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Computer Program Documentation for a Subcritical Wing Design Code Using Higher Order Far-Field Drag Minimization

John M. Kuhlman and Jin-Yea Shu

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Computer Program Documentation for a Subcritical Wing Design Code Using Higher Order Far-Field Drag Minimization

John M. Kuhlman and Jin-Yea Shu
Old Dominion University Research Foundation
Norfolk, Virginia

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SUMMARY

A subsonic, linearized aerodynamic theory, wing design program for one or two planforms has been developed which uses a vortex lattice near-field model and a higher order panel method in the far field. The theoretical development of the wake model and its implementation in the vortex lattice design code are summarized in this report and sample results are given. Detailed program usage instructions, sample input and output data, and a program listing are presented in the Appendixes.

The far-field wake model assumes a wake vortex sheet whose strength varies piecewise linearly in the spanwise direction. From this model analytical expressions for lift coefficient, induced drag coefficient, pitching moment coefficient, and bending moment coefficient have been developed. From these relationships a direct optimization scheme is used to determine the optimum wake vorticity distribution for minimum induced drag, subject to constraints on lift, and pitching or bending moment. Integration spanwise yields the bound circulation, which is interpolated in the near-field vortex lattice to obtain the design camber surface(s).

INTRODUCTION

The current computer program has been developed as a preliminary design tool for one or two interacting, subsonic lifting surfaces. Linearized aerodynamic theory is used, in the form of a vortex lattice representation of the wings in the near field, along with a piecewise linearly varying

vortex sheet model of the undistorted wake. Summaries of the theoretical development and the overall code structure have been given in references 1, 2 and 3, along with some sample results. Reference 3 also describes a second design code currently under development, which includes viscous effects. In all cases, results from the current code have been compared to results for the same configuration obtained from an earlier design code (ref. 4), from which the current design program has been developed. This earlier design program, due to Lamar, uses a discrete vortex filament wake model, in contrast to the current continuous wake vortex distribution.

A detailed development of the current far-field wake model has been given in reference 5; this theory has been developed from the model formulated by Loth and Boyle (ref. 6). A separate, stand-alone, far-field drag minimization program has been written using the current wake model, which has been documented in a user's guide (ref. 7). For completeness, a summary of this theory is given herein, including some details of the development of expressions for pitching moment and bending moment coefficients which were not given in references 1 to 3. An example of the use of the current design code in the design of a wind-tunnel model of a transport wing fitted with winglets may be found in reference 8. Again, comparison is made between the current design and the design obtained using the earlier code of reference 4.

Following the theoretical development, several sample results for configurations having one or two planforms are given. Comparison with results from the earlier code (ref. 4) generally shows a significant difference between designs only in the vicinity of a change in planform dihedral (see also refs. 1-3). Finally, the detailed user instructions, such as program limitations, input data preparation, output data, sample input and output, and the computer program listing are included in the Appendixes.

NOMENCLATURE

- A vortex lattice aerodynamic influence coefficient matrix
 [eq. (29)]
- A_i term in equation (14)

A_{ij}	induced drag coefficient matrix [eqs. (24) and (25)]
a	chordwise loading function parameter
b	wing span
B	bending moment
\bar{c}	reference wing chord
$\frac{c_{\ell}c}{C_L\bar{c}}$	span load
C_B	wing root bending moment coefficient
C_D	induced drag coefficient
C_L	lift coefficient
C_m	pitching moment coefficient
ΔC_p	pressure difference coefficient
$G_i, \bar{G}_i, \hat{G}_i$	variables containing unknown wake vortex sheet strengths; appearing in drag and bound circulation equations (3) and (10)
$\left. \begin{array}{l} I_{1ij}, I_{2ij}, \\ I_{3ij}, I_{4ij}, \\ I_{5ij}, I_{6ij} \end{array} \right\}$	influence coefficient integrals appearing in drag equation (3)
M	Mach number
N	total number of wake panels; total number of horseshoe vortices; normal force
N_{cv}	number of chordwise rows of horseshoe vortices [eqs. (15) and (16)]
S	reference wing area
s	local higher order wake panel coordinate
s	higher order wake panel semiwidth
U	free-stream speed
X_i	term in equation (14)
x	streamwise body axis coordinate

x_c	x-coordinate of center of pressure
Δx	shift of trim point
XP, XM	terms containing x_c in equation for C_B [eq. (19)]
y	spanwise body axis coordinate
z	vertical body axis coordinate
z_c	vertical separation between planforms
γ	wing wake vortex sheet strength
Γ	bound circulation; horeshoe vortex strength
$\Gamma_o(-S_i)$	bound circulation at outboard edge of wake panel i
ϵ	incidence angle
η	local fractional spanwise coordinate
Λ	wing sweep angle
λ	Lagrange multiplier
ξ	local fractional chordwise coordinate
ρ	density
ϕ	dihedral angle

THEORETICAL DEVELOPMENT OF FAR-FIELD WAKE MODEL

A summary of the theoretical development for the current code's far-field wake model is given in this section; further details may be found in references 1, 2, and 5. The wake vortex sheet strength γ is assumed to vary along the spanwise direction in a piecewise linear fashion: that is, on wake panel i,

$$\gamma(\delta_i) = \frac{\gamma_{i+1} + \gamma_i}{2} + \frac{\gamma_{i+1} - \gamma_i}{2} \frac{\delta_i}{s_i} \quad (1)$$

where s_i is the semiwidth of panel i. The wake(s) are segmented into N flat panels, having a cosine size distribution, with small panels near wing tips or changes in wing dihedral. The Biot-Savart and Kutta-Joukowski

laws are applied so that the lift coefficient is a linear function of the γ values (ref. 5):

$$C_L = \frac{8}{S} \left\{ \frac{1}{3} \sum_{i=1}^N \left[\cos \phi_i s_i^2 \left(\frac{\gamma_{i+1}}{U} + \frac{2\gamma_i}{U} \right) \right] + \sum_{i=1}^N \left(\cos \phi_i s_i \frac{\Gamma_o(-s_i)}{U} \right) \right\} \quad (2)$$

where $\Gamma_o(-s_i)$ is the bound circulation at the outboard edge of wake panel i (ref. 5). The induced drag coefficient on wake panel i due to panel j and its image is quadratic in the γ_i values:

$$C_{D,ij} = \frac{1}{S} \left(G_i \bar{G}_j I_{1ij} + G_i \hat{G}_j I_{2ij} + \bar{G}_i \bar{G}_j I_{3ij} + \bar{G}_i \hat{G}_j I_{4ij} + \hat{G}_i \bar{G}_j I_{5ij} + \hat{G}_i \hat{G}_j I_{6ij} \right) \quad (3)$$

where the G_i , \bar{G}_i , and \hat{G}_i are linear functions of the unknown wake vortex sheet strengths γ_i and the $(I_{1ij}, I_{2ij}, I_{3ij}, I_{4ij}, I_{5ij}, I_{6ij})$ are influence coefficients given in reference 5.

Expressions for the pitching moment coefficient and wing root bending moment coefficient are developed as follows. First, for the pitching moment coefficient, let M_i equal the contribution to the pitching moment due to that portion of the wing located between the inboard and outboard edges of wake panel i (see fig. 1). Then the local x -coordinate of the center of pressure may be written as

$$x_c(\delta_i) = \left\{ \frac{x_{c_{i+1}} + x_{c_i}}{2} \right\} + \left\{ \frac{x_{c_{i+1}} - x_{c_i}}{2} \right\} \frac{\delta_i}{s_i} \quad (4)$$

where x_{c_i} denotes the x -coordinate of the center of pressure at a y corresponding to the outboard edge of wake panel i (fig. 1). Then the contribution to C_m due to M_i equals

$$C_{m_i} = \frac{2}{\rho U^2 S c} \int_{-s_i}^{s_i} \cos \phi_i x_c(\delta_i) N(\delta_i) d\delta_i \quad (5)$$

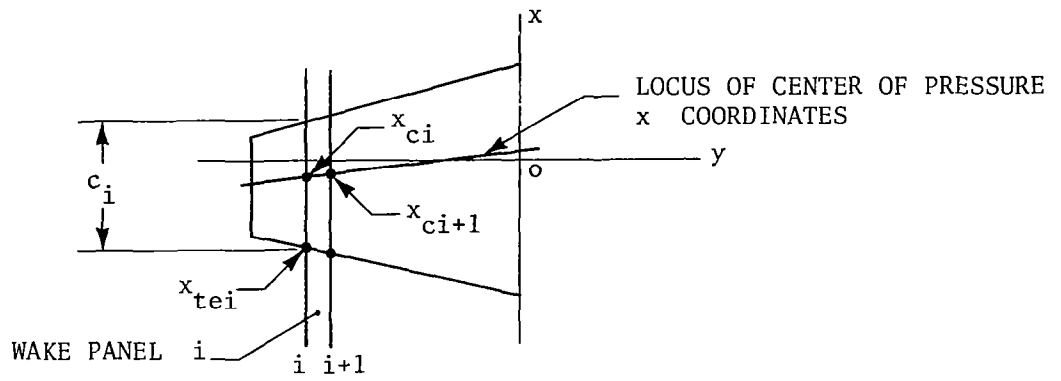


Figure 1. Geometry definition for pitching moment derivation.

where $N(\delta_i)$ is the local distribution of normal force. Using the Kutta Joukowski theorem results in

$$C_{m_i} = \frac{2 \cos \phi_i}{S \bar{c}} \int_{-s_i}^{s_i} \frac{\Gamma}{U}(\delta_i) x_c(\delta_i) d\delta_i \quad (6)$$

where $x_c(\delta_i)$ is written as

$$x_c(\delta_i) = XP_i + XM_i \frac{\delta_i}{s_i} \quad (7)$$

$$XP_i = \frac{x_{c_{i+1}} + x_{c_i}}{2} \quad (8)$$

$$XM_i = \frac{x_{c_{i+1}} - x_{c_i}}{2} \quad (9)$$

and from references 1, 2, and 5:

$$\frac{\Gamma}{U}(\delta_i) = \frac{\Gamma_o(-s_i)}{U} + \bar{G}_i (\delta_i + s_i) + \frac{\hat{G}_i}{2s_i} (\delta_i^2 - s_i^2) \quad (10)$$

where

$$\bar{G}_i = \frac{\gamma_{i+1} + \gamma_i}{2U}; \quad \hat{G}_i = \frac{\gamma_{i+1} - \gamma_i}{2U} \quad (11)$$

and $\Gamma_o(-s_i)$ equals the value of the bound circulation at $\delta_i = -s_i$. Substitution of equations (7) and (10) into equation (6) and integration yield

$$C_{m_i} = \frac{2 \cos \phi_i}{S \bar{c}} \left\{ 2 \frac{\Gamma_o(-s_i)}{U} s_i XP_i + G_i \left(2s_i^2 XP_i + \frac{2}{3} s_i^2 XM_i \right) - \frac{2}{3} s_i^2 XP_i \hat{G}_i \right\} \quad (12)$$

or, as given in references 1 to 3, the total pitching moment coefficient is

$$C_m = \frac{2}{S \bar{c}} \sum_{i=1}^N \cos \phi_i \left\{ 2s_i XP_i \frac{\Gamma_0(-s_i)}{U} + \frac{\gamma_{i+1}}{U} \frac{s_i^2}{3} (XM_i + 2XP_i) + \frac{\gamma_i}{U} \frac{s_i^2}{3} (XM_i + 4XP_i) \right\} \quad (13)$$

The x_{c_i} values are obtained through linear interpolation from the near-field vortex lattice local chords and x values for the wing trailing edge, along with the user-specified NACA a series mean line value (ref. 4). As shown in figure 2,

$$x_{c_i} = \frac{\sum_{i=1}^{N_{cv}} A_i X_i}{\sum_{i=1}^{N_{cv}} A_i} \quad (14)$$

where

$$X_i = 1 - \left(\frac{0.75 - i}{N_{cv}} \right) \quad (15)$$

and

$$A_i = \frac{1}{N_{cv}} \text{ if } a \geq \frac{i - 0.75}{N_{cv}}$$

$$= \frac{\left(1 - \frac{i - 0.75}{N_{cv}} \right)}{N_{cv} (1 - a)} \text{ if } a < \frac{i - 0.75}{N_{cv}} \quad (16)$$

For the bending moment coefficient calculated about the wing root [similar to eq. (5)]

$$C_{Bi} \equiv \frac{2B_i}{Sb\rho U^2} = \frac{-2}{Sb} \int_{-s_i}^{s_i} \cos \phi_i \frac{\Gamma(\delta_i)}{U} (y_i + \delta_i \cos \phi_i) d\delta_i$$

$$- \frac{2}{Sb} \int_{-s_i}^{s_i} \sin \phi_i \frac{\Gamma(\delta_i)}{U} (z_i + \delta_i \sin \phi_i) d\delta_i \quad (17)$$

where the y_i, z_i values correspond to coordinates of the center of wake panel i . Substitution for $\Gamma(\delta_i)$ from equation (10) and integration yield

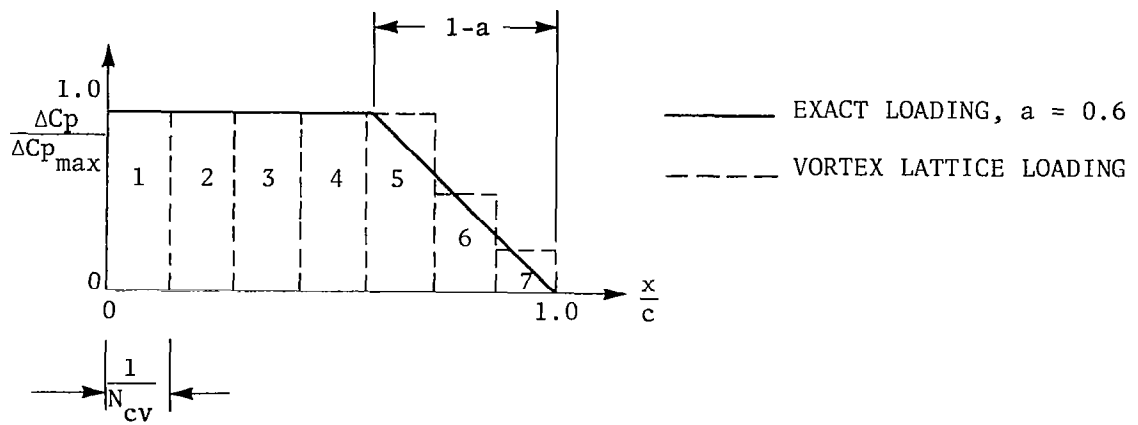


Figure 2. Example of vortex lattice representation of chordwise loading function; seven chordwise vortices.

$$C_{B,i} = \frac{2}{Sb} \left\{ (y_i \cos \phi_i + z_i \sin \phi_i) \left(2s_i \frac{\Gamma_o(-s_i)}{U} \right. \right. \\ \left. \left. + \frac{4}{3} s_i^2 \frac{\gamma_i}{U} + \frac{2}{3} s_i^2 \frac{\gamma_{i+1}}{U} \right) + \frac{1}{3} s_i^3 \left(\frac{\gamma_{i+1}}{U} + \frac{\gamma_i}{U} \right) \right\} \quad (18)$$

Thus, the total wing root bending moment coefficient (refs. 1, 2, 3) is

$$C_B = \frac{-2}{Sb} \sum_{i=1}^N \left\{ (y_i \cos \phi_i + z_i \sin \phi_i) \left(2s_i \frac{\Gamma_o(-s_i)}{U} \right. \right. \\ \left. \left. + \frac{4}{3} s_i^2 \frac{\gamma_i}{U} + \frac{2}{3} s_i^2 \frac{\gamma_{i+1}}{U} \right) + \frac{1}{3} s_i^3 \left(\frac{\gamma_{i+1}}{U} + \frac{\gamma_i}{U} \right) \right\} \quad (19)$$

It must be noted that the computer program currently can impose a bending moment constraint only for an isolated wing.

