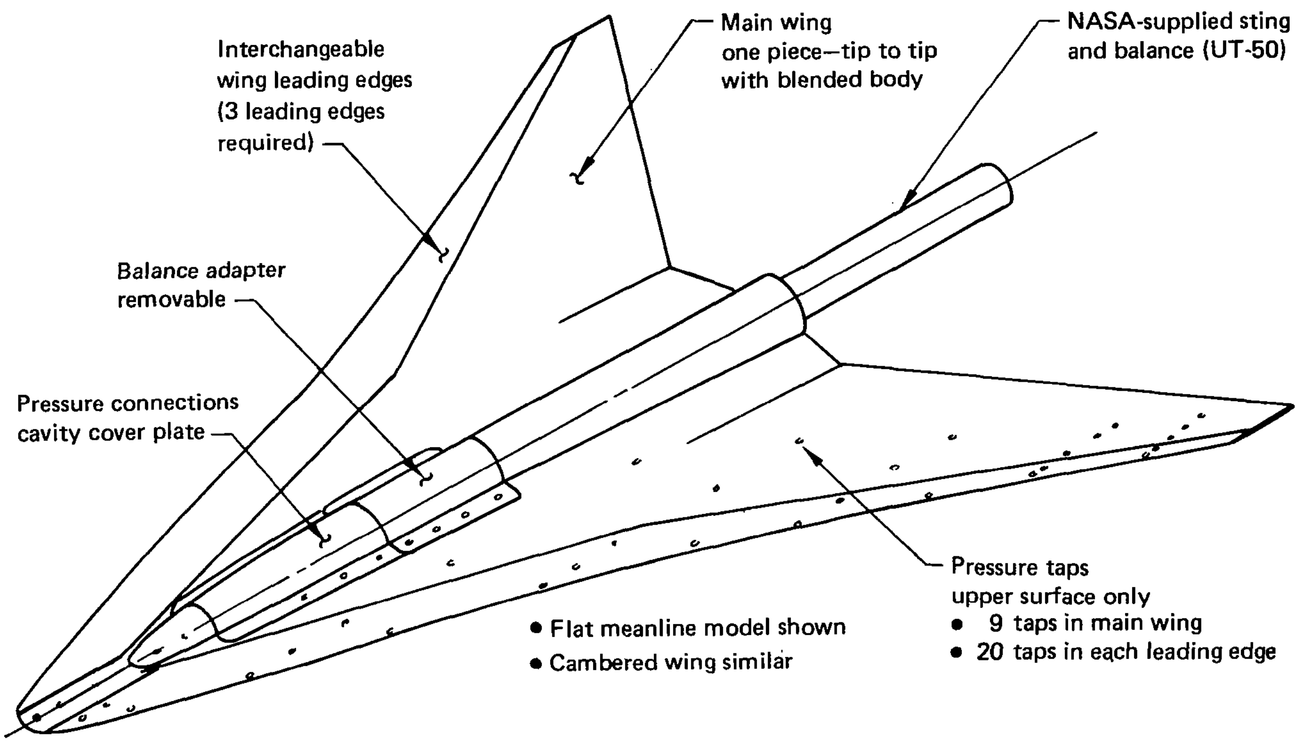


Figure 60. Wind Tunnel Model Layout

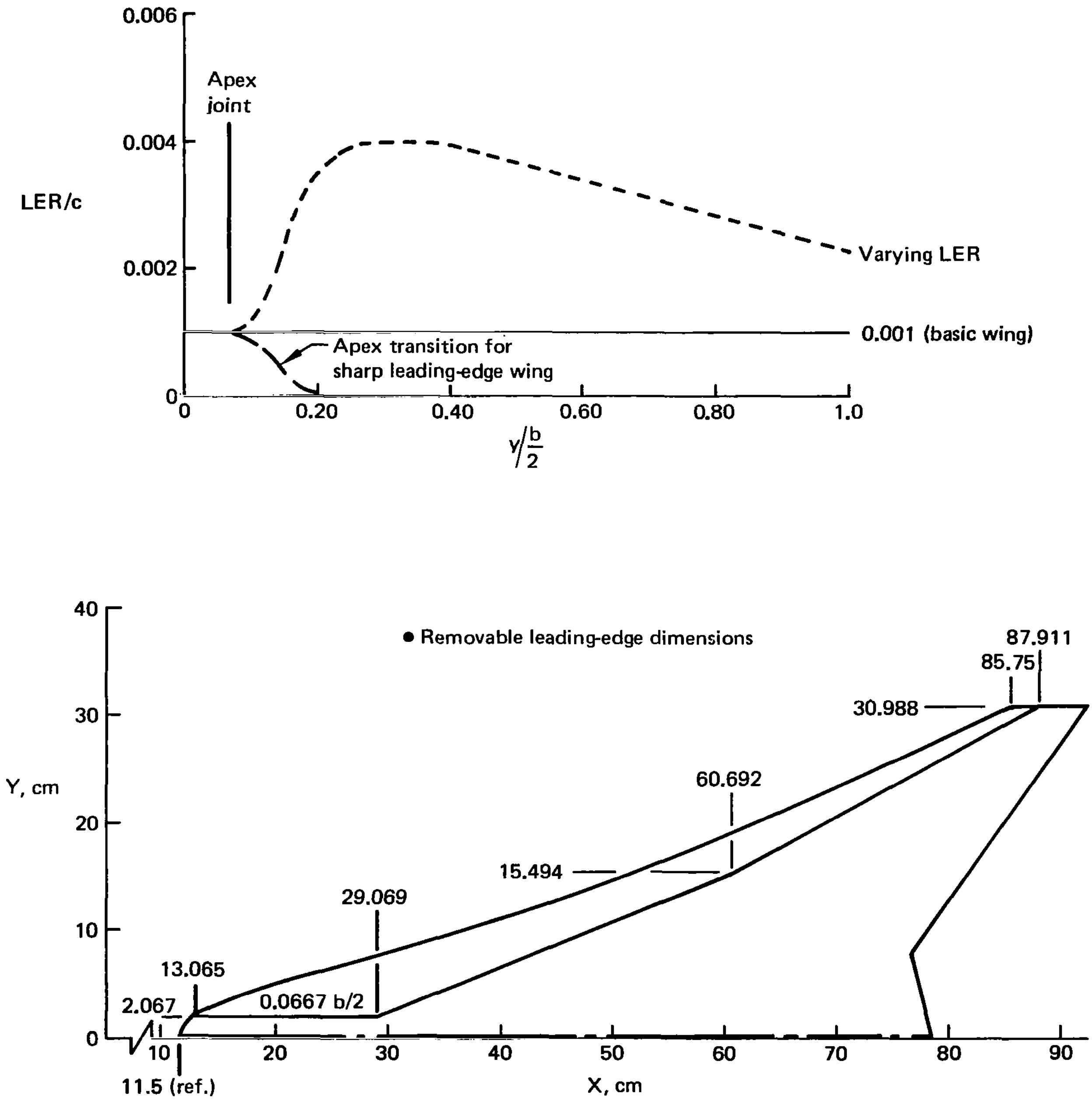


Figure 61. Leading-Edge Radius and Removable Leading Edge—Flat Meanline Wing

Table 2. Flat Meanline Wing Geometry—Sharp Leading Edge

```
WING 7  FLAT MEANLINE   SHARP L.E.    DIM. IN CM.                                      2
 1 -1                      20 36                                                        3
2091.   40.28   57.22                                                                   4
0.0     .025    .05     .1      .15     .2      .3      .4      .5      .625     XAF 1
.75     .9      1.075   1.25    2.5     5.      7.5     10.     15.     20.      XAF 2
25.     30.     35.     40.     45.     50.     55.     60.     65.     70.      XAF 3
75.     80.     85.     90.     95.     100.                                     XAF 4
  11.500  0.000  0.000 67.000                                                    WORG  1
  11.947  1.031  0.000 66.353                                                    WORG  2
  13.065  2.068  0.000 65.035                                                    WORG  3
  14.690  3.099  0.000 63.210                                                    WORG  4
  17.031  4.130  0.000 60.669                                                    WORG  5
  19.918  5.166  0.000 57.582                                                    WORG  6
  23.065  6.198  0.000 54.235                                                    WORG  7
  28.032  7.747  0.000 48.968                                                    WORG  8
  33.073  9.296  0.000 44.939                                                    WORG  9
  38.083 10.848  0.000 40.943                                                    WORG 10
  42.881 12.395  0.000 37.155                                                    WORG 11
  47.380 13.945  0.000 33.669                                                    WORG 12
  51.547 15.494  0.000 30.514                                                    WORG 13
  55.459 17.043  0.000 27.614                                                    WORG 14
  59.188 18.593  0.000 24.898                                                    WORG 15
  62.783 20.142  0.000 22.314                                                    WORG 16
  66.274 21.692  0.000 19.836                                                    WORG 17
  73.000 24.750  0.000 15.134                                                    WORG 18
  79.473 27.889  0.000 10.685                                                    WORG 19
  85.752 30.988  0.000  6.430                                                    WORG 20
  0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380   WAF  1-1
   .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450   WAF  1-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  1-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  1-4
  0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380   WAF  2-1
   .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450   WAF  2-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  2-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  2-4
  0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380   WAF  3-1
   .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450   WAF  3-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  3-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  3-4
  0.0000  .0623  .0860  .1233  .1530  .1789  .2208  .2547  .2840  .3164   WAF  4-1
   .3452  .3761  .4097  .4425  .6176  .8500 1.0382 1.1960 1.4520 1.6426   WAF  4-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  4-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  4-4
  0.0000  .0510  .0720  .1022  .1255  .1453  .1786  .2067  .2316  .2596   WAF  5-1
   .2850  .3131  .3435  .3725  .5391  .7865  .9854 1.1522 1.4346 1.6366   WAF  5-2
  1.7680 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  5-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  5-4
  0.0000  .0201  .0297  .0440  .0557  .0661  .0850  .1020  .1181  .1373   WAF  6-1
   .1553  .1766  .2006  .2237  .3790  .6521  .8904 1.0931 1.4095 1.6302   WAF  6-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  6-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  6-4
  0.0000  .0027  .0055  .0113  .0172  .0233  .0351  .0465  .0580  .0727   WAF  7-1
   .0868  .1044  .1250  .1453  .2957  .5814  .8430 1.0673 1.3981 1.6278   WAF  7-2
  1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020   WAF  7-3
  1.1950  .9670  .7290  .4900  .2500  .0090                              WAF  7-4
0.      .00269 .0055  .01129 .01724 .02325 .03505 .0465  .058    .0727    WAF  8-1
.0868   .1044  .125   .14534 .29567 .58138 .843   1.0673 1.3981 1.6278    WAF  8-2
1.788   1.892  1.962  1.997  1.996  1.954  1.868  1.743  1.586  1.402     WAF  8-3
1.195   .967   .729   .490   .250   .009                                  WAF  8-4
0.      .00269 .0055  .01129 .01724 .02325 .03505 .0465  .058    .0727    WAF  9-1
```

Table 2. Flat Meanline Wing Geometry—Sharp Leading Edge (Concluded)

.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 9-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 9-3
1.195	.967	.729	.490	.250	.009					WAF 9-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 10-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 10-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 10-3
1.195	.967	.729	.490	.250	.009					WAF 10-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 11-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 11-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 11-3
1.195	.967	.729	.490	.250	.009					WAF 11-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 12-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 12-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 12-3
1.195	.967	.729	.490	.250	.009					WAF 12-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 13-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 13-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 13-3
1.195	.967	.729	.490	.250	.009					WAF 13-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 14-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 14-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 14-3
1.195	.967	.729	.490	.250	.009					WAF 14-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 15-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 15-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 15-3
1.195	.967	.729	.490	.250	.009					WAF 15-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 16-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 16-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 16-3
1.195	.967	.729	.490	.250	.009					WAF 16-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 17-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 17-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 17-3
1.195	.967	.729	.490	.250	.009					WAF 17-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 18-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 18-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 18-3
1.195	.967	.729	.490	.250	.009					WAF 18-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 19-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 19-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 19-3
1.195	.967	.729	.490	.250	.009					WAF 19-4
0.	.00269	.0055	.01129	.01724	.02325	.03505	.0465	.058	.0727	WAF 20-1
.0868	.1044	.125	.14534	.29567	.58138	.843	1.0673	1.3981	1.6278	WAF 20-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 20-3
1.195	.967	.729	.490	.250	.009					WAF 20-4

Table 3. Flat Meanline Wing Geometry—LER = 0.001c

```
WING 7    FLAT MEANLINE    LER=.001C    DIM. IN CM.                                       2
 1 -1                   20 36                                                              3
2091.   40.28   57.22                                                                      4
0.0     .025    .05     .1      .15     .2      .3      .4      .5      .625     XAF  1
.75     .9      1.075   1.25    2.5     5.      7.5     10.     15.     20.      XAF  2
25.     30.     35.     40.     45.     50.     55.     60.     65.     70.      XAF  3
75.     80.     85.     90.     95.     100.                                     XAF  4
 11.500  0.000  0.000 67.000                                                     WORG  1
 11.947  1.031  0.000 66.353                                                     WORG  2
 13.065  2.068  0.000 65.035                                                     WORG  3
 14.690  3.099  0.000 63.210                                                     WORG  4
 17.031  4.130  0.000 60.669                                                     WORG  5
 19.918  5.166  0.000 57.582                                                     WORG  6
 23.065  6.198  0.000 54.235                                                     WORG  7
 28.032  7.747  0.000 48.968                                                     WORG  8
 33.073  9.296  0.000 44.939                                                     WORG  9
 38.083 10.848  0.000 40.943                                                     WORG 10
 42.881 12.395  0.000 37.155                                                     WORG 11
 47.380 13.945  0.000 33.669                                                     WORG 12
 51.547 15.494  0.000 30.514                                                     WORG 13
 55.459 17.043  0.000 27.614                                                     WORG 14
 59.188 18.593  0.000 24.898                                                     WORG 15
 62.783 20.142  0.000 22.314                                                     WORG 16
 66.274 21.692  0.000 19.836                                                     WORG 17
 73.000 24.790  0.000 15.134                                                     WORG 18
 79.473 27.889  0.000 10.685                                                     WORG 19
 85.752 30.988  0.000  6.430                                                     WORG 20
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  1-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  1-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  1-3
1.195   .967    .729    .490    .250    .009                                     WAF  1-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  2-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  2-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  2-3
1.195   .967    .729    .490    .250    .009                                     WAF  2-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  3-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  3-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  3-3
1.195   .967    .729    .490    .250    .009                                     WAF  3-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  4-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  4-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  4-3
1.195   .967    .729    .490    .250    .009                                     WAF  4-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  5-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  5-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  5-3
1.195   .967    .729    .490    .250    .009                                     WAF  5-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  6-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  6-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  6-3
1.195   .967    .729    .490    .250    .009                                     WAF  6-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  7-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  7-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  7-3
1.195   .967    .729    .490    .250    .009                                     WAF  7-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  8-1
.368    .4      .435    .469    .647    .875    1.059   1.213   1.459   1.645    WAF  8-2
1.788   1.892   1.962   1.997   1.996   1.954   1.868   1.743   1.586   1.402    WAF  8-3
1.195   .967    .729    .490    .250    .009                                     WAF  8-4
0.0     .067    .092    .132    .164    .192    .237    .273    .304    .338     WAF  9-1
```

Table 3. Flat Meanline Wing Geometry—LER = 0.001c (Concluded)

.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 9-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 9-3
1.195	.967	.729	.490	.250	.009					WAF 9-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 10-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 10-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 10-3
1.195	.967	.729	.490	.250	.009					WAF 10-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 11-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 11-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 11-3
1.195	.967	.729	.490	.250	.009					WAF 11-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 12-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 12-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 12-3
1.195	.967	.729	.490	.250	.009					WAF 12-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 13-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 13-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 13-3
1.195	.967	.729	.490	.250	.009					WAF 13-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 14-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 14-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 14-3
1.195	.967	.729	.490	.250	.009					WAF 14-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 15-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 15-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 15-3
1.195	.967	.729	.490	.250	.009					WAF 15-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 16-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 16-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 16-3
1.195	.967	.729	.490	.250	.009					WAF 16-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 17-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 17-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 17-3
1.195	.967	.729	.490	.250	.009					WAF 17-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 18-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 18-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 18-3
1.195	.967	.729	.490	.250	.009					WAF 18-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 19-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 19-2
1.768	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 19-3
1.195	.967	.729	.490	.250	.009					WAF 19-4
0.0	.067	.092	.132	.164	.192	.237	.273	.304	.338	WAF 20-1
.368	.4	.435	.469	.647	.875	1.059	1.213	1.459	1.645	WAF 20-2
1.788	1.892	1.962	1.997	1.996	1.954	1.868	1.743	1.586	1.402	WAF 20-3
1.195	.967	.729	.490	.250	.009					WAF 20-4

Table 4. Flat Meanline Wing Geometry—Varying-Radius Leading Edge

```
WING 7    FLAT MEANLINE     VARYING LER     DIM. IN CM.                              2
  1 -1                   20 36                                                       3
2091.   40.28   57.22                                                                4
0.0     .025    .05     .1      .15     .2      .3      .4      .5      .625      XAF 1
.75     .9      1.075   1.25    2.5     5.      7.5     10.     15.     20.       XAF 2
25.     30.     35.     40.     45.     50.     55.     60.     65.     70.       XAF 3
75.     80.     85.     90.     95.     100.                                      XAF 4
 11.500  0.000  0.000 67.000                                                      WORG  1
 11.947  1.031  0.000 66.353                                                      WORG  2
 13.065  2.066  0.000 65.035                                                      WORG  3
 14.650  3.099  0.000 63.210                                                      WORG  4
 17.031  4.130  0.000 60.669                                                      WORG  5
 19.918  5.166  0.000 57.582                                                      WORG  6
 23.065  6.198  0.000 54.235                                                      WORG  7
 28.032  7.747  0.000 48.968                                                      WORG  8
 33.073  9.296  0.000 44.939                                                      WORG  9
 38.083 10.848  0.000 40.943                                                      WORG 10
 42.881 12.395  0.000 37.155                                                      WORG 11
 47.380 13.945  0.000 33.669                                                      WORG 12
 51.547 15.494  0.000 30.514                                                      WORG 13
 55.459 17.043  0.000 27.614                                                      WORG 14
 59.188 18.593  0.000 24.898                                                      WORG 15
 62.783 20.142  0.000 22.314                                                      WORG 16
 66.274 21.692  0.000 19.836                                                      WORG 17
 73.000 24.790  0.000 15.134                                                      WORG 18
 79.473 27.889  0.000 10.685                                                      WORG 19
 85.752 30.988  0.000  6.430                                                      WORG 20
 0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380            WAF  1-1
  .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450            WAF  1-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  1-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  1-4
 0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380            WAF  2-1
  .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450            WAF  2-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  2-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  2-4
 0.0000  .0670  .0920  .1320  .1640  .1920  .2370  .2730  .3040  .3380            WAF  3-1
  .3680  .4000  .4350  .4690  .6470  .8750 1.0590 1.2130 1.4590 1.6450            WAF  3-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  3-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  3-4
 0.0000  .0754  .1041  .1477  .1818  .2112  .2584  .2965  .3292  .3650            WAF  4-1
  .3966  .4301  .4683  .5023  .6821  .9156 1.0937 1.2387 1.4720 1.6495            WAF  4-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  4-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  4-4
 0.0000  .0919  .1277  .1785  .2168  .2492  .3011  .3435  .3797  .4191            WAF  5-1
  .4538  .4905  .5338  .5678  .7507  .9918 1.1582 1.2868 1.4963 1.6579            WAF  5-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  5-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  5-4
 0.0000  .1208  .1686  .2326  .2794  .3180  .3795  .4302  .4728  .5193            WAF  6-1
  .5597  .6023  .6490  .6832  .8698 1.1083 1.2537 1.3593 1.5327 1.6702            WAF  6-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  6-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  6-4
 0.0000  .1338  .1867  .2571  .3084  .3506  .4176  .4725  .5185  .5685            WAF  7-1
  .6119  .6574  .7014  .7359  .9227 1.1483 1.2838 1.3634 1.5446 1.6739            WAF  7-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  7-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  7-4
 0.0000  .1405  .1958  .2697  .3237  .3681  .4383  .4956  .5436  .5956            WAF  8-1
  .6406  .6878  .7284  .7631  .9494 1.1628 1.2931 1.3917 1.5486 1.6750            WAF  8-2
 1.7880 1.8920 1.9620 1.9970 1.9960 1.9540 1.8680 1.7430 1.5860 1.4020            WAF  8-3
 1.1950  .9670  .7290  .4900  .2500  .0090                                        WAF  8-4
 0.0000  .1412  .1968  .2711  .3254  .3701  .4407  .4984  .5465  .5988            WAF  9-1
```

Table 4. Flat Meanline Wing Geometry—Varying-Radius Leading Edge (Concluded)

.6440	.6914	.7315	.7662	.9524	1.1640	1.2938	1.3924	1.5489	1.6750	WAF	9-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	9-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	9-4
0.0000	.1412	.1968	.2711	.3254	.3701	.4407	.4984	.5465	.5988	WAF	10-1
.6440	.6914	.7315	.7662	.9524	1.1640	1.2938	1.3924	1.5489	1.6750	WAF	10-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	10-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	10-4
0.0000	.1405	.1958	.2697	.3237	.3681	.4383	.4956	.5436	.5956	WAF	11-1
.6406	.6878	.7284	.7631	.9494	1.1628	1.2931	1.3917	1.5486	1.6750	WAF	11-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	11-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	11-4
0.0000	.1391	.1939	.2670	.3204	.3643	.4338	.4906	.5381	.5897	WAF	12-1
.6343	.6812	.7227	.7573	.9438	1.1602	1.2916	1.3903	1.5479	1.6748	WAF	12-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	12-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	12-4
0.0000	.1368	.1907	.2627	.3151	.3583	.4266	.4826	.5294	.5803	WAF	13-1
.6244	.6707	.7134	.7479	.9346	1.1554	1.2886	1.3876	1.5466	1.6745	WAF	13-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	13-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	13-4
0.0000	.1344	.1874	.2581	.3096	.3520	.4192	.4743	.5205	.5706	WAF	14-1
.6141	.6598	.7036	.7381	.9249	1.1496	1.2848	1.3842	1.5450	1.6741	WAF	14-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.9680	1.7430	1.5860	1.4020	WAF	14-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	14-4
0.0000	.1316	.1837	.2529	.3035	.3450	.4110	.4651	.5105	.5599	WAF	15-1
.6028	.6478	.6926	.7269	.9139	1.1424	1.2797	1.3800	1.5429	1.6734	WAF	15-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	15-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	15-4
0.0000	.1289	.1800	.2479	.2974	.3382	.4030	.4562	.5010	.5496	WAF	16-1
.5918	.6362	.6817	.7161	.9030	1.1347	1.2740	1.3754	1.5407	1.6728	WAF	16-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	16-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	16-4
0.0000	.1261	.1761	.2426	.2912	.3312	.3948	.4471	.4911	.5390	WAF	17-1
.5806	.6244	.6704	.7047	.8916	1.1261	1.2675	1.3702	1.5381	1.6719	WAF	17-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	17-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	17-4
0.0000	.1201	.1677	.2313	.2779	.3163	.3776	.4281	.4706	.5168	WAF	18-1
.5571	.5996	.6463	.6805	.8671	1.1059	1.2519	1.3579	1.5320	1.6700	WAF	18-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	18-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	18-4
0.0000	.1133	.1582	.2186	.2631	.2999	.3588	.4072	.4481	.4926	WAF	19-1
.5315	.5725	.6193	.6534	.8394	1.0911	1.2321	1.3426	1.5243	1.6675	WAF	19-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	19-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	19-4
0.0000	.1063	.1483	.2055	.2478	.2831	.3395	.3859	.4252	.4680	WAF	20-1
.5055	.5450	.5912	.6252	.8104	1.0534	1.2094	1.3253	1.5157	1.6646	WAF	20-2
1.7880	1.8920	1.9620	1.9970	1.9960	1.9540	1.8680	1.7430	1.5860	1.4020	WAF	20-3
1.1950	.9670	.7290	.4900	.2500	.0090					WAF	20-4

Table 5. Planform and Shear Definition—Cambered Wing

```
WING 7   CAMBERED VERSION  PLANFORM                                            2
WING SHEARED ABOUT .65 C AT 8 DEG ANHEDRAL
 11.500  0.000  3.916 67.000                                                   WORG  1
 11.947  1.031  3.768 66.353                                                   WORG  2
 13.065  2.068  3.557 65.035                                                   WORG  3
 14.650  3.099  3.289 63.210                                                   WORG  4
 17.031  4.130  2.562 60.669                                                   WORG  5
 19.918  5.166  2.571 57.582                                                   WORG  6
 23.065  6.198  2.140 54.235                                                   WORG  7
 28.032  7.747  1.421 48.968                                                   WORG  8
 33.073  9.296   .792 44.939                                                   WORG  9
 38.083 10.848   .192 40.943                                                   WORG 10
 42.881 12.395  -.375 37.155                                                   WORG 11
 47.380 13.945  -.918 33.669                                                   WORG 12
 51.547 15.494 -1.405 30.514                                                   WORG 13
 55.459 17.043 -1.842 27.614                                                   WORG 14
 59.188 18.593 -2.249 24.898                                                   WORG 15
 62.783 20.142 -2.633 22.314                                                   WORG 16
 66.274 21.692 -2.979 19.836                                                   WORG 17
 73.000 24.790 -3.573 15.134                                                   WORG 18
 79.473 27.889 -4.066 10.685                                                   WORG 19
 85.752 30.988 -4.467  6.430                                                   WORG 20
```