INDUCED DRAG MINIMIZATION METHOD

The minimum induced drag, subject to constraints on C_L and either C_m or C_B is obtained using Lagrange multipliers; thus the function to be minimized becomes of the form

$$C_D + \lambda_1 \left(\sum_{i=1}^N C_{L,i} \frac{\gamma_i}{U} - C_L \right) + \lambda_2 \left(\sum_{i=1}^N C_{m,i} \frac{\gamma_i}{U} - 0 \right) \\ + \lambda_3 \left(\sum_{i=1}^N C_{B,i} \frac{\gamma_i}{U} - C_B \right) \quad (20)$$

The $C_{L,i}$, $C_{m,i}$, and $C_{B,i}$ denote derivatives of the respective coefficients with respect to (γ_i/U) which are (refs. 1-3):

$$C_{L,i} = \frac{8}{S} \left[\frac{2}{3} \cos \phi_i s_i^2 + \frac{1}{3} \cos \phi_{i-1} s_{i-1}^2 \right. \\ \left. + \sum_{m=1}^{N-i} \cos \phi_{m+i} s_{m+i} (s_i + s_{i-1}) \right] \quad (21)$$

$$\begin{aligned}
C_{m,i} = & \frac{4}{S \bar{c}} \left[\frac{1}{3} \cos \phi_i s_i^2 (XM_i + XP_i) \right. \\
& + \frac{1}{3} \cos \phi_{i-1} s_{i-1}^2 (XM_{i-1} + 2XP_{i-1}) \\
& + \frac{8}{S \bar{c}} \left[s_i \cos \phi_i XP_i s_{i-1} + (s_i + s_{i-1}) \right. \\
& \left. \left. \cdot \sum_{j=i+1}^{N-1} s_j \cos \phi_j XP_j \right] \right] \quad (22)
\end{aligned}$$

$$\begin{aligned}
C_{B,i} = & \frac{-4}{3Sb} \left[s_i^3 + s_{i-1}^3 + 4s_i^2 (y_i \cos \phi_i + z_i \sin \phi_i) \right. \\
& + 2s_{i-1}^2 (y_{i-1} \cos \phi_{i-1} + z_{i-1} \sin \phi_{i-1}) \\
& + 2s_i s_{i-1} (y_i \cos \phi_i + z_i \sin \phi_i) \\
& \left. + 2(s_i + s_{i-1}) \sum_{j=i+1}^N s_j (y_j \cos \phi_j + z_j \sin \phi_j) \right] \quad (23)
\end{aligned}$$

The total induced drag is written as

$$C_D = 2 \sum_{i=1}^N \sum_{j=1}^N C_{D,ij} = \left(\frac{Y}{U} \right)^T [A_{ij}] \left(\frac{Y}{U} \right) \quad (24)$$

where explicit expressions for elements of $[A]$ are given in references 1 to 3 and 5. A system of $N + 2$ linear equations are written for the unknown λ_i values, λ_1 , and either λ_2 or λ_3 . For a trimmed configuration these equations are

$$\sum_{j=1}^N (A_{ij} + A_{ji}) \frac{Y_j}{U} + \lambda_1 C_{L,i} + \lambda_2 C_{m,i} = 0, \quad i = 1, \dots, N \quad (25)$$

while the remaining equations are

$$\sum_{i=1}^N C_{L,i} \frac{Y_i}{U} - C_L = 0 \quad (26)$$

$$\sum_{i=1}^N C_{m,i} \frac{\gamma_i}{U} = 0 \quad (27)$$

For a single planform subject to a constraint on C_B , equation (27) is replaced by

$$\sum_{i=1}^N C_{B,i} \frac{\gamma_i}{U} - C_B = 0 \quad (28)$$

As discussed in references 1 and 2, special treatment of these equations is necessary at the tip of each wing and in the summations containing $\Gamma_0(-s_i)$ in equations (2), (13), and (19).

MEAN CAMBER DETERMINATION

Once the far-field optimum wake vortex sheet strength distribution is obtained from equations (25) to (28), the bound circulation at the wing trailing edge is obtained from equation (10). This piecewise quadratic Γ/U distribution is linearly interpolated to obtain the chordwise sums of the Γ/U values for the near-field vortex lattice. The assumed chordwise loading value then determines the strengths of the individual horseshoe vortices. As in reference 4, this circulation distribution is related to the local surface slope by

$$\left(\frac{\partial z}{\partial x} \right) = [A] \left(\frac{\Gamma}{U} \right) \quad (29)$$

where the matrix $[A]$ is the near-field vortex lattice aerodynamic influence coefficient matrix, as given in reference 4.

Once the surface slope array at the vortex lattice control points $\left(\frac{\partial z}{\partial x} \right)$ is obtained from equation (29), chordwise integration from the trailing edge forward is performed to obtain the nondimensional camber surface distribution z/c , which contains the combined effects of incidence, twist, and camber. This integration process uses a cubic spline interpolation between near-field slope values (ref. 4). Further details of the integration procedure and discussion of its accuracy may be found in reference 4.

SAMPLE RESULTS

In this section, results for four sample configurations are discussed (see refs. 1-3 and 8 for presentation of design results for other geometries). In most instances the current design has been compared to results obtained for the same planform using the earlier design code of reference 4. Appendix B contains an example of the computer program input data and the resultant output for one of the examples presented in the current report.

Figure 3 presents optimum induced drag coefficient values for a close-coupled wing canard configuration, as shown at the top of the figure. This planform is identical to that shown as an example, first in reference 4, and later in references 1 to 3. Solutions are shown for various vertical separations z_c , between wing and canard, and various trim points Δx . Initial results from references 1 to 3 showed that the current code (solid line) consistently yields a higher, more accurate, induced drag coefficient compared to values obtained from the original design code of reference 4 (dashed line). New results in figure 3 show that for small separations between canard and wing, $|z_c/(b/2)| < 0.169$, there is a smooth transition in the variation of C_D with the shifted pitching moment center, $\Delta x/(b/2)$, from a curve with a definite minimum C_D value at large vertical separations to a relatively straight curve at zero separation between wing and canard. Although not shown, camber surface results for the two codes (present and ref. 4) are nearly identical for this planar configuration.

As a second example, figure 4 shows the geometry of a high aspect ratio wing-strut configuration for a high-altitude reconnaissance airplane described in reference 9. Optimum spanload results are shown in figure 5 for both design codes, while wing and strut camber surface results appear in figures 6 and 7, respectively. All results shown are for a shifted moment trim point, $\Delta x = -0.9137$, at the natural trim point for the configuration. The original code (ref. 4) shows large differences in spanload and camber surfaces depending on the number of wake unknowns. Major differences between the present design and that obtained using the earlier code of reference 4 occur for this configuration largely in the wing-strut junction on the wing, and over the entire strut span. This

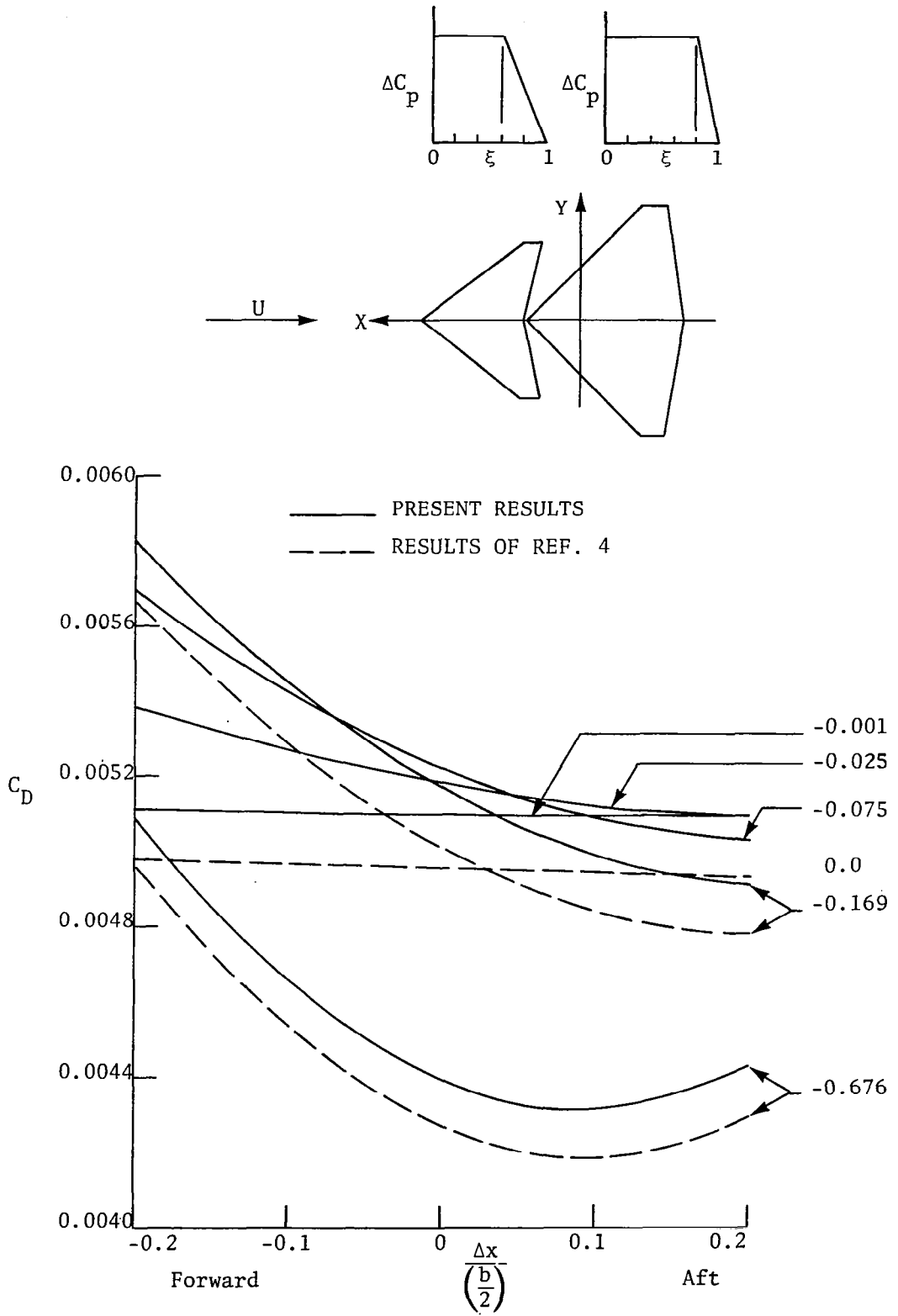


Figure 3. Optimum induced drag coefficient for a wing-canard configuration for a range of moment trim points and vertical separations for $C_L = 0.2$, $M = 0.3$.

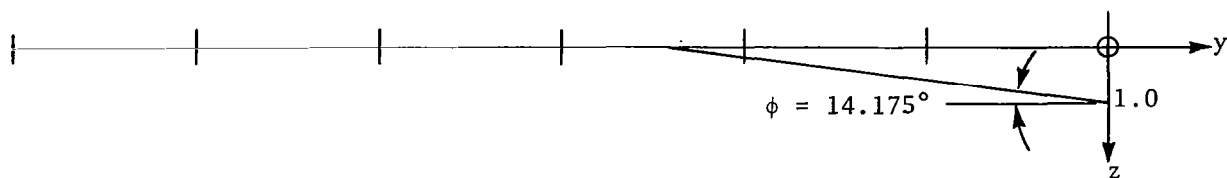
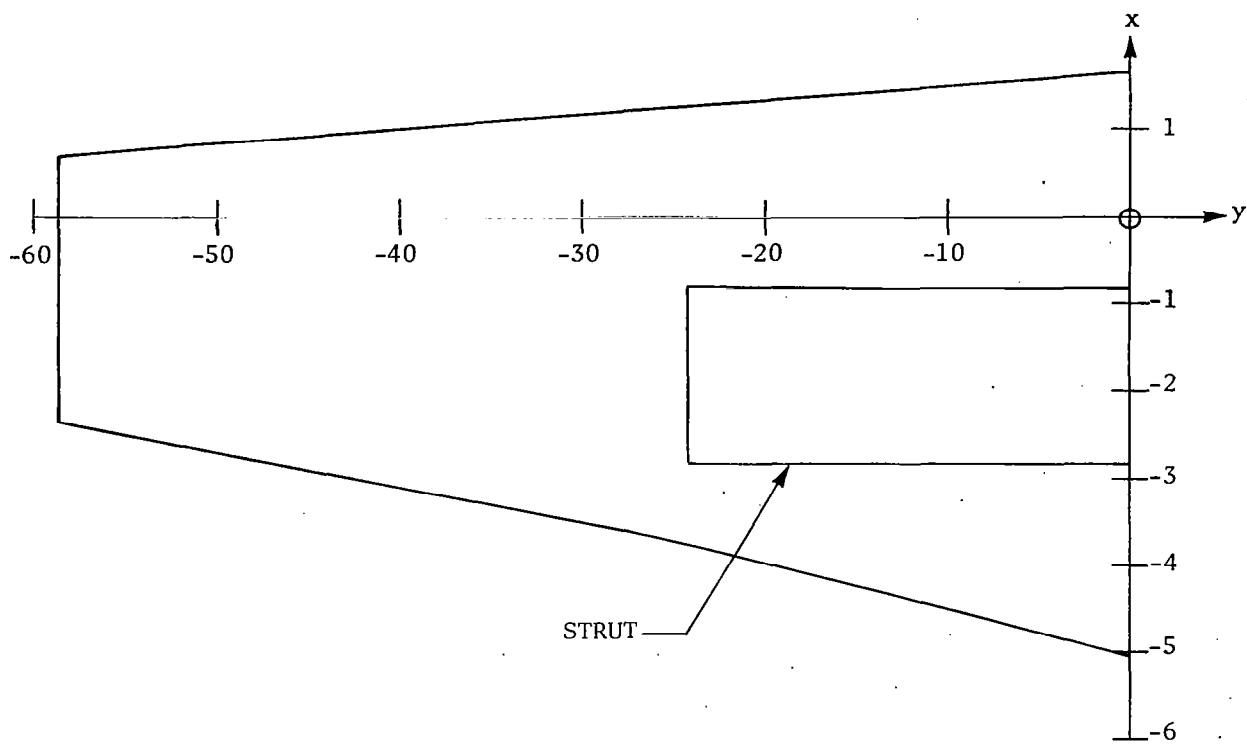


Figure 4. Wing-strut configuration geometry (note stretched x -axis).

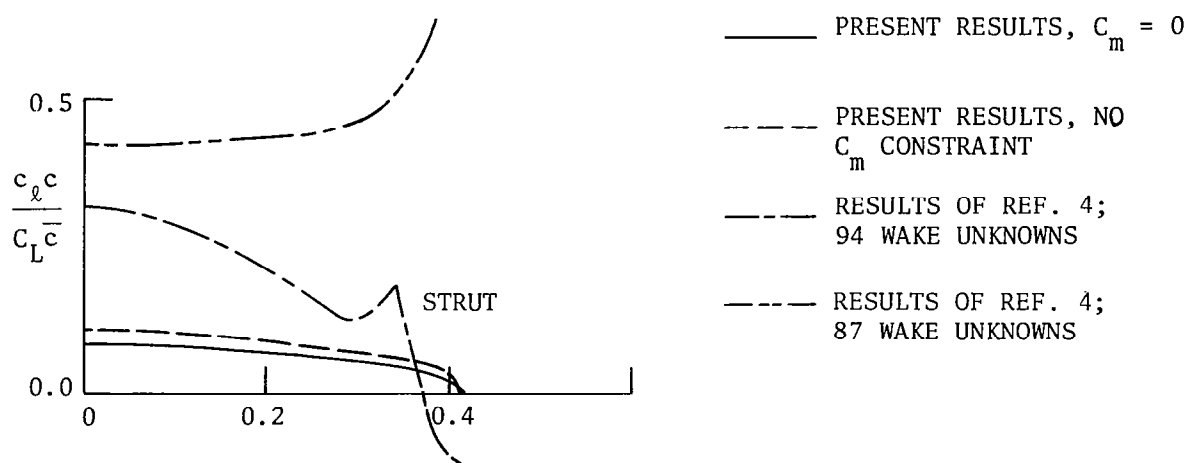
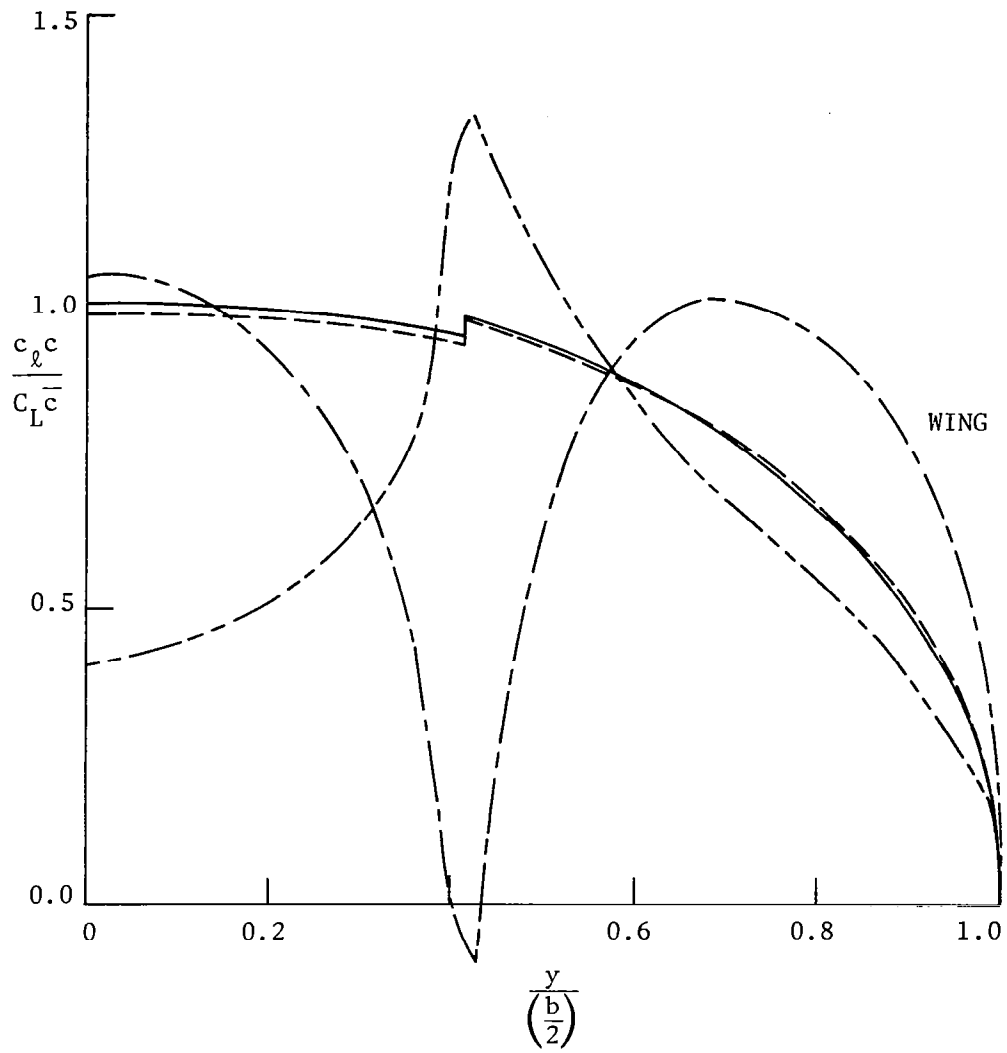


Figure 5. Optimal spanload results for a wing-strut configuration at $C_L = 0.7$; $M = 0.65$, $a = 0.8$, 14×18 vortex lattice, no gap at junction, $\Delta x = -0.9137$.

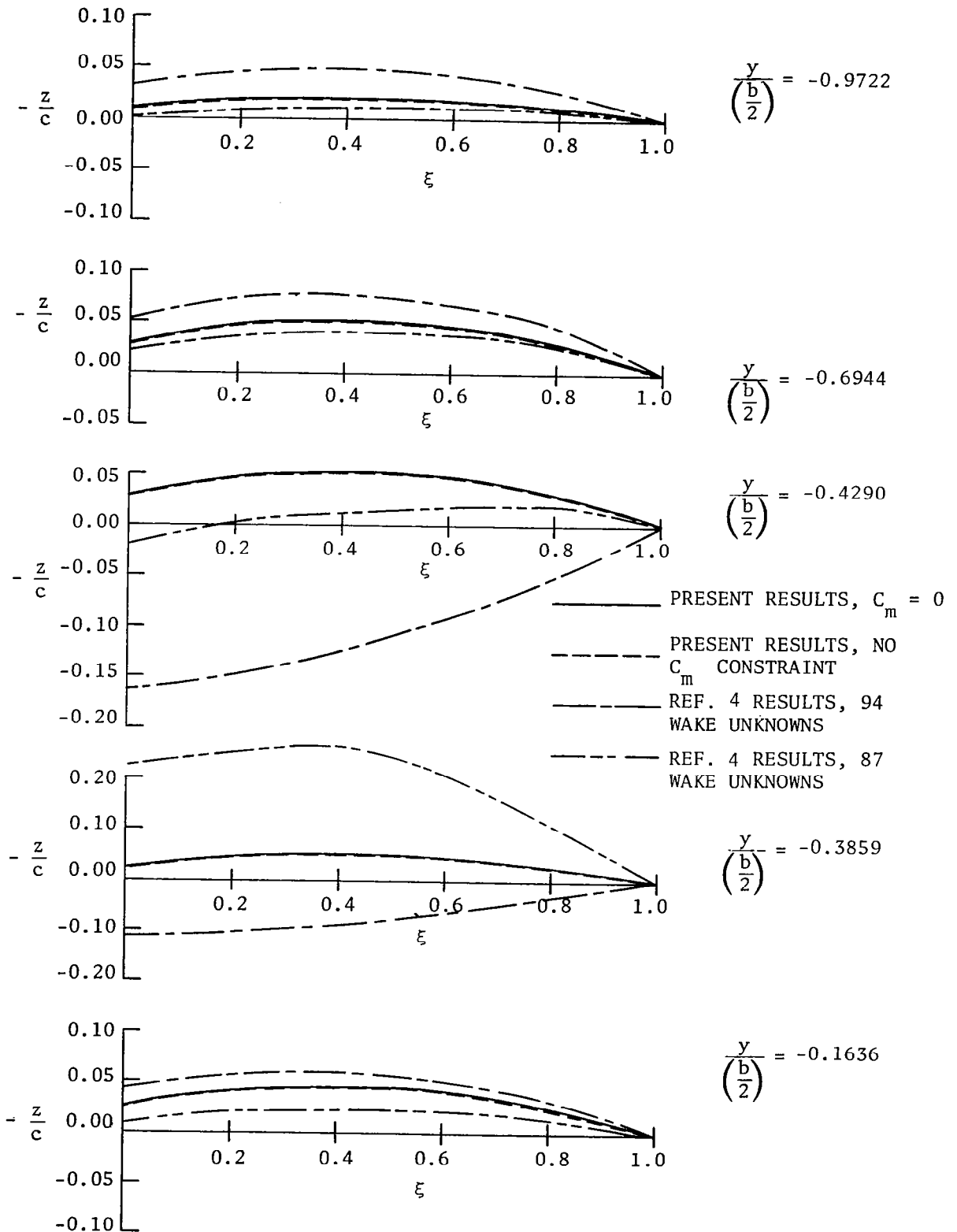


Figure 6. Optimal camber surface results for the wing of a wing-strut configuration at $C_L = 0.7$, $M = 0.65$, $a = 0.8$, 14×18 vortex lattice, no gap at junction, $\Delta x = -0.9137$.

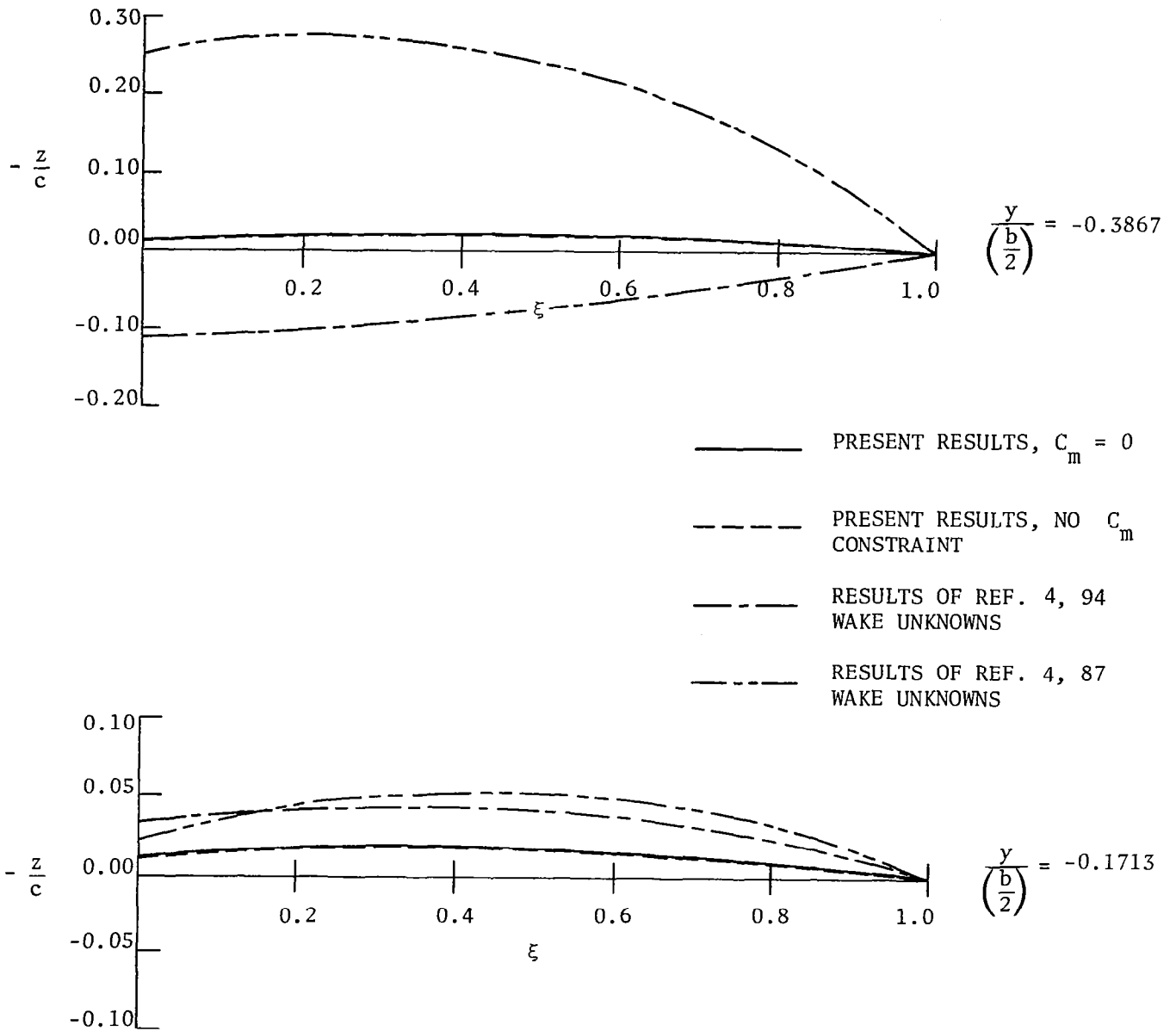


Figure 7. Optimal camber surface results for the strut of a wing-strut configuration at $C_L = 0.7$, $M = 0.65$, $a = 0.8$, 14×18 vortex lattice, no gap at junction, $\Delta x = -0.9137$.

configuration appears to be one for which the results of reference 5 are not entirely satisfactory.

Two additional 2-planform configurations are summarized in figures 8 to 11. Figures 8 and 9 show the optimal spanload and camber surface results, respectively, for a high aspect ratio joined wing (ref. 10), while figures 10 and 11 display similar results for the basic joined wing fitted with upper and lower winglets. The respective planforms are shown in figures 8 and 10. Optimal induced drag values for the joined wing are $C_D = 0.007386$ for the present results and $C_D = 0.007338$ for the code of reference 4. Differences between results of reference 4 and the current code are confined to the vicinity of the wing tips and on the winglets. A similar behavior was noted for a single transport-type wing fitted with winglets in references 1 to 3 and 8, where significant design differences were noted only on the winglet.

CONCLUSIONS

A subsonic, linear lifting surface, wing design code using a higher order panel method far-field wake model and a vortex lattice near-field model has been developed which can handle one or two planforms. A summary of the theoretical development of the far-field wake model has been given. Several sample results for a computer code which implements this wake model have been shown; these results differ from those for a code using a discrete vortex wake model in the vicinity of a wingtip, a change in planform dihedral, or near a point of intersection of the planform wakes. The spanloads and camber surface results obtained using the present code are believed to be superior to those of the original code for such complex configurations. Finally, use of the current program has been documented in a series of appendixes.

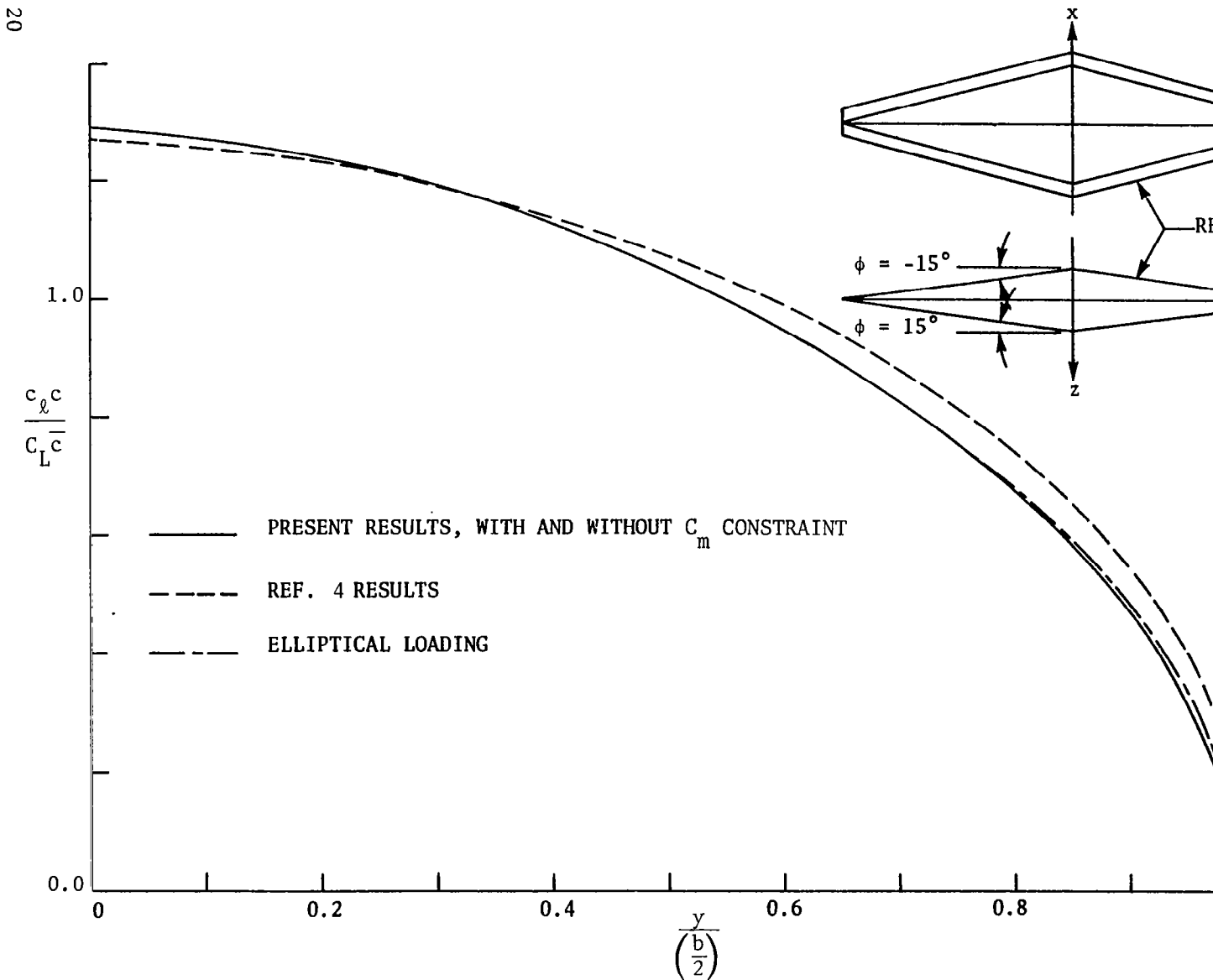


Figure 8. Optimal spanload results for a joined wing configuration of aspect for $C_L = 0.5$, $M = 0.8$, $a = 1.0$, front or rear wing, 14×14 vortex