Table 6. Meanline Geometry—Cambered Wing

```
 WING 7   CAMBER SURFACE   NC L.E. DEFLECTION  Z/C,PER CENT                    2
  0.000  1.250  2.500  5.000  7.500 10.000 15.000 20.000 25.000 30.000  TPCT 1
 35.000 40.000 45.000 50.000 55.000 60.000 70.000 80.000 90.000100.000  TPCT 2
  0.000  5.000 10.000 15.000 20.000 25.000 30.000 35.000 40.000 45.000  TYB2  1
 50.000 55.000 60.000 65.000 70.000 75.000 80.000 85.000 90.000 95.000  TYB2  2
100.000                                                                 TYB2  3
 0.0000 -.1790 -.3684 -.7664-1.1731-1.5652-2.2844-2.8973-3.4189-3.8620  WZ  1-1
-4.2348-4.5573-4.8486-5.1192-5.3742-5.6148-6.0654-6.4804-6.8623-7.2248  WZ  1-2
 0.0000 -.1194 -.2536 -.5799 -.9435-1.3122-2.0232-2.6726-3.2514-3.7507  WZ  2-1
-4.1698-4.5336-4.8551-5.1464-5.4167-5.6697-6.1377-6.5672-6.9585-7.3222  WZ  2-2
 0.0000 -.0380 -.1010 -.3211 -.6305 -.9704-1.6594-2.3169-2.9206-3.4606  WZ  3-1
-3.9362-4.3519-4.7150-5.0450-5.3462-5.6267-6.1375-6.5887-6.9900-7.3550  WZ  3-2
 0.0000  .0638  .0949  .0003 -.2246 -.5014-1.1048-1.7268-2.3346-2.9135  WZ  4-1
-3.4532-3.9439-4.3867-4.7873-5.1501-5.4820-6.0632-6.5520-6.9692-7.3404  WZ  4-2
 0.0000  .1430  .2518  .2782  .1358 -.0779 -.5954-1.1747-1.7722-2.3654  WZ  5-1
-2.9379-3.4729-3.9672-4.4179-4.8285-5.2037-5.8566-6.3991-6.8529-7.2504  WZ  5-2
 0.0000  .1592  .3731  .5352  .4811  .3366 -.0936 -.6242-1.1963-1.7724  WZ  6-1
-2.3354-2.8753-3.3862-3.8651-4.3126-4.7291-5.4754-6.1138-6.6476-7.1119  WZ  6-2
 0.0000  .2335  .4483  .7035  .7198  .6328  .2878 -.1847 -.7185-1.2666  WZ  7-1
-1.8106-2.3422-2.8544-3.3441-3.8088-4.2466-5.0466-5.7447-6.3335-6.8441  WZ  7-2
 0.0000  .2364  .4576  .7488  .8128  .7689  .5114  .1130 -.3650 -.8736  WZ  8-1
-1.3907-1.8999-2.3970-2.8775-3.3350-3.7682-4.5699-5.2801-5.8929-6.4243  WZ  8-2
 0.0000  .2367  .4602  .7739  .8773  .8702  .6896  .3615 -.0570 -.5170  WZ  9-1
 -.9942-1.4692-1.9386-2.3973-2.8373-3.2577-4.0461-4.7554-5.3792-5.9210  WZ  9-2
 0.0000  .2348  .4562  .7743  .9067  .9279  .8128  .5516  .1986 -.1985  WZ 10-1
 -.6154-1.0379-1.4609-1.8787-2.2874-2.6855-3.4467-4.1458-4.7722-5.3190  WZ 10-2
 0.0000  .2296  .4453  .7637  .9209  .9683  .9099  .7112  .4221  .0871  WZ 11-1
 -.2715 -.6423-1.0190-1.3958-1.7705-2.1403-2.8573-3.5261-4.1323-4.6636  WZ 11-2
 0.0000  .2192  .4232  .7355  .9129  .9847  .9700  .8290  .6045  .3328  WZ 12-1
  .0307 -.2898 -.6220 -.9607-1.3015-1.6376-2.2935-2.9101-3.4682-3.9573  WZ 12-2
 0.0000  .2091  .4029  .7098  .9035  .9972 1.0257  .9389  .7732  .5595  WZ 13-1
  .3114  .0420 -.2424 -.5368 -.8355-1.1307-1.7086-2.2561-2.7536-3.1924  WZ 13-2
 0.0000  .1992  .3842  .6869  .8917 1.0041 1.0760 1.0394  .9250  .7631  WZ 14-1
  .5671  .3524  .1230 -.1153 -.3573 -.5992-1.0695-1.5201-1.9384-2.3179  WZ 14-2
 0.0000  .1902  .3675  .6661  .8405 1.0103 1.1240 1.1353 1.0696  .9559  WZ 15-1
  .8084  .6434  .4643  .2774  .0874 -.1041 -.4754 -.8341-1.1729-1.4866  WZ 15-2
 0.0000  .1824  .3530  .6478  .8698 1.0152 1.1681 1.2253 1.2061 1.1362  WZ 16-1
 1.0336  .9113  .7766  .6353  .4924  .3495  .0705 -.1953 -.4440 -.6704  WZ 16-2
 0.0000  .1751  .3400  .6310  .8598 1.0206 1.2131 1.3131 1.3369 1.3090  WZ 17-1
 1.2481 1.1669 1.0748  .9765  .8766  .7766  .5778  .3878  .2091  .0466  WZ 17-2
 0.0000  .1679  .3280  .6152  .8493 1.0255 1.2580 1.3972 1.4615 1.4774  WZ 18-1
 1.4575 1.4196 1.3731 1.3201 1.2629 1.2030 1.0766  .9445  .8105  .6798  WZ 18-2
 0.0000  .1622  .3183  .6023  .8417 1.0331 1.3060 1.4822 1.5816 1.6322  WZ 19-1
 1.6453 1.6413 1.6288 1.6089 1.5826 1.5512 1.4763 1.3870 1.2876 1.1832  WZ 19-2
 0.0000  .1580  .3108  .5923  .8370 1.0434 1.3572 1.5680 1.6973 1.7735  WZ 20-1
 1.8116 1.8320 1.8418 1.8429 1.8357 1.8212 1.7769 1.7152 1.6405 1.5567  WZ 20-2
 0.0000  .1554  .3055  .5851  .8352 1.0564 1.4116 1.6547 1.8085 1.9013  WZ 21-1
 1.9563 1.9916 2.0122 2.0222 2.0222 2.0129 1.9785 1.9291 1.8691 1.8004  WZ 21-2
```

Table 7. Meanline Geometry—Cambered Wing, Leading Edge Drooped for α = 2 deg

```
CAMBERED WING 7    L.E. DEFLECTED FOR ALPHA=2 DEG.      Z/C, PER CENT        2
  0.000   1.250   2.500   5.000   7.500  10.000 15.000 20.000 25.000 30.000   TPCT 1
 35.000  40.000  45.000  50.000  55.000  60.000 70.000 80.000 90.000100.000   TPCT 2
  0.000   5.000  10.000  15.000  20.000  25.000 30.000 35.000 40.000 45.000   TYB2  1
 50.000  55.000  60.000  65.000  70.000  75.000 80.000 85.000 90.000 95.000   TYB2  2
100.000                                                                       TYB2  3
 0.0000 -.1790 -.3684 -.7664-1.1731-1.5652-2.2844-2.8973-3.4189-3.8620   WZ  1-1
-4.2348-4.5573-4.8486-5.1192-5.3742-5.6148-6.0654-6.4804-6.8623-7.2248   WZ  1-2
 0.0000 -.1194 -.2536 -.5799 -.9435-1.3122-2.0232-2.6726-3.2514-3.7507   WZ  2-1
-4.1698-4.5336-4.8551-5.1464-5.4167-5.6697-6.1377-6.5672-6.9565-7.3222   WZ  2-2
 -.0737 -.1050 -.1613 -.3694 -.6680 -.9986-1.6728-2.3209-2.9206-3.4606   WZ  3-1
-3.9362-4.3519-4.7150-5.0450-5.3462-5.6267-6.1375-6.5887-6.9900-7.3550   WZ  3-2
 -.1966 -.1148 -.0660 -.1284 -.3247 -.5765-1.1405-1.7375-2.3346-2.9135   WZ  4-1
-3.4532-3.9439-4.3867-4.7873-5.1501-5.4820-6.0632-6.5520-6.9692-7.3404   WZ  4-2
 -.3195 -.1472 -.0096  .0691 -.0269 -.1999 -.6535-1.1921-1.7722-2.3654   WZ  5-1
-2.9379-3.4729-3.9672-4.4179-4.8285-5.2037-5.8566-6.3991-6.8529-7.2504   WZ  5-2
 -.4424 -.2026  .0111  .2456  .2559  .1677 -.1740 -.6483-1.1963-1.7724   WZ  6-1
-2.3354-2.8753-3.3862-3.8651-4.3126-4.7291-5.4754-6.1138-6.6476-7.1119   WZ  6-2
 -.5653 -.2799 -.0142  .3335  .4320  .4170  .1850 -.2155 -.7185-1.2666   WZ  7-1
-1.8106-2.3422-2.8544-3.3441-3.8038-4.2466-5.0466-5.7447-6.3335-6.8441   WZ  7-2
 -.6882 -.3886 -.1054  .2984  .4625  .5061  .3863  .0755 -.3650 -.8736   WZ  8-1
-1.3907-1.8995-2.3970-2.8775-3.3350-3.7682-4.5699-5.2801-5.8929-6.4243   WZ  8-2
 -.8111 -.4999 -.2034  .2430  .4644  .5605  .5421  .3173 -.0570 -.5170   WZ  9-1
 -.9942-1.4692-1.9386-2.3973-2.8373-3.2577-4.0461-4.7554-5.3792-5.9210   WZ  9-2
 -.9339 -.6134 -.3079  .1630  .4312  .5713  .6430  .5007  .1986 -.1985   WZ 10-1
 -.6154-1.0379-1.4609-1.8787-2.2374-2.6855-3.4467-4.1458-4.7722-5.3190   WZ 10-2
-1.0568 -.7302 -.4194  .0720  .3829  .5648  .7177  .6535  .4221  .0871   WZ 11-1
 -.2715 -.6423-1.0190-1.3958-1.7705-2.1403-2.8573-3.5261-4.1323-4.6636   WZ 11-2
-1.1797 -.8522 -.5420 -.0367  .3123  .5343  .7555  .7646  .6045  .3328   WZ 12-1
  .0307 -.2898 -.6220 -.9607-1.3015-1.6376-2.2935-2.9101-3.4682-3.9573   WZ 12-2
-1.3026 -.9739 -.6629 -.1428  .2404  .4998  .7889  .8678  .7732  .5595   WZ 13-1
  .3114  .0420 -.2424 -.5368 -.8355-1.1307-1.7086-2.2561-2.7536-3.1924   WZ 13-2
-1.4255-1.0954 -.7821 -.2461  .1660  .4598  .8168  .9616  .9250  .7631   WZ 14-1
  .5671  .3524  .1230 -.1153 -.3573 -.5992-1.0695-1.5201-1.9384-2.3179   WZ 14-2
-1.5484-1.2160 -.8994 -.3474  .0922  .4191  .8425 1.0508 1.0696  .9559   WZ 15-1
  .8084  .6434  .4643  .2774  .0374 -.1041 -.4754 -.8341-1.1729-1.4866   WZ 15-2
-1.6713-1.3354-1.0144 -.4461  .0190  .3771  .8642 1.1341 1.2061 1.1362   WZ 16-1
 1.0336  .9113  .7766  .6353  .4924  .3495  .0705 -.1953 -.4440 -.6704   WZ 16-2
-1.7942-1.4543-1.1279 -.5433 -.0536  .3356  .8869 1.2152 1.3369 1.3090   WZ 17-1
 1.2481 1.1669 1.0748  .9765  .8766  .7766  .5778  .3878  .2091  .0466   WZ 17-2
-1.9170-1.5732-1.2405 -.6396 -.1266  .2935  .9094 1.2926 1.4615 1.4774   WZ 18-1
 1.4575 1.4196 1.3731 1.3201 1.2629 1.2030 1.0766  .9445  .8105  .6798   WZ 18-2
-2.0399-1.6905-1.3507 -.7329 -.1968  .2542  .9351 1.3709 1.5816 1.6322   WZ 19-1
 1.6453 1.6413 1.6288 1.6089 1.5826 1.5512 1.4763 1.3870 1.2876 1.1832   WZ 19-2
-2.1628-1.8063-1.4588 -.8233 -.2641  .2176  .9640 1.4500 1.6973 1.7735   WZ 20-1
 1.8116 1.8320 1.8418 1.8429 1.8357 1.8212 1.7769 1.7152 1.6405 1.5567   WZ 20-2
-2.2857-1.9205-1.5646 -.9110 -.3284  .1837  .9960 1.5300 1.8085 1.9013   WZ 21-1
 1.9563 1.9916 2.0122 2.0222 2.0222 2.0129 1.9785 1.9291 1.8691 1.8004   WZ 21-2
```

Table 8. Meanline Geometry—Cambered Wing, Leading Edge Drooped for $\alpha = 4$ deg

```
CAMBERED WING 7    L.E. DEFLECTED FOR ALPHA=4 DEG.      Z/C, PER CENT     2
  0.000   1.250   2.500   5.000   7.500 10.000 15.000 20.000 25.000 30.000   TPCT 1
 35.000  40.000  45.000  50.000  55.000 60.000 70.000 80.000 90.000100.000   TPCT 2
  0.000   5.000  10.000  15.000  20.000 25.000 30.000 35.000 40.000 45.000   TYB2   1
 50.000  55.000  60.000  65.000  70.000 75.000 80.000 85.000 90.000 95.000   TYB2   2
100.000                                                                      TYB2   3
 0.0000 -.1790 -.3684 -.7664-1.1731-1.5652-2.2844-2.8973-3.4189-3.8620   WZ   1-1
-4.2348-4.5573-4.8486-5.1192-5.3742-5.6148-6.0654-6.4804-6.8623-7.2248   WZ   1-2
 0.0000 -.1194 -.2536 -.5799 -.9435-1.3122-2.0232-2.6726-3.2514-3.7507   WZ   2-1
-4.1698-4.5336-4.8551-5.1464-5.4167-5.6697-6.1377-6.5672-6.9585-7.3222   WZ   2-2
 -.1416 -.1666 -.2169 -.4138 -.7026-1.0245-1.6852-2.3246-2.9206-3.4606   WZ   3-1
-3.9362-4.3519-4.7150-5.0450-5.3462-5.6267-6.1375-6.5887-6.9900-7.3550   WZ   3-2
 -.3777 -.2792 -.2141 -.2469 -.4169 -.6456-1.1735-1.7474-2.3346-2.9135   WZ   4-1
-3.4532-3.9439-4.3867-4.7873-5.1501-5.4820-6.0632-6.5520-6.9692-7.3404   WZ   4-2
 -.6138 -.4144 -.2504 -.1235 -.1767 -.3123 -.7070-1.2082-1.7722-2.3654   WZ   5-1
-2.9379-3.4729-3.9672-4.4179-4.8235-5.2037-5.8566-6.3991-6.8529-7.2504   WZ   5-2
 -.8499 -.5726 -.3222 -.0211  .0484  .0121 -.2481 -.6706-1.1963-1.7724   WZ   6-1
-2.3354-2.8753-3.3862-3.8651-4.3126-4.7291-5.4754-6.1138-6.6476-7.1119   WZ   6-2
-1.0859 -.7527 -.4402 -.0073  .1670  .2182  .0904 -.2439 -.7185-1.2666   WZ   7-1
-1.8106-2.3422-2.8544-3.3441-3.8088-4.2466-5.0466-5.7447-6.3335-6.8441   WZ   7-2
-1.3220 -.9642 -.6240 -.1165  .1398  .2641  .2710  .0409 -.3650 -.8736   WZ   8-1
-1.3907-1.8999-2.3970-2.8775-3.3350-3.7682-4.5699-5.2801-5.8929-6.4243   WZ   8-2
-1.5581-1.1783 -.8146 -.2459  .0841  .2753  .4063  .2765 -.0570 -.5170   WZ   9-1
 -.9942-1.4692-1.9386-2.3973-2.8373-3.2577-4.0461-4.7554-5.3792-5.9210   WZ   9-2
-1.7942-1.3946-1.0117 -.4000 -.0067  .2429  .4866  .4537  .1986 -.1985   WZ  10-1
 -.6154-1.0379-1.4609-1.8787-2.2874-2.6855-3.4467-4.1458-4.7722-5.3190   WZ  10-2
-2.0302-1.6142-1.2158 -.5652 -.1127  .1931  .5408  .6005  .4221  .0871   WZ  11-1
 -.2715 -.6423-1.0190-1.3958-1.7705-2.1403-2.8573-3.5261-4.1323-4.6636   WZ  11-2
-2.2663-1.8391-1.4310 -.7479 -.2408  .1194  .5579  .7054  .6045  .3328   WZ  12-1
  .0307 -.2898 -.6220 -.9607-1.3015-1.6376-2.2935-2.9101-3.4682-3.9573   WZ  12-2
-2.5024-2.0636-1.6445 -.9281 -.3704  .0417  .5707  .8024  .7732  .5595   WZ  13-1
  .3114  .0420 -.2424 -.5368 -.8355-1.1307-1.7086-2.2561-2.7536-3.1924   WZ  13-2
-2.7384-2.2879-1.8563-1.1055 -.5024 -.0415  .5781  .8900  .9250  .7631   WZ  14-1
  .5671  .3524  .1230 -.1153 -.3573 -.5992-1.0695-1.5201-1.9384-2.3179   WZ  14-2
-2.9745-2.5113-2.0662-1.2808 -.6338 -.1254  .5832  .9730 1.0696  .9559   WZ  15-1
  .8084  .6434  .4643  .2774  .0374 -.1041 -.4754 -.8341-1.1729-1.4866   WZ  15-2
-3.2106-2.7335-2.2738-1.4537 -.7547 -.2107  .5844 1.0502 1.2061 1.1362   WZ  16-1
 1.0336  .9113  .7766  .6353  .4924  .3495  .0705 -.1953 -.4440 -.6704   WZ  16-2
-3.4467-2.9552-2.4800-1.6250 -.8949 -.2954  .5864 1.1251 1.3369 1.3090   WZ  17-1
 1.2481 1.1669 1.0748  .9765  .8766  .7766  .5778  .3878  .2091  .0466   WZ  17-2
-3.6827-3.1768-2.6851-1.7953-1.0255 -.3806  .5884 1.1963 1.4615 1.4774   WZ  18-1
 1.4575 1.4196 1.3731 1.3201 1.2629 1.2030 1.0766  .9445  .8105  .6798   WZ  18-2
-3.9188-3.3969-2.8880-1.9627-1.1533 -.4632  .5935 1.2684 1.5816 1.6322   WZ  19-1
 1.6453 1.6413 1.6288 1.6089 1.5826 1.5512 1.4763 1.3870 1.2876 1.1832   WZ  19-2
-4.1549-3.6155-3.0886-2.1272-1.2782 -.5430  .6018 1.3414 1.6973 1.7735   WZ  20-1
 1.8116 1.8320 1.8418 1.8429 1.8357 1.8212 1.7769 1.7152 1.6405 1.5567   WZ  20-2
-4.3910-3.8325-3.2871-2.2890-1.4002 -.6202  .6132 1.4152 1.8085 1.9013   WZ  21-1
 1.9563 1.9916 2.0122 2.0222 2.0222 2.0129 1.9785 1.9291 1.8691 1.8004   WZ  21-2
```

Table 9. Meanline Geometry—Cambered Wing, Leading Edge Drooped for $\alpha = 6$ deg

```
CAMBERED WING 7    L.E. DEFLECTED FOR ALPHA=6 DEG.    Z/C, PER CENT         2
 0.000   1.250   2.500   5.000   7.500 10.000 15.000 20.000 25.000 30.000   TPCT 1
 35.000 40.000 45.000 50.000 55.000 60.000 70.000 80.000 90.000100.000      TPCT 2
 0.000   5.000 10.000 15.000 20.000 25.000 30.000 35.000 40.000 45.000      TYB2   1
 50.000 55.000 60.000 65.000 70.000 75.000 80.000 85.000 90.000 95.000      TYB2   2
100.000                                                                     TYB2   3
 0.0000 -.1790 -.3684 -.7664-1.1731-1.5652-2.2844-2.8973-3.4189-3.8620      WZ   1-1
-4.2348-4.5573-4.8486-5.1192-5.3742-5.6148-6.0654-6.4804-6.8623-7.2248      WZ   1-2
 0.0000 -.1194 -.2536 -.5799 -.9435-1.3122-2.0232-2.6726-3.2514-3.7507      WZ   2-1
-4.1698-4.5336-4.8551-5.1464-5.4167-5.6697-6.1377-6.5672-6.9585-7.3222      WZ   2-2
 -.1979 -.2177 -.2629 -.4506 -.7313-1.0460-1.6954-2.3277-2.9206-3.4606      WZ   3-1
-3.9362-4.3519-4.7150-5.0450-5.3462-5.6267-6.1375-6.5687-6.9900-7.3550      WZ   3-2
 -.5278 -.4155 -.3369 -.3451 -.4933 -.7029-1.2008-1.7556-2.3346-2.9135      WZ   4-1
-3.4532-3.9439-4.3867-4.7873-5.1501-5.4820-6.0632-6.5520-6.9692-7.3404      WZ   4-2
 -.8576 -.6359 -.4499 -.2831 -.3008 -.4054 -.7513-1.2215-1.7722-2.3654      WZ   5-1
-2.9379-3.4729-3.9672-4.4179-4.8285-5.2037-5.8566-6.3991-6.8529-7.2504      WZ   5-2
-1.1875 -.8793 -.5985 -.2421 -.1234 -.1168 -.3095 -.6890-1.1963-1.7724      WZ   6-1
-2.3354-2.8753-3.3862-3.8651-4.3126-4.7291-5.4754-6.1138-6.6476-7.1119      WZ   6-2
-1.5173-1.1445 -.7932 -.2697 -.0527  .0535  .0119 -.2675 -.7185-1.2666      WZ   7-1
-1.8106-2.3422-2.8544-3.3441-3.8088-4.2466-5.0466-5.7447-6.3335-6.8441      WZ   7-2
-1.6472-1.4412-1.0537 -.4603 -.1276  .0636  .1755  .0122 -.3650 -.8736      WZ   8-1
-1.3907-1.8999-2.3970-2.8775-3.3350-3.7682-4.5699-5.2801-5.8929-6.4243      WZ   8-2
-2.1770-1.7405-1.3210 -.6511 -.2310  .0390  .2938  .2427 -.0570 -.5170      WZ   9-1
 -.9942-1.4692-1.9386-2.3973-2.8373-3.2577-4.0461-4.7554-5.3792-5.9210      WZ   9-2
-2.5069-2.0420-1.5949 -.8666 -.3695 -.0293  .3570  .4148  .1986 -.1985      WZ  10-1
 -.6154-1.0379-1.4609-1.8787-2.2874-2.6855-3.4467-4.1458-4.7722-5.3190      WZ  10-2
-2.8368-2.3467-1.8757-1.0931 -.5233 -.1148  .3941  .5565  .4221  .0871      WZ  11-1
 -.2715 -.6423-1.0190-1.3958-1.7705-2.1403-2.8573-3.5261-4.1323-4.6636      WZ  11-2
-3.1666-2.6567-2.1677-1.3272 -.6992 -.2244  .3942  .6563  .6045  .3328      WZ  12-1
  .0307 -.2898 -.6220 -.9607-1.3015-1.6376-2.2935-2.9101-3.4682-3.9573      WZ  12-2
-3.4965-2.9664-2.4578-1.5788 -.8765 -.3378  .3900  .7482  .7732  .5595      WZ  13-1
  .3114  .0420 -.2424 -.5368 -.8355-1.1307-1.7086-2.2561-2.7536-3.1924      WZ  13-2
-3.8263-3.2759-2.7464-1.8176-1.0562 -.4569  .3803  .8307  .9250  .7631      WZ  14-1
  .5671  .3524  .1230 -.1153 -.3573 -.5992-1.0695-1.5201-1.9384-2.3179      WZ  14-2
-4.1562-3.5844-3.0330-2.0543-1.2354 -.5766  .3683  .9086 1.0696  .9559      WZ  15-1
  .6084  .6434  .4643  .2774  .0374 -.1041 -.4754 -.8341-1.1729-1.4866      WZ  15-2
-4.4660-3.8916-3.3174-2.2885-1.4140 -.6977  .3525  .9806 1.2061 1.1362      WZ  16-1
 1.0336  .9113  .7766  .6353  .4924  .3495  .0705 -.1953 -.4440 -.6704      WZ  16-2
-4.8159-4.1987-3.6003-2.5212-1.5919 -.8182  .3375 1.0504 1.3369 1.3090      WZ  17-1
 1.2481 1.1669 1.0748  .9765  .8766  .7766  .5778  .3878  .2091  .0466      WZ  17-2
-5.1457-4.5055-3.8821-2.7525-1.7703 -.9392  .3224 1.1165 1.4615 1.4774      WZ  18-1
 1.4575 1.4196 1.3731 1.3201 1.2629 1.2030 1.0766  .9445  .8105  .6798      WZ  18-2
-5.4756-4.8107-4.1617-2.9817-1.9459-1.0576  .3104 1.1835 1.5816 1.6322      WZ  19-1
 1.6453 1.6413 1.6288 1.6089 1.5826 1.5512 1.4763 1.3870 1.2876 1.1832      WZ  19-2
-5.8054-5.1145-4.4391-3.2076-2.1185-1.1732  .3017 1.2513 1.6973 1.7735      WZ  20-1
 1.8116 1.8320 1.8418 1.8429 1.8357 1.8212 1.7769 1.7152 1.6405 1.5567      WZ  20-2
-6.1353-5.4167-4.7143-3.4307-2.2482-1.2862  .2961 1.3200 1.8085 1.9013      WZ  21-1
 1.9563 1.9916 2.0122 2.0222 2.0222 2.0129 1.9785 1.9291 1.8691 1.8004      WZ  21-2
```

Cross sections taken through the cambered wing loft (with the varying-radius leading edge) are shown in Figure 62.

To permit test/theory pressure distribution comparisons and to provide a means of locating the leading-edge flow-separation point, static pressure taps in the wing upper surfaces are recommended. The pressure tap locations consist of five spanwise rows plus five additional taps located near the leading edge at intermediate span stations, as tabulated below.