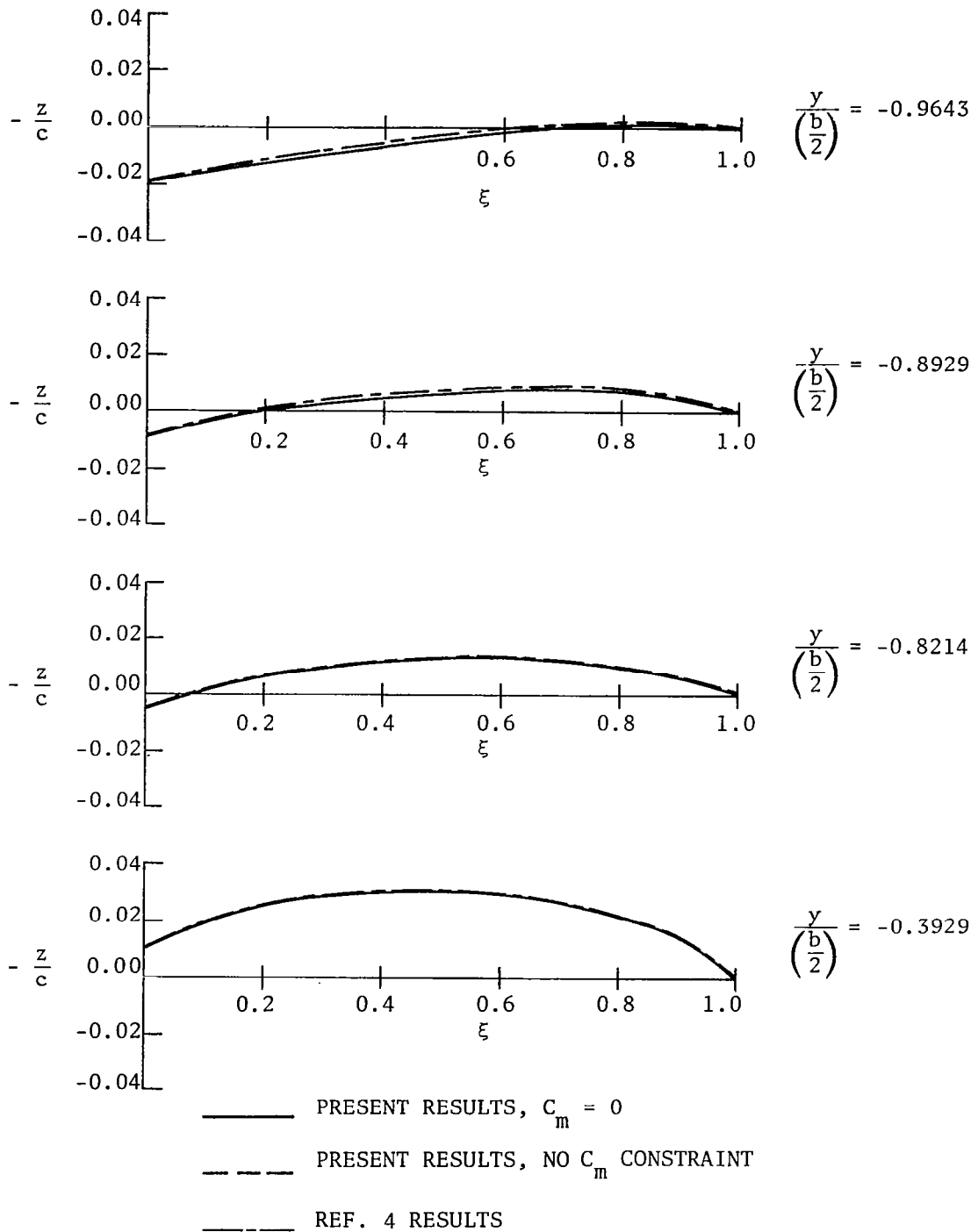


Figure 9(a). Optimal camber surface results for a joined wing configuration of aspect ratio 10.0 for $C_L = 0.5$, $M = 0.8$, $a = 1.0$, front wing, 14×14 vortex lattice.

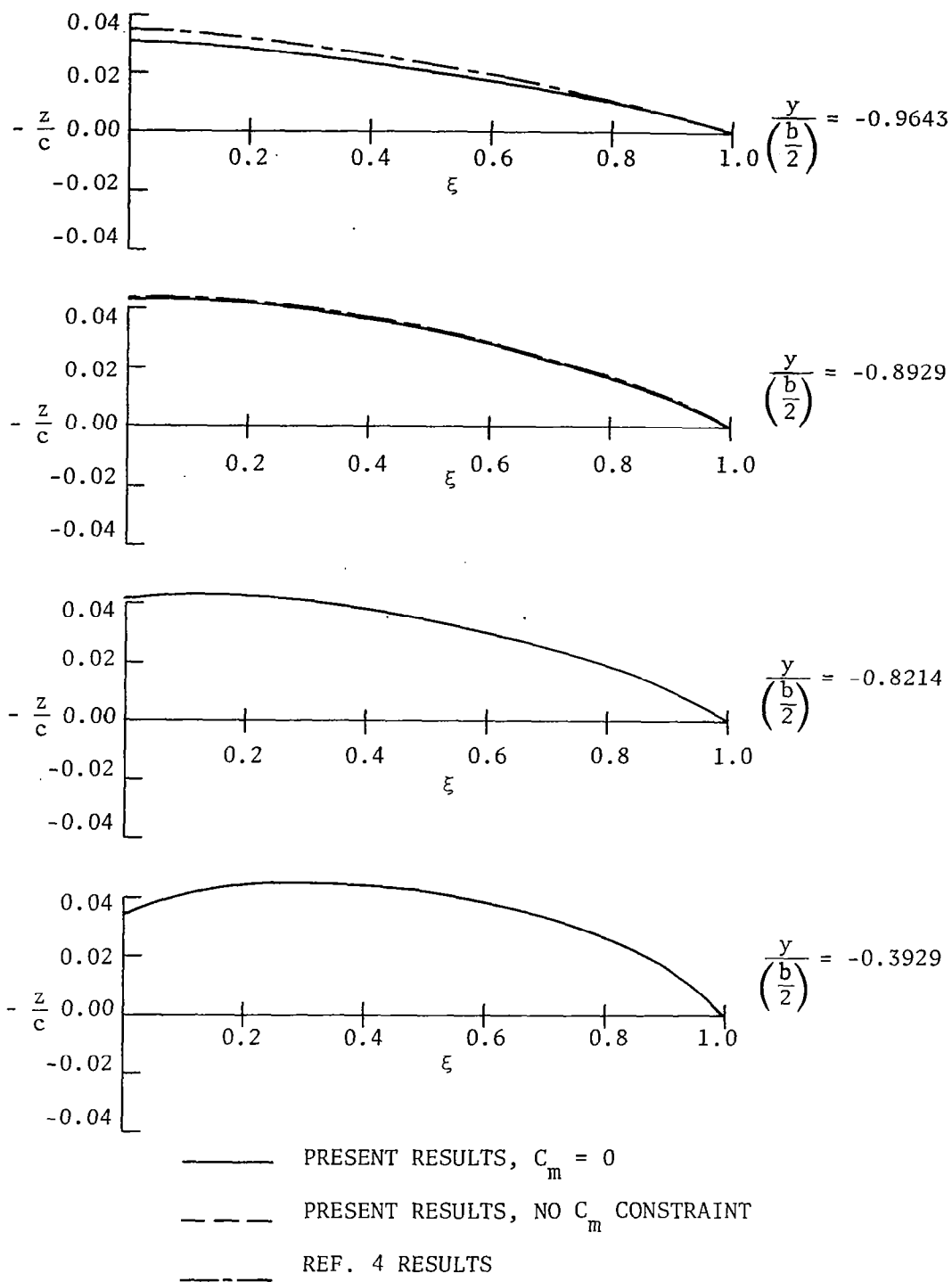


Figure 9(b). Optimal camber surface results for a joined wing configuration of aspect ratio 10.0 for $C_L = 0.5$, $M = 0.8$, $a = 1.0$, rear wing, 14×14 vortex lattice.

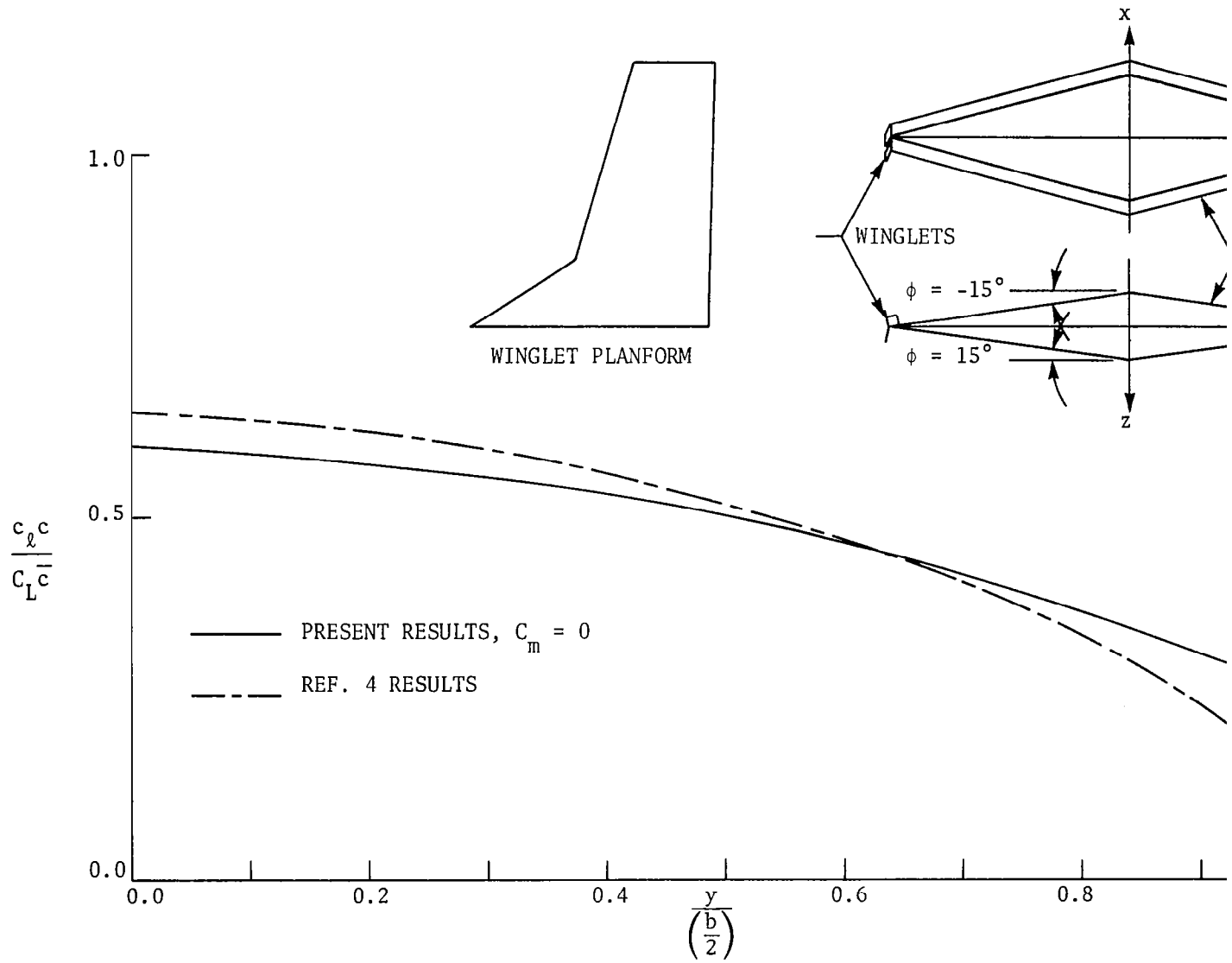


Figure 10. Optimal spanload results for a joined wing configuration with upper winglets for $C_L = 0.3$, $M = 0.75$, $a = 1.0$, front or rear planform, 14 vortex lattice.

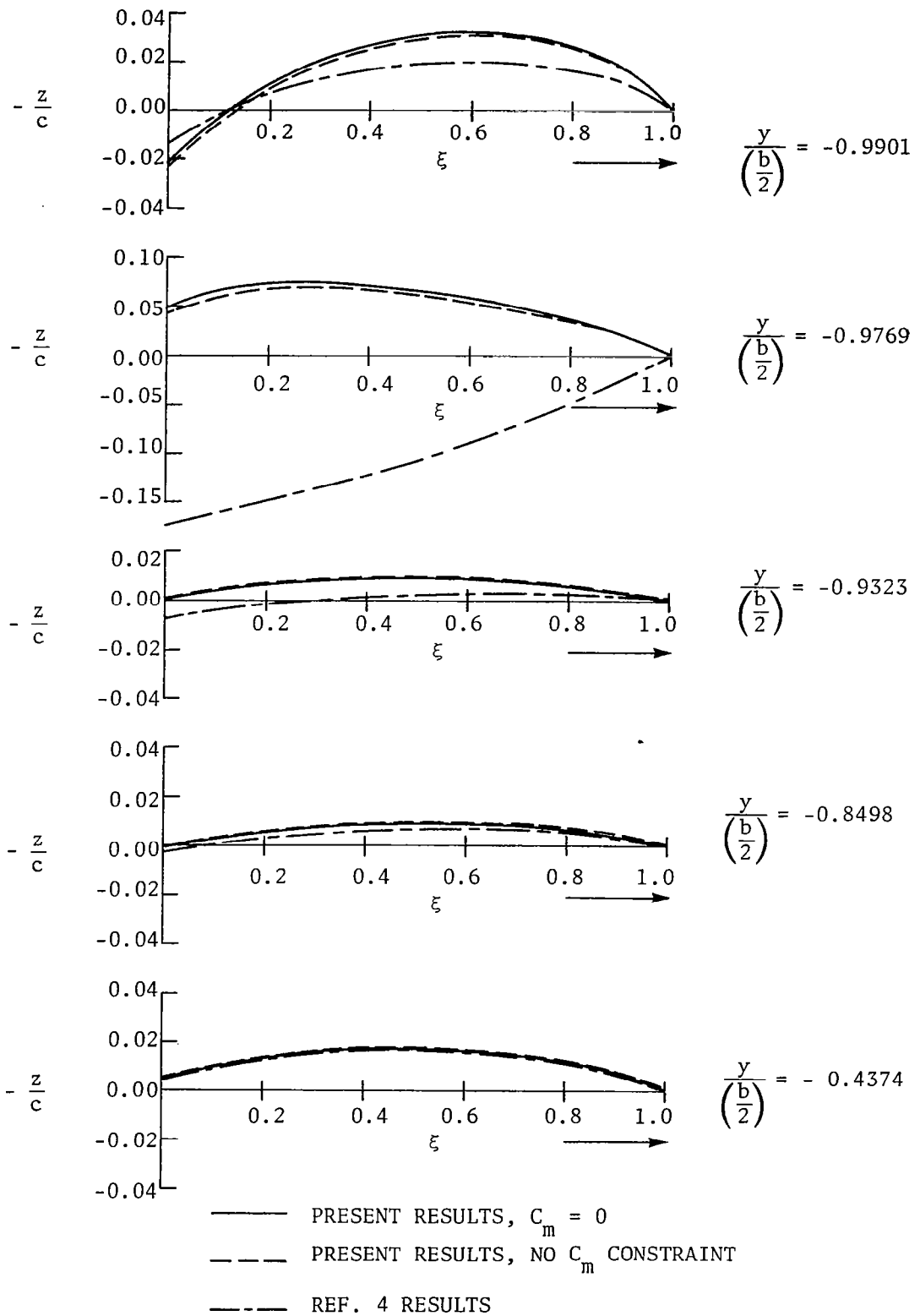


Figure 11(a). Optimal camber surface results for a jointed wing configuration with upper and lower winglets for $C_L = 0.3$, $M = 0.8$, $a = 1.0$, front planform, 14×14 vortex lattice.

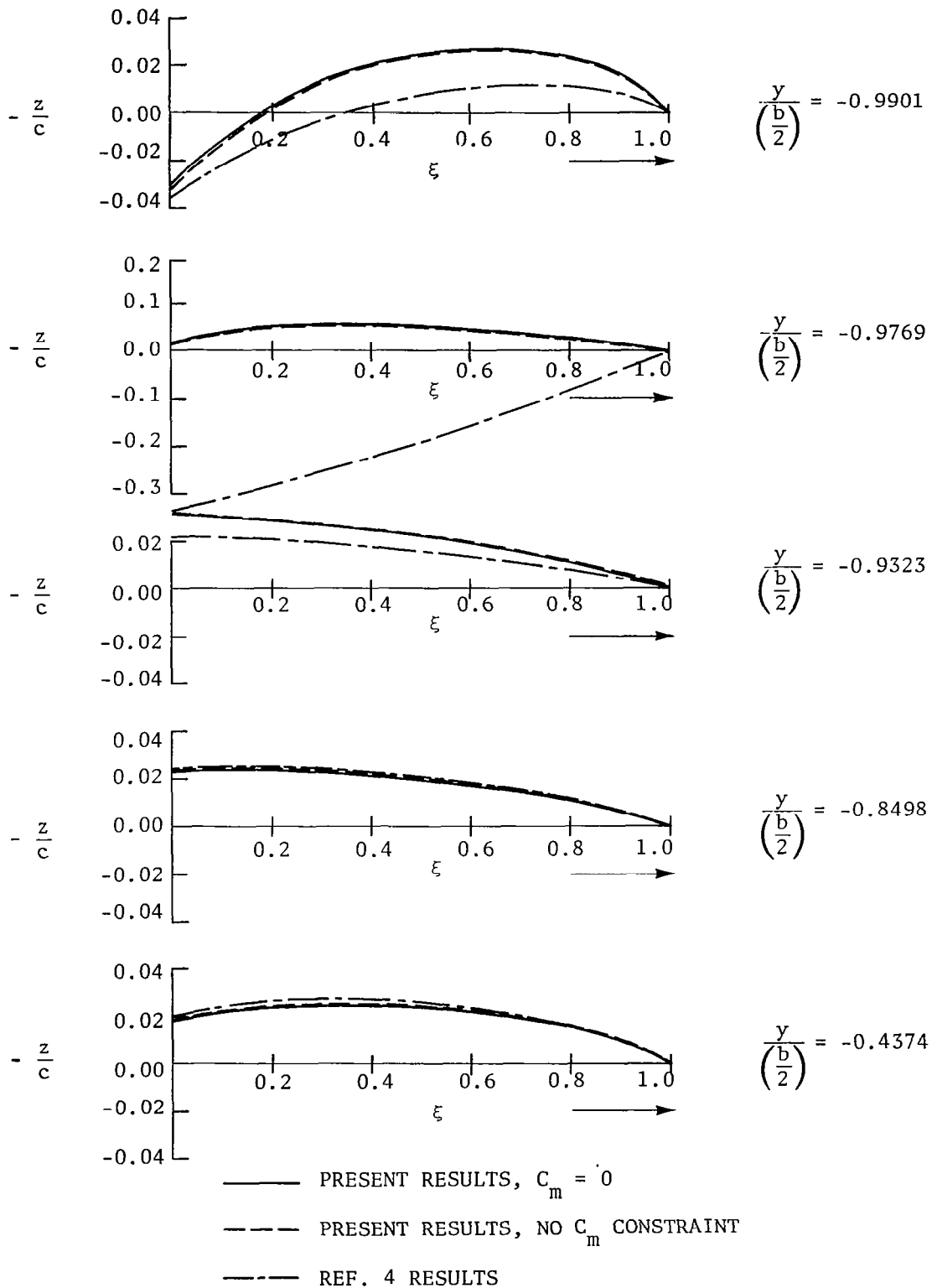
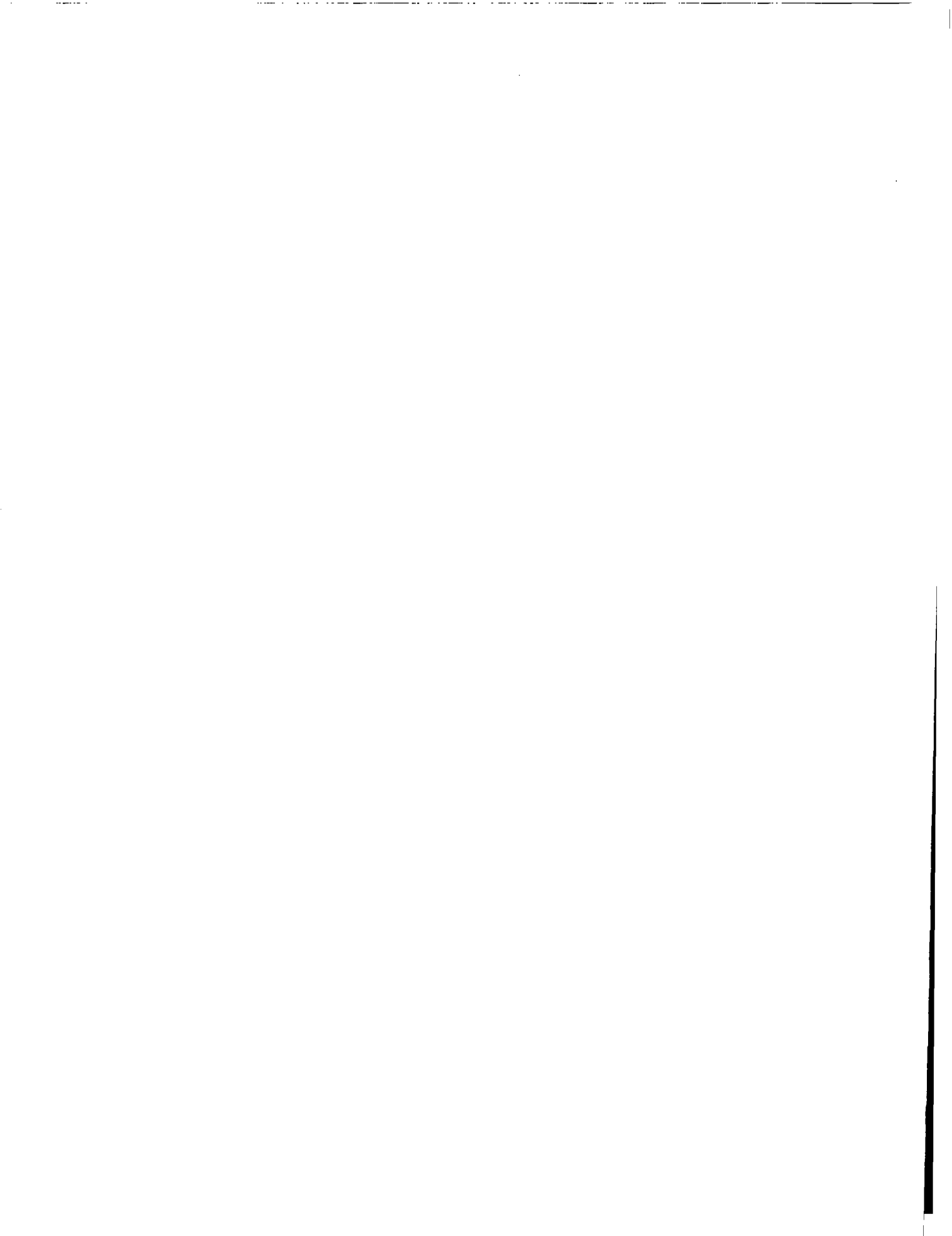


Figure 11(b). Optimal camber surface results for a joined wing configuration with upper and lower winglets for $C_L = 0.3$, $M = 0.8$, $a = 1.0$, rear planform, 14×14 vortex lattice.



APPENDIX A

COMPUTER PROGRAM DESCRIPTION AND LIMITATIONS

This appendix briefly describes the organization of the computer program written to implement the theory described in the main body of the report: known program limitations are also discussed. Input and output data are described in Appendix B and Appendix C, respectively, while a sample input deck and output are given in Appendix D. A complete listing of the program appears in Appendix E.

This computer program has been written in FORTRAN IV and is currently operational on a Cyber 173 computer at the NASA/Langley Research Center (LaRC). This computer uses approximately 15 decimal digits in all computations. As a result, some modifications to the code may be necessary to ensure correct execution on a computer system which uses a significantly different number of decimal digits. Specifically, tolerances set in the program in subroutines SNTAN and LOGS and in programs GEOMETRY and ZOCDETM may have to be changed. Further, double precision arithmetic in program WINGAL through subroutine LOGS will be required for machines using eight decimal digits. This would entail adding implicit double precision (A-H, O-Z) statements in the main programs and all subroutines, as well as using double precision for all special functions such as DCOS, DSIN, DLOG, DATAN, DATAN2, DSQRT, DABS, DMIN1, and DMAX1. Finally, some variable names should be changed in subroutines CCAL and CONCAL to be consistent with the implicit double precision statements. Use of double precision arithmetic seems to be of particular importance in the far-field drag minimization section of the code (program CIRCUL2).

The computer program consists of two separate job steps: First, program GEOMETRY is compiled and executed, and vortex lattice geometry results are written on a disk file designated TAPE25. Program GEOMETRY is nearly identical to the first portion of the program described in reference 4. It is in this program that all configuration data are read from the input file. This program uses 51000 octal storage locations. Once the geometry has been defined and stored on disk, a second program written using three overlays is compiled. The zero overlay consists of a controlling program WINGAL, and interpolation and linear equation solver subroutines. WINGAL calls overlay 1 (program CIRCUL2) where the far-field drag minimization is performed followed by a call to overlay 2 (program

ZOCDETM) to determine the optimum mean camber surface. The program CIRCUL2 and subroutines GAMCAL, DRACAL, CCAL, CONCAL, SNTAN, and LOGS are similar in many respects to the direct optimization program described in reference 7. However, the earlier program was not written to allow solution by direct optimization for the minimum drag for the two planform case. To allow the inclusion of constraints on pitching moment or wing root bending moment, as described in the main body of this report, required the direct optimization method implemented in CIRCUL2. The program ZOCDETM uses circulation strengths computed in CIRCUL2 to determine vortex lattice control point slopes, from which the optimal camber surfaces are determined by integration, using a cubic spline curve fit of the slopes between control points. This portion of the code also is essentially unchanged from that of reference 4, with the exception of additional output data, as discussed in Appendix C. (See reference 4 for some discussion of the accuracy of this integration process.)

The known limitations of the program are now described. First, the program will not correctly execute with a wing dihedral value of exactly 90° . Instead, it is necessary to use a dihedral near 90° (say $\phi \approx 87-88^\circ$) to approximate the effect of an endplate on the design. This same limitation also exists in both the original design code (ref. 4), and in the stand alone drag minimization code (ref. 7).

Next, the current limitations on the number of unknowns are described. The total (both planforms) number of horseshoe vortices must be no greater than 400, while the total number of far-field wake panels must be no more than 50. This number of unknowns leads to accuracy comparable to that obtained using 200 to 250 discrete vortex unknowns (see ref. 5). The user must also determine the chordwise number of horseshoe vortices and the spanwise numbers of both horseshoe vortices and wake panels which yield the best solution. Reference 4 discusses the recommended near-field lattice arrangement. The wake paneling is automatically done using a cosine size distribution, but the user must determine how many wake panels to assign to each planform and to each spanwise portion of a wing having constant ϕ . (See Appendix B for more details of input data preparation.)

Third, the code currently uses NASA/LARC system subroutines such as INFOPLT for plotting which are not generally available outside the NASA computing system. Hence, plotting of the optimal camber surfaces or airfoils is not generally available. (See Appendix B for a description of the available plotting options.)

Finally, as discussed in Appendix A of reference 7, for configurations with two planforms, or for configurations having wake shapes comprised of smoothly curved surfaces which are to be approximated by a series of flat wake panels, the following restrictions hold. The wakes cannot cross one another unless such wake crossing points occur at (to machine accuracy) edges of wake panels. The code automatically searches for such wake breakpoints having equal span (y) stations with z -coordinates within 10^{-4} of one another. The z -coordinate of the wake on the second planform is then adjusted to be equal to the corresponding z -coordinate on the first planform to insure exact intersection. However, other logic in program GEOMETRY necessitates that there be a slight change in planform dihedral on a planform across such wake intersections, as for example in the wing-strut-configuration discussed in this report. (See Appendix B for further discussion of preparation of input data.) If there are intersections of wakes away from wake panel edges, the statement "80 ENTERED" appears on the program output file; design results for such computer runs are of questionable accuracy and should not be utilized. This is because there is an apparent midrange singularity which occurs in the far-field influence coefficients which is not currently dealt with adequately (ref. 7). It must also be mentioned that this singularity may occur for curved wakes, even when there are no physical wake crossings, whenever the projection of the plane containing one wake panel intersects another wake panel away from the edges of the panel. Such projection intersection points must be calculated to machine accuracy by the user, and input as planform breakpoints (see Appendix B), across which there is a slight change in planform dihedral.

APPENDIX B

INPUT DATA PREPARATION

Introduction

In this appendix instructions are given for the preparation of an input deck to use the computer program listed in Appendix E. An example input deck and the resultant output are given in Appendix D. Almost all user-supplied input, with the exception of those cards dealing with the wake paneling, is identical to input required for the original design code (discrete wake) described in reference 4. Thus, much of what follows is identical to the instructions given in reference 4. The required input data are broken into three groups: groups one and two are identical to input for the code described in reference 4, while group three contains input for the higher order wake model.

Group One

First the planform(s) geometry and reference values are input. All coordinates and sweep angles should be for the left half of the wing planform (negative y). The axis system used is shown in the planform sketch of figure 3. Any consistent set of input units is acceptable; output will be in terms of the user-chosen input units. The x-axis is in the symmetry plane and points into the wind. The y-axis is positive pointing along the right wing, while the z-axis is positive downwards. All input cards in group one use a format of 8F10.6.

Data on the first card are for the five named variables below, supplied in the following order:

PLAN	number of planforms for the configuration; use either 1. or 2.; this sets the maximum value of the variable IT;
TOTAL	specify 1. for this field;
CREF	reference chord of the configuration; this chord is used to nondimensionalize the pitching moment terms and must be greater than zero;
SREF	reference area of the configuration; this area is used to nondimensionalize the lift, drag, pitching moment, and root bending moment terms and must be greater than zero; and

XLOCTN location of pitching moment reference point
 (trim point), if shifted from zero of coordinate
 system.

The data required to define each planform are next provided by a set of cards. The initial card in each set contains the following data, for planform IT:

AAN(IT) number of straight line segments used to define
 the left half of a wing planform excluding the
 root chord; a maximum of 24 line segments may
 be used;

XS(IT) x-location of the pivot for a variable sweep
 wing; use 0. for a fixed wing; the axis system
 used is shown in the inset to figure 3;

YS(IT) y-location of the pivot; use 0. for a fixed wing;
 and

RTCDHT(IT) vertical coordinate of the root chord of the
 particular planform being defined.