Recommended Pressure Measurement Stations—Wing Upper Surface

Spanwise station, 2y/b	Chordwise station, x/c
0	0.02, 0.10
0.10	0.02, 0.10, 0.40
0.20	0.02
0.30	0.02, 0.10, 0.20, 0.40, 0.67
0.40	0.02
0.50	0.02, 0.10, 0.20, 0.40, 0.70
0.60	0.02
0.70	0.02, 0.10, 0.20, 0.40, 0.70
0.80	0.02
0.90	0.02, 0.10, 0.20, 0.45, 0.70

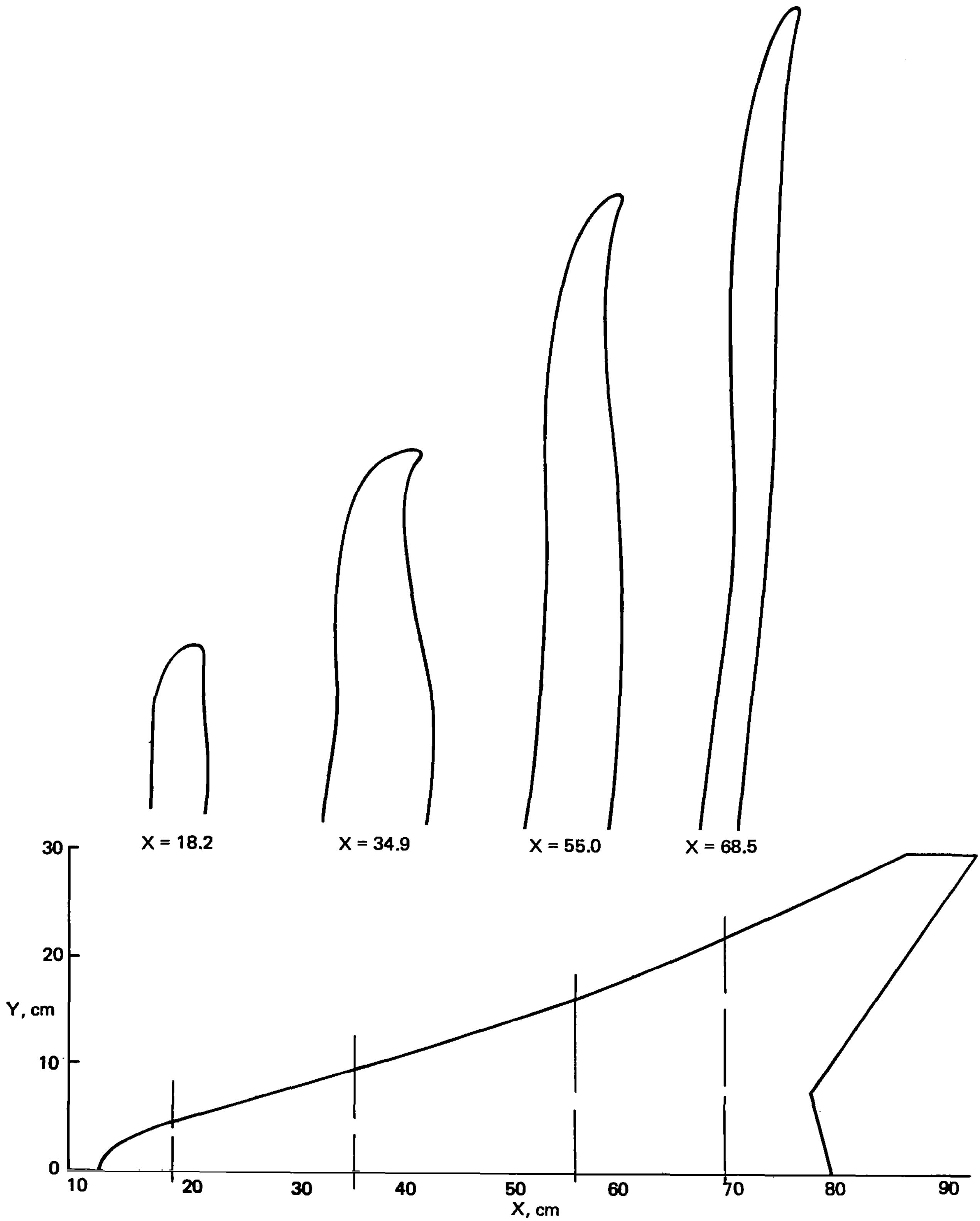


Figure 62. Cross Sectional Views, Wing 7—Cambered

6.0 CONCLUDING REMARKS

A theoretical study was made of supersonic wing geometries at Mach 1.8, using the attainable leading-edge thrust concept. The attainable thrust method offers a powerful means to improve overall aerodynamic efficiency by identifying wing leading-edge geometries that promote attached flow and by defining a local angle-of-attack range over which attached flow may be obtained. The concept applies to flat and to cambered wings, which leads to the consideration of drooped-wing leading edges for attached flow at high lift coefficients.

7.0 REFERENCES

1. Robins, A. Warner; Lamb, Milton; and Miller, David S.: Aerodynamic Characteristics at Mach Numbers of 1.5, 1.8, and 2.0 of a Blended Wing-Body Configuration With and Without Integral Canards. NASA TP-1427, 1979.

2. Carlson, Harry W.; and Mack, Robert J.: Estimation of Leading-Edge Thrust for Supersonic Wings of Arbitrary Planform. NASA TP-1270, 1978.

3. Carlson, Harry W.; Mack, Robert J.; and Barger, Raymond L.: Estimation of Attainable Leading-Edge Thrust for Wings at Subsonic and Supersonic Speeds. NASA TP-1500, 1979.

4. Middleton, W. D.; and Lundry, J. L.: A System for Aerodynamic Design and Analysis of Supersonic Aircraft. Part 1 – General Description and Theoretical Development. NASA CR-3351, 1980.

5. Middleton, W. D.; Lundry, J. L.; and Coleman, R. G.: A System for Aerodynamic Design and Analysis of Supersonic Aircraft. Part 2 – User's Manual. NASA CR-3352, 1980.

6. Middleton, W. D.; Lundry, J. L.; and Coleman, R. G.: A System for Aerodynamic Design and Analysis of Supersonic Aircraft. Part 3 – Computer Program Description. NASA CR-3353, 1980.

7. Robins, A. Warner; Carlson, Harry W.; and Mack, Robert J.: Supersonic Wings With Significant Leading-Edge Thrust at Cruise. NASA TP-1632, 1980.

APPENDIX

THEORETICAL CHARACTERISTICS OF RECOMMENDED WIND TUNNEL MODELS

APPENDIX

THEORETICAL CHARACTERISTICS OF RECOMMENDED WIND TUNNEL MODELS

Theoretical characteristics of the recommended wind tunnel model series for comparison with experimental data are presented in this section. The data were obtained from the methods of References 4 to 6 and include force and pressure characteristics for Mach 1.8 (design), 1.6, and 2.0.

The models use a minimum-size body to house the balance and surface pressure instrumentation. The effect of the body on surface pressure coefficients is treated as an increment added to the wing characteristics.

Flat Meanline Wing

The recommended flat meanline wing has three different leading edges (sharp, LER = 0.001c, varying LER). Theoretical suction and K_T characteristics at Mach 1.6 and 2.0 are shown in Figures A-1 and A-2. Wing thickness pressures for the three wing versions at Mach 1.6, 1.8, and 2.0 are presented in Tables A-1 through A-9. Incremental thickness pressures for the body are presented in Figures A-3 and A-4.

Theoretical estimates of zero lift wave drag and skin friction drag for the wings at the three Mach numbers are presented in Table A-10. The incremental effect of the body, which is included in the tabulated wing numbers, is given separately. The wave drag numbers were calculated using the near-field program and show a leading-edge drag increment for the blunt leading-edge wings that is considered inaccurate due to linear theory violations because of steep local angles.

Lifting pressure distributions for the flat meanline wing per degree of angle of attack are presented in Tables A-11 through A-13. Drag-due-to-lift characteristics for the three Mach numbers are presented in Tables A-14 through A-16. The drag-due-to-lift summaries include no leading-edge suction, full leading-edge suction, leading-edge suction treated as vortex lift (Polhamus analogy), and attainable thrust.

Cambered Wing

By superposition, the skin friction drag and zero lift wave drag for the cambered wing are the same as the flat meanline wing of the same thickness description. The lifting pressure increment per degree of angle of attack for the cambered wing is the same as the flat meanline wing.

The lifting pressure distributions at $\alpha = 0$ for the cambered wing 7 with the basic leading edge at Mach 1.6, 1.8, and 2.0 are presented in Tables A-17 through A-19. Lifting pressure distributions for the drooped leading-edge wings at $\alpha = 0$ and $M = 1.8$ are presented in Tables A-20 through A-22. Drag-due-to-lift characteristics for the cambered wing configurations are given in Tables A-23 through A-28.

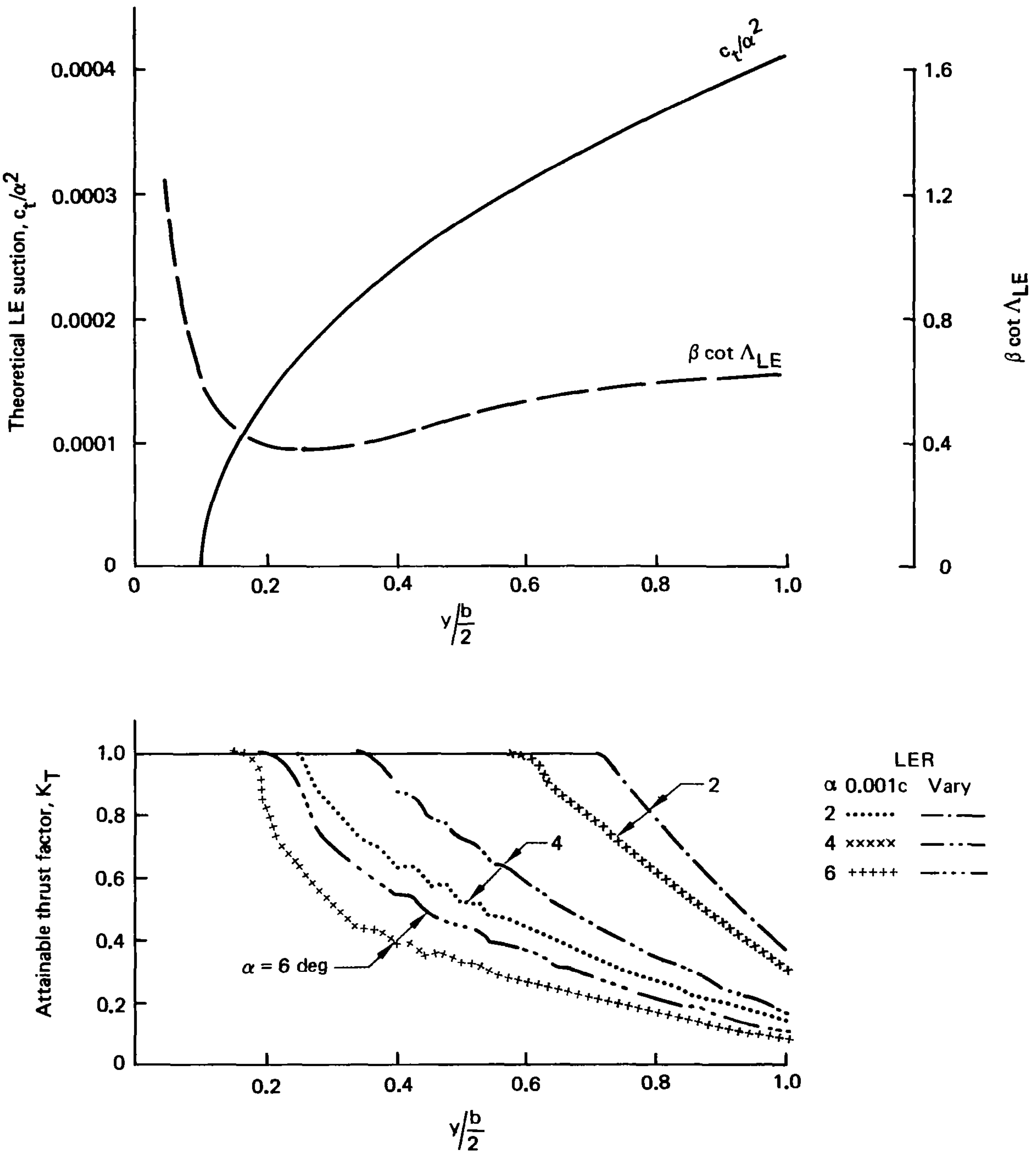


Figure A-1. Leading-Edge Suction Characteristics, Wing 7—Flat Meanline Planform (M = 1.6)

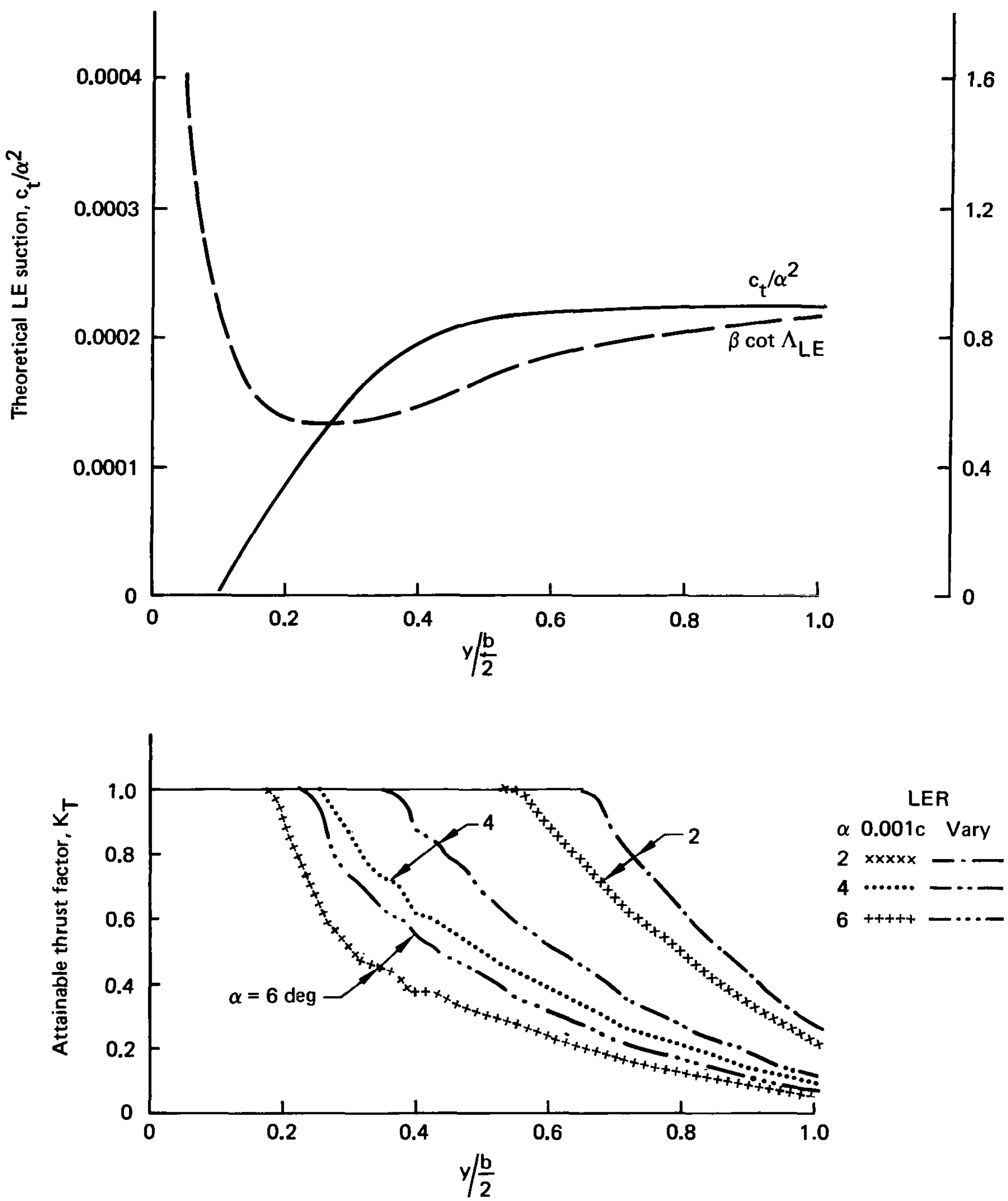


Figure A-2. Leading-Edge Suction Characteristics, Wing 7—Flat Meanline Planform (M = 2.0)

Table A-1. Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 1.6)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.385204	.079948	.030698	.014734	.005749	.001826	.001400	-.004762	-.009982	-.020332	-.027913	-.036922
	-.043070	-.047122	-.052123	-.054221	-.055106	-.054735	-.053305	-.052230	-.051490			
.025	.349490	.059514	.030037	.012506	.005418	.001387	-.000333	-.005355	-.012370	-.020865	-.029594	-.037273
	-.045630	-.047203	-.052203	-.054300	-.055451	-.054922	-.053403	-.052274	-.051827			
.050	.448852	.049210	.031936	.010453	.005143	.001774	-.001205	-.006266	-.013594	-.021597	-.030357	-.038000
	-.043982	-.047847	-.052270	-.054607	-.055588	-.055163	-.053497	-.052502	-.051873			
.075	.518201	.033528	.030347	.009122	.005953	.001938	-.002524	-.006944	-.014022	-.021391	-.030299	-.038150
	-.043958	-.048153	-.052305	-.054757	-.055811	-.055441	-.053742	-.052700	-.052165			
.100	.439079	.021174	.026261	.009133	.006994	.001076	-.003843	-.009029	-.015663	-.022904	-.031624	-.038982
	-.044670	-.048662	-.053382	-.055062	-.056335	-.056063	-.054179	-.053203	-.052458			
.125	.757402	.022828	.019515	.009013	.005138	-.002194	-.006129	-.010805	-.016676	-.023563	-.032802	-.040119
	-.046538	-.049796	-.054636	-.055993	-.057023	-.056595	-.054765	-.053612	-.052997			
.150	.134221	.027142	.020943	.009182	.001838	-.004704	-.008300	-.011881	-.019178	-.026448	-.034913	-.041875
	-.047739	-.051248	-.055002	-.056840	-.057768	-.057242	-.055239	-.054213	-.053445			
.200	.187721	.053207	.013914	.001782	-.006371	-.011138	-.012393	-.016844	-.022996	-.030316	-.039350	-.045615
	-.051576	-.053703	-.057661	-.059072	-.059508	-.059244	-.057234	-.055911	-.055178			
.250	.110293	.049399	.006952	-.005115	-.013015	-.015908	-.017035	-.021677	-.027290	-.035447	-.044064	-.050097
	-.054835	-.057375	-.060728	-.062048	-.062570	-.061466	-.059679	-.058163	-.057074			
.300	.131395	.042208	.000950	-.012968	-.017646	-.019150	-.022595	-.027327	-.034103	-.042268	-.050450	-.056215
	-.060097	-.062117	-.065709	-.065869	-.066023	-.064537	-.061923	-.060611	-.058957			
.350	.118827	.037062	-.004453	-.017911	-.021545	-.025344	-.028980	-.032902	-.040844	-.049694	-.056605	-.062592
	-.065651	-.067500	-.070875	-.070558	-.069953	-.067825	-.064852	-.063136	-.061507			
.400	.105382	.036528	-.007899	-.022410	-.026597	-.031016	-.034784	-.040905	-.047977	-.056747	-.064171	-.069261
	-.071824	-.073604	-.076510	-.075298	-.074251	-.071742	-.068321	-.066122	-.064565			
.450	.130322	.039910	-.011858	-.026922	-.033911	-.036782	-.041727	-.047898	-.055482	-.063115	-.070961	-.075654
	-.077940	-.079652	-.082222	-.080765	-.079002	-.076348	-.072144	-.069348	-.067769			
.500	.090740	.036723	-.012253	-.032433	-.039400	-.044210	-.048726	-.054836	-.062330	-.070252	-.077424	-.082141
	-.084413	-.086132	-.088360	-.086759	-.084064	-.081032	-.076666	-.072959	-.071163			
.600	.080591	.033661	-.012681	-.041981	-.052880	-.057856	-.062532	-.068067	-.075642	-.084018	-.091330	-.095878
	-.098319	-.099543	-.100690	-.099558	-.095895	-.092063	-.087227	-.082691	-.079225			
.700	.071734	.024476	-.019871	-.050459	-.067362	-.072607	-.075752	-.082663	-.090211	-.098633	-.105715	-.110879
	-.113527	-.114606	-.114661	-.113894	-.109816	-.104763	-.099890	-.095744	-.092458			
.800	.043161	.006444	-.028126	-.056486	-.075609	-.087868	-.094008	-.099838	-.106931	-.114976	-.122069	-.127552
	-.131025	-.132311	-.131439	-.130122	-.126914	-.121820	-.115421	-.110364	-.102824			
.900	.003663	-.022074	-.044812	-.065509	-.084375	-.099965	-.114255	-.122108	-.129219	-.135719	-.141994	-.147701

Table A-1. *Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 1.6) (Concluded)*

	-.151463	-.153041	-.152040	-.149710	-.146863	-.14382.	.138117	-.132289	-.126535			
.950	-.023580	-.040049	-.059517	-.077471	-.093680	-.108840	-.119891	-.130943	-.139896	-.148719	-.154523	-.158908
	-.162893	-.166323	-.169061	-.168094	-.167127	-.163332	-.159210	-.151944	-.142868			
1.000	-.034825	-. 56520	-.078216	-.097732	-.113403	-.129074	-.142957	-.153549	-.164141	-.172554	-.176786	-.181018
	-.182852	-.179881	-.176910	-.173121	-.167616	-.162112	-.155531	-.146590	-.137650			

Table A-2. Wing Thickness Pressures—LER = 0.001c Wing (M = 1.6)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.385204	.080307	.032532	.018229	.010257	-.000172	.000402	-.010368	-.006664	-.022431	-.023349	-.037101
	-.040486	-.047171	-.050435	-.055045	-.053536	-.054353	-.053262	-.052393	-.051614			
.025	.349490	.060028	.032199	.016429	.009284	.001191	-.003449	-.009267	-.014463	-.022530	-.033956	-.037719
	-.044706	-.047367	-.052217	-.055342	-.055396	-.054783	-.053399	-.052377	-.051928			
.050	.448965	.050439	.034686	.014572	.008595	.002140	-.003240	-.009411	-.016013	-.023015	-.031552	-.038772
	-.044752	-.048630	-.052442	-.055153	-.056137	-.054931	-.053516	-.052580	-.051978			
.075	.520990	.034772	.033593	.011808	.005699	.000492	-.007549	-.009052	-.018065	-.021045	-.031370	-.037635
	-.044075	-.047749	-.052251	-.053925	-.056476	-.054507	-.053668	-.052722	-.052284			
.100	.446457	.021634	.029028	.009033	.008064	.001749	-.005740	-.010965	-.018976	-.023967	-.033385	-.039371
	-.044775	-.047727	-.054329	-.053884	-.056308	-.056132	-.054092	-.053242	-.052560			
.125	.797991	.019785	.018556	.007430	.004127	-.003533	-.007364	-.013762	-.019141	-.024122	-.032887	-.039135
	-.045836	-.049095	-.055397	-.056007	-.056998	-.057085	-.054673	-.053644	-.053055			
.150	.154407	.011390	.013573	.006475	.000069	-.002486	-.010279	-.009673	-.021138	-.027268	-.036661	-.040680
	-.047821	-.052205	-.054269	-.056776	-.057744	-.058021	-.054759	-.054178	-.053458			
.200	.183389	.007025	.003685	.004916	-.003928	-.008214	-.011526	-.016991	-.024657	-.030417	-.039992	-.044167
	-.052388	-.053301	-.057951	-.058873	-.058880	-.059309	-.057658	-.055817	-.055181			
.250	.059111	.003050	-.001011	.003399	-.009461	-.012909	-.016598	-.023730	-.026418	-.035375	-.046085	-.048852
	-.054704	-.057504	-.061192	-.062069	-.062686	-.061520	-.060631	-.057848	-.056755			
.300	.150231	-.000340	-.002750	-.007817	-.013704	-.015254	-.021197	-.027700	-.035704	-.041707	-.050569	-.056453
	-.059950	-.062321	-.066312	-.065811	-.066153	-.064527	-.062007	-.060658	-.058662			
.350	.127983	-.005558	-.007334	-.014014	-.017156	-.023336	-.029129	-.030492	-.039847	-.049910	-.054641	-.062613
	-.065567	-.067178	-.071333	-.070410	-.070032	-.067211	-.064740	-.063401	-.060814			
.400	.108409	-.004924	-.019284	-.020596	-.019688	-.027361	-.031042	-.039908	-.048341	-.056560	-.064433	-.069144
	-.071907	-.072729	-.076783	-.074504	-.074086	-.071154	-.068771	-.066923	-.064949			
.450	.115590	.000653	-.027231	-.024159	-.029175	-.030944	-.039324	-.047285	-.055194	-.061372	-.070739	-.075335
	-.077591	-.078179	-.082240	-.080412	-.079598	-.075678	-.072239	-.069639	-.068001			
.500	.056840	-.011576	-.032066	-.029581	-.032110	-.039050	-.045947	-.053917	-.061019	-.070029	-.076182	-.081376
	-.084190	-.085481	-.088767	-.086774	-.084189	-.080465	-.076352	-.072352	-.071507			
.600	.056714	-.006823	-.031639	-.041188	-.044564	-.052856	-.058687	-.065927	-.075111	-.083404	-.090615	-.095337
	-.097869	-.098367	-.100019	-.098986	-.096504	-.092156	-.086791	-.082597	-.078030			
.700	.019167	-.025832	-.042907	-.054355	-.059175	-.064476	-.068206	-.079065	-.088268	-.099079	-.105113	-.110597
	-.113136	-.113304	-.113593	-.113162	-.109739	-.105261	-.099900	-.095533	-.091890			
.800	-.003986	-.033794	-.053569	-.064283	-.069958	-.079104	-.086669	-.096120	-.106423	-.113588	-.121171	-.126985
	-.130250	-.130858	-.130211	-.129140	-.126107	-.121481	-.116278	-.110551	-.102748			
.900	.000751	-.024939	-.059629	-.070260	-.084450	-.098912	-.113481	-.119610	-.125103	-.133074	-.140468	-.146397

Table A-2. *Wing Thickness Pressures—LER = 0.001c Wing (M = 1.6) (Concluded)*

	-.150112	-.151340	-.150596	-.148836	-.145976	-.142827	-.137296	-.131838	-.126630			
.950	-.050597	-.064853	-.079108	-.091173	-.100717	-.109992	-.118215	-.126438	-.135165	-.143922	-.150560	-.156204
	-.161283	-.165582	-.169052	-.168096	-.167140	-.163304	-.159134	-.151490	-.141849			
1.000	-.021810	-.048638	-.075466	-.097857	-.112417	-.126977	-.140299	-.151342	-.162385	-.170777	-.174078	-.177379
	-.178826	-.176555	-.174284	-.171165	-.166270	-.161375	-.155198	-.146215	-.137231			

Table A-3. Wing Thickness Pressures– Varying LER Wing (M = 1.6)

TABLE OF THICKNESS PRESSURE COEFFICIENT

Y/B/2 \ KPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
0.000	.385204	.080746	.035148	.022113	.013871	-.002298	-.001041	-.015612	-.004056	-.024915	-.019385	-.037506
.025	.349490	.060697	.035007	.020473	.012341	.000689	-.006297	-.012680	-.016495	-.024378	-.032350	-.038205
.050	.449109	.052138	.037909	.018302	.011227	.001816	-.005130	-.012167	-.018377	-.024629	-.032786	-.039520
.075	.524634	.036214	.036794	.014094	.005410	-.000751	-.012278	-.010837	-.022063	-.020856	-.032631	-.037182
.100	.457284	.021431	.030840	.008787	.008534	.002397	-.007560	-.012683	-.022076	-.025006	-.035118	-.039800
.125	.844254	.014365	.016947	.005386	.003321	-.004605	-.008574	-.016380	-.021300	-.024843	-.033224	-.038345
.150	.179354	-.005747	.005811	.003444	-.002013	-.000098	-.012512	-.007482	-.022833	-.028022	-.038536	-.039563
.200	.179231	-.030319	-.009665	.004257	-.003347	-.004409	-.010443	-.016634	-.026097	-.030603	-.040745	-.042852
.250	.016788	-.037557	-.015146	.006970	-.006804	-.008379	-.015356	-.025444	-.025543	-.035266	-.048013	-.047783
.300	.172877	-.039802	-.013031	-.006652	-.010173	-.009874	-.019141	-.027680	-.037107	-.041346	-.050694	-.056622
.350	.141758	-.045159	-.016029	-.013736	-.012777	-.019820	-.028394	-.028015	-.038829	-.050023	-.052819	-.062587
.400	.115652	-.042320	-.035319	-.022251	-.013401	-.022254	-.027108	-.038741	-.048609	-.056319	-.064571	-.068937
.450	.105775	-.034433	-.046130	-.025419	-.025033	-.023968	-.036078	-.046463	-.054666	-.059622	-.070421	-.075015
.500	.033373	-.052439	-.055024	-.031250	-.025838	-.032769	-.042233	-.052605	-.059606	-.069605	-.075040	-.080726
.600	.039171	-.040800	-.052421	-.044927	-.038278	-.047226	-.054017	-.063228	-.074304	-.082556	-.089923	-.094611
.700	-.020710	-.064500	-.065003	-.061146	-.054507	-.056906	-.060697	-.075364	-.086153	-.098797	-.104350	-.110052
.800	-.037340	-.064057	-.074005	-.072231	-.066982	-.072765	-.080414	-.092025	-.104798	-.112093	-.120073	-.126255
.900	-.000408	-.028334	-.056260	-.074935	-.085305	-.098051	-.111742	-.116711	-.121230	-.130314	-.138698	-.145304

Y/B/2 \ KPCT	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00
0.000	-.038150	-.047335	-.048920	-.055817	-.052203	-.054005	-.053235	-.052394	-.051671
.025	-.046154	-.047582	-.052199	-.056335	-.055403	-.054654	-.053402	-.052467	-.051998
.050	-.045402	-.049363	-.052520	-.055662	-.056687	-.054733	-.053523	-.052649	-.052061
.075	-.044292	-.047428	-.052267	-.053199	-.057128	-.053710	-.053590	-.052724	-.052362
.100	-.044960	-.046834	-.055377	-.052840	-.056259	-.056232	-.054017	-.053258	-.052626
.125	-.045494	-.048448	-.056164	-.056041	-.056971	-.057555	-.054597	-.053652	-.053100
.150	-.047910	-.053159	-.053664	-.056681	-.057702	-.058764	-.054324	-.054113	-.053435
.200	-.053206	-.052934	-.058231	-.058724	-.058288	-.059362	-.058050	-.055724	-.055148
.250	-.054593	-.057538	-.061631	-.062110	-.062806	-.061503	-.061518	-.057560	-.056398
.300	-.059877	-.062470	-.066875	-.065746	-.066227	-.064467	-.062113	-.060755	-.058423
.350	-.065525	-.066819	-.071717	-.070294	-.070049	-.066653	-.064661	-.063691	-.060203
.400	-.071825	-.071890	-.076988	-.073863	-.073940	-.070625	-.069089	-.067603	-.065236
.450	-.077171	-.076837	-.082291	-.080146	-.080001	-.075032	-.072166	-.069896	-.068232
.500	-.083956	-.084835	-.089089	-.086663	-.084128	-.079927	-.076054	-.071943	-.071921
.600	-.097445	-.097360	-.099603	-.098543	-.096728	-.092118	-.086251	-.082251	-.077197
.700	-.112379	-.112119	-.112911	-.112684	-.109552	-.105354	-.099780	-.095254	-.051276
.800	-.129430	-.129511	-.129412	-.128555	-.125598	-.121129	-.116384	-.110420	-.102525

Table A-3. Wing Thickness Pressures—Varying LER Wing (M = 1.6) (Concluded)

	-.149150	-.149896	-.149383	-.148221	-.145380	-.142152	-.136690	-.131434	-.126885			
.950	-.070086	-.081280	-.092473	-.100710	-.105543	-.110672	-.116961	-.123250	-.131656	-.140191	-.147384	-.153945
	-.159791	-.164645	-.168610	-.167821	-.167033	-.163186	-.158984	-.151111	-.141124			
1.000	-.014327	-.044069	-.073811	-.097807	-.111667	-.125526	-.138449	-.149650	-.160850	-.169158	-.171912	-.174666
	-.175880	-.174004	-.172129	-.169455	-.165109	-.160763	-.154947	-.145916	-.136884			

Table A-4. Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 1.8)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.300924	.078538	.035402	.012120	.006408	.002415	-.000476	-.003831	-.009767	-.017352	-.025453	-.032617
	-.038401	-.042037	-.046273	-.048333	-.049419	-.049336	-.047719	-.046974	-.045681			
.025	.265827	.077411	.029986	.014956	.005262	.001657	-.000691	-.004007	-.009985	-.017553	-.025645	-.032799
	-.038495	-.042236	-.046305	-.048429	-.049459	-.049361	-.047836	-.046921	-.046238			
.050	.326969	.076513	.024809	.013482	.006247	.002290	-.001001	-.005131	-.010566	-.017982	-.026007	-.033172
	-.038779	-.042490	-.046595	-.048561	-.049694	-.049431	-.048110	-.047050	-.046357			
.075	.343320	.070257	.024044	.012681	.006744	.002083	-.001550	-.006283	-.011653	-.018670	-.026581	-.033737
	-.039163	-.042988	-.046750	-.048903	-.049974	-.049682	-.048553	-.046999	-.046414			
.100	.380904	.065831	.023377	.012509	.007590	.001856	-.002936	-.007662	-.012775	-.019470	-.027362	-.034518
	-.039849	-.043677	-.047317	-.049426	-.050396	-.050108	-.048787	-.047619	-.046847			
.125	.258383	.047827	.022795	.012260	.006384	-.000236	-.005085	-.009513	-.014329	-.020870	-.028731	-.035570
	-.041017	-.044378	-.048228	-.050107	-.050905	-.050717	-.049171	-.048187	-.047318			
.150	.349757	.036842	.022869	.011112	.003097	-.003384	-.007563	-.011302	-.015912	-.022510	-.030183	-.037076
	-.042467	-.045473	-.049218	-.050777	-.051643	-.051298	-.049581	-.048588	-.048030			
.200	.141055	.058803	.017957	.002678	-.004700	-.009662	-.011712	-.014985	-.019647	-.026091	-.033947	-.040407
	-.045181	-.048308	-.051281	-.053105	-.053396	-.052810	-.051231	-.050266	-.049774			
.250	.117272	.055707	.010116	-.004699	-.010302	-.014065	-.015553	-.018537	-.023423	-.030235	-.037741	-.044249
	-.048521	-.051170	-.054214	-.055742	-.055726	-.055143	-.053816	-.052551	-.051263			
.300	.114162	.047641	.003986	-.010012	-.015323	-.018087	-.019988	-.023011	-.028528	-.036107	-.043538	-.049486
	-.053570	-.055804	-.058156	-.059585	-.059126	-.058237	-.055626	-.054650	-.053460			
.350	.114503	.043990	-.000051	-.014843	-.019695	-.022062	-.024301	-.028124	-.034207	-.042074	-.049915	-.055336
	-.058624	-.060839	-.063109	-.063992	-.062806	-.061429	-.059141	-.056898	-.055615			
.400	.109949	.041342	-.001488	-.018949	-.024061	-.026616	-.029346	-.033878	-.040381	-.047872	-.055778	-.060869
	-.064415	-.066519	-.067590	-.068564	-.067535	-.065047	-.062635	-.060208	-.057439			
.450	.130416	.045493	-.000705	-.022319	-.028783	-.031801	-.034042	-.039604	-.045761	-.054286	-.062015	-.067077
	-.069971	-.072051	-.073766	-.073234	-.072321	-.069623	-.066414	-.063665	-.062313			
.500	.098461	.046275	.001029	-.025466	-.033095	-.036463	-.040128	-.045447	-.051735	-.059814	-.067702	-.073332
	-.073809	-.077859	-.079134	-.079287	-.076769	-.074477	-.071034	-.068088	-.064828			
.600	.079231	.041639	.003090	-.029244	-.042908	-.046275	-.051136	-.056308	-.063074	-.071472	-.078367	-.085084
	-.088647	-.090468	-.090530	-.090276	-.088928	-.085704	-.082093	-.076693	-.074356			
.700	.067196	.033604	.000747	-.028852	-.050658	-.059246	-.061482	-.067701	-.075201	-.083098	-.091363	-. 98157
	-.107631	-.103725	-.104019	-.103372	-.101947	-.098789	-.094023	-.090576	-.084124			
.800	.101972	.040900	.000907	-.027821	-.049699	-.067067	-.077323	-.082394	-.088189	-.095530	-.104343	-.109593
	-.114589	-.119362	-.119800	-.119040	-.116995	-.113980	-.110134	-.104872	-.099030			
.900	.029786	.005460	-.018866	-.038121	-.056957	-.070705	-.082785	-.093900	-.104325	-.112646	-.117972	-.123508

Table A-4. Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 1.8) (Concluded)

	-.129705	-.135522	-.136420	-.137318	-.135463	-.133307	-.130595	-.127678	-.124761			
.950	.002761	-.013745	-.030251	-.046757	-.061239	-.074452	-.087664	-.099522	-.111238	-.121876	-.128065	-.134253
	-.138890	-.141879	-.144868	-.146659	-.148103	-.149273	-.146512	-.143751	-.140989			
1.000	.007984	-.016211	-.040039	-.056287	-.072535	-.088784	-.102055	-.111536	-.121018	-.130499	-.137772	-.144604
	-.151436	-.156328	-.154612	-.152897	-.151182	-.148226	-.144512	-.140797	-.137082			

Table A-5. Wing Thickness Pressures—LER = 0.001c Wing (M = 1.8)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.300924	.078768	.036729	.014525	.009515	.004097	-.002002	-.007550	-.011792	-.018515	-.025985	-.033455
	-.039065	-.041746	-.046542	-.047385	-.049388	-.048924	-.048130	-.047313	-.044416			
.025	.265827	.077874	.031511	.017748	.008448	.002346	-.002906	-.006823	-.011832	-.018677	-.026155	-.033288
	-.038971	-.042507	-.046531	-.048220	-.049345	-.049090	-.048202	-.047349	-.046237			
.050	.327310	.077412	.026554	.016159	.008481	.002675	-.003461	-.007728	-.012022	-.019048	-.026731	-.033634
	-.039118	-.042828	-.046763	-.048567	-.049336	-.049332	-.048023	-.047625	-.046449			
.075	.345925	.071627	.026028	.014992	.007146	.001462	-.002759	-.008279	-.013268	-.019636	-.027262	-.034214
	-.039411	-.043404	-.045948	-.049038	-.049314	-.049896	-.048633	-.046286	-.046800			
.100	.387955	.066552	.025103	.012958	.007189	.000856	-.003749	-.008929	-.014419	-.020610	-.028097	-.034898
	-.040310	-.044051	-.047212	-.049507	-.050294	-.050431	-.049023	-.047307	-.047118			
.125	.270500	.044795	.021490	.010858	.004756	.000382	-.005273	-.010229	-.015720	-.021801	-.029424	-.035752
	-.041364	-.043771	-.048391	-.050006	-.050920	-.050583	-.049104	-.047715	-.047812			
.150	.399444	.023458	.016996	.008381	.003517	-.001806	-.007031	-.011707	-.017294	-.023435	-.030357	-.037380
	-.042657	-.045460	-.049379	-.050508	-.052347	-.051125	-.048972	-.048805	-.047902			
.200	.155002	.015907	.009096	.002627	-.001666	-.005769	-.010709	-.015489	-.020592	-.026581	-.034381	-.039651
	-.045182	-.048451	-.051341	-.053639	-.053728	-.052184	-.050926	-.050250	-.049987			
.250	.092566	.007754	.000667	-.003060	-.005437	-.009805	-.013835	-.018656	-.023714	-.029774	-.037734	-.044281
	-.048012	-.051407	-.054600	-.056139	-.055082	-.055318	-.053891	-.052645	-.050912			
.300	.087113	.003147	-.004391	-.006535	-.009101	-.013973	-.018510	-.022164	-.028336	-.036142	-.043146	-.049705
	-.053824	-.056290	-.057384	-.059514	-.059042	-.059009	-.054659	-.053836	-.053685			
.350	.101771	.006233	-.010799	-.010537	-.012927	-.017652	-.022759	-.026998	-.033774	-.042973	-.050049	-.055488
	-.057871	-.060887	-.063207	-.064762	-.062091	-.061008	-.060362	-.056085	-.055126			
.400	.094926	.006384	-.016340	-.015162	-.017979	-.022312	-.028911	-.033284	-.040350	-.046527	-.055216	-.061167
	-.064243	-.067316	-.066323	-.068169	-.068844	-.064282	-.062366	-.061325	-.055990			
.450	.110384	.010378	-.017468	-.021606	-.023717	-.027681	-.029774	-.037939	-.045839	-.053875	-.062639	-.066506
	-.068985	-.072042	-.074484	-.072222	-.071986	-.070710	-.066025	-.063435	-.061979			
.500	.064693	.003798	-.016535	-.022724	-.026882	-.031858	-.036784	-.045116	-.050176	-.058310	-.066892	-.074286
	-.074624	-.077530	-.079324	-.079973	-.075650	-.074109	-.071648	-.068333	-.064022			
.600	.061023	.014701	-.016418	-.038029	-.038278	-.037975	-.046028	-.053221	-.063844	-.070559	-.076501	-.084120
	-.088693	-.091269	-.089901	-.089481	-.088193	-.086461	-.082250	-.076358	-.074060			
.700	.035833	.002801	-.022230	-.037236	-.052157	-.052261	-.054535	-.062827	-.071877	-.081585	-.091862	-.097444
	-.099925	-.102948	-.102761	-.102742	-.101989	-.098686	-.095231	-.090747	-.083475			
.800	.092342	.025436	-.012083	-.034762	-.049173	-.063815	-.072301	-.076516	-.086020	-.094857	-.103058	-.108010
	-.112982	-.118062	-.118184	-.117826	-.117432	-.114034	-.109968	-.105606	-.098943			
.900	.003995	-.017351	-.038696	-.050492	-.061496	-.072096	-.082562	-.091788	-.100125	-.107726	-.114279	-.120860

Table A-5. Wing Thickness Pressures—LER = 0.001c Wing (M = 1.8) (Concluded)

	-.127532	-.133791	-.134700	-.135610	-.134565	-.133307	-.130649	-.127475	-.124301			
.950	-.007681	-.022182	-.036682	-.051183	-.063481	-.074397	-.085314	-.096919	-.108598	-.119173	-.125191	-.131210
	-.136323	-.140475	-.144627	-.146356	-.147382	-.148173	-.145600	-.143026	-.140453			
1.000	.007224	-.019059	-.044798	-.059315	-.073833	-.088350	-.100527	-.109725	-.118923	-.128120	-.134901	-.141198
	-.147495	-.152149	-.151208	-.150266	-.149325	-.146781	-.143257	-.139733	-.136209			

Table A-6. Wing Thickness Pressures—LER = Varying LER Wing (M = 1.8)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.300924	.079055	.038514	.017450	.012140	.005239	-.003700	-.010728	-.013668	-.019862	-.026668	-.034430
	-.039761	-.041548	-.046804	-.046536	-.049357	-.048613	-.048529	-.047610	-.043355			
.025	.265827	.078476	.033527	.020791	.011051	.002645	-.005170	-.009291	-.013536	-.019927	-.026815	-.033871
	-.039483	-.042800	-.046763	-.048033	-.049233	-.048878	-.048575	-.047688	-.046176			
.050	.327743	.078616	.028735	.018718	.010338	.002711	-.005690	-.010217	-.013452	-.020164	-.027619	-.034182
	-.039512	-.043180	-.046947	-.048572	-.049008	-.049244	-.048023	-.048152	-.046448			
.075	.349512	.073206	.027816	.016987	.007508	.000550	-.003889	-.010269	-.014813	-.020622	-.028070	-.034764
	-.039734	-.043829	-.045248	-.049168	-.048762	-.050102	-.048727	-.045679	-.047236			
.100	.398173	.066933	.025797	.013283	.006766	.000086	-.004566	-.010366	-.015920	-.021760	-.028918	-.035357
	-.040831	-.044444	-.047124	-.049595	-.050230	-.050755	-.049146	-.047010	-.047446			
.125	.286326	.040446	.019075	.009330	.003427	.001088	-.005516	-.011087	-.016939	-.022675	-.030179	-.036008
	-.041757	-.043251	-.048562	-.049949	-.050938	-.050496	-.049022	-.047336	-.048346			
.150	.451612	.009588	.009526	.005275	.003581	-.000023	-.006500	-.012184	-.018470	-.024275	-.030618	-.037731
	-.042895	-.045461	-.049555	-.050297	-.053039	-.050888	-.048437	-.049057	-.047836			
.200	.171738	-.019142	-.003186	-.000651	-.000221	-.001337	-.009347	-.015891	-.021287	-.026957	-.034818	-.039012
	-.045210	-.048627	-.051420	-.054192	-.053936	-.051665	-.050672	-.050286	-.050132			
.250	.078170	-.033916	-.013846	-.005962	-.001967	-.004580	-.011504	-.018493	-.023762	-.029253	-.037702	-.044350
	-.047647	-.051671	-.055020	-.056400	-.054523	-.055516	-.054021	-.052617	-.050686			
.300	.065446	-.038492	-.018142	-.007522	-.003665	-.008654	-.016343	-.020935	-.027921	-.036064	-.042840	-.049924
	-.054127	-.056630	-.056735	-.059473	-.059031	-.059434	-.053915	-.053183	-.053831			
.350	.092555	-.029329	-.026058	-.010289	-.006824	-.012096	-.020266	-.025592	-.033137	-.043728	-.050224	-.055513
	-.057198	-.060986	-.063358	-.065216	-.061515	-.060724	-.061165	-.055479	-.054734			
.400	.092357	-.025871	-.034524	-.015483	-.012738	-.016894	-.027340	-.032337	-.039881	-.045260	-.054658	-.061482
	-.064144	-.067785	-.065317	-.067924	-.069699	-.063682	-.062199	-.062012	-.054836			
.450	.095810	-.022064	-.036998	-.024916	-.019574	-.022227	-.024663	-.035846	-.045703	-.053477	-.062782	-.065953
	-.068219	-.072030	-.074954	-.071462	-.071768	-.071315	-.065733	-.063346	-.061746			
.500	.036256	-.033944	-.036473	-.024675	-.022011	-.026445	-.032507	-.043675	-.048532	-.057005	-.066140	-.074783
	-.073639	-.077292	-.079368	-.080417	-.074822	-.073893	-.071923	-.068441	-.063388			
.600	.045457	-.010332	-.037098	-.048760	-.035400	-.029786	-.040268	-.049638	-.063593	-.069572	-.074929	-.083341
	-.088469	-.091607	-.089343	-.088930	-.087712	-.086894	-.082306	-.075952	-.073858			
.700	.010297	-.023996	-.043918	-.046952	-.054118	-.045878	-.047505	-.057892	-.068712	-.079971	-.091746	-.096643
	-.099075	-.102257	-.101886	-.102318	-.102000	-.098541	-.095744	-.090775	-.082906			
.800	.083914	.012091	-.024318	-.042213	-.050178	-.061569	-.067876	-.070875	-.082923	-.093152	-.101649	-.106449
	-.111566	-.117167	-.117064	-.116948	-.117664	-.114010	-.109742	-.105802	-.098861			
.900	-.015081	-.034223	-.053366	-.059723	-.065019	-.072894	-.081614	-.089325	-.096313	-.103480	-.110903	-.118314

Table A-6. Wing Thickness Pressures—LER = Varying LER Wing (M = 1.8) (Concluded)

	-.125689	-.132597	-.133453	-.134309	-.133824	-.133192	-.130585	-.127253	-.123920			
.950	-.014014	-.027395	-.040776	-.054157	-.064940	-.074095	-.083250	-.094656	-.106298	-.116807	-.122630	-.128453
	-.133892	-.138922	-.143952	-.145739	-.146585	-.147217	-.144781	-.142344	-.139908			
1.000	.008700	-.019019	-.046088	-.059759	-.073430	-.087102	-.098745	-.107807	-.116869	-.125930	-.132475	-.138516
	-.144557	-.149126	-.148682	-.148238	-.147793	-.145540	-.142179	-.138819	-.135459			

Table A-7. Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 2.0)

TABLE OF THICKNESS PRESSURE COEFFICIENT

Y/B/2 \ XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00
0.000	.214384	.081306	.039913	.017759	.002736	.001687	-.001508	-.003732	-.007931	-.014949	-.022522	-.029205	-.034489	-.038269	-.041843	-.043986	-.044545	-.044918	-.043721	-.042496	-.041966
.025	.249288	.074404	.030226	.019491	.007692	.001967	-.000780	-.003949	-.008616	-.015191	-.022624	-.029294	-.034553	-.038328	-.041966	-.044090	-.045096	-.044988	-.043901	-.042676	-.042145
.050	.232861	.082117	.025903	.011464	.006960	.001789	-.000887	-.004320	-.009325	-.015688	-.022933	-.029600	-.034888	-.038493	-.042072	-.044101	-.045205	-.045026	-.044073	-.043013	-.041990
.075	.239195	.082808	.025601	.013191	.006012	.001680	-.001322	-.005719	-.010335	-.016229	-.023428	-.030088	-.035337	-.038854	-.042532	-.044333	-.045467	-.045342	-.043847	-.043307	-.042001
.100	.322536	.079950	.023565	.014963	.006296	.001075	-.002341	-.007033	-.011534	-.017061	-.024090	-.030759	-.035893	-.039364	-.042885	-.044911	-.045922	-.045862	-.044410	-.043693	-.042749
.125	.290708	.068513	.022431	.013458	.005510	-.000339	-.004320	-.008656	-.012954	-.018356	-.025340	-.031862	-.036820	-.040405	-.043460	-.045643	-.046325	-.046003	-.044766	-.044021	-.043537
.150	.394287	.063885	.020919	.011451	.003369	-.003040	-.006584	-.010335	-.014431	-.019851	-.026736	-.033014	-.038024	-.041030	-.044416	-.046446	-.047085	-.046657	-.045674	-.044004	-.043686
.200	.102664	.060433	.023828	.007421	-.001887	-.008330	-.010657	-.013706	-.017768	-.023144	-.029827	-.036220	-.040528	-.043782	-.046583	-.048385	-.048767	-.048383	-.046459	-.045840	-.045374
.250	.168457	.064980	.014451	-.001535	-.008647	-.012649	-.014380	-.017068	-.020982	-.026832	-.032983	-.039190	-.043713	-.046543	-.048634	-.050618	-.051161	-.050178	-.048997	-.048223	-.047363
.300	.108095	.054402	.012672	-.006037	-.013730	-.016576	-.018240	-.020510	-.025260	-.031559	-.038351	-.044142	-.047647	-.050694	-.053178	-.053684	-.053848	-.053416	-.051427	-.049497	-.048747
.350	.086458	.048038	.008680	-.012220	-.017553	-.020140	-.022435	-.025254	-.029989	-.036068	-.043599	-.049249	-.052958	-.055219	-.057141	-.058464	-.057619	-.055949	-.054540	-.052758	-.052118
.400	.151529	.054286	.006623	-.015706	-.021793	-.024501	-.025778	-.029672	-.034881	-.041749	-.048164	-.054231	-.058289	-.060367	-.062229	-.062045	-.061897	-.060329	-.058119	-.055956	-.053418
.450	.094848	.048481	.007813	-.016566	-.025289	-.029051	-.030590	-.033830	-.039225	-.046809	-.053955	-.059701	-.062619	-.065670	-.066888	-.067763	-.066078	-.064619	-.061485	-.059306	-.057207
.500	.089810	.047720	.008851	-.016806	-.028812	-.032730	-.035623	-.038154	-.044462	-.050316	-.058759	-.064664	-.069088	-.070679	-.072372	-.071421	-.071566	-.068862	-.066464	-.063475	-.060893
.600	.084699	.049235	.014858	-.015468	-.035412	-.041481	-.043140	-.047877	-.051419	-.060360	-.067482	-.074401	-.079418	-.081616	-.083291	-.182755	-.081407	-.079493	-.076024	-.073740	-.070380
.700	.091035	.052987	.017690	-.013243	-.034816	-.047355	-.053591	-.055349	-.062720	-.068615	-.075386	-.084306	-.088736	-.092450	-.094820	-.195095	-.093353	-.091438	-.088847	-.084566	-.081199
.800	.083097	.049695	.016774	-.008209	-.030910	-.047852	-.060284	-.068390	-.073472	-.077476	-.085313	-.092581	-.096816	-.101179	-.105721	-.106613	-.105488	-.104484	-.103275	-.099982	-.096689
.900	.045423	.025379	.005335	-.014710	-.029999	-.044139	-.058020	-.071277	-.084534	-.091552	-.096833	-.101923									

Table A-7. Wing Thickness Pressures—Sharp Leading-Edge Wing (M = 2.0) (Concluded)

	-.106502	-.111081	-.114227	-.116916	-.118717	-.117812	-.116907	-.114814	-.112294			
.950	.052595	.029912	.007229	-.014863	-.029773	-.044684	-.059595	-.070548	-.081249	-.091951	-.099472	-.106219
	-.112966	-.116816	-.119226	-.121635	-.123365	-.124496	-.125627	-.126757	-.127888			
1.000	.051637	.025369	-.000899	-.021008	-.035568	-.050128	-.064688	-.077008	-.085215	-.093421	-.101627	-.109202
	-.113877	-.118551	-.123226	-.127869	-.126411	-.124952	-.123494	-.122035	-.120577			