The rest of this data set to define a planform requires one data card for each straight line segment used to define the left half of the planform [variable AAN(IT)]. Note that, as discussed in Appendix A, if there are wake intersections it will be necessary to break a straight portion of a planform leading or trailing edge into two pieces by adding a planform breakpoint at the y-coordinate of the wake intersection. All data described below are required on all except the last card of this set; the last card uses only the first two variables in the following set:

XREG(I,IT) x-location of the Ith breakpoint; the first
 breakpoint is located at the intersection of
 the left wing leading edge with the root chord;
 the breakpoints are numbered in increasing
 order, for each intersection of lines, in a
 counterclockwise direction;

YREG(I,IT) y-location of the Ith breakpoint;

DIH(I,IT) dihedral angle (in degrees) in Y-Z plane of
 line from breakpoint I to breakpoint I+1,
 positive upward; along a streamwise line the
 dihedral angle is not defined, so use 0. for
 these lines; the dihedral angle must have the
 same sign and magnitude along the leading and
 trailing edges of a planform over the same
 spanwise extent; note also that there must be a

slight change in dihedral across a planform breakpoint corresponding to the intersection of wakes as discussed in Appendix A; and

AMCD

move code; this number indicates whether the line segment is on the movable panel of a variable-sweep wing; use 1. for a line which is fixed or 2. for a line which is movable.

Group Two

Two sections of data form the group two data. The first section is a single card which gives the details of the particular configuration for which the mean camber surface is to be found. This card requires a format of 5F5.1, 2F10.4. The second section is used to specify the fractional chord locations where the chord load changes from a constant to a linearly decreasing value. This card uses a format of 2F10.4.

Section one data are to be supplied in the following order:

CONFIG	arbitrary configuration number which may include up to four digits;
SCW	number of chordwise horseshoe vortices to be used to represent the wing; a maximum of 20 may be used; do not set equal to zero;
VIC	nominal number of spanwise rows at which chordwise rows of horseshoe vortices will be located; the variable VIC must not result in more than 50 chordwise rows of vortices to be used by the program to describe the left half of the configuration; in addition, the product of SCW and SSW (the actual number of spanwise rows) must not exceed 400;
MACH	Mach number; this value should be less than the critical Mach number; if a value other zero is specified, the Prandtl-Glauert correction factor will be applied to all x-coordinates;
CLDES	design lift coefficient for the lifting system;
SA(1)	variable sweep angle of the first planform; specify leading edge sweep angle (in degrees) for the first movable line adjacent to the fixed portion of the planform; for a fixed planform this quantity may be omitted; and

SA(2) variable sweep angle for the second planform.

Section two data consist of two quantities:

XCFW fractional chord location where the chord load changes from a constant value to a linearly varying value toward zero at the trailing edge of the first planform; this is the same as the symbol a used in the body of this report;

XCFT fractional chord location where the chord load changes from a constant value to a linearly varying value, decreasing to zero at the trailing edge of the second planform; if only one planform is present, the variable XCFT should be omitted from the input data.

Group Three

Two sections of data form the group three data. The first section sets various control flags to define what constraints are desired, to specify whether thickness data is to be used to obtain airfoil coordinates, and to control various plot and card punch options. The second section determines the wake panel spacing and defines the desired bending moment coefficient or thickness distribution, if required. Both sections of data are in 10F5.0 format, except for the thickness data, which is in 6F10.0 format.

Section one data consists of a single card; values are to be supplied in the following order:

FJFLAG flag to set the type of constraints to be imposed on the minimum drag design, as discussed in the theoretical development section of this report; the following values may be chosen:

0. the configuration is to be constrained only as to the total lift generated;
1. in addition to the constraint as to the total lift, the configuration is to be trimmed;
2. in addition to the constraint as to the total lift, the configuration is to have a specified wing root bending moment coefficient, as input in section two; this option is available for a single planform only; and

FJCTL flag to determine whether or not thickness data is to be input in section two, and to determine which plotting option is to be used; the following values may be specified:

0. no thickness data is to be specified; no plotting is to be performed;
1. no thickness data is to be specified; optimal chordwise mean line results at the centers of each chordwise row of horseshoe vortices will be plotted using NASA/LARC computer system subroutine INFOPLT;
2. thickness data is to be specified; optimal airfoil results obtained as the addition of the optimal mean camber surface results plus or minus the specified thickness distribution will be plotted using NASA/LARC computer system subroutine INFOPLT.

FSLP flag to determine whether or not a deck of optimal design control point slopes is to be punched; use 1. here to obtain a deck or 0. if no deck is desired.

Section two data determines the wake panel spacing for each planform, as well as determining the wing root bending moment coefficient and thickness distribution, if required. The initial card contains the following data for planform IT:

BRK(IT) number of breakpoints for the wake of planform IT; equal to number of flat portions of the wake of planform IT plus one; and

TOT(IT) total number of wake panels for the wake of planform IT; this value cannot exceed 50; for configurations having 2 planforms, the sum of TOT(IT) values for both planforms cannot exceed 50.

The second card determines the distribution of the TOT(IT) wake panels among the BRK(IT)-1 flat portions of the wake of planform IT; it consists of BRK(IT)-1 values; for planform IT:

SEGG(I) number of cosine-spaced wake panels on Ith flat portion of wake of planform IT; first value specified will be the number of wake panels on the inboard portion of the wake; the sum of all SEGG(I) values on planform IT must equal TOT(IT).

The above data must be specified separately for both planforms for a two-planform configuration. Next, if FJFLAG=2., a single card follows to determine the required wing root bending moment:

CRBM desired ratio of the design wing root bending moment coefficient, divided by the wing root bending moment coefficient of an elliptically loaded planar wing having the same span and lift coefficient as the designed configuration.

Finally, if FJCTL=2., thickness data are to be specified beginning with a single card to fix the number of thickness values:

FNZS number of specified percent chord and thickness values; the value specified must not exceed 50.

Following the definition of FNZS are a series of cards to specify, first, the fractional chord stations where thickness data are to be given, followed by the fractional thickness values; only a single thickness distribution, valid for both planforms, may be specified. Thus, the first set of cards contains FNZS values, in 6F10.0 format:

PCTX(I) fractional chordwise locations at which thickness data are specified; values must be specified in increasing order and must begin with 0.0 and end with 1.0.

A set of FNZS thickness data values are given as the last set of cards:

PCTZ(I) fractional airfoil thickness at corresponding PCTX(I) chord station.

A sample input deck, as well as the resulting output appears in Appendix D. It is recommended that a minimum of 10 spanwise and 10 chordwise rows of horseshoe vortices be used (ref. 4). Use of at least 25 wake panels is also recommended. Further, some sensitivity studies as to the effects of vortex lattice arrangement and wake panel spacing are advisable (see refs. 4 and 5 for further discussion).

APPENDIX C

OUTPUT DATA DESCRIPTION

Introduction

The printed results of this computer program appear in three sections: geometry data, aerodynamic data, and local elevation data. The geometry data follows the output format of the program of reference 4, while portions of the aerodynamic and local elevation data differ in format from those of reference 4.

Geometric and Aerodynamic Data

The geometry data are described in the order that they appear on the printout. The first group of data describes the planform(s), stating the number of straight line segments used to describe the planform perimeter(s), the root-chord height, and the pivot position, followed by the breakpoints, sweep and dihedral angles and move codes. These listed data are all input data except for the sweep angles.

The second group of data describes the particular planform for which the local elevation data are being computed. Included are the configuration number, the sweep position, a listing of the breakpoints of the wing planform (x, y, z) values, sweep and dihedral angles and move codes. These data are listed primarily for variable-sweep wings to provide a definition of the planform where the outer panel sweep differs from that of the reference planform. Also listed is information about the number of horseshoe vortices and the shift of the coordinate system origin, if any.

The third group of data describes the wake geometry and far-field optimum drag solution. The wake breakpoint coordinates are listed, followed by the numbers of wake panels on each flat wake segment. Next the individual wake panel center coordinates (y, z, ϕ) and wake panel semiwidth values are printed. Following the wake geometry data, the calculated induced velocities at the wake panel centers, followed by the optimal wake vortex sheet strength and bound circulation solution values and optimal induced drag are listed.

The fourth group of data presents a detailed description of the vortex lattice used to represent the configuration. These data are listed in eight columns, where each line describes one elemental horseshoe vortex. The following information is presented for each panel or horseshoe vortex:

X C/4	x-location of quarter-chord at midspan of horseshoe vortex
X 3C/4	x-location of three-quarter-chord at midspan of horseshoe vortex; this is the x-location of the control point
Y	y-location of the midspan of the horseshoe vortex
Z	z-location of the midspan of the horseshoe vortex
S	semiwidth of the horseshoe vortex
C/4 SWEEP ANGLE	sweep angle of the quarter-chord
DIHEDRAL ANGLE	dihedral angle of the elemental panel
GAMMA/U AT CLDES	Γ/U value at the design C_L

The fifth group of data lists the following configuration reference data:

REF. CHORD	reference chord
C AVERAGE	average chord; equal to true planform area divided by true span
TRUE AREA	true planform area
REF. AREA	reference area
B/2	largest true semispan of the planforms listed in the second group of geometry data
REF. AR	reference aspect ratio computed from reference planform area and true span
TRUE AR	true aspect ratio computed from true planform area and true span
MACH NUMBER	Mach number

The sixth group of data gives aerodynamic results:

A1	fractional chord location where chord load changes from a constant value to triangular on the first planform; this is the same as the symbol a used in the body of this paper
A2	fractional chord location where chord load changes from a constant value to triangular on the second planform; this is the same as the symbol a used in the body of this paper

CL*C	$c_{\ell}c$, span loading
CL DESIGN	C_{Ld} , design lift coefficient
CL COMPUTED	total C_L actually developed from the interpolated spanwise bound circulations
CM COMPUTED	total C_m actually developed from the interpolated spanwise bound circulations
CD V	C_D vortex drag coefficient based on the higher order far-field solution at C_{Ld}

Local Elevation Data

This section presents the optimal local elevation solutions at varying spanwise stations, for up to two planforms. An explanation of the variables listed follows:

Y	spanwise location
Y/B/2	$2y/b$, fractional spanwise location based on semi-span of larger planform
CHORD	physical chord at y , projected into wing reference plane
DZ/DX	slope of local elevation curves along the chord

These data are followed by the angle of attack of the local chord line with respect to the x-axis in the X-Z plane, followed by the following elevation data, for configurations where no thickness data have been specified:

X/C	fractional chordwise distance measured from the leading edge, positive aft
Z/C	z/c , local elevation normalized by the chord measured with respect to elevation of the local trailing edge, positive down
(Z/C) COS(DIH)	$z/c \cos(\phi)$, local elevation normalized by the chord times cosine of the local dihedral angle; equal to local normalized elevation with respect to wing reference plane, positive down
DELTA X	(x/c) (chord)
DELTA Z	(z/c) (chord)
(DLT Z) COS(DIH)	(z/c) (chord) $(\cos \phi)$

If thickness data have been specified, columns of the above data will also contain the following:

Z/C US COS(DIH)	upper surface local elevation normalized by the chord times cosine of the local dihedral angle; equal to local normalized wing upper surface coordinate with respect to wing reference plane, positive down
Z/C LS COS(DIH)	lower surface local elevation normalized by the chord times cosine of the local dihedral angle; equal to local normalized wing lower surface coordinate with respect to wing reference plane, positive down
Z US COS(DIH)	(z/c) (chord) (cos ϕ) upper surface
Z LS COS(DIH)	(z/c) (chord) (cos ϕ) lower surface

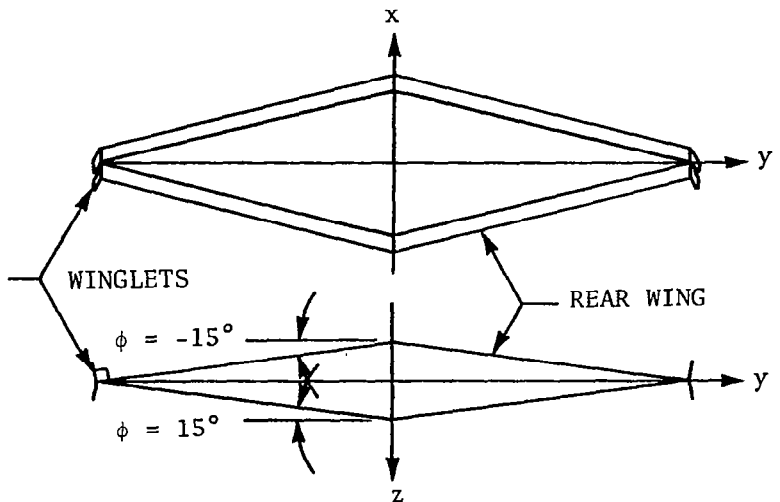
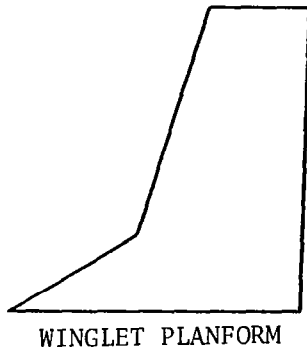
APPENDIX D

EXAMPLE OF INPUT AND OUTPUT DATA

Sample input and output data are presented for the joined wing with winglet configuration presented in figures 10 and 11 of this report. Input data and a sketch of the input planform and wake shape appear on page 46, while the output data begins on page 47.

INPUT DATA FOR JOINED WING FITTED WITH WINGLETS

2.	1.	2.	160.	0.
6.	0.	0.	5.3589839	
12.	0.	15.	1.	
2.	-20.	-75.	1.	
1.0551885	-20.13588	-75.	1.	
.3207539	-20.54352	0.	1.	
-.3292461	-20.54352	-75.	1.	
0.	-20.	15.	1.	
10.	0.			
6.	0.	0.	-5.3589839	
-10.	0.	-15.	1.	
0.	-20.	75.	1.	
-0.9448115	-20.13588	75.	1.	
-1.6792461	-20.54352	0.	1.	
-2.3292461	-20.54352	75.	1.	
-2.	-20.	-15.	1.	
-12.	0.			
2.	14.	13.	.75	.3
1.	1.			
0.	1.			
3	25			
15	10			
3	25			
15	10			



PROGRAM OUTPUT DATA FOR JOINED WING FITTED WITH WINGLETS

GEOMETRY DATA

FIRST REFERENCE PLANFORM HAS 6 CURVES

ROOT CHORD HEIGHT = 5.35898390 VARIABLE SWEEP PIVOT POSITION X(S) = 0.00000 Y(S) =

BREAK POINTS FOR THE REFERENCE PLANFORM

POINT	X REF	Y REF	SWEEP ANGLE	DIHEDRAL ANGLE	MOVE CODE
1	12.00000	0.00000	26.56505	15.00000	1
2	2.00000	-20.00000	81.81601	-75.00000	1
3	1.05519	-20.13588	60.96801	-75.00000	1
4	.32075	-20.54352	90.00000	0.00000	1
5	-.32925	-20.54352	31.20607	-75.00000	1
6	0.00000	-20.00000	26.56505	15.00000	1
7	10.00000	0.00000			

SECOND REFERENCE PLANFORM HAS 6 CURVES

ROOT CHORD HEIGHT = -5.35898390 VARIABLE SWEEP PIVOT POSITION X(S) = 0.00000 Y(S) =

BREAK POINTS FOR THE REFERENCE PLANFORM

POINT	X REF	Y REF	SWEEP ANGLE	DIHEDRAL ANGLE	MOVE CODE
1	-10.00000	0.00000	-26.56505	-15.00000	1
2	0.00000	-20.00000	81.81601	75.00000	1
3	-.94481	-20.13588	60.96801	75.00000	1
4	-1.67925	-20.54352	90.00000	0.00000	1
5	-2.32925	-20.54352	31.20607	75.00000	1
6	-2.00000	-20.00000	-26.56505	-15.00000	1
7	-12.00000	0.00000			

CONFIGURATION NO. 2.