Table A-8. Wing Thickness Pressures—LER = 0.001c Wing (M = 2.0)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.214384	.081426	.041001	.019875	.005051	.003718	-.003533	-.006206	-.009203	-.016315	-.023008	-.029484
	-.034828	-.038661	-.042166	-.043952	-.043045	-.045602	-.042861	-.042608	-.040879			
.025	.249288	.074604	.031237	.022148	.010458	.003663	-.001720	-.006362	-.010758	-.016441	-.023341	-.029799
	-.035036	-.038653	-.042222	-.044152	-.044837	-.045370	-.044242	-.042802	-.042620			
.050	.233162	.082858	.027205	.013183	.009156	.001466	-.001886	-.005839	-.011369	-.016692	-.023598	-.030123
	-.035274	-.038782	-.042108	-.043817	-.045065	-.044476	-.044764	-.042601	-.042175			
.075	.241034	.084392	.027539	.015064	.006666	.001345	-.002511	-.007365	-.011923	-.017093	-.024272	-.030422
	-.035607	-.039183	-.042789	-.043972	-.046277	-.044811	-.043766	-.043073	-.042187			
.100	.328818	.081368	.024454	.015291	.005377	.000035	-.002324	-.008379	-.012537	-.017817	-.024797	-.031245
	-.036221	-.039527	-.042674	-.044776	-.046216	-.045938	-.044163	-.044738	-.042899			
.125	.304968	.066046	.020689	.011163	.004078	.000097	-.003850	-.009086	-.013566	-.019481	-.026081	-.032287
	-.037143	-.040616	-.043087	-.046762	-.046121	-.046071	-.043636	-.044098	-.043871			
.150	.430108	.053172	.013792	.008565	.003667	-.001882	-.005168	-.010469	-.015184	-.020813	-.027388	-.033500
	-.038219	-.040232	-.044425	-.046665	-.047222	-.046685	-.046105	-.043970	-.043458			
.200	.089489	.021390	.011503	.006645	.001259	-.004767	-.008761	-.013503	-.018042	-.024005	-.030048	-.036540
	-.040187	-.044959	-.046248	-.048432	-.048894	-.049007	-.046574	-.044894	-.045032			
.250	.164095	.021854	-.002316	-.000554	-.004517	-.008020	-.011797	-.016723	-.020620	-.027301	-.032459	-.039871
	-.043905	-.046729	-.048803	-.050141	-.051553	-.050433	-.048326	-.048061	-.047681			
.300	.076189	.012413	-.001768	-.003269	-.008207	-.011180	-.015498	-.018521	-.024692	-.033139	-.037899	-.044305
	-.047859	-.049986	-.053478	-.054041	-.052759	-.053538	-.052364	-.048770	-.047673			
.350	.059529	.010075	-.005479	-.008768	-.009298	-.014202	-.022156	-.023980	-.029985	-.036100	-.043546	-.049481
	-.053075	-.055392	-.056172	-.058511	-.058608	-.055345	-.054104	-.053357	-.052105			
.400	.149227	.026624	-.009373	-.016182	-.014130	-.019225	-.023245	-.028244	-.034556	-.041514	-.048408	-.053201
	-.058599	-.060830	-.062716	-.061189	-.061082	-.061193	-.058521	-.056428	-.052771			
.450	.063707	.008617	-.010261	-.016603	-.017247	-.024950	-.027444	-.032625	-.037211	-.046704	-.054188	-.060505
	-.061554	-.065214	-.066264	-.067970	-.067154	-.064738	-.060979	-.058542	-.057920			
.500	.064701	.009444	-.009958	-.020176	-.021280	-.026320	-.031565	-.038181	-.044237	-.048399	-.057790	-.063957
	-.069383	-.071394	-.072757	-.070456	-.071198	-.068101	-.066636	-.063643	-.060888			
.600	.054960	.018618	-.006455	-.022623	-.034579	-.034596	-.039838	-.045010	-.048689	-.058908	-.065182	-.074569
	-.078685	-.081935	-.083550	-.082928	-.081651	-.079044	-.075412	-.073542	-.069371			
.700	.062007	.022351	-.006044	-.022893	-.038358	-.043368	-.046733	-.051769	-.059904	-.066055	-.073355	-.083486
	-.087151	-.091795	-.094908	-.093830	-.093463	-.091646	-.088752	-.085400	-.081071			
.800	.057497	.025366	-.005746	-.020036	-.034162	-.047872	-.057104	-.062041	-.068740	-.076068	-.083800	-.090931
	-.095444	-.099994	-.104597	-.105489	-.104328	-.103897	-.103244	-.099519	-.095794			
.900	.023508	.007055	-.009399	-.025853	-.036560	-.045878	-.056105	-.068520	-.080935	-.087468	-.092361	-.097603

Table A-8. Wing Thickness Pressures—LER = 0.001c Wing (M = 2.0) (Concluded)

	-.103782	-.109961	-.113236	-.115587	-.117321	-.117172	-.117024	-.114736	-.111680			
.950	.032594	.012384	-.007825	-.027295	-.037777	-.048260	-.058743	-.069101	-.079452	-.089803	-.096626	-.102589
	-.108552	-.113062	-.116848	-.120635	-.122926	-.123903	-.124879	-.125855	-.126832			
1.000	.028360	.004803	-.018753	-.035548	-.046251	-.056954	-.067657	-.077222	-.084695	-.092169	-.099642	-.106488
	-.110449	-.114410	-.118371	-.122308	-.121601	-.120894	-.120187	-.119480	-.118774			

Table A-9. Wing Thickness Pressures—Varying LER Wing (M = 2.0)

TABLE OF THICKNESS PRESSURE COEFFICIENT

XPCT	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00			
Y/B/2												
0.000	.214384	.081570	.042421	.022475	.007049	.005277	-.005680	-.008553	-.010260	-.017626	-.023671	-.029886
	-.035251	-.039099	-.042428	-.043874	-.041768	-.046242	-.042194	-.042731	-.040074			
.025	.249288	.074876	.032621	.025142	.012979	.004882	-.002900	-.008690	-.012613	-.017682	-.024238	-.030426
	-.035600	-.039027	-.042492	-.044187	-.044611	-.045753	-.044492	-.042902	-.042953			
.050	.233522	.083871	.028838	.014873	.011199	.000920	-.002924	-.007313	-.013204	-.017663	-.024342	-.030764
	-.035731	-.039089	-.042171	-.043578	-.044896	-.044056	-.045363	-.042305	-.042365			
.075	.243519	.086258	.029305	.016539	.007302	.000771	-.003544	-.008947	-.013479	-.017933	-.025146	-.030865
	-.035957	-.039538	-.043021	-.043669	-.047031	-.044326	-.043736	-.042931	-.042309			
.100	.338025	.082589	.024378	.015544	.004512	-.000715	-.002238	-.009725	-.013649	-.018532	-.025515	-.031830
	-.036579	-.039730	-.042534	-.044679	-.046535	-.045904	-.044021	-.045565	-.042996			
.125	.322746	.062724	.017768	.008725	.002947	.000808	-.003398	-.009668	-.014321	-.020525	-.026761	-.032800
	-.037511	-.040836	-.042808	-.047839	-.045934	-.046127	-.042741	-.044133	-.044270			
.150	.470682	.043175	.004731	.005426	.003836	-.000449	-.003821	-.010682	-.016047	-.021657	-.027958	-.033976
	-.038426	-.039601	-.044467	-.046948	-.047262	-.046778	-.046324	-.043941	-.043427			
.200	.083038	-.010781	-.002937	.002856	.002877	-.000822	-.006465	-.013245	-.018356	-.024644	-.030119	-.036800
	-.039952	-.046095	-.046072	-.048452	-.049121	-.049361	-.046655	-.044175	-.044758			
.250	.168504	-.015048	-.022438	-.004066	-.001941	-.002739	-.008544	-.016146	-.020214	-.027552	-.031890	-.040458
	-.044200	-.046792	-.049053	-.049857	-.051811	-.050704	-.047809	-.047920	-.047982			
.300	.050459	-.026874	-.020159	-.005244	-.003654	-.004882	-.011927	-.016491	-.023983	-.034440	-.037434	-.044283
	-.048176	-.049514	-.053642	-.054403	-.051976	-.053635	-.053059	-.048203	-.046844			
.350	.036611	-.025885	-.023664	-.009651	-.002262	-.007418	-.020850	-.022549	-.029461	-.035953	-.043465	-.049489
	-.053155	-.055629	-.055435	-.058575	-.059345	-.054898	-.053821	-.053728	-.052115			
.400	.150613	-.000017	-.028572	-.020532	-.007682	-.012921	-.019835	-.026614	-.033836	-.040989	-.048466	-.052389
	-.058730	-.061149	-.063144	-.060527	-.060511	-.061759	-.058807	-.056821	-.052218			
.450	.036254	-.027884	-.030737	-.020670	-.011084	-.019538	-.023259	-.030876	-.035291	-.046165	-.054129	-.061023
	-.060691	-.064884	-.065755	-.068086	-.067873	-.064892	-.060595	-.058041	-.058453			
.500	.043894	-.024218	-.030606	-.027060	-.016347	-.019639	-.026585	-.036905	-.043697	-.046512	-.056844	-.063228
	-.069488	-.071789	-.073083	-.069643	-.070981	-.067592	-.066775	-.063688	-.060894			
.600	.029052	-.009883	-.028556	-.032467	-.035477	-.028222	-.035118	-.041353	-.045658	-.057403	-.063160	-.074465
	-.078008	-.081922	-.083578	-.082915	-.081739	-.078721	-.074939	-.073467	-.068676			
.700	.036962	-.005046	-.028689	-.034345	-.042669	-.040164	-.040064	-.046882	-.056529	-.063345	-.071325	-.082605
	-.085807	-.091152	-.094858	-.092979	-.093419	-.091699	-.088638	-.085689	-.080980			
.800	.035359	.003795	-.026287	-.031884	-.038642	-.048331	-.054089	-.056077	-.063625	-.073155	-.081548	-.089204
	-.093907	-.098717	-.103678	-.104605	-.103301	-.103377	-.103232	-.099144	-.095056			
.900	.005497	-.008315	-.022127	-.035940	-.042619	-.047575	-.054469	-.066027	-.077585	-.083580	-.088024	-.093323

Table A-9. Wing Thickness Pressures—Varying LER Wing (M = 2.0) (Concluded)

	-.100929	-.108534	-.112067	-.114305	-.116087	-.116474	-.116862	-.114484	-.111110			
.950	.015655	-.002449	-.020552	-.037793	-.044557	-.051321	-.058086	-.067720	-.077538	-.087355	-.093588	-.098948
	-.104307	-.109326	-.114175	-.119024	-.121816	-.122798	-.123780	-.124762	-.125744			
1.000	.008859	-.011436	-.031732	-.045500	-.053388	-.061277	-.069165	-.076694	-.083564	-.090433	-.097303	-.103584
	-.107164	-.110743	-.114323	-.117883	-.117718	-.117553	-.117388	-.117223	-.117058			

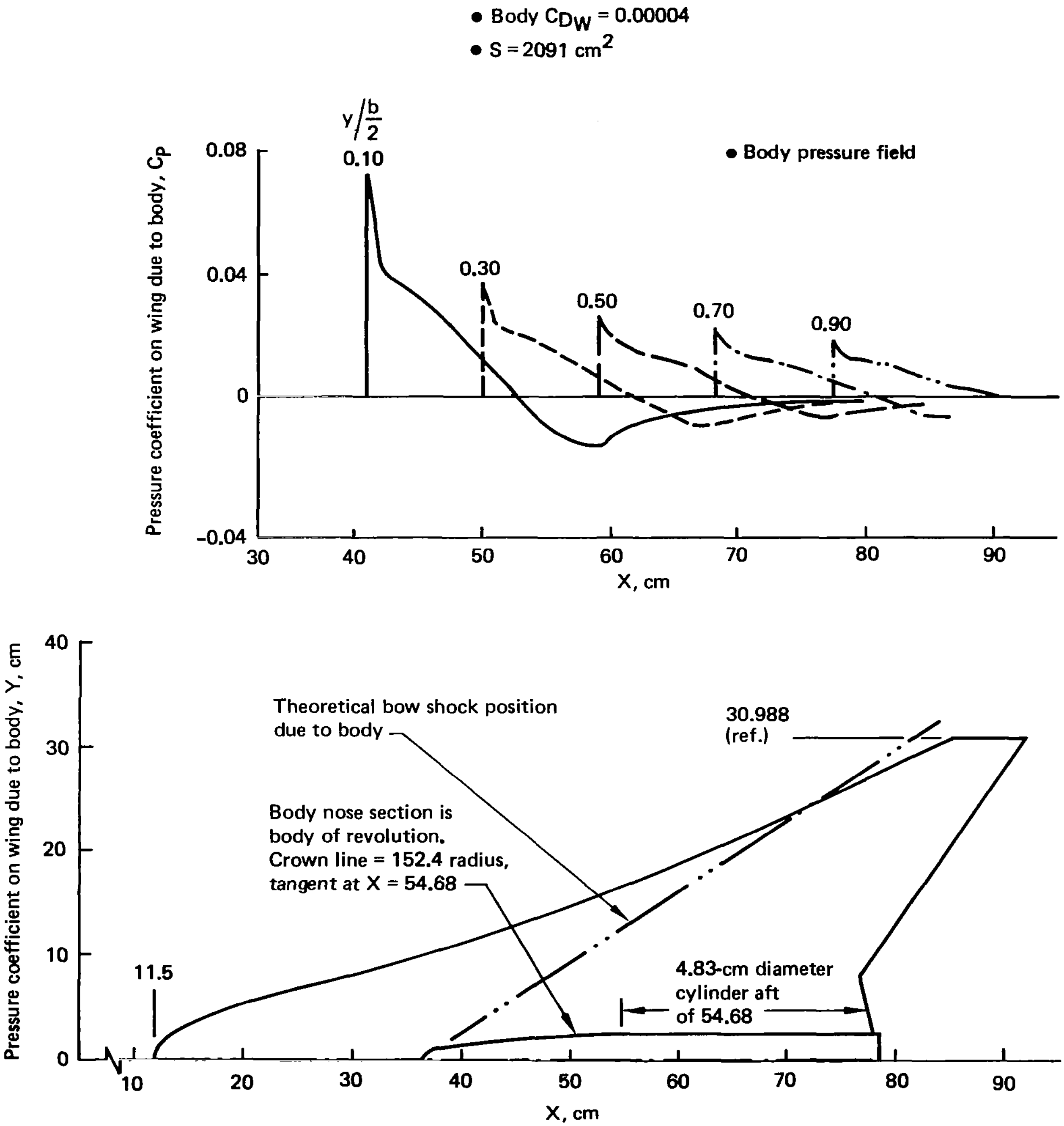


Figure A-3. Theoretical Effect of Body on Wing (M = 1.8)

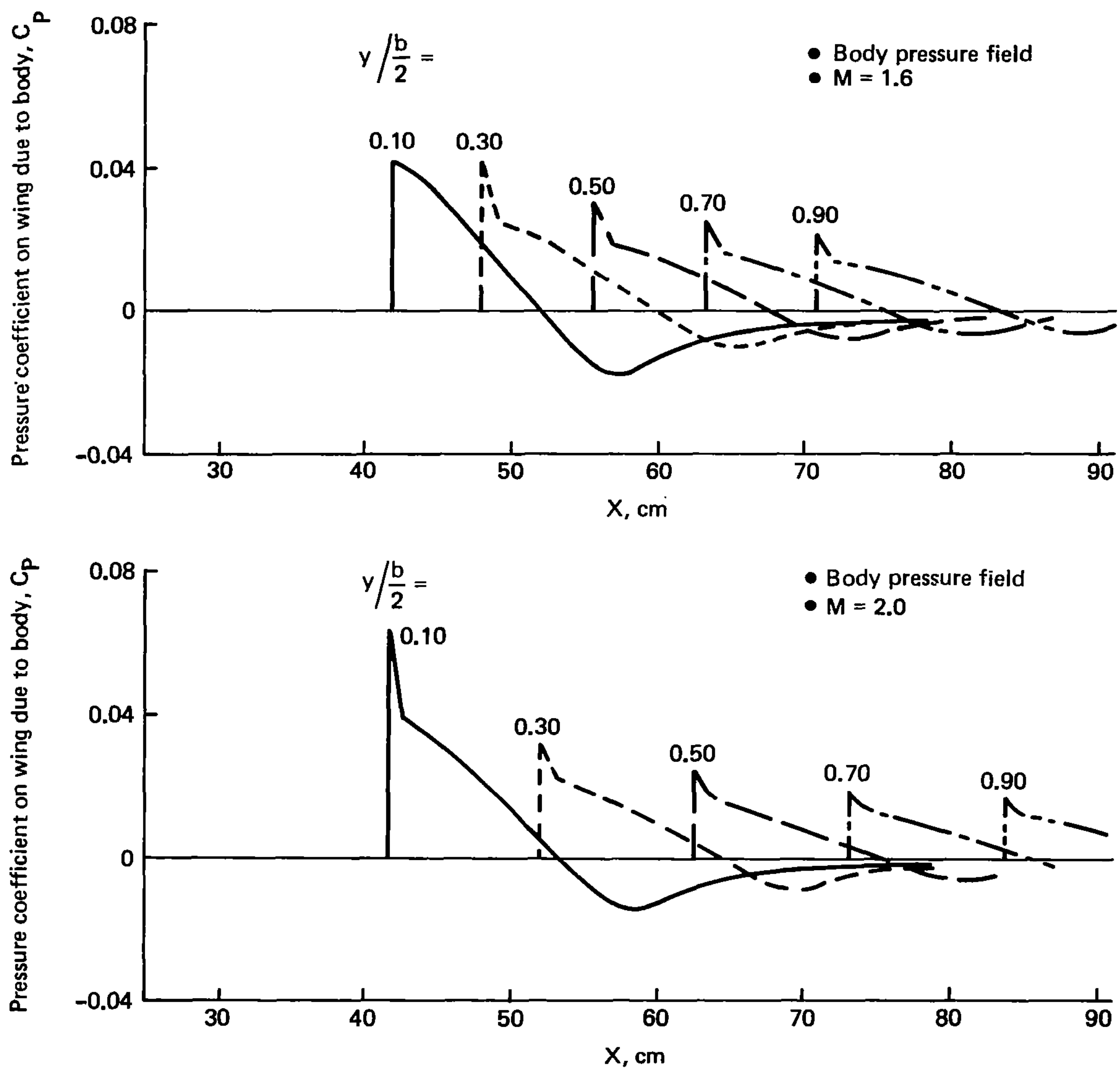


Figure A-4. Theoretical Effect of Body on Wing (M = 1.6 and 2.0)

Table A-10. Wing Characteristics Summary, Zero Lift Wave Drag and Skin Friction Drag, $S = 2091\ cm^2$

- Zero lift wave drag, $C_{D_W}{}^*$

Leading-edge geometry	Mach number		
	1.6	1.8	2.0
Sharp leading edge	0.00475	0.00439	0.00417
LER = 0.001c	0.00481	0.00439	0.00415
Varying LER	0.00493	0.00439	0.00412
*Body effect (included above)	0.0003	0.00015	0

- Skin friction drag, $C_{D_F}{}^*$

• R/M = 6.56×10^6 • T_o = 339K • Fully turbulent boundary layer	Mach number		
	1.6	1.8	2.0
Wing 7	0.00670	0.00645	0.00620
*Body effect (included above)	0.00044	0.00042	0.00040

Table A-11. *Wing Lifting Pressures per Degree of Angle of Attack (M = 1.6)*

TABLE OF FLAT PLATE CP AT 1 DEG ANGLE OF ATTACK

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.05244	.04507	.03747	.03624	.03382	.03073	.02489	.02148	.01852	.01809
	.01716	.01854	.01789	.01885	.01898	.01935	.02034	.02144	.02226	.02382
.025	.05272	.04895	.04216	.03770	.03417	.02842	.02361	.02170	.01978	.01897
	.01812	.01862	.01801	.01838	.01842	.01866	.01980	.02128	.02261	.02361
.050	.06677	.05575	.04371	.03727	.03073	.03108	.02580	.02366	.02157	.02067
	.02084	.01975	.01994	.01901	.01895	.01880	.01957	.02119	.02255	.02352
.075	.08026	.06427	.04403	.03067	.03461	.02486	.02295	.02071	.01874	.01810
	.01797	.01758	.01814	.01825	.01864	.01922	.01997	.02108	.02228	.02306
.100	.08255	.06658	.04343	.04095	.02968	.03121	.02501	.02359	.02276	.02233
	.02020	.02003	.01857	.01819	.01847	.01855	.01990	.02110	.02269	.02377
.125	.13500	.06795	.04507	.04112	.02629	.03333	.02972	.02424	.02097	.01947
	.01821	.01796	.01835	.01932	.02022	.02054	.02170	.02201	.02298	.02380
.150	.08625	.07439	.04851	.04234	.02935	.03099	.02420	.01947	.01923	.02004
	.02194	.02199	.02062	.01954	.01933	.02003	.02112	.02182	.02279	.02356
.175	.11079	.08295	.05321	.04381	.03582	.02637	.02049	.02232	.02295	.02413
	.02188	.02001	.01896	.01959	.02109	.02160	.02227	.02240	.02340	.02454
.200	.17942	.07878	.05839	.03506	.03909	.01836	.02490	.02643	.02634	.02165
	.01913	.02075	.02193	.02191	.02155	.02098	.02156	.02276	.02369	.02439
.225	.12503	.09745	.06098	.04594	.04898	.02432	.02958	.03037	.02377	.01959
	.02196	.02479	.02305	.02130	.02073	.02272	.02283	.02322	.02319	.02437
.250	.21893	.09377	.06822	.03123	.04720	.02846	.03738	.02864	.02134	.02362
	.02622	.02364	.02193	.02178	.02410	.02405	.02255	.02395	.02406	.02453
.275	.16042	.11482	.07145	.04867	.05071	.03197	.03843	.02772	.02317	.02757
	.02646	.02311	.02262	.02539	.02436	.02310	.02379	.02464	.02401	.02521
.300	.12053	.11064	.07712	.05182	.05196	.03948	.03838	.02453	.02740	.02910
	.02596	.02314	.02628	.02656	.02353	.02440	.02476	.02432	.02524	.02504
.325	.23194	.13435	.08250	.05185	.05035	.04273	.04213	.02466	.03143	.02982
	.02428	.02732	.02774	.02550	.02512	.02571	.02494	.02542	.02521	.02538
.350	.14449	.12813	.08578	.05903	.05629	.05083	.03869	.02988	.03325	.03007
	.02687	.02937	.02800	.02575	.02689	.02667	.02554	.02647	.02605	.02601
.375	.24722	.14633	.09496	.06154	.05082	.05252	.03762	.03185	.03719	.03040
	.02945	.03039	.02841	.02743	.02822	.02711	.02689	.02630	.02655	.02629
.400	.15476	.14334	.10382	.06984	.06325	.05426	.03856	.03666	.03858	.03029
	.03234	.03172	.02830	.02936	.02959	.02696	.02809	.02766	.02677	.02746

Table A-11. Wing Lifting Pressures per Degree of Angle of Attack (M = 1.6) (Continued)

.425	.21724	.17004	.10024	.07181	.06181	.06294	.04121	.04007	.03883	.03156
	.03477	.03197	.03040	.03088	.02882	.02873	.02775	.02785	.02759	.02739
.450	.28505	.16276	.11539	.07529	.06010	.06710	.04230	.04351	.04034	.03310
	.03573	.03246	.03231	.03214	.02967	.03120	.02947	.02825	.02835	.02888
.475	.15293	.15293	.12667	.08395	.06971	.06940	.04538	.04778	.04058	.03718
	.03769	.03239	.03415	.03134	.03216	.03109	.03039	.02926	.02847	.02816
.500	.17452	.17178	.13668	.08935	.07369	.07215	.04651	.05136	.04192	.04033
	.03857	.03529	.03706	.03301	.03414	.03175	.03071	.03052	.03047	.02919
.525	.18221	.18004	.14464	.09452	.07700	.07454	.04792	.05346	.04053	.04310
	.03721	.03899	.03481	.03564	.03354	.03285	.03133	.03019	.02988	.02938
.550	.19198	.19039	.15319	.09766	.07848	.07669	.04535	.05497	.03916	.04682
	.03817	.04123	.03675	.03734	.03452	.03459	.03282	.03255	.03092	.03034
.575	.18630	.18630	.15827	.10167	.08449	.07816	.04888	.05972	.04754	.04766
	.04301	.04076	.03802	.03752	.03563	.03656	.03486	.03248	.03164	.03211
.600	.18261	.18261	.16287	.10717	.08866	.07876	.06047	.05785	.05300	.04587
	.04450	.04142	.04070	.03890	.03776	.03535	.03462	.03315	.03226	.03238
.625	.17244	.17244	.16345	.11910	.09283	.07934	.06938	.05471	.05445	.04782
	.04779	.04247	.04316	.03849	.04145	.03860	.03595	.03443	.03457	.03350
.650	.31209	.24827	.16868	.12595	.09658	.08804	.06879	.05535	.05903	.04921
	.04990	.04357	.04553	.04334	.03914	.03997	.03709	.03688	.03439	.03378
.675	.31845	.28696	.21353	.12900	.10419	.09209	.07312	.06098	.06188	.04968
	.05261	.04999	.04325	.04482	.04110	.04064	.03858	.03680	.03602	.03428
.700	.25411	.25371	.21142	.12906	.11033	.09286	.08410	.05295	.06758	.05966
	.04903	.05133	.04621	.04505	.04330	.04158	.04015	.03912	.03670	.03509
.725	.21082	.21082	.20060	.15005	.11299	.09918	.08650	.06787	.06151	.06034
	.05354	.05168	.04867	.04624	.04788	.04447	.04276	.03964	.03707	.03750
.750	.33495	.27323	.20693	.15587	.12221	.10380	.08664	.07096	.06177	.06460
	.05380	.05511	.05430	.04936	.04688	.04748	.04303	.03970	.04038	.03888
.775	.35232	.33260	.26791	.15131	.13019	.10907	.09465	.07380	.06490	.06916
	.06440	.05237	.05540	.05264	.04946	.04783	.04252	.04411	.04091	.03979
.800	.26041	.26041	.24227	.17988	.13199	.11751	.09719	.08957	.06442	.06692
	.06677	.05975	.05525	.05436	.05029	.04844	.04828	.04467	.04268	.04026
.825	.21100	.21100	.21100	.18412	.14976	.11988	.09986	.08682	.07662	.06644
	.06786	.06248	.05439	.05834	.05690	.05328	.05017	.04669	.04436	.04105
.850	.43552	.40843	.33525	.18889	.15288	.13319	.10665	.09667	.07649	.06724
	.07289	.07052	.06484	.05563	.05754	.05719	.05190	.04853	.04569	.04573
.875	.27609	.27609	.26990	.21746	.16501	.13666	.11272	.10100	.09544	.07653
	.06689	.07260	.06911	.06275	.06053	.05844	.05237	.05299	.05114	.04612
.900	.22356	.22356	.22356	.21132	.18304	.15476	.11939	.10307	.09197	.08295
	.07683	.07153	.07130	.06859	.05957	.05710	.06170	.05501	.05088	.03753

Table A-11. Wing Lifting Pressures per Degree of Angle of Attack (M = 1.6) (Concluded)

.925	.42260	.42153	.37188	.27257	.17412	.15956	.13046	.11197	.10437	.09165
	.07343	.06754	.07552	.07811	.07435	.06920	.05866	.05616	.04099	.02526
.950	.26895	.26895	.26895	.24866	.21460	.18054	.13630	.11955	.10555	.10231
	.09907	.08637	.07308	.07068	.07339	.07139	.05387	.03085	.01886	.01104
.975	.21501	.21501	.21501	.21501	.20645	.18609	.14536	.10957	.10699	.10441
	.09770	.08755	.07741	.06227	.04694	.03475	.02049	.01370	.00995	.00762
1.000	.33115	.33115	.33115	.30319	.27092	.23865	.18146	.13722	.09299	.05965
	.04635	.03306	.02291	.01879	.01468	.01138	.00802	.00583	.00435	.00345

Table A-12. *Wing Lifting Pressures per Degree of Angle of Attack (M = 1.8)*

TABLE OF FLAT PLATE CP AT 1 DEG ANGLE OF ATTACK

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.04453	.04009	.03460	.03323	.03085	.02881	.02511	.02301	.02082	.01957
	.01880	.01807	.01752	.01727	.01724	.01726	.01822	.01958	.02049	.02156
.025	.04448	.04245	.03813	.03324	.03072	.02824	.02371	.02112	.01930	.01826
	.01811	.01806	.01795	.01793	.01795	.01796	.01843	.01945	.02042	.02162
.050	.05152	.04759	.04084	.03300	.03032	.02860	.02473	.02162	.01989	.01839
	.01754	.01756	.01773	.01793	.01807	.01837	.01892	.01964	.02057	.02170
.075	.05806	.05230	.04470	.03180	.03098	.02620	.02355	.02102	.01967	.01958
	.01915	.01907	.01869	.01822	.01779	.01787	.01873	.02000	.02082	.02162
.100	.10848	.06453	.04391	.03602	.02674	.02981	.02569	.02365	.02156	.01959
	.01850	.01828	.01833	.01834	.01865	.01873	.01913	.02003	.02074	.02155
.125	.07312	.06457	.04252	.03394	.02777	.03098	.02487	.02063	.01931	.01960
	.01988	.01990	.01908	.01823	.01819	.01842	.01953	.02004	.02108	.02156
.150	.11709	.06342	.04770	.03733	.03178	.02725	.02063	.02156	.02200	.02139
	.02036	.01945	.01857	.01873	.01930	.02014	.01942	.02005	.02119	.02162
.175	.12971	.06892	.05125	.03894	.03689	.02295	.02388	.02486	.02327	.02116
	.01978	.01961	.02032	.02015	.01932	.01960	.02030	.02065	.02139	.02190
.200	.14504	.07497	.05701	.03995	.04098	.02256	.02780	.02653	.02286	.02075
	.02069	.02218	.02047	.01926	.02038	.02077	.02042	.02102	.02179	.02277
.225	.08549	.08288	.06312	.04240	.04261	.02524	.03101	.02623	.02259	.02189
	.02341	.02136	.02028	.02132	.02191	.02075	.02096	.02178	.02200	.02250
.250	.09731	.09206	.06820	.04607	.04445	.03078	.03418	.02476	.02359	.02525
	.02269	.02128	.02281	.02242	.02107	.02190	.02169	.02178	.02220	.02245
.275	.11464	.10323	.07145	.04905	.04637	.03515	.03522	.02343	.02614	.02758
	.02131	.02366	.02442	.02177	.02270	.02276	.02229	.02276	.02270	.02296
.300	.13966	.11602	.07087	.05117	.04765	.03975	.03512	.02570	.02850	.02631
	.02431	.02519	.02388	.02361	.02355	.02320	.02308	.02285	.02334	.02377
.325	.17453	.13019	.07578	.05337	.04827	.04499	.03501	.02802	.03129	.02578
	.02626	.02692	.02476	.02445	.02418	.02411	.02429	.02325	.02335	.02373
.350	.19505	.12948	.08238	.05618	.04983	.04841	.03424	.03280	.03312	.02582
	.02847	.02681	.02554	.02570	.02564	.02468	.02437	.02472	.02389	.02401
.375	.20812	.13310	.08995	.05995	.05086	.05156	.03428	.03599	.03315	.02998
	.02975	.02780	.02668	.02754	.02532	.02620	.02468	.02463	.02478	.02449
.400	.22281	.13641	.09787	.06400	.05488	.05238	.03357	.03858	.03329	.03077
	.03037	.02873	.02861	.02764	.02718	.02635	.02647	.02532	.02497	.02516

Table A-12. Wing Lifting Pressures per Degree of Angle of Attack (M = 1.8) (Continued)

.425	.22084	.14990	.10185	.07006	.05925	.05348	.03633	.03957	.03442	.03247
	.03329	.02975	.03040	.02881	.02744	.02818	.02649	.02641	.02564	.02542
.450	.21925	.16260	.10623	.07698	.06408	.05596	.04216	.04225	.03719	.03567
	.03282	.03205	.03046	.02862	.03012	.02833	.02779	.02664	.02668	.02585
.475	.21582	.18535	.12550	.08319	.06726	.06165	.04331	.04563	.03548	.03775
	.03471	.03241	.03219	.03178	.02968	.02888	.02823	.02751	.02665	.02717
.500	.17664	.17034	.13442	.08558	.06911	.06463	.04228	.04774	.04113	.03813
	.03413	.03601	.03291	.03179	.03097	.03090	.02898	.02853	.02741	.02740
.525	.14521	.14521	.13214	.09101	.07445	.06414	.05262	.04764	.03861	.04226
	.03831	.03551	.03326	.03421	.03224	.03121	.03076	.02879	.02906	.02719
.550	.22752	.18876	.13481	.09900	.07694	.07024	.04660	.05293	.04669	.04089
	.03806	.03811	.03640	.03389	.03307	.03282	.03065	.03004	.02888	.02811
.575	.18970	.18936	.15693	.08840	.08328	.07221	.06065	.04991	.04582	.04384
	.04207	.03763	.03721	.03530	.03547	.03372	.03156	.03120	.02935	.02963
.600	.15081	.15081	.14690	.11227	.08475	.07432	.05585	.05437	.05156	.04327
	.04304	.03915	.03988	.03754	.03544	.03440	.03400	.03113	.03154	.03006
.625	.23490	.22561	.18144	.10929	.09204	.07815	.06755	.05191	.05273	.04566
	.04590	.04277	.03965	.03817	.03688	.03750	.03363	.03263	.03215	.03078
.650	.16641	.16641	.16213	.12502	.09298	.08235	.06419	.05707	.05580	.05043
	.04546	.04335	.04119	.04188	.03929	.03689	.03441	.03465	.03249	.03174
.675	.26286	.25155	.20390	.11934	.10223	.08511	.07459	.05895	.05618	.05059
	.04805	.04783	.04435	.04105	.03918	.03730	.03764	.03506	.03349	.03282
.700	.17408	.17408	.17352	.13887	.10422	.09095	.07209	.05762	.06162	.05713
	.05064	.04675	.04411	.04173	.04354	.04156	.03812	.03592	.03471	.03387
.725	.25765	.25655	.21763	.13978	.11133	.09637	.08048	.06974	.05778	.05740
	.04967	.04908	.04950	.04658	.04393	.04212	.03913	.03738	.03667	.03455
.750	.17064	.17064	.17064	.14969	.12185	.09752	.08034	.06521	.05899	.06324
	.05792	.05323	.04973	.04733	.04426	.04363	.04092	.03982	.03701	.03534
.775	.23786	.23786	.22100	.16546	.11798	.10591	.08465	.07732	.06843	.06138
	.05919	.05354	.05047	.05035	.04708	.04596	.04371	.04018	.03843	.03858
.800	.26296	.23597	.20529	.15779	.13629	.11479	.09182	.07988	.06656	.06194
	.06335	.05706	.05382	.05346	.05093	.04830	.04440	.04157	.04177	.03910
.825	.21609	.21609	.21609	.18180	.14515	.11448	.09613	.08130	.07068	.06757
	.06599	.06246	.05821	.05322	.05138	.04992	.04657	.04565	.04319	.04085
.850	.35038	.34538	.29956	.20791	.14067	.12709	.09992	.08948	.08159	.07119
	.06350	.06321	.06054	.05519	.05398	.05476	.05019	.04757	.04467	.04251
.875	.19272	.19272	.19272	.18539	.16280	.14021	.10603	.09308	.08123	.07121
	.06614	.06817	.06723	.06257	.05905	.05679	.05275	.04859	.04617	.04313
.900	.26657	.26657	.26621	.22365	.18110	.13854	.11558	.09776	.08824	.08144
	.07603	.07161	.06830	.06552	.06270	.05882	.05416	.05106	.04847	.04909

Table A-12. *Wing Lifting Pressures per Degree of Angle of Attack (M = 1.8) (Concluded)*

.925	.26363	.25459	.23664	.20073	.16694	.15377	.12743	.10365	.09612	.08855
	.08074	.07277	.06723	.06698	.06672	.06257	.05616	.05750	.04838	.02724
.950	.21581	.21581	.21581	.21581	.19597	.17550	.13457	.11201	.10097	.08993
	.08210	.07460	.06888	.07053	.07218	.07064	.06081	.04205	.02770	.01819
.975	.29810	.29810	.29810	.27296	.24057	.20818	.15409	.13601	.11794	.10153
	.09580	.09007	.08403	.07028	.05654	.04279	.02886	.01873	.01324	.00822
1.000	.27647	.27106	.26332	.24785	.23238	.21646	.17585	.13524	.09463	.06646
	.05413	.04180	.02947	.02417	.02027	.01638	.01139	.00817	.00642	.00502

Table A-13. Wing Lifting Pressures per Degree of Angle of Attack (M = 2.0)

TABLE OF FLAT PLATE CP AT 1 DEG ANGLE OF ATTACK

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.03607	.03425	.03250	.02976	.02866	.02722	.02390	.02083	.01973	.01811
	.01743	.01769	.01773	.01774	.01734	.01726	.01725	.01851	.01908	.01987
.025	.04104	.03772	.03367	.03076	.02818	.02733	.02364	.02138	.01975	.01886
	.01823	.01784	.01746	.01712	.01719	.01722	.01773	.01850	.01907	.01991
.050	.04160	.04012	.03679	.03127	.02896	.02667	.02332	.02128	.01949	.01839
	.01843	.01807	.01767	.01737	.01732	.01727	.01760	.01821	.01921	.02020
.075	.04773	.04632	.03928	.03123	.02838	.02616	.02377	.02146	.02025	.01986
	.01829	.01754	.01759	.01767	.01777	.01760	.01766	.01824	.01924	.02026
.100	.05776	.05300	.04128	.03239	.02578	.02776	.02412	.02240	.01953	.01904
	.01859	.01843	.01825	.01807	.01757	.01755	.01839	.01871	.01926	.02015
.125	.06711	.06088	.04311	.03156	.02860	.02672	.02410	.02040	.02076	.02030
	.01930	.01831	.01831	.01805	.01802	.01826	.01835	.01877	.01954	.02014
.150	.11943	.07149	.04578	.03508	.02877	.02708	.02200	.02318	.02222	.02021
	.01913	.01870	.01906	.01862	.01841	.01815	.01869	.01919	.01985	.02010
.175	.08285	.07150	.04676	.03505	.03406	.02333	.02634	.02454	.02177	.02037
	.01981	.01971	.01951	.01855	.01869	.01957	.01899	.01957	.02016	.02027
.200	.07577	.07238	.05518	.03817	.03632	.02650	.02817	.02476	.02186	.02114
	.02094	.02012	.01941	.01944	.02016	.01943	.01949	.01977	.02028	.02059
.225	.07447	.07445	.05984	.04042	.03555	.03121	.02953	.02392	.02272	.02280
	.02153	.02001	.02060	.02071	.02016	.01993	.02019	.02008	.02061	.02095
.250	.13686	.08918	.06313	.04379	.03886	.03395	.03062	.02523	.02424	.02340
	.02133	.02153	.02205	.02100	.02077	.02077	.02082	.02082	.02075	.02163
.275	.16795	.11584	.06521	.04552	.04187	.03481	.03014	.02572	.02618	.02461
	.02235	.02363	.02196	.02144	.02168	.02134	.02118	.02133	.02119	.02155
.300	.14181	.11467	.06793	.04875	.04415	.03711	.03083	.02632	.02759	.02342
	.02515	.02341	.02270	.02261	.02261	.02224	.02210	.02171	.02180	.02162
.325	.12688	.11388	.08060	.05397	.04597	.04124	.03335	.02970	.03004	.02635
	.02558	.02454	.02385	.02429	.02327	.02273	.02270	.02221	.02241	.02195
.350	.11725	.11266	.08750	.05718	.04722	.04605	.03158	.03406	.02895	.02647
	.02674	.02490	.02558	.02439	.02378	.02425	.02312	.02297	.02256	.02270
.375	.10562	.10562	.09059	.05969	.04973	.04642	.03270	.03372	.03080	.02880
	.02868	.02696	.02597	.02518	.02538	.02465	.02390	.02373	.02291	.02344
.400	.17972	.12892	.09245	.06560	.05437	.04724	.03734	.03701	.03144	.03119
	.02893	.02755	.02792	.02667	.02594	.02502	.02508	.02392	.02374	.02360

Table A-13. Wing Lifting Pressures per Degree of Angle of Attack (M = 2.0) (Continued)

.425	.17254	.15317	.10959	.07121	.05706	.05257	.03593	.03933	.03394	.03207
	.03002	.02984	.02846	.02733	.02669	.02600	.02546	.02446	.02465	.02378
.450	.13088	.13088	.11144	.07148	.06027	.05250	.04306	.03976	.03358	.03473
	.03202	.03062	.02886	.02843	.02812	.02757	.02583	.02543	.02498	.02430
.475	.17913	.14782	.10716	.08150	.06378	.05741	.04043	.04374	.03802	.03526
	.03262	.03194	.03018	.03037	.02901	.02785	.02702	.02656	.02542	.02501
.500	.15344	.15344	.12829	.08020	.06786	.05801	.04867	.04314	.03890	.03663
	.03386	.03423	.03228	.03055	.02941	.02879	.02836	.02688	.02601	.02591
.525	.18370	.15627	.12051	.09112	.06955	.06320	.04923	.04534	.04039	.03932
	.03700	.03436	.03271	.03123	.03099	.03024	.02886	.02751	.02674	.02640
.550	.15330	.15330	.13812	.09485	.07509	.06406	.04982	.04895	.04480	.03952
	.03749	.03483	.03452	.03290	.03293	.03142	.02952	.02839	.02795	.02739
.575	.23831	.21615	.16456	.09673	.08035	.06812	.05801	.04792	.04574	.04000
	.03977	.03692	.03688	.03482	.03319	.03210	.03053	.02978	.02876	.02746
.600	.13884	.13884	.13768	.10888	.08016	.07174	.05679	.04921	.04848	.04301
	.04242	.03961	.03702	.03554	.03414	.03323	.03188	.03063	.02928	.02835
.625	.17957	.17957	.16127	.11242	.08656	.07528	.05997	.05401	.05151	.04664
	.04237	.04051	.03819	.03691	.03545	.03475	.03306	.03138	.03006	.02896
.650	.29164	.26163	.20091	.11012	.09379	.07745	.06632	.05669	.05100	.04787
	.04367	.04235	.03966	.03880	.03778	.03628	.03406	.03224	.03098	.02984
.675	.14529	.14529	.14529	.12428	.09930	.08152	.06677	.05710	.05326	.05040
	.04518	.04506	.04254	.04060	.03928	.03751	.03501	.03334	.03198	.03143
.700	.18344	.18344	.17645	.13662	.09680	.08703	.06894	.05846	.05652	.05414
	.04871	.04677	.04433	.04190	.03983	.03865	.03630	.03455	.03343	.03273
.725	.24196	.24196	.20931	.14240	.10491	.09271	.07333	.06412	.05968	.05568
	.05152	.04783	.04525	.04346	.04155	.04027	.03766	.03622	.03513	.03375
.750	.19522	.18284	.16476	.13156	.11506	.09855	.07821	.06866	.06091	.05577
	.05357	.04999	.04720	.04571	.04358	.04184	.03966	.03841	.03645	.03519
.775	.16254	.16254	.16254	.14860	.12546	.10233	.08183	.06944	.06255	.05829
	.05678	.05282	.04906	.04796	.04608	.04358	.04264	.03964	.03752	.03565
.800	.19802	.19802	.19802	.16660	.13332	.10291	.08689	.07319	.06532	.06102
	.06011	.05616	.05112	.05048	.04965	.04731	.04368	.04090	.03895	.03759
.825	.24616	.24616	.23378	.18508	.13637	.11106	.09237	.07754	.06891	.06403
	.06338	.06081	.05668	.05347	.05076	.04866	.04533	.04280	.04063	.03842
.850	.19508	.19213	.17962	.15461	.13175	.12043	.09779	.08302	.07613	.07010
	.06526	.06110	.05827	.05552	.05302	.05069	.04757	.04465	.04276	.04045
.875	.15966	.15966	.15966	.15966	.14820	.13343	.10388	.08744	.07843	.07116
	.06694	.06291	.06085	.05880	.05618	.05342	.05016	.04725	.04507	.04386
.900	.18352	.18352	.18352	.18240	.16403	.14566	.10892	.09367	.08362	.07516
	.07053	.06589	.06368	.06214	.06021	.05722	.05270	.05042	.04714	.04483

Table A-13. Wing Lifting Pressures per Degree of Angle of Attack (M = 2.0) (Concluded)

.925	.21146 .07517	.21146 .07018	.21146 .06653	.20426 .06541	.18182 .06429	.[illegible]938 .06200	.11449 .05556	.10110 .05361	.09023 .04920	.08017 .04164
.950	.25033 .08030	.25033 .07513	.25033 .06997	.23188 .06842	.20323 .06774	.17458 .06707	.12076 .05924	.10912 .04986	.09748 .03977	.08585 .02968
.975	.31933 .09012	.31933 .08428	.31711 .07845	.28000 .07218	.24289 .06224	.20578 .05230	.14722 .03502	.13119 .02504	.11516 .01731	.09913 .01210
1.000	.20517 .05697	.20438 .04845	.20086 .03992	.19382 .03140	.18678 .02390	.17974 .02108	.15882 .01545	.13172 .01161	.10462 .00953	.07752 .00745

Table A-14. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Flat Meanline Planform (M = 1.6)

α, deg	No suction		Full leading-edge suction		Attainable suction					
					Sharp leading edge		LER = 0.001c		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D
0	0	0	0	0	0	0	0	0	0	0
1	0.0363	0.00063	0.0363	0.00038	0.0369	0.00064	0.0363	0.00039	0.0363	0.00038
2	0.0725	0.00253	0.0725	0.00153	0.0751	0.00262	0.0736	0.00179	0.0733	0.0017
3	0.1088	0.0057	0.1089	0.00345	0.1147	0.0060	0.1127	0.0046	0.1117	0.00429
4	0.145	0.0101	0.145	0.00614	0.1556	0.0109	0.154	0.00897	0.152	0.00841
5	0.181	0.0158	0.182	0.0096	0.198	0.0173	0.196	0.0149	0.194	0.01417
6	0.218	0.0228	0.218	0.01385	0.241	0.0253	0.24	0.0225	0.238	0.0216

• $S = 2091\ cm^2$

Table A-15. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Flat Meanline Planform (M = 1.8)

α, deg	No suction		Full leading-edge suction		Attainable suction					
					Sharp leading edge		LER = 0.001c		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D
0	0	0	0	0	0	0	0	0	0	0
1	0.0346	0.00060	0.0346	0.00039	0.0351	0.00061	0.0346	0.0004	0.0346	0.0004
2	0.0691	0.00241	0.0691	0.00158	0.0713	0.00249	0.0700	0.00181	0.0698	0.00173
3	0.104	0.00543	0.104	0.00355	0.1086	0.00569	0.1069	0.00453	0.1061	0.00427
4	0.138	0.00965	0.138	0.00631	0.147	0.0103	0.145	0.0087	0.144	0.00824
5	0.173	0.01507	0.173	0.00988	0.187	0.0163	0.185	0.0143	0.184	0.0137
6	0.207	0.0217	0.208	0.01424	0.227	0.0238	0.226	0.0215	0.224	0.0207

• $S = 2091\ cm^2$

Table A-16. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Flat Meanline Planform (M = 2.0)

α, deg	No suction		Full leading-edge suction		Attainable suction					
					Sharp leading edge		LER = 0.001c		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D
0	0	0	0	0	0	0	0	0	0	0
1	0.0330	0.00058	0.0330	0.00041	0.0335	0.00058	0.0331	0.00041	0.0330	0.00042
2	0.0660	0.00230	0.0660	0.00164	0.0678	0.00237	0.0668	0.00185	0.0666	0.00179
3	0.0990	0.00519	0.0990	0.0037	0.1030	0.00539	0.1016	0.00449	0.1011	0.00431
4	0.132	0.00922	0.132	0.00658	0.139	0.00971	0.1378	0.00849	0.137	0.00813
5	0.165	0.0144	0.165	0.01029	0.176	0.01537	0.175	0.01385	0.174	0.01336
6	0.198	0.0207	0.199	0.01484	0.214	0.0224	0.213	0.0206	0.212	0.0200

• $S = 2091\ cm^2$

Table A-17. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 1.6$)

TABLE OF CAMBER CP AT BASIC ALPHA
ALPHA=0.0000 DEG.

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.43799	.37627	.31742	.30018	.25956	.21847	.14482	.09417	.05508	.02805
	.01460	.01941	.02079	.02764	.02884	.02982	.03033	.02718	.02451	.01960
.025	.39741	.38266	.34901	.31011	.26250	.21187	.13759	.09253	.05554	.02671
	.01425	.01623	.01809	.02399	.02619	.02683	.02845	.02626	.02460	.01965
.050	.39722	.40097	.34819	.30798	.25577	.22622	.15101	.10366	.06334	.03290
	.02153	.01835	.01935	.02342	.02502	.02558	.02718	.02565	.02390	.01911
.075	.38628	.41427	.33798	.29201	.27565	.20456	.14193	.09291	.05527	.02942
	.01886	.01550	.02082	.02358	.02672	.02764	.02861	.02565	.02305	.01797
.100	.43618	.39574	.33713	.34441	.25473	.23551	.15717	.11057	.07396	.04529
	.02711	.01895	.02072	.02126	.02524	.02492	.02683	.02381	.02230	.01848
.125	.47094	.39865	.33988	.32531	.25272	.23442	.16778	.10812	.07051	.04561
	.02940	.02369	.02566	.02572	.02832	.02714	.02697	.02280	.02135	.01836
.150	.44339	.41440	.35110	.32793	.26708	.21844	.15062	.10549	.08086	.06236
	.04626	.03446	.02678	.02417	.02450	.02551	.02460	.02129	.01995	.01739
.175	.49776	.43346	.36477	.31502	.28193	.20376	.15252	.12586	.09819	.07301
	.04958	.03455	.02978	.02792	.03000	.02865	.02404	.01947	.01924	.01920
.200	.50567	.41630	.37329	.28476	.28265	.19877	.17792	.14350	.10595	.07494
	.05257	.04603	.03870	.03169	.03067	.02659	.02364	.01886	.01831	.01522
.225	.49157	.44180	.37597	.31531	.30340	.22970	.20037	.15262	.10960	.08015
	.06700	.05772	.04123	.03565	.03467	.03300	.02530	.01741	.01581	.01484
.250	.46049	.41246	.37675	.29728	.29076	.24908	.21544	.15688	.11745	.09764
	.07930	.05911	.04934	.04455	.04259	.03640	.02670	.01717	.01583	.01342
.275	.47090	.42209	.37568	.31891	.29577	.27494	.22005	.15872	.13079	.10979
	.08142	.06703	.05956	.05333	.04511	.03828	.02962	.01620	.01462	.01483
.300	.41023	.40200	.37413	.35287	.29871	.28472	.22012	.16623	.14293	.11422
	.09045	.07667	.06947	.05888	.04754	.04353	.03059	.01533	.01523	.01124
.325	.49508	.41657	.37436	.32497	.29857	.29068	.23208	.17526	.15416	.12284
	.09800	.08988	.07555	.06237	.05349	.04810	.03203	.01748	.01439	.01275
.350	.42358	.41156	.38046	.36082	.30255	.30789	.22588	.19152	.16521	.13137
	.10901	.09863	.07986	.06767	.05933	.05026	.03456	.01956	.01485	.00993
.375	.38359	.39387	.38579	.33747	.29805	.30013	.23380	.20418	.17567	.13933
	.12097	.10396	.08676	.07408	.06342	.05351	.03803	.02135	.01464	.01168
.400	.42836	.41916	.38731	.35994	.32575	.30975	.24175	.21554	.18346	.14740
	.13087	.11009	.09233	.08001	.06796	.05674	.04160	.02497	.01420	.00920

Table A-17. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 1.6$) (Continued)

.425	.47295	.43576	.38075	.35835	.31110	.31856	.25335	.22740	.18874	.15669
	.14058	.11542	.10033	.08516	.07195	.06388	.04475	.02663	.01510	.01073
.450	.37602	.39468	.38662	.35050	.30834	.32711	.25738	.23604	.19534	.16423
	.14456	.12174	.10763	.09040	.07877	.07063	.05027	.02921	.01521	.00874
.475	.41842	.41842	.39600	.35952	.34522	.32831	.26875	.24695	.19932	.17438
	.15025	.12721	.11293	.09545	.08777	.07538	.05439	.03269	.01563	.00878
.500	.42799	.42574	.39693	.35785	.34330	.33259	.27513	.25387	.20589	.18335
	.15480	.13612	.12033	.10411	.09528	.07962	.05672	.03528	.01757	.00774
.525	.42838	.42669	.39910	.36032	.34571	.33336	.28245	.25548	.20967	.18962
	.15935	.14591	.12396	.11330	.09727	.08578	.06087	.03682	.01602	.00956
.550	.42802	.42688	.40007	.36006	.34624	.33797	.28201	.25310	.21152	.19542
	.16561	.15342	.13077	.12005	.10241	.09114	.06523	.04055	.01807	.00929
.575	.42030	.42030	.40038	.36018	.34797	.33773	.28225	.25738	.22418	.20108
	.17725	.15548	.13923	.12225	.10780	.09483	.06956	.04114	.01914	.01417
.600	.41213	.41213	.39857	.36032	.34761	.33781	.29253	.25885	.23527	.19889
	.18282	.15806	.14607	.12742	.11316	.09661	.06985	.04362	.02167	.01426
.625	.40825	.40825	.40139	.36758	.34755	.33726	.30475	.25187	.23625	.20259
	.18902	.16490	.15034	.13034	.11934	.10200	.07402	.04794	.02689	.01960
.650	.37815	.38199	.38677	.36459	.34159	.32423	.30165	.24836	.24055	.20952
	.19082	.16889	.15536	.13799	.11542	.10493	.07652	.05251	.02974	.02068
.675	.50105	.47750	.42258	.35936	.34081	.32684	.29763	.26220	.24296	.21157
	.19635	.17820	.15027	.14043	.12048	.10514	.07979	.05567	.03450	.02453
.700	.44210	.44182	.41176	.35321	.33989	.32711	.31027	.25500	.24881	.22493
	.18818	.17901	.15708	.13856	.12410	.10762	.08409	.06110	.03771	.02744
.725	.41637	.41637	.40823	.36792	.33837	.32736	.31182	.26770	.23893	.22392
	.19691	.17706	.16051	.14106	.12837	.11283	.08861	.06203	.04026	.03183
.750	.37057	.37638	.38262	.36367	.33801	.31957	.29447	.27718	.23327	.22733
	.19813	.18068	.16560	.14504	.12809	.11713	.08747	.06443	.04733	.03655
.775	.51309	.49726	.44530	.35167	.33471	.31774	.30213	.27188	.24362	.22692
	.21125	.17761	.16693	.14919	.13016	.11537	.08888	.07151	.05158	.04391
.800	.43001	.43001	.41610	.36820	.33143	.32032	.30345	.29160	.24127	.22761
	.21127	.18678	.16030	.14876	.13175	.11694	.09732	.07571	.05757	.04509
.825	.38377	.38377	.38377	.36407	.33888	.31698	.30231	.28359	.25687	.21735
	.20741	.18750	.16211	.15038	.13835	.12472	.10338	.08213	.06485	.05167
.850	.53903	.51949	.46670	.36112	.33514	.32094	.29859	.28404	.25078	.22334
	.20495	.19157	.17328	.14833	.14183	.13274	.10755	.08994	.07221	.06127
.875	.42176	.42176	.41706	.37714	.33722	.31563	.29741	.28298	.27007	.22926
	.20127	.19452	.17842	.16046	.14488	.13306	.11346	.09878	.08543	.07028
.900	.37766	.37766	.37766	.36831	.34668	.32505	.29800	.28552	.26482	.24086
	.21195	.18462	.17765	.16717	.14780	.13635	.12738	.10800	.09216	.06159

Table A-17. Cambered Wing Lifting Pressures at α = 0 deg (M = 1.6) (Concluded)

.925	.52643	.52560	.48712	.41018	.33389	.32262	.30007	.29076	.26479	.24394
	.20864	.18859	.18232	.17513	.16686	.15523	.12898	.11667	.08426	.04663
.950	.40542	.40542	.40542	.38893	.36126	.33358	.29763	.28402	.27019	.25547
	.24076	.21229	.18296	.17230	.17040	.16282	.13025	.07825	.04102	.00928
.975	.36446	.36446	.36446	.36446	.35784	.34212	.31067	.28140	.26677	.25213
	.23559	.21748	.19936	.16672	.13354	.10494	.06256	.03672	.01975	.00730
1.000	.40786	.40700	.40700	.40365	.39979	.39593	.36728	.30174	.23620	.19143
	.14648	.11153	.08342	.06844	.05346	.04390	.02546	.01391	.00448	-.00427

Table A-18. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 1.8$)

TABLE OF CAMBER CP AT BASIC ALPHA
ALPHA=0.0000 DEG.