CURVE 1 IS SWEEP 26.56505 DEGREES ON PLANFORM 1

CURVE 1 IS SWEEP -26.56505 DEGREES ON PLANFORM 2

BREAK POINTS FOR THIS CONFIGURATION

POINT	X	Y	Z	SWEEP ANGLE	DIHEDRAL ANGLE	MOVE CODE
1	12.00000	0.00000	5.35898	26.56505	15.00000	1
2	2.00000	-20.00000	.00000	81.81601	-75.00000	1
3	1.05519	-20.13588	.50711	60.96801	-75.00000	1
4	.32075	-20.54352	2.02844	90.00000	0.00000	1
5	-.32925	-20.54352	2.02844	31.20607	-75.00000	1
6	0.00000	-20.00000	.00000	26.56505	15.00000	1
7	10.00000	0.00000	5.35898			

SECOND PLANFORM BREAK POINTS

1	-10.00000	0.00000	-5.35898	-26.56505	-15.00000	1
2	0.00000	-20.00000	-.00000	81.81601	75.00000	1
3	-.94481	-20.13588	-.50711	60.96801	75.00000	1
4	-1.67925	-20.54352	-2.02844	90.00000	0.00000	1
5	-2.32925	-20.54352	-2.02844	31.20607	75.00000	1
6	-2.00000	-20.00000	-.00000	-26.56505	-15.00000	1
7	-12.00000	0.00000	-5.35898			

392 HORSESHOE VORTICES USED ON THE LEFT HALF OF THE CONFIGURATION

PLANFORM	TOTAL	SPANWISE
1	196	14
2	196	14

14. HORSESHOE VORTICES IN EACH CHORDWISE ROW

X SHIFT OF ORIGIN = 0.0000 UNITS

MINIMUM FIELD LENGTH = 63000

PLANFORM 1

WAKE GEOMETRY

Y	Z	PHI
0.00000	5.35898	15.00000
-20.00000	.00000	-75.00000
-20.54352	2.02844	0.00000

NO OF WAKE VORTICITY SEGMENTS = 25
WAKE VORTICITY SEGS ON WING SEGMENT NO 1= 15
WAKE VORTICITY SEGS ON WING SEGMENT NO 2= 10
TOTAL PLANFORM PERIPHERAL LENGTH= 22.80552

PLANFORM 2

WAKE GEOMETRY

Y	Z	PHI
0.00000	-5.35898	-15.00000
-20.00000	.00000	75.00000
-20.54352	-2.02844	0.00000

NO OF WAKE VORTICITY SEGMENTS = 25
WAKE VORTICITY SEGS ON WING SEGMENT NO 5= 15
WAKE VORTICITY SEGS ON WING SEGMENT NO 6= 10
TOTAL PLANFORM PERIPHERAL LENGTH= 22.80552

SEGMENT NO	Y	Z	PHI
1	-20.536870	2.003625	-1.308997
2	-20.510919	1.906775	-1.308997
3	-20.461557	1.722556	-1.308997
4	-20.393617	1.469001	-1.308997
5	-20.313749	1.170928	-1.308997
6	-20.229771	.857516	-1.308997
7	-20.149903	.559444	-1.308997
8	-20.081963	.305888	-1.308997
9	-20.032601	.121669	-1.308997
10	-20.006650	.024820	-1.308997

(cont'd)

PLANFORM 2

WAKE GEOMETRY (Continued)

SEGMENT NO.	Y	Z	PHT
11	-19.945219	.014679	.261799
12	-19.726695	.073232	.261799
13	-19.292041	.189697	.261799
14	-18.646020	.362798	.261799
15	-17.795709	.590638	.261799
16	-16.750424	.870721	.261799
17	-15.521618	1.199979	.261799
18	-14.122754	1.574803	.261799
19	-12.569159	1.991088	.261799
20	-10.877853	2.444272	.261799
21	-9.067366	2.929390	.261799
22	-7.157536	3.441128	.261799
23	-5.169287	3.973878	.261799
24	-3.124402	4.521803	.261799
25	-1.045285	5.078901	.261799
26	-20.536870	-2.003625	1.308997
27	-20.510919	-1.906775	1.308997
28	-20.461557	-1.722556	1.308997
29	-20.393617	-1.469000	1.308997
30	-20.313749	-1.170928	1.308997
31	-20.229771	-.857516	1.308997
32	-20.149902	-.559444	1.308997
33	-20.081962	-.305888	1.308997
34	-20.032601	-.121669	1.308997
35	-20.006650	-.024820	1.308997
36	-19.945219	-.014678	-.261799
37	-19.726695	-.073232	-.261799
38	-19.292041	-.189697	-.261799
39	-18.646020	-.362798	-.261799
40	-17.795709	-.590638	-.261799
41	-16.750424	-.870721	-.261799
42	-15.521618	-1.199979	-.261799
43	-14.122754	-1.574803	-.261799
44	-12.569159	-1.991088	-.261799
45	-10.877852	-2.444272	-.261799
46	-9.067366	-2.929390	-.261799
47	-7.157536	-3.441128	-.261799
48	-5.169287	-3.973878	-.261799
49	-3.124401	-4.521803	-.261799
50	-1.045285	-5.078901	-.261799

I	SNN(I)
1	.02570
2	.07457
3	.11615
4	.14635
5	.16223
6	.16223
7	.14635
8	.11615
9	.07457
10	.02570
11	.05671
12	.16952
13	.28047
14	.38834
15	.49196
16	.59019
17	.68196
18	.76625
19	.84215
20	.90882
21	.96553
22	1.01167
23	1.04672
24	1.07030
25	1.08216
26	.02570
27	.07457
28	.11615
29	.14635
30	.16223
31	.16223
32	.14635
33	.11615
34	.07457
35	.02570
36	.05671
37	.16952
38	.28047
39	.38834
40	.49196
41	.59019
42	.68196
43	.76625
44	.84215
45	.90882
46	.96553
47	1.01167
48	1.04672
49	1.07030
50	1.08216

I	DOWNWASH	W/COS (PHI)
1	.26354E-02	.10182E-01
2	.42277E-03	.16335E-02
3	.20471E-02	.79092E-02
4	.18115E-02	.69990E-02
5	.19528E-02	.75450E-02
6	.18834E-02	.72770E-02
7	.20239E-02	.78199E-02
8	.16775E-02	.64814E-02
9	.19696E-02	.76099E-02
10	.23813E-02	.92005E-02
11	.42885E-02	.44397E-02
12	.74524E-02	.77153E-02
13	.72964E-02	.75538E-02
14	.71862E-02	.74397E-02
15	.72206E-02	.74753E-02
16	.72209E-02	.74756E-02
17	.72197E-02	.74743E-02
18	.72173E-02	.74719E-02
19	.72166E-02	.74711E-02
20	.72159E-02	.74705E-02
21	.72160E-02	.74706E-02
22	.72151E-02	.74696E-02
23	.72167E-02	.74713E-02
24	.72095E-02	.74638E-02
25	.72408E-02	.74963E-02
26	.25909E-02	.10010E-01
27	.42875E-03	.16565E-02
28	.20391E-02	.78784E-02
29	.18250E-02	.70514E-02
30	.19174E-02	.74083E-02
31	.19672E-02	.76009E-02
32	.17630E-02	.68117E-02
33	.24998E-02	.96587E-02
34	-.85679E-03	-.33104E-02
35	.25199E-01	.97360E-01
36	-.84587E-03	-.87571E-03
37	.81431E-02	.84303E-02
38	.70199E-02	.72675E-02
39	.72548E-02	.75107E-02
40	.72021E-02	.74562E-02
41	.72270E-02	.74819E-02
42	.72181E-02	.74728E-02
43	.72181E-02	.74727E-02
44	.72164E-02	.74710E-02
45	.72160E-02	.74706E-02
46	.72161E-02	.74707E-02
47	.72150E-02	.74695E-02
48	.72170E-02	.74716E-02
49	.72090E-02	.74633E-02
50	.72413E-02	.74967E-02

SEGMT	ROUND	CTRC	SHED	STRTH	ETA
1	0.		.97090E+00		.10000E+01
2	.31154E-01		.24155E+00		.99935E+00
3	.60112E-01		.14678E+00		.99747E+00
4	.88570E-01		.98235E-01		.99455E+00
5	.11406E+00		.75912E-01		.99086E+00
6	.13622E+00		.60708E-01		.98677E+00
7	.15430E+00		.50696E-01		.98268E+00
8	.16767E+00		.40692E-01		.97900E+00
9	.17638E+00		.34269E-01		.97607E+00
10	.18042E+00		.19976E-01		.97419E+00
11	.18416E+00		.12560E+00		.97354E+00
12	.19136E+00		.12458E-02		.96821E+00
13	.19249E+00		.54515E-02		.95227E+00
14	.19675E+00		.97408E-02		.92589E+00
15	.20601E+00		.14101E-01		.88938E+00
16	.22068E+00		.15718E-01		.84311E+00
17	.23913E+00		.15546E-01		.78761E+00
18	.25958E+00		.14436E-01		.72348E+00
19	.28057E+00		.12958E-01		.65143E+00
20	.30105E+00		.11357E-01		.57223E+00
21	.32022E+00		.97358E-02		.48677E+00
22	.33745E+00		.81115E-02		.39598E+00
23	.35221E+00		.64832E-02		.30084E+00
24	.36398E+00		.47619E-02		.20241E+00
25	.37230E+00		.30113E-02		.10176E+00
26	0.		.97300E+00		.10000E+01
27	.31228E-01		.24230E+00		.99935E+00
28	.60270E-01		.14716E+00		.99747E+00
29	.88819E-01		.98639E-01		.99455E+00
30	.11440E+00		.76128E-01		.99086E+00
31	.13671E+00		.61428E-01		.98677E+00
32	.15485E+00		.50356E-01		.98268E+00
33	.16872E+00		.44426E-01		.97900E+00
34	.17691E+00		.26073E-01		.97607E+00
35	.18486E+00		.80547E-01		.97419E+00
36	.18227E+00		.18143E+00		.97354E+00
37	.17274E+00		.13398E-01		.96821E+00
38	.17531E+00		.17682E-02		.95227E+00
39	.17874E+00		.10474E-01		.92589E+00
40	.18818E+00		.13832E-01		.88938E+00
41	.20273E+00		.15752E-01		.84311E+00
42	.22119E+00		.15511E-01		.78761E+00
43	.24161E+00		.14433E-01		.72348E+00
44	.26259E+00		.12950E-01		.65143E+00
45	.28306E+00		.11354E-01		.57223E+00
46	.30222E+00		.97334E-02		.48677E+00
47	.31945E+00		.81094E-02		.39598E+00
48	.33421E+00		.64830E-02		.30084E+00
49	.34598E+00		.47594E-02		.20241E+00
50	.35430E+00		.30137E-02		.10176E+00
51	.35756E+00	0.		0.	

CD CALCULATED USING DIRECT OPTIMIZATION LINEAR SHSHEET DIST = .22412E-02

FIRST PLANFORM

HORSESHOE VORTEX DESCRIPTIONS

X C/4	X 30/4	Y	Z	S	C/4 SWEEP ANGLE	DIHEDRAL ANGLE	GAMMA/U AT CLDES= .3000
.67201	.64009	-20.33970	1.26778	.78750	60.67720	-75.00000	.00845
.60817	.57625	-20.33970	1.26778	.78750	59.45913	-75.00000	.00845
.54433	.51241	-20.33970	1.26778	.78750	58.14646	-75.00000	.00845
.48049	.44857	-20.33970	1.26778	.78750	56.72931	-75.00000	.00845
.41665	.38473	-20.33970	1.26778	.78750	55.19663	-75.00000	.00845
.35281	.32090	-20.33970	1.26778	.78750	53.53619	-75.00000	.00845
.28898	.25706	-20.33970	1.26778	.78750	51.73447	-75.00000	.00845
.22514	.19322	-20.33970	1.26778	.78750	49.77671	-75.00000	.00845
.16130	.12938	-20.33970	1.26778	.78750	47.64693	-75.00000	.00845
.09746	.06554	-20.33970	1.26778	.78750	45.32815	-75.00000	.00845
.03362	.00170	-20.33970	1.26778	.78750	42.80274	-75.00000	.00845
-.03022	-.06214	-20.33970	1.26778	.78750	40.05299	-75.00000	.00845
-.09406	-.12598	-20.33970	1.26778	.78750	37.06210	-75.00000	.00845
-.15790	-.18982	-20.33970	1.26778	.78750	33.81547	-75.00000	.00845
1.49956	1.44355	-20.06794	.25356	.26250	81.68227	-75.00000	.01243
1.38753	1.33150	-20.06794	.25356	.26250	81.10092	-75.00000	.01243
1.27547	1.21945	-20.06794	.25356	.26250	80.43301	-75.00000	.01243
1.16342	1.10739	-20.06794	.25356	.26250	79.65789	-75.00000	.01243
1.05137	.99534	-20.06794	.25356	.26250	78.74785	-75.00000	.01243
.93931	.88329	-20.06794	.25356	.26250	77.66492	-75.00000	.01243
.82726	.77123	-20.06794	.25356	.26250	76.35571	-75.00000	.01243
.71521	.65918	-20.06794	.25356	.26250	74.74293	-75.00000	.01243
.60315	.54713	-20.06794	.25356	.26250	72.71089	-75.00000	.01243
.49110	.43507	-20.06794	.25356	.26250	70.07951	-75.00000	.01243
.37905	.32302	-20.06794	.25356	.26250	66.55590	-75.00000	.01243
.26699	.21096	-20.06794	.25356	.26250	61.64062	-75.00000	.01243
.15494	.09891	-20.06794	.25356	.26250	54.44693	-75.00000	.01243
.04288	-.01314	-20.06794	.25356	.26250	43.40400	-75.00000	.01243
2.38791	2.31648	-19.15275	.22702	.87714	26.56505	15.00000	.01398
2.24505	2.17362	-19.15275	.22702	.87714	26.56505	15.00000	.01398
2.10220	2.03077	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.95934	1.88791	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.81648	1.74505	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.67362	1.60220	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.53077	1.45934	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.38791	1.31648	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.24505	1.17362	-19.15275	.22702	.87714	26.56505	15.00000	.01398
1.10220	1.03077	-19.15275	.22702	.87714	26.56505	15.00000	.01398
.95934	.88791	-19.15275	.22702	.87714	26.56505	15.00000	.01398
.81648	.74505	-19.15275	.22702	.87714	26.56505	15.00000	.01398
.67362	.60220	-19.15275	.22702	.87714	26.56505	15.00000	.01398
.53077	.45934	-19.15275	.22702	.87714	26.56505	15.00000	.01398
3.23516	3.16373	-17.45826	.68106	.87714	26.56505	15.00000	.01561

(cont'd)

FIRST PLANFORM

HORSESHOE VORTEX DESCRIPTIONS (Continued)

X C/4	X 3C/4	Y	Z	S	C/4 SWEEP ANGLE	DIHEDRAL ANGLE	GAMMA/U AT CLDES = 0.3000
3.09230	3.02087	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.94944	2.87801	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.80659	2.73516	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.66373	2.59230	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.52087	2.44944	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.37801	2.30659	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.23516	2.16373	-17.45826	.68106	.87714	26.56505	15.00000	.01561
2.09230	2.02087	-17.45826	.68106	.87714	26.56505	15.00000	.01561
1.94944	1.87801	-17.45826	.68106	.87714	26.56505	15.00000	.01561
1.80659	1.73516	-17.45826	.68106	.87714	26.56505	15.00000	.01561
1.66373	1.59230	-17.45826	.68106	.87714	26.56505	15.00000	.01561
1.52087	1.44944	-17.45826	.68106	.87714	26.56505	15.00000	.01561
1.37801	1.30659	-17.45826	.68106	.87714	26.56505	15.00000	.01561
4.08241	4.01098	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.93955	3.86812	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.79669	3.72526	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.65383	3.58241	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.51098	3.43955	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.36812	3.29669	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.22526	3.15383	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
3.08241	3.01098	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.93955	2.86812	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.79669	2.72526	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.65383	2.58241	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.51098	2.43955	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.36812	2.29669	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
2.22526	2.15383	-15.76376	1.13510	.87714	26.56505	15.00000	.01754
4.92965	4.85822	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.78680	4.71537	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.64394	4.57251	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.50108	4.42965	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.35822	4.28680	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.21537	4.14394	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
4.07251	4.00108	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.92965	3.85822	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.78680	3.71537	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.64394	3.57251	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.50108	3.42965	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.35822	3.28680	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.21537	3.14394	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
3.07251	3.00108	-14.06927	1.58914	.87714	26.56505	15.00000	.01935
5.77690	5.70547	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
5.63404	5.56262	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
5.49119	5.41976	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
5.34833	5.27690	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
5.20547	5.13404	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
5.06262	4.99119	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.91976	4.84833	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.77690	4.70547	-12.37477	2.04317	.87714	26.56505	15.00000	.02095