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.37476	.33691	.29429	.27375	.23996	.20796	.14579	.10463	.07018	.04028
	.02377	.02056	.02103	.02372	.02616	.02726	.02755	.02465	.02333	.02017
.025	.33881	.33331	.31843	.27745	.24197	.20933	.14499	.10009	.06495	.03582
	.02354	.02160	.02259	.02526	.02689	.02726	.02688	.02393	.02267	.01986
.050	.31730	.34578	.32272	.28114	.24841	.21259	.15093	.10322	.06605	.03512
	.02279	.02029	.02234	.02574	.02701	.02752	.02704	.02382	.02229	.02002
.075	.30216	.33412	.33153	.28950	.25296	.21094	.15147	.10574	.07127	.04480
	.03084	.02405	.02320	.02385	.02465	.02583	.02643	.02394	.02207	.01950
.100	.37851	.33382	.31285	.30747	.24729	.22586	.16233	.11579	.07646	.04809
	.03250	.02438	.02584	.02570	.02638	.02661	.02523	.02230	.02053	.01835
.125	.35579	.34387	.31314	.29844	.25146	.22554	.15852	.10898	.07843	.05773
	.04273	.03152	.02755	.02351	.02435	.02477	.02435	.02066	.02003	.01813
.150	.33483	.36057	.33031	.29674	.26793	.21295	.15133	.12138	.09540	.06877
	.04649	.03363	.02888	.02630	.02650	.02565	.02136	.01925	.01920	.01615
.175	.37130	.37041	.34284	.29458	.28431	.20533	.16953	.13835	.10249	.07209
	.05323	.04168	.03432	.02899	.02569	.02446	.02271	.01867	.01787	.01543
.200	.37207	.37615	.34771	.28682	.28654	.21904	.18691	.14701	.10637	.08266
	.06308	.04961	.03640	.02926	.03003	.02738	.02190	.01729	.01699	.01546
.225	.38823	.38382	.35046	.31546	.29005	.23908	.19978	.15043	.11716	.09388
	.07165	.05276	.04158	.03776	.03513	.02820	.02415	.01662	.01560	.01442
.250	.39133	.38378	.34951	.31771	.29139	.26081	.21007	.15648	.13121	.10362
	.07619	.06053	.05238	.04414	.03652	.03378	.02571	.01685	.01461	.01410
.275	.39444	.38231	.34854	.32475	.28936	.27553	.21763	.16224	.14172	.11146
	.07890	.07172	.06039	.04678	.04370	.03807	.02759	.01703	.01368	.01283
.300	.39705	.37976	.34588	.33109	.29268	.28920	.22166	.17447	.14837	.11392
	.09273	.07997	.06462	.05564	.04854	.04039	.03021	.01548	.01365	.01430
.325	.41745	.38882	.35368	.33760	.29066	.29638	.22657	.18569	.15604	.12012
	.10480	.08771	.07149	.06176	.05178	.04460	.03309	.01714	.01326	.01140
.350	.32518	.35209	.36349	.34079	.29529	.30259	.22988	.19960	.16608	.12651
	.11384	.09332	.07925	.06748	.05653	.04872	.03381	.02029	.01348	.01323
.375	.31955	.36531	.37721	.34664	.29562	.30277	.23664	.21447	.17197	.14229
	.12231	.09990	.08584	.07295	.06003	.05390	.03682	.02200	.01445	.01051
.400	.32307	.37599	.38060	.34857	.30647	.30590	.23988	.22376	.17819	.15227
	.12753	.10808	.09344	.07782	.06636	.05732	.04193	.02470	.01475	.01338

Table A-18. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 1.8$) (Continued)

.425	.32069	.36437	.38199	.35270	.31526	.30230	.24744	.22731	.18393	.15951
	.13575	.11569	.10085	.08314	.07183	.06348	.04568	.02847	.01551	.01175
.450	.33344	.35429	.37099	.34872	.32670	.30850	.26112	.23571	.19486	.16988
	.14237	.12431	.10408	.08870	.07965	.06861	.05001	.03135	.01657	.00970
.475	.44162	.41994	.37736	.34726	.33200	.31649	.27346	.24187	.19903	.17687
	.148[illegible]2	.12978	.11150	.09853	.08501	.07479	.05443	.03424	.01689	.01244
.500	.40047	.39673	.37540	.34642	.33664	.32699	.27216	.24854	.20932	.18076
	.15385	.13764	.11767	.10514	.09187	.08160	.05916	.03781	.01625	.01079
.525	.39130	.39130	.38166	.35134	.33913	.32911	.28801	.24774	.21124	.18799
	.16436	.14334	.12494	.11192	.09855	.08675	.06343	.04030	.02044	.01321
.550	.31114	.33217	.36145	.35341	.33714	.32479	.28197	.25150	.22360	.19181
	.16994	.15002	.13438	.11717	.10450	.09133	.06659	.04300	.02125	.01277
.575	.41325	.41301	.39002	.34853	.33780	.32783	.29669	.25255	.22594	.19831
	.17866	.15454	.14141	.12349	.10984	.09600	.07049	.04657	.02412	.01668
.600	.36947	.36947	.36742	.34922	.33475	.32926	.29353	.25472	.23392	.20035
	.185[illegible]4	.16210	.14629	.12975	.11355	.10035	.07531	.04916	.02839	.01677
.625	.41043	.40557	.38245	.34469	.33567	.32638	.30127	.25401	.23728	.20865
	.18765	.16929	.14984	.13449	.11768	.10524	.07773	.05385	.03161	.02142
.650	.36594	.36594	.36395	.34574	.33010	.32492	.29863	.26255	.23736	.21476
	.19055	.17339	.15392	.13924	.12263	.10655	.08176	.05867	.03587	.02633
.675	.41395	.40817	.38383	.34063	.33188	.32314	.30353	.26162	.24161	.21756
	.19513	.17800	.15928	.14027	.12545	.10972	.08710	.06215	.04148	.03029
.700	.36017	.36017	.35989	.34280	.32570	.31916	.30214	.26598	.24266	.22395
	.19842	.17827	.16140	.14353	.13149	.11543	.08938	.06683	.04589	.03311
.725	.40611	.40551	.38397	.34089	.32515	.31687	.30139	.27574	.23915	.22646
	.19936	.18288	.16786	.14903	.13009	.11723	.09321	.07052	.05104	.03803
.750	.35096	.35096	.35096	.33970	.32473	.31164	.30267	.27181	.24512	.23145
	.20927	.18536	.16548	.15054	.13318	.12128	.09626	.07507	.05497	.04143
.775	.39904	.39904	.38797	.35153	.32038	.31246	.29667	.28104	.25091	.22292
	.20932	.18678	.16854	.15560	.13789	.12367	.10067	.07861	.06139	.05127
.800	.28976	.30510	.32253	.34047	.32667	.31287	.29371	.27755	.24724	.22731
	.21450	.19129	.17144	.15480	.14111	.12737	.10422	.08458	.06993	.05261
.825	.36513	.36513	.36513	.34449	.32244	.30398	.29294	.27696	.25506	.23172
	.20919	.19349	.17576	.15596	.14378	.13276	.11087	.09390	.07571	.06354
.850	.42845	.42572	.40065	.35052	.31374	.30631	.29145	.27716	.26196	.23196
	.20676	.19475	.17981	.16160	.14998	.14154	.11851	.09951	.08519	.07488
.875	.33642	.33642	.33642	.33240	.32000	.30761	.28886	.28175	.26591	.23555
	.21281	.20103	.18741	.17149	.15692	.14380	.12491	.10726	.09382	.07856
.900	.39721	.39721	.39696	.36718	.33740	.30762	.29154	.27908	.26190	.24318
	.22226	.19978	.18267	.17323	.16310	.15078	.13258	.11793	.10432	.09677

Table A-18. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 1.8$) (Concluded)

.925	.28272	.28658	.29425	.30959	.32257	.31253	.29245	.27314	.25875	.24435
	.22466	.20297	.18601	.17931	.17261	.16116	.14092	.13116	.10785	.05713
.950	.34634	.34634	.34634	.34634	.33261	.31845	.29013	.27453	.26689	.25525
	.23769	.21466	.19493	.18878	.18262	.17387	.15085	.10896	.07260	.04317
.975	.37538	.37538	.37538	.37038	.36393	.35748	.34061	.31033	.28005	.25224
	.24033	.22843	.21587	.18740	.15894	.13048	.09064	.05844	.03590	.01106
1.000	.295[illegible]8	.30443	.31652	.34070	.36488	.38454	.33517	.28581	.23644	.19548
	.16521	.13495	.10468	.08806	.07417	.06028	.04070	.02629	.01659	.00800

Table A-19. Cambered Wing Lifting Pressures at α = 0 deg (M = 2.0)

TABLE OF CAMBER CP AT BASIC ALPHA
ALPHA=0.0000 DEG.

Y/B/2 \ XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
0.000	.30521	.29301	.27808	.24822	.22396	.19807	.14282	.10216	.07239	.04373
.025	.30306	.29993	.28145	.25733	.22538	.20174	.14528	.10597	.07334	.04565
.050	.28234	.28625	.29342	.26627	.23614	.20189	.14847	.10607	.07286	.04538
.075	.28709	.28736	.28868	.27691	.23592	.20684	.15507	.11146	.07763	.05015
.100	.19973	.29848	.28086	.27669	.23871	.21629	.15799	.11481	.07919	.05548
.125	.29752	.29569	.29046	.28606	.25347	.20915	.16055	.11600	.09018	.06531
.150	.33969	.31050	.29486	.28273	.25283	.21357	.16188	.13166	.09993	.07107
.175	.32971	.31964	.29771	.28664	.26571	.21278	.17914	.13966	.10501	.07893
.200	.33598	.33201	.31183	.29187	.27483	.22531	.18960	.14653	.11299	.08982
.225	.33825	.33823	.32084	.29774	.28151	.24370	.19612	.15061	.12563	.09938
.250	.25449	.30462	.31803	.29742	.26957	.26577	.20423	.16339	.13551	.10402
.275	.36784	.34310	.31906	.30905	.27745	.26590	.20959	.17526	.14461	.11121
.300	.34791	.33683	.31776	.31033	.29257	.27209	.21544	.18297	.14930	.11646
.325	.35346	.34611	.32731	.31226	.30043	.28122	.22676	.19403	.15955	.12687
.350	.35604	.35304	.33664	.31686	.30821	.29750	.23427	.20946	.16328	.13584
.375	.35601	.35601	.34489	.32202	.31465	.30104	.23643	.21091	.17149	.14595
.400	.25382	.31093	.34185	.32547	.30921	.29366	.25050	.22365	.18273	.15575

Y/B/2 \ XPCT	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
0.000	.03002	.02753	.02725	.02852	.02782	.02755	.02679	.02384	.02306	.02041
.025	.03151	.02616	.02541	.02631	.02760	.02831	.02759	.02352	.02238	.02016
.050	.03330	.02718	.02576	.02632	.02720	.02749	.02690	.02310	.02214	.02040
.075	.03481	.02581	.02678	.02756	.02818	.02684	.02565	.02247	.02122	.01992
.100	.04020	.03113	.02904	.02681	.02630	.02590	.02562	.02177	.01980	.01890
.125	.04619	.03219	.03052	.02773	.02640	.02553	.02334	.02102	.01963	.01696
.150	.05072	.03909	.03387	.02768	.02590	.02442	.02236	.02019	.01895	.01622
.175	.05954	.04533	.03490	.02879	.02758	.02629	.02164	.01877	.01800	.01558
.200	.06725	.04889	.03879	.03323	.03076	.02559	.02231	.01643	.01654	.01524
.225	.07140	.05555	.04611	.03858	.03288	.02921	.02427	.01699	.01512	.01549
.250	.08028	.06593	.05374	.04352	.03838	.03261	.02589	.01761	.01447	.01517
.275	.08857	.07390	.05760	.04951	.04269	.03695	.02723	.01667	.01411	.01284
.300	.09950	.07902	.06588	.05614	.04836	.04035	.02988	.01655	.01352	.01438
.325	.10656	.08588	.07380	.06329	.05140	.04421	.03114	.01851	.01372	.01228
.350	.11298	.09410	.08150	.06533	.05641	.04935	.03376	.02006	.01376	.01142
.375	.12393	.10267	.08637	.07232	.06215	.05142	.03780	.02257	.01446	.01352
.400	.12663	.10958	.09497	.07766	.06590	.05666	.04107	.02558	.01567	.01132

Table A-19. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 2.0$) (Continued)

.425	.38903 .13690	.37790 .11862	.35286 .09798	.33081 .08374	.32068 .07298	.30643 .06250	.25799 .04532	.23059 .02906	.18931 .01659	.16249 .01413
.450	.36696 .14313	.36696 .12350	.35478 .10520	.32975 .09152	.32273 .07917	.31267 .06905	.26781 .05023	.23368 .03265	.19631 .01769	.17147 .01372
.475	.25277 .15005	.29234 .13253	.34371 .11264	.33871 .09821	.32570 .08605	.31160 .07503	.27073 .05600	.24480 .03628	.20693 .01923	.17425 .01289
.500	.39214 .15772	.39214 .13782	.37275 .12050	.33570 .10479	.32620 .09300	.31643 .08165	.28510 .06023	.24141 .03940	.21037 .02111	.18327 .01539
.525	.24218 .16625	.28126 .14414	.33222 .12795	.33985 .11215	.33000 .10048	.31779 .08724	.28155 .06442	.25108 .04288	.21803 .02304	.18842 .01411
.550	.35129 .17296	.35129 .15143	.34658 .13658	.33317 .11908	.32705 .10582	.32363 .09262	.29038 .06903	.25022 .04664	.22498 .02586	.19276 .01585
.575	.35615 .18128	.35200 .15939	.34236 .14233	.32967 .12577	.32661 .11042	.32088 .09779	.29578 .07408	.25184 .05058	.22974 .02792	.19946 .01916
.600	.33179 .18518	.33179 .16653	.33162 .14720	.32736 .13129	.32311 .11605	.32186 .10311	.29858 .07833	.25783 .05314	.23512 .03176	.20724 .02187
.625	.32980 .18855	.32980 .17193	.32808 .15306	.32351 .13720	.32109 .12169	.32003 .10807	.29631 .08151	.26313 .05751	.23546 .03676	.21329 .02643
.650	.34800 .19359	.34312 .17763	.33327 .15848	.31854 .14241	.31589 .12664	.31323 .11102	.29581 .08555	.26357 .06259	.23712 .04257	.21731 .03132
.675	.32045 .19852	.32045 .18280	.32045 .16345	.31700 .14500	.31291 .12867	.31000 .11457	.30758 .08998	.26829 .06793	.24281 .04818	.22271 .03775
.700	.32288 .20283	.32288 .18261	.32191 .16501	.31637 .14831	.31084 .13165	.30949 .11886	.30228 .09479	.26873 .07341	.24750 .05417	.22674 .03899
.725	.34130 .20616	.34130 .18572	.33365 .16822	.31798 .15276	.30920 .13662	.30634 .12344	.29530 .09934	.27350 .07825	.24659 .05856	.22365 .04522
.750	.21146 .21024	.23181 .19035	.26151 .17226	.31108 .15734	.30501 .14166	.29894 .12733	.28668 .10371	.27425 .08210	.24700 .06399	.22543 .05373
.775	.32218 .21485	.32218 .19507	.32218 .17568	.31644 .16130	.30694 .14609	.29743 .13019	.28901 .10766	.28047 .08682	.25205 .06954	.23008 .05570
.800	.30572 .21795	.30572 .19841	.30572 .17749	.30158 .16264	.29720 .14831	.28320 .13518	.29110 .11173	.28191 .09245	.25483 .07580	.23359 .06612
.825	.32402 .21603	.32402 .19856	.32109 .18229	.30958 .16686	.29807 .15190	.29209 .13966	.28768 .11835	.27673 .10017	.25528 .08471	.23499 .06900
.850	.21216 .21702	.21607 .19825	.23263 .18479	.26575 .17138	.29275 .15816	.28692 .14560	.27527 .12643	.26418 .10825	.25368 .09406	.23854 .08045
.875	.30922 .22279	.30922 .20073	.30922 .18915	.30922 .17757	.30198 .16547	.29264 .15326	.27397 .13478	.26358 .11806	.25788 .10503	.24587 .09580
.900	.30092 .22865	.30092 .20646	.30092 .19381	.30046 .18383	.29299 .17354	.28551 .16242	.27056 .14314	.26435 .12857	.26026 .11306	.25085 .09657

Table A-19. Cambered Wing Lifting Pressures at $\alpha = 0$ deg ($M = 2.0$) (Concluded)

.925	.29391	.29391	.29391	.29208	.28636	.28065	.26921	.26580	.26303	.25776
	.23664	.21552	.19878	.19026	.18175	.17230	.15189	.13844	.12184	.10100
.950	.26626	.26626	.26626	.26601	.26561	.26522	.26447	.26431	.26415	.26399
	.24559	.22604	.20648	.19674	.18939	.18204	.16056	.13702	.11155	.08607
.975	.24225	.24225	.24329	.26077	.27825	.29574	.31565	.29472	.27379	.25285
	.23851	.22717	.21582	.20329	.18079	.15829	.11664	.08443	.05616	.03231
1.000	.20795	.21100	.22449	.25146	.27844	.30541	.31275	.27810	.24345	.20880
	.17858	.15652	.13446	.11240	.09233	.08139	.05951	.04344	.03314	.02284

Table A-20. *Cambered Wing Lifting Pressures at $\alpha = 0$ deg, Leading Edge Drooped for $\alpha = 2$ deg ($M = 1.8$)*

TABLE OF CAMBER CP AT BASIC ALPHA

XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
Y/B/2										
0.000	.37476	.33691	.29429	.27345	.23861	.20544	.14128	.09871	.06428	.03509
	.01955	.01757	.01921	.02285	.02595	.02758	.02780	.02425	.02324	.02032
.025	.33881	.33331	.31838	.27671	.24020	.20669	.14088	.09502	.06001	.03170
	.02009	.01885	.02057	.02385	.02598	.02679	.02680	.02366	.02262	.01984
.050	.31730	.34538	.32177	.27942	.24604	.20893	.14598	.09792	.06106	.03123
	.02010	.01830	.02086	.02461	.02619	.02676	.02640	.02339	.02208	.01996
.075	.29640	.32983	.32796	.28725	.24915	.20769	.14728	.10165	.06774	.04101
	.02754	.02116	.02102	.02254	.02426	.02585	.02636	.02328	.02171	.01569
.100	.35370	.31989	.30402	.30173	.24401	.22042	.15723	.11085	.07258	.04507
	.03049	.02299	.02467	.02483	.02549	.02599	.02493	.02180	.02043	.01876
.125	.33646	.32728	.30360	.29153	.24700	.21835	.15413	.10748	.07828	.05618
	.04069	.02933	.02616	.02315	.02446	.02508	.02399	.02057	.01975	.01889
.150	.28294	.33841	.31541	.28523	.26071	.20761	.15106	.12147	.09552	.06698
	.04483	.03268	.02889	.02632	.02607	.02432	.02152	.01967	.01924	.01678
.175	.30039	.33887	.32201	.28011	.27285	.20348	.16886	.13837	.10323	.07177
	.05359	.04194	.03338	.02805	.02587	.02456	.02238	.01879	.01800	.01594
.200	.27638	.33434	.31886	.26964	.27082	.21901	.18499	.14816	.11011	.08493
	.06411	.04810	.03620	.03039	.02995	.02683	.02208	.01757	.01703	.01489
.225	.33205	.32983	.31294	.29524	.27193	.23859	.19704	.15467	.12370	.09714
	.07099	.05335	.04301	.03753	.03400	.02850	.02465	.01639	.01593	.01478
.250	.31810	.31554	.30389	.29309	.27093	.25714	.20644	.16556	.14035	.10514
	.07783	.06300	.05204	.04364	.03762	.03375	.02607	.01764	.01542	.01518
.275	.29657	.29651	.29635	.29623	.26675	.26941	.21578	.17661	.15116	.11199
	.08413	.07284	.05938	.04845	.04402	.03815	.02828	.01726	.01444	.01387
.300	.26396	.27332	.29167	.29968	.26891	.28034	.22279	.19036	.15694	.11804
	.09651	.08078	.06588	.05650	.04922	.04107	.03110	.01657	.01422	.01458
.325	.23572	.26119	.29245	.30385	.26672	.28358	.23102	.20268	.16379	.12764
	.10840	.08790	.07323	.06343	.05302	.04550	.03335	.01894	.01493	.01261
.350	.09495	.21522	.29274	.30438	.27109	.28792	.23913	.21438	.17544	.13675
	.11676	.09580	.08229	.06924	.05717	.05059	.03519	.02073	.01525	.01502
.375	.05776	.21827	.29465	.30583	.27123	.28564	.24984	.23016	.18441	.15018
	.12591	.10334	.08942	.07364	.06326	.05505	.03946	.02403	.01577	.01230
.400	.02672	.22030	.28535	.30304	.27898	.29047	.25874	.24084	.19396	.16328
	.13301	.11302	.09648	.08073	.06856	.06014	.04300	.02695	.01710	.01490

Table A-20. *Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 2 deg (M = 1.8) (Continued)*

.425	.01447	.18077	.27983	.29893	.28340	.28715	.26695	.24685	.20357	.17139
	.13931	.12215	.10349	.08617	.07604	.06497	.04858	.03019	.01790	.01404
.450	.01871	.14110	.25840	.28477	.29001	.29320	.27783	.25766	.21437	.18104
	.15073	.12991	.10932	.09491	.08112	.07188	.05211	.03437	.01814	.01261
.475	.13374	.16632	.23034	.27560	.29180	.29535	.29547	.26303	.22850	.18859
	.15617	.13831	.11648	.10171	.08973	.07957	.05774	.03705	.02069	.01364
.500	.15447	.16282	.21037	.27501	.29682	.30543	.30180	.27354	.23341	.19645
	.16760	.14265	.12417	.11126	.09676	.08480	.06331	.04038	.02181	.01312
.525	.20405	.20405	.22032	.27151	.29212	.30592	.30689	.27771	.24731	.20033
	.17477	.15296	.13453	.11592	.10383	.09213	.06578	.04459	.02219	.01750
.550	-.07305	.03687	.18988	.25962	.29143	.30191	.31962	.27986	.25078	.21201
	.18544	.15804	.14138	.12505	.11138	.09579	.07152	.04669	.02508	.01703
.575	.12240	.12292	.17264	.26237	.28556	.30454	.31504	.29237	.26045	.21854
	.19079	.16735	.15093	.13201	.11437	.10150	.07652	.04998	.02933	.01873
.600	.16279	.16279	.17001	.23408	.28499	.30430	.32755	.29298	.26461	.22599
	.20023	.17674	.15321	.13712	.12156	.10809	.07876	.05517	.03116	.01957
.625	-.00088	.01720	.10323	.24374	.27732	.30491	.32142	.30554	.27299	.23710
	.20091	.18095	.16148	.14509	.12648	.10942	.08452	.05938	.03453	.02562
.650	.12318	.12318	.13212	.20977	.27682	.29906	.32894	.31126	.27078	.23959
	.21052	.18937	.16730	.14551	.12985	.11486	.09017	.06210	.04059	.03059
.675	-.08322	-.05859	.04512	.22920	.26645	.30371	.32721	.31273	.28191	.24983
	.21620	.18896	.17039	.15180	.13709	.12122	.09161	.06731	.04697	.03473
.700	.10508	.10508	.10635	.18517	.26399	.29416	.32978	.33327	.27859	.24854
	.21878	.19609	.17807	.15864	.13826	.12157	.09572	.07360	.05120	.03671
.725	-.07854	-.07603	.01310	.18136	.25650	.29076	.32613	.32313	.29019	.25695
	.22914	.20223	.17843	.15831	.13800	.12572	.10168	.07726	.05490	.04305
.750	.12277	.12277	.12277	.17207	.23756	.29483	.33408	.33284	.30360	.25676
	.22816	.20020	.17833	.16314	.14604	.13184	.10461	.07978	.06086	.04745
.775	.00402	.00402	.03940	.15594	.25557	.28089	.32361	.32788	.29430	.25528
	.23112	.20751	.18662	.16859	.15082	.13322	.10702	.08585	.06864	.05550
.800	-.23682	-.12624	-.00055	.17976	.22669	.27362	.31691	.32738	.30077	.26983
	.23618	.21254	.18846	.16396	.15026	.13664	.11343	.09373	.07483	.05535
.825	.05813	.05803	.05803	.13171	.21046	.27639	.31581	.32987	.31351	.27200
	.22841	.20899	.18972	.17060	.15725	.14499	.12125	.09995	.07956	.06799
.850	-.24073	-.22963	-.12783	.07579	.22518	.25536	.31571	.31786	.30863	.27157
	.23846	.21619	.19672	.18041	.16554	.15135	.12626	.10382	.09085	.08089
.875	.12444	.12444	.12444	.13982	.18724	.23466	.30638	.33356	.33454	.29017
	.25224	.22286	.19972	.18437	.16840	.15175	.13200	.11474	.10165	.08613
.900	.05403	.05403	.05461	.12210	.18959	.25707	.29350	.32175	.30975	.28456
	.25337	.21790	.19319	.18381	.17377	.16168	.14311	.12787	.11295	.10186

Table A-20. Cambered Wing Lifting Pressures at $\alpha = 0$ deg, Leading Edge Drooped for $\alpha = 2$ deg (M = 1.8) (Concluded)

.925	-.16096	-.12467	-.05256	.09166	.22411	.24176	.27708	.30562	.29125	.27688
	.25404	.22800	.20678	.19599	.18521	.17450	.15422	.13724	.11657	.06854
.950	.16321	.16321	.16321	.16321	.18782	.21320	.26397	.29195	.30564	.31933
	.28973	.25557	.22505	.20954	.19403	.18129	.16167	.12259	.08546	.05220
.975	.01740	.01740	.01740	.07780	.15561	.23343	.34789	.32359	.29930	.27646
	.26307	.24968	.23572	.20819	.18067	.15314	.10686	.06909	.04249	.01462
1.000	-.06593	-.03174	.01716	.11498	.21279	.30105	.29017	.27929	.26841	.24505
	.20580	.16655	.12730	.10617	.08866	.07116	.04743	.03082	.01986	.01022

Table A-21. Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 4 deg (M = 1.8)

TABLE OF CAMBER CP AT BASIC ALPHA

Y/B/2 \ XPCT	0.00	1.25	2.50	5.00	7.50	10.00	15.00	20.00	25.00	30.00
0.000	.37476	.33691	.29429	.27317	.23736	.20312	.13712	.09327	.05884	.03030
.025	.33881	.33331	.31833	.27602	.23858	.20426	.13710	.09037	.05547	.02791
.050	.31730	.34500	.32089	.27783	.24387	.20556	.14144	.09305	.05647	.02764
.075	.29108	.32588	.32468	.28520	.24563	.20471	.14343	.09789	.06449	.03752
.100	.33077	.30704	.29591	.29645	.24096	.21545	.15252	.10629	.06900	.04228
.125	.31867	.31201	.29483	.28517	.24290	.21181	.15006	.10608	.07816	.05477
.150	.23500	.31802	.30170	.27460	.25408	.20274	.15075	.12154	.09563	.06533
.175	.23505	.30983	.30282	.26682	.26234	.20179	.16821	.13839	.10391	.07147
.200	.18822	.29585	.29229	.25385	.25638	.21893	.18322	.14920	.11356	.08701
.225	.28035	.28013	.27841	.27661	.25523	.23813	.19451	.15855	.12973	.10014
.250	.25069	.25271	.26190	.27042	.25205	.25376	.20307	.17392	.14877	.10655
.275	.20645	.21750	.24828	.26997	.24592	.26373	.21408	.18984	.15987	.11248
.300	.14139	.17530	.24175	.27074	.24704	.27214	.22384	.20497	.16485	.12182
.325	.06837	.14365	.23604	.27274	.24468	.27180	.23513	.21831	.17093	.13458
.350	-.11703	.08919	.22757	.27084	.24881	.27445	.24763	.22799	.18407	.14618
.375	-.18333	.08284	.21862	.26824	.24876	.26988	.26198	.24461	.19586	.15745
.400	-.24623	.07690	.19762	.26111	.25363	.27627	.27610	.25655	.20848	.17343

Y/B/2 \ XPCT	35.00	40.00	45.00	50.00	55.00	60.00	70.00	80.00	90.00	100.00
0.000	.01567	.01481	.01752	.02205	.02575	.02787	.02803	.02388	.02315	.02045
.025	.01691	.01633	.01871	.02255	.02515	.02635	.02672	.02342	.02257	.01982
.050	.01761	.01647	.01949	.02356	.02542	.02606	.02582	.02301	.02189	.01990
.075	.02450	.01851	.01901	.02133	.02390	.02587	.02631	.02267	.02137	.01988
.100	.02864	.02170	.02360	.02404	.02466	.02541	.02465	.02134	.02034	.01912
.125	.03880	.02731	.02489	.02283	.02456	.02536	.02365	.02048	.01950	.01959
.150	.04330	.03181	.02890	.02634	.02568	.02309	.02167	.02005	.01927	.01736
.175	.05392	.04219	.03251	.02719	.02603	.02464	.02207	.01891	.01812	.01641
.200	.06505	.04672	.03601	.03143	.02987	.02631	.02225	.01783	.01707	.01436
.225	.07038	.05389	.04433	.03731	.03295	.02878	.02511	.01618	.01624	.01510
.250	.07934	.06527	.05173	.04319	.03864	.03372	.02640	.01837	.01617	.01617
.275	.08895	.07387	.05845	.04999	.04433	.03822	.02891	.01748	.01513	.01483
.300	.09998	.08154	.06705	.05730	.04983	.04170	.03192	.01757	.01474	.01483
.325	.11173	.08808	.07483	.06496	.05415	.04633	.03358	.02061	.01646	.01372
.350	.11946	.09809	.08510	.07085	.05775	.05232	.03647	.02113	.01689	.01666
.375	.12923	.10651	.09271	.07428	.06625	.05611	.04188	.02590	.01699	.01396
.400	.13805	.11757	.09927	.08341	.07059	.06273	.04399	.02902	.01927	.01631

Table A-21. Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 4 deg (M = 1.8) (Continued)

.425	-.26762	.01165	.18573	.24942	.25408	.27321	.28492	.26483	.22164	.182[illegible]
	.14258	.12811	.10592	.08897	.07992	.06634	.05125	.03178	.02010	.01616
.450	-.27126	-.05529	.15470	.22588	.25624	.27914	.29319	.27785	.23235	.19132
	.15843	.13506	.11357	.10063	.08247	.07489	.05404	.03715	.01959	.01533
.475	-.14984	-.06729	.09494	.20959	.25477	.27589	.31571	.28252	.25566	.19938
	.16368	.14617	.12106	.10463	.09408	.08398	.06079	.03964	.02305	.01473
.500	-.07211	-.05263	.05836	.20923	.26012	.28556	.32913	.29658	.25562	.21091
	.18026	.14727	.13015	.11690	.10126	.08775	.06714	.04275	.02508	.01527
.525	.03158	.03158	.07170	.19796	.24880	.28454	.32433	.30533	.28053	.21170
	.18435	.16182	.14336	.11961	.10869	.09708	.06794	.04853	.02381	.02144
.550	-.42695	-.23514	.03183	.17321	.24931	.28081	.35432	.30630	.27580	.23061
	.19972	.16543	.14782	.13230	.11772	.09990	.07606	.05009	.02861	.02096
.575	-.14549	-.14427	-.02758	.18301	.23743	.28308	.33195	.32907	.29223	.23717
	.20196	.17915	.15970	.13985	.11855	.10657	.08208	.05311	.03413	.02062
.600	-.02759	-.02759	-.01183	.12802	.23914	.28130	.35888	.32824	.29287	.24963
	.21423	.19022	.15958	.14391	.12894	.11522	.08194	.06071	.03372	.02215
.625	-.37973	-.34053	-.15396	.15076	.22358	.28914	.33999	.35302	.30587	.26330
	.21313	.19169	.17219	.15486	.13458	.11327	.09077	.06446	.03723	.02949
.650	-.10042	-.10042	-.08131	.08454	.22775	.27526	.35687	.35614	.30156	.26246
	.22891	.20408	.17961	.15129	.13649	.12252	.09792	.06526	.04493	.03451
.675	-.54114	-.48850	-.26685	.12657	.20619	.28581	.34903	.35981	.31903	.27955
	.23559	.19906	.18061	.16242	.14781	.13181	.09576	.07206	.05203	.03877
.700	-.12986	-.12986	-.12717	.03999	.20716	.27114	.35524	.39524	.31169	.27117
	.23753	.21251	.19343	.17254	.14449	.12721	.10156	.07984	.05609	.04002
.725	-.52493	-.51954	-.32848	.05365	.19328	.26672	.34893	.36678	.33721	.28504
	.25601	.22005	.18817	.16686	.14529	.13355	.10948	.08346	.05845	.04767
.750	-.08741	-.08741	-.08741	.01768	.15729	.27935	.36302	.38904	.35746	.28007
	.24555	.21387	.19016	.17474	.15789	.14156	.11229	.08412	.06628	.05299
.775	-.35983	-.35983	-.28167	-.02422	.19588	.25182	.34844	.37102	.33427	.28508
	.25120	.22661	.20327	.18056	.16273	.14201	.11287	.09252	.07532	.05939
.800	-.72180	-.52349	-.29812	.03173	.13460	.23748	.33828	.37329	.35008	.30900
	.25615	.23211	.20413	.17240	.15869	.14518	.12192	.10216	.07935	.05787
.825	-.22484	-.22484	-.22484	-.06428	.10733	.25098	.33689	.37861	.36735	.30911
	.24611	.22327	.20258	.18408	.16966	.15625	.13082	.10552	.08310	.07209
.850	-.85710	-.83327	-.61460	-.17726	.14361	.20843	.33807	.35534	.35161	.30805
	.26766	.23593	.21229	.19774	.17986	.16038	.13340	.10780	.09607	.08642
.875	-.07080	-.07080	-.07080	-.03755	.06496	.16747	.32253	.38129	.39679	.34047
	.28855	.24296	.21105	.19623	.17898	.15907	.13853	.12162	.10886	.09309
.900	-.26205	-.26205	-.26070	-.10363	.05345	.21053	.29530	.36105	.35382	.32267
	.28203	.23459	.20287	.19354	.18360	.17172	.15282	.13702	.12090	.10656

Table A-21. *Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 4 deg (M = 1.8) (Concluded)*

.925	-.56963	-.50347	-.37201	-.10908	.13342	.17659	.26292	.33554	.32119	.30684
	.28110	.25106	.22591	.21136	.19681	.18677	.16647	.14284	.12461	.07905
.950	-.00546	-.00546	-.00546	-.00546	.05446	.11626	.23987	.30800	.34133	.37467
	.33766	.29325	.25278	.22866	.20453	.18811	.17163	.13513	.09730	.06051
.375	-.31231	-.31231	-.31231	-.19168	-.03625	.11918	.35460	.33581	.31702	.29878
	.28401	.26925	.25401	.22734	.20068	.17401	.12180	.07890	.04855	.01790
1.000	-.39926	-.34138	-.25856	-.09293	.07270	.22415	.24871	.27328	.29785	.29071
	.24319	.19566	.14814	.12285	.10201	.08118	.05363	.03498	.02287	.01227

Table A-22. Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 6 deg (M = 1.8)

TABLE OF CAMBER CP AT BASIC ALPHA

XPCT Y/B/2	0.00 35.00	1.25 40.00	2.50 45.00	5.00 50.00	7.50 55.00	10.00 60.00	15.00 70.00	20.00 80.00	25.00 90.00	30.00 100.00
0.000	.37476 .01245	.33691 .01253	.29429 .01614	.27294 .02138	.23632 .02559	.20120 .02811	.13368 .02823	.08875 .02357	.05435 .02307	.02633 .02057
.025	.33861 .01427	.33331 .01423	.31829 .01718	.27545 .02148	.23724 .02445	.20226 .02599	.13395 .02666	.08651 .02322	.05170 .02252	.02476 .01980
.050	.31730 .01555	.34469 .01495	.32016 .01836	.27652 .02269	.24207 .02479	.20276 .02547	.13767 .02534	.08902 .02269	.05266 .02173	.02467 .01985
.075	.28665 .02198	.32260 .01631	.32197 .01735	.28351 .02033	.24271 .02360	.20222 .02588	.14025 .02626	.09476 .02216	.06179 .02109	.03462 .02003
.100	.31170 .32711	.29639 .02064	.28920 .02272	.29209 .02338	.23840 .02397	.21130 .02494	.14865 .02442	.10248 .02096	.06694 .02026	.03998 .01943
.125	.30391 .03723	.29934 .02564	.28757 .02383	.27990 .02256	.23947 .02465	.20635 .02559	.14672 .02338	.10490 .02041	.07806 .01928	.05359 .02016
.150	.19532 .04204	.30112 .03108	.29033 .02892	.26579 .02636	.24856 .02535	.19870 .02207	.15053 .02179	.12159 .02036	.09573 .01930	.06397 .01784
.175	.18094 .05419	.28575 .04239	.28691 .03179	.25578 .02648	.25362 .02616	.20040 .02472	.16768 .02182	.13840 .01900	.10448 .01822	.07121 .01680
.200	.11524 .06583	.26393 .04557	.27027 .03585	.24076 .03229	.24442 .02980	.21888 .02588	.18175 .02238	.15008 .01804	.11641 .01710	.08874 .01392
.225	.23747 .06987	.23891 .05434	.24978 .04542	.26119 .03713	.24143 .03209	.23774 .02902	.19241 .02549	.16178 .01601	.13473 .01650	.10261 .01537
.250	.19480 .08059	.20063 .06716	.22709 .05147	.25165 .04281	.23646 .03948	.25094 .03369	.20028 .02667	.18085 .01898	.15574 .01679	.10771 .01700
.275	.13177 .09294	.15203 .07473	.20846 .05769	.24822 .05127	.22867 .04458	.25905 .03829	.21266 .02943	.20080 .01765	.16708 .01571	.11289 .01562
.300	.03985 .10287	.09409 .08216	.20039 .06801	.24676 .05795	.22889 .05035	.26539 .04222	.22470 .03260	.21707 .01841	.17140 .01517	.12497 .01504
.325	-.07029 .11448	.04627 .08823	.18930 .07616	.24697 .06622	.22640 .05509	.26207 .04702	.23852 .03378	.23126 .02199	.17686 .01773	.14033 .01464
.350	-.29269 .12169	-.01525 .09999	.17356 .08742	.24303 .07220	.23034 .05824	.26330 .05376	.25467 .03752	.23926 .02147	.19122 .01824	.15400 .01803
.375	-.38367 .13198	-.02937 .10914	.15560 .09545	.23708 .07481	.23016 .06871	.25683 .05698	.27205 .04389	.25658 .02744	.20536 .01800	.16348 .01533
.400	-.47231 .14223	-.04191 .12134	.12491 .10159	.22635 .08563	.23265 .07227	.26451 .06488	.29050 .04480	.26957 .03074	.22652 .02107	.18184 .01747

Table A-22. *Cambered Wing Lifting Pressures at α = 0 deg, Leading Edge Drooped for α = 6 deg (M = 1.8) (Continued)*

.425	-.50127	-.12846	.10775	.20838	.22978	.26167	.29982	.27972	.23663	.19139
	.14530	.13304	.10794	.09128	.08314	.06747	.05347	.03339	.02192	.01792
.450	-.51145	-.21798	.06877	.17708	.22824	.26746	.30593	.29459	.24725	.19984
	.16481	.13935	.11734	.10537	.08359	.07738	.05564	.03945	.02079	.01753
.475	-.38483	-.26087	-.01726	.15491	.22410	.25975	.33249	.29867	.27815	.20832
	.16990	.15268	.12487	.10705	.09768	.08763	.06332	.04179	.02550	.01565
.500	-.25986	-.23115	-.06760	.15473	.22974	.26910	.35174	.31566	.27401	.22288
	.19075	.15110	.13511	.12157	.10499	.09019	.07031	.04471	.02779	.01705
.525	-.11133	-.11133	-.05144	.13703	.21292	.26683	.33874	.32822	.30866	.22112
	.19230	.16917	.15069	.12267	.11272	.10119	.06973	.05180	.02514	.02472
.550	-.72013	-.46049	-.09912	.10162	.21441	.26333	.38307	.32765	.29654	.24603
	.21155	.17155	.15317	.13831	.12297	.10330	.07982	.05291	.03153	.02421
.575	-.36748	-.36567	-.19349	.11725	.19755	.26530	.34597	.35948	.31857	.25261
	.21122	.18892	.16697	.14635	.12201	.11077	.08668	.05571	.03811	.02218
.600	-.18534	-.18534	-.16251	.04014	.20117	.26225	.38486	.35744	.31629	.26921
	.22583	.20139	.16486	.14953	.13506	.12113	.08457	.06531	.03583	.02429
.625	-.69367	-.63696	-.36708	.07372	.17906	.26876	.35538	.39236	.33311	.28501
	.22325	.20058	.18106	.16295	.14130	.11646	.09596	.06868	.03947	.03270
.650	-.28570	-.28570	-.25817	-.01924	.18709	.25553	.38001	.39332	.32707	.28141
	.24415	.21628	.18981	.15608	.14200	.12886	.10434	.06788	.04853	.03777
.675	-.92057	-.84473	-.52535	.04152	.15625	.27098	.36712	.39882	.34979	.30418
	.25166	.20742	.18909	.17122	.15669	.14059	.09919	.07599	.05622	.04214
.700	-.32454	-.32454	-.32067	-.08030	.16006	.25206	.37634	.44662	.33911	.28993
	.25306	.22611	.20616	.18407	.14965	.13189	.10640	.08501	.06014	.04276
.725	-.89481	-.88703	-.61151	-.06047	.14090	.24680	.36782	.40296	.37616	.30831
	.27827	.23483	.19624	.17395	.15133	.14003	.11595	.08860	.06139	.05150
.750	-.26156	-.26156	-.26156	-.11024	.09077	.26653	.38700	.43562	.40259	.29939
	.25997	.22519	.19997	.18436	.16771	.14962	.11865	.08771	.07077	.05758
.775	-.66130	-.66130	-.54769	-.17349	.14643	.22773	.36900	.40676	.36738	.30977
	.26784	.24243	.21707	.19048	.17260	.14930	.11771	.09804	.08086	.06261
.800	-1.12364	-.85265	-.54467	-.09092	.05831	.20753	.35599	.41132	.39093	.34145
	.27270	.24832	.21711	.17939	.16568	.15226	.12895	.10914	.08309	.05996
.825	-.45921	-.45921	-.45921	-.22667	.02187	.22993	.35435	.41899	.41196	.33985
	.26077	.23511	.21323	.19525	.17993	.16558	.13874	.11013	.08603	.07549
.850	-1.36779	-1.33341	-1.01791	-.38692	.07603	.16955	.35660	.38641	.38723	.33828
	.29185	.25229	.22520	.21210	.19173	.16786	.13931	.11110	.10039	.09101
.875	-.23258	-.23258	-.23258	-.18451	-.03636	.11180	.33591	.42083	.44879	.38215
	.31864	.25962	.22044	.20606	.18774	.16514	.14394	.12733	.11484	.09886
.900	-.52395	-.52395	-.52197	-.29066	-.05935	.17196	.29680	.39362	.39034	.35425
	.30577	.24842	.21090	.20161	.19174	.18004	.16086	.14460	.12749	.11044

Table A-22. Cambered Wing Lifting Pressures at $\alpha = 0$ deg, Leading Edge Drooped for $\alpha = 6$ deg ($M = 1.8$) (Concluded)

.925	-.90823	-.81732	-.63668	-.27540	.05828	.12258	.25119	.36033	.34600	.33167
	.30353	.27017	.24176	.22410	.20643	.19695	.17661	.14748	.13127	.08775
.950	-.14522	-.14522	-.14522	-.14522	-.05604	.03594	.21990	.32129	.37091	.42052
	.37738	.32446	.27577	.24450	.21324	.19377	.17989	.14553	.10711	.06740
.975	-.58549	-.58549	-.58549	-.41496	-.19522	.02451	.36016	.34594	.33171	.31727
	.30136	.28546	.26916	.24321	.21726	.19131	.13417	.08793	.05357	.02062
1.000	-.67544	-.59792	-.48701	-.26519	-.04336	.16043	.21437	.26831	.32225	.32854
	.27416	.21978	.16540	.13667	.11307	.08948	.05876	.03844	.02536	.01397

Table A-23. *Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered (M = 1.6)*

α, deg	No suction C_L	No suction C_D	Full leading-edge suction C_L	Full leading-edge suction C_D	Attainable suction: Sharp leading edge C_L	Sharp leading edge C_D	LER = 0.001c C_L	LER = 0.001c C_D	Vary LER C_L	Vary LER C_D
-3	0	0.0009	0	0	-0.003	0.00147	-0.002	0.00036	-0.0013	0.00017
-2	0.0361	0.00073	0.0360	0.0004	0.0353	0.00088	0.0360	0.00043	0.0360	0.00041
-1	0.0724	0.00183	0.0724	0.00179	0.0724	0.00183	0.0724	0.00179	0.0724	0.00179
0	0.0109	0.00419	0.109	0.00398	0.109	0.00412	0.109	0.00398	0.109	0.00398
1	0.145	0.00782	0.145	0.00694	0.147	0.00755	0.145	0.00702	0.145	0.00699
2	0.181	0.0127	0.181	0.0107	0.187	0.01217	0.184	0.01112	0.183	0.0110
3	0.217	0.01887	0.217	0.0152	0.292	0.0181	0.225	0.0164	0.223	0.0162
4	0.254	0.0263	0.254	0.0205	0.269	0.0253	0.267	0.0232	0.265	0.0227
5	0.290	0.0350	0.290	0.0266	0.312	0.0339	0.310	0.0314	0.308	0.0306
6	0.326	0.0449	0.326	0.0334	0.357	0.0440	0.355	0.0410	0.353	0.0401

• S = 2091 cm^2

Table A-24. *Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered (M = 1.8)*

α, deg	No suction C_L	No suction C_D	Full leading-edge suction C_L	Full leading-edge suction C_D	Attainable suction: Sharp leading edge C_L	Sharp leading edge C_D	LER = 0.001c C_L	LER = 0.001c C_D	Vary LER C_L	Vary LER C_D
-3	0.0049	0.00092	0.0047	0	0.0021	0.00144	0.0033	0.00049	0.0036	0.000318
-2	0.0394	0.00090	0.0393	0.00056	0.0385	0.00106	0.0392	0.00063	0.0392	0.00060
-1	0.0740	0.00209	0.0740	0.00206	0.0739	0.0021	0.0740	0.00206	0.0740	0.00206
0	0.1085	0.00449	0.1085	0.00437	0.1088	0.00445	0.1085	0.00437	0.1085	0.00437
1	0.143	0.00809	0.143	0.00748	0.145	0.0079	0.143	0.00753	0.143	0.00751
2	0.1776	0.01290	0.1774	0.01139	0.1816	0.01249	0.1796	0.01169	0.1789	0.01163
3	0.212	0.01891	0.212	0.01610	0.220	0.01828	0.2175	0.01703	0.216	0.01684
4	0.247	0.02613	0.246	0.0216	0.259	0.02534	0.257	0.2367	0.255	0.02329
5	0.281	0.03456	0.281	0.0279	0.299	0.0337	0.297	0.0317	0.296	0.0311
6	0.316	0.0442	0.315	0.0350	0.340	0.434	0.339	0.0411	0.337	0.0404

• S = 2091 cm^2

Table A-25. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered (M = 2.0)

α, deg	No suction		Full leading-edge suction		Attainable suction					
					Sharp leading edge		LER = 0.001c		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D	C_L	C_D
-3	0.0090	0.00101	0.0088	0.0001	0.0063	0.0015	0.0073	0.00066	0.0076	0.00052
-2	0.0420	0.00111	0.0420	0.00069	0.0410	0.00128	0.0415	0.00086	0.0417	0.00080
-1	0.0750	0.00237	0.0750	0.00229	0.0748	0.00239	0.0750	0.0023	0.0750	0.00230
0	0.108	0.00477	0.108	0.00474	0.108	0.00476	0.108	0.00474	0.108	0.00474
1	0.141	0.00834	0.141	0.00802	0.142	0.00823	0.141	0.00804	0.141	0.00803
2	0.174	0.0130	0.174	0.0121	0.177	0.0128	0.175	0.0123	0.175	0.01227
3	0.207	0.0189	0.207	0.0171	0.220	0.0185	0.210	0.0177	0.210	0.0176
4	0.240	0.0259	0.240	0.0229	0.248	0.0254	0.247	0.0243	0.246	0.0240
5	0.273	0.0341	0.273	0.0295	0.286	0.0335	0.284	0.0321	0.283	0.0317
6	0.306	0.0434	0.306	0.0369	0.324	0.0429	0.322	0.0412	0.321	0.0407

• $S = 2091\ cm^2$

Table A-26. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered, Leading Edge Drooped for α = 2 deg (M = 1.8)

α, deg	No suction		Attainable suction			
			Sharp leading edge		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D
-3	0.0027	0.00206	-0.0072	0.00487	-0.0054	0.00266
-2	0.0372	0.00145	0.0312	0.00305	0.0325	0.00144
-1	0.0718	0.00204	0.0687	0.00282	0.0695	0.00180
0	0.106	0.00384	0.105	0.00411	0.1056	0.00355
1	0.141	0.00685	0.141	0.00688	0.141	0.00666
2	0.175	0.01106	0.176	0.01096	0.175	0.01082
3	0.210	0.0165	0.212	0.0162	0.210	0.0158
4	0.244	0.0231	0.249	0.0225	0.245	0.0216
5	0.279	0.0309	0.287	0.0300	0.283	0.0284
6	0.313	0.0400	0.326	0.0386	0.322	0.0364

• $S = 2091\ cm^2$

Table A-27. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered, Leading Edge Drooped for α = 4 deg (M = 1.8)

α, deg	No suction		Attainable suction			
			Sharp leading edge		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D
-3	0.0007	0.0039	-0.0194	0.0115	-0.0181	0.0086
-2	0.0352	0.00274	0.0207	0.0080	0.0221	0.0055
-1	0.0698	0.00279	0.0603	0.0060	0.0613	0.0041
0	0.104	0.00404	0.0983	0.0060	0.0992	0.0046
1	0.1388	0.0065	0.1356	0.0075	0.136	0.00656
2	0.173	0.0102	0.172	0.0106	0.172	0.00994
3	0.208	0.0150	0.208	0.0151	0.208	0.01464
4	0.242	0.0211	0.244	0.0209	0.242	0.02056
5	0.277	0.0284	0.280	0.0280	0.277	0.0274
6	0.311	0.03687	0.317	0.0361	0.312	0.0349

• S = 2091 cm^2

Table A-28. Theoretical Drag-due-to-Lift Characteristics, Wing 7—Cambered, Leading Edge Drooped for α = 6 deg (M = 1.8)

α, deg	No suction		Attainable suction			
			Sharp leading edge		Vary LER	
	C_L	C_D	C_L	C_D	C_L	C_D
-3	-0.001	0.0060	-0.0317	0.0200	-0.0308	0.0167
-2	0.0336	0.0044	0.0096	0.0149	0.0107	0.0120
-1	0.0681	0.0040	0.0501	0.0115	0.0512	0.0090
0	0.1026	0.0048	0.0898	0.00998	0.0906	0.0079
1	0.137	0.00678	0.128	0.0102	0.129	0.0086
2	0.172	0.00999	0.166	0.0119	0.167	0.0108
3	0.206	0.01441	0.204	0.01545	0.204	0.0146
4	0.241	0.0200	0.240	0.0204	0.240	0.0197
5	0.275	0.02686	0.276	0.0268	0.275	0.0262
6	0.310	0.03489	0.313	0.0345	0.310	0.0339

• S = 2091 cm^2

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16. Abstract

A theoretical study was made of supersonic wing geometries at Mach 1.8, using the attainable leading-edge thrust concept. The attainable thrust method offers a powerful means to improve overall aerodynamic efficiency by identifying wing leading-edge geometries that promote attached flow and by defining a local angle-of-attack range over which attached flow may be obtained. The concept applies to flat and to cambered wings, which leads to the consideration of drooped-wing leading edges for attached flow at high lift coefficients.

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