FIRST PLANFORM

HORSESHOE VORTEX DESCRIPTIONS (Continued)

C/4	X 3C/4	Y	Z	S	C/4 SWEEP ANGLE	DIHEDRAL ANGLE	GAMMA/U AT CLDES = 0.3000
4.63404	4.56262	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.49119	4.41976	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.34833	4.27690	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.20547	4.13404	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
4.06262	3.99119	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
3.91976	3.84833	-12.37477	2.04317	.87714	26.56505	15.00000	.02095
6.62415	6.55272	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
6.48129	6.40986	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
6.33843	6.26701	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
6.19558	6.12415	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
6.05272	5.98129	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.90986	5.83843	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.76701	5.69558	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.62415	5.55272	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.48129	5.40986	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.33843	5.26701	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.19558	5.12415	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
5.05272	4.98129	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
4.90986	4.83843	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
4.76701	4.69558	-10.68027	2.49721	.87714	26.56505	15.00000	.02234
7.47140	7.39997	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
7.32854	7.25711	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
7.18568	7.11425	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
7.04283	6.97140	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.89997	6.82854	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.75711	6.68568	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.61425	6.54283	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.47140	6.39997	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.32854	6.25711	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.18568	6.11425	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
6.04283	5.97140	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
5.89997	5.82854	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
5.75711	5.68568	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
5.61425	5.54283	-8.98578	2.95125	.87714	26.56505	15.00000	.02354
8.31864	8.24722	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
8.17579	8.10436	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
8.03293	7.96150	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.89007	7.81864	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.74722	7.67579	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.60436	7.53293	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.46150	7.39007	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.31864	7.24722	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.17579	7.10436	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
7.03293	6.96150	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
6.89007	6.81864	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
6.74722	6.67579	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
6.60436	6.53293	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
6.46150	6.39007	-7.29128	3.40529	.87714	26.56505	15.00000	.02456
9.16589	9.09446	-5.59679	3.85933	.87714	26.56505	15.00000	.02540

FIRST PLANFORM

HORSESHOE VORTEX DESCRIPTIONS (Concluded)

C/4	X 3C/4	Y	Z	S	C/4 SWEEP ANGLE	DIHEDRAL ANGLE	GAMMA/U AT CLDES =0.3000
9.02304	8.95161	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.88018	8.80875	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.73732	8.66589	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.59446	8.52304	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.45161	8.38018	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.30875	8.23732	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.16589	8.09446	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
8.02304	7.95161	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
7.88018	7.80875	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
7.73732	7.66589	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
7.59446	7.52304	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
7.45161	7.38018	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
7.30875	7.23732	-5.59679	3.85933	.87714	26.56505	15.00000	.02540
10.01314	9.94171	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.87028	9.79885	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.72743	9.65600	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.58457	9.51314	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.44171	9.37028	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.29885	9.22743	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.15600	9.08457	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
9.01314	8.94171	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.87028	8.79885	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.72743	8.65600	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.58457	8.51314	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.44171	8.37028	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.29885	8.22743	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
8.15600	8.08457	-3.90229	4.31337	.87714	26.56505	15.00000	.02607
10.86039	10.78896	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.71753	10.64610	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.57467	10.50325	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.43182	10.36039	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.28896	10.21753	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.14610	10.07467	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
10.00325	9.93182	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.86039	9.78896	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.71753	9.64610	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.57467	9.50325	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.43182	9.36039	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.28896	9.21753	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.14610	9.07467	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
9.00325	8.93182	-2.20780	4.76741	.87714	26.56505	15.00000	.02656
11.62415	11.55272	-.68027	5.17671	.70427	26.56505	15.00000	.02675
11.48129	11.40986	-.68027	5.17671	.70427	26.56505	15.00000	.02675
11.33843	11.26701	-.68027	5.17671	.70427	26.56505	15.00000	.02675
11.19558	11.12415	-.68027	5.17671	.70427	26.56505	15.00000	.02675
11.05272	10.98129	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.90986	10.83843	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.76701	10.69558	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.62415	10.55272	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.48129	10.40986	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.33843	10.26701	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.19558	10.12415	-.68027	5.17671	.70427	26.56505	15.00000	.02675
10.05272	9.98129	-.68027	5.17671	.70427	26.56505	15.00000	.02675
9.90986	9.83843	-.68027	5.17671	.70427	26.56505	15.00000	.02675
9.76701	9.69558	-.68027	5.17671	.70427	26.56505	15.00000	.02675

SECOND PLANFORM HORSESHOE VORTEX DESCRIPTIONS

-1.32799	-1.35991	-20.33970	-1.26778	.78750	60.67720	75.00000	.00848
-1.39183	-1.42375	-20.33970	-1.26778	.78750	59.45913	75.00000	.00848
-1.45567	-1.48759	-20.33970	-1.26778	.78750	58.14646	75.00000	.00848
-1.51951	-1.55143	-20.33970	-1.26778	.78750	56.72931	75.00000	.00848
-1.58335	-1.61527	-20.33970	-1.26778	.78750	55.19663	75.00000	.00848
-1.64719	-1.67910	-20.33970	-1.26778	.78750	53.53619	75.00000	.00848
-1.71102	-1.74294	-20.33970	-1.26778	.78750	51.73447	75.00000	.00848
-1.77486	-1.80678	-20.33970	-1.26778	.78750	49.77671	75.00000	.00848
-1.83870	-1.87062	-20.33970	-1.26778	.78750	47.64693	75.00000	.00848
-1.90254	-1.93446	-20.33970	-1.26778	.78750	45.32815	75.00000	.00848
-1.96638	-1.99830	-20.33970	-1.26778	.78750	42.80274	75.00000	.00848
-2.03022	-2.06214	-20.33970	-1.26778	.78750	40.05299	75.00000	.00848
-2.09406	-2.12598	-20.33970	-1.26778	.78750	37.06210	75.00000	.00848
-2.15790	-2.18982	-20.33970	-1.26778	.78750	33.81547	75.00000	.00848
-.50042	-.55645	-20.06794	-.25356	.26250	81.68227	75.00000	.01248
-.61247	-.66850	-20.06794	-.25356	.26250	81.10092	75.00000	.01248
-.72453	-.78055	-20.06794	-.25356	.26250	80.43301	75.00000	.01248
-.83658	-.89261	-20.06794	-.25356	.26250	79.65789	75.00000	.01248
-.94863	-1.00466	-20.06794	-.25356	.26250	78.74785	75.00000	.01248
-1.06069	-1.11671	-20.06794	-.25356	.26250	77.66492	75.00000	.01248
-1.17274	-1.22877	-20.06794	-.25356	.26250	76.35571	75.00000	.01248
-1.28479	-1.34082	-20.06794	-.25356	.26250	74.74293	75.00000	.01248
-1.39685	-1.45287	-20.06794	-.25356	.26250	72.71089	75.00000	.01248
-1.50890	-1.56493	-20.06794	-.25356	.26250	70.07951	75.00000	.01248
-1.62095	-1.67698	-20.06794	-.25356	.26250	66.55590	75.00000	.01248
-1.73301	-1.78904	-20.06794	-.25356	.26250	61.64062	75.00000	.01248
-1.84506	-1.90109	-20.06794	-.25356	.26250	54.44693	75.00000	.01248
-1.95712	-2.01314	-20.06794	-.25356	.26250	43.40480	75.00000	.01248
-.45934	-.53077	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-.60220	-.67362	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-.74505	-.81648	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-.88791	-.95934	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.03077	-1.10220	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.17362	-1.24505	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.31648	-1.38791	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.45934	-1.53077	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.60220	-1.67362	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.74505	-1.81648	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.88791	-1.95934	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-2.03077	-2.10220	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271

(cont'd)

SECOND PLANFORM HORSESHOE

VORTEX DESCRIPTIONS

(Continued)

-2.17362	-2.24505	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-2.31648	-2.38791	-19.15275	-.22702	.87714	-26.56505	-15.00000	.01271
-1.30659	-1.37801	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-1.44944	-1.52087	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-1.59230	-1.66373	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-1.73516	-1.80659	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-1.87801	-1.94944	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.02087	-2.09230	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.16373	-2.23516	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.30659	-2.37801	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.44944	-2.52087	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.59230	-2.66373	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.73516	-2.80659	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.87801	-2.94944	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-3.02087	-3.09230	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-3.16373	-3.23516	-17.45826	-.68106	.87714	-26.56505	-15.00000	.01433
-2.15383	-2.22526	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-2.29669	-2.36812	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-2.43955	-2.51098	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-2.58241	-2.65383	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-2.72526	-2.79669	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-2.86812	-2.93955	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.01098	-3.08241	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.15383	-3.22526	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.29669	-3.36812	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.43955	-3.51098	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.58241	-3.65383	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.72526	-3.79669	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.86812	-3.93955	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-4.01098	-4.08241	-15.76376	-1.13510	.87714	-26.56505	-15.00000	.01626
-3.00108	-3.07251	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.14394	-3.21537	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.28680	-3.35822	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.42965	-3.50108	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.57251	-3.64394	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.71537	-3.78680	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.85822	-3.92965	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.00108	-4.07251	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.14394	-4.21537	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.28680	-4.35822	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.42965	-4.50108	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.57251	-4.64394	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.71537	-4.78680	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-4.85822	-4.92965	-14.06927	-1.58914	.87714	-26.56505	-15.00000	.01806
-3.84833	-3.91976	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-3.99119	-4.06262	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.13404	-4.20547	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.27690	-4.34833	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.41976	-4.49119	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966

SECOND PLANFORM HORSESHOE
 VORTEX DESCRIPTION
 (Continued)

-4.56262	-4.63404	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.70547	-4.77690	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.84833	-4.91976	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.99119	-5.06262	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-5.13404	-5.20547	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-5.27690	-5.34833	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-5.41976	-5.49119	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-5.56262	-5.63404	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-5.70547	-5.77690	-12.37477	-2.04317	.87714	-26.56505	-15.00000	.01966
-4.69558	-4.76701	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-4.83843	-4.90986	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-4.98129	-5.05272	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.12415	-5.19558	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.26701	-5.33843	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.40986	-5.48129	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.55272	-5.62415	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.69558	-5.76701	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.83843	-5.90986	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.98129	-6.05272	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-6.12415	-6.19558	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-6.26701	-6.33843	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-6.40986	-6.48129	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-6.55272	-6.62415	-10.68027	-2.49721	.87714	-26.56505	-15.00000	.02106
-5.54283	-5.61425	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-5.68568	-5.75711	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-5.82854	-5.89997	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-5.97140	-6.04283	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.11425	-6.18568	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.25711	-6.32854	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.39997	-6.47140	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.54283	-6.61425	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.68568	-6.75711	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.82854	-6.89997	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.97140	-7.04283	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-7.11425	-7.18568	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-7.25711	-7.32854	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-7.39997	-7.47140	-8.98578	-2.95125	.87714	-26.56505	-15.00000	.02226
-6.39007	-6.46150	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-6.53293	-6.60436	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-6.67579	-6.74722	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-6.81864	-6.89007	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-6.96150	-7.03293	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.10436	-7.17579	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.24722	-7.31864	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.39007	-7.46150	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.53293	-7.60436	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.67579	-7.74722	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.81864	-7.89007	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.96150	-8.03293	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327

SECOND PLANFORM HORSESHOE

VORTEX DESCRIPTIONS

(Continued)

-8.10436	-8.17579	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-8.24722	-8.31864	-7.29128	-3.40529	.87714	-26.56505	-15.00000	.02327
-7.23732	-7.30875	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-7.38018	-7.45161	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-7.52304	-7.59446	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-7.66589	-7.73732	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-7.80875	-7.88018	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-7.95161	-8.02304	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.09446	-8.16589	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.23732	-8.30875	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.38018	-8.45161	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.52304	-8.59446	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.66589	-8.73732	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.80875	-8.88018	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.95161	-9.02304	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-9.09446	-9.16589	-5.59679	-3.85933	.87714	-26.56505	-15.00000	.02411
-8.08457	-8.15600	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.22743	-8.29885	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.37028	-8.44171	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.51314	-8.58457	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.65600	-8.72743	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.79885	-8.87028	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.94171	-9.01314	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.08457	-9.15600	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.22743	-9.29885	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.37028	-9.44171	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.51314	-9.58457	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.65600	-9.72743	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.79885	-9.87028	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-9.94171	-10.01314	-3.90229	-4.31337	.87714	-26.56505	-15.00000	.02479
-8.93182	-9.00325	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.07467	-9.14610	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.21753	-9.28896	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.36039	-9.43182	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.50325	-9.57467	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.64610	-9.71753	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.78896	-9.86039	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.93182	-10.00325	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.07467	-10.14610	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.21753	-10.28896	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.36039	-10.43182	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.50325	-10.57467	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.64610	-10.71753	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-10.78896	-10.86039	-2.20780	-4.76741	.87714	-26.56505	-15.00000	.02527
-9.69558	-9.76701	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-9.83843	-9.90986	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-9.98129	-10.05272	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.12415	-10.19558	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.26701	-10.33843	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546

SECOND PLANFORM HORSESHOE

VORTEX DESCRIPTIONS

(Concluded)

-10.40986	-10.48129	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.55272	-10.62415	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.69558	-10.76701	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.83843	-10.90986	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-10.98129	-11.05272	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-11.12415	-11.19558	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-11.26701	-11.33843	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-11.40986	-11.48129	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546
-11.55272	-11.62415	-.68027	-5.17671	.70427	-26.56505	-15.00000	.02546

REF. CHORD	C AVERAGE	TRUE AREA	REFERENCE AREA	P/2	REF. AR	TRUE AR	MACH NUMBER
2.00000	3.95039	162.30996	160.00000	20.54352	10.55091	10.40075	.75000

A1 = 1.00000

A2 = 1.00000

F I R S T P L A N F O R M S P A N L O A D I N G

Y	CL*C
-20.33970	.06123
-20.06794	.09010
-19.15275	.37810
-17.45826	.42221
-15.76376	.47446
-14.06927	.52321
-12.37477	.56652
-10.68027	.60426
-8.98578	.63671
-7.29128	.66421
-5.59679	.68699
-3.90229	.70515
-2.20780	.71832
-.68027	.72348

CL DEVELOPED ON THIS PLANFORM= .154441

CM DEVELOPED ON THIS PLANFORM= .502438

S E C O N D P L A N F O R M S P A N L O A D I N G

Y	CL*C
-20.33970	.06142
-20.06794	.09044
-19.15275	.34369
-17.45826	.38758
-15.76376	.43977
-14.06927	.48848
-12.37477	.53178
-10.68027	.56950
-8.98578	.60195
-7.29128	.62944
-5.59679	.65221
-3.90229	.67037
-2.20780	.68354
-.68027	.68871

CL DEVELOPED ON THIS PLANFORM= .145462
 CM DEVELOPED ON THIS PLANFORM= -.471198

CL DESIGN = .300000 CL COMPUTED= .299904 CM COMPUTED= .312E-01 CD V= .002241

LOCAL ELEVATION DATA

Y= -20.3397

Y/P/2= -.9901

CHORD= .8938

SLOPES.DZ/DX.AT SLOPE POINTS.FROM FRONT TO REAR

.1996 .1494 .1169 .0918 .0704 .0511 .0328 .0147-.0039-.0238-.0466-.0751-.1177-.2332
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= 1.3739DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
.0000	.0240	.0062	.0000	.0214	.0055
.0250	.0190	.0049	.0223	.0170	.0044
.0500	.0139	.0036	.0447	.0124	.0032
.0750	.0090	.0023	.0670	.0081	.0021
.1000	.0046	.0012	.0894	.0041	.0011
.1250	.0006	.0001	.1117	.0005	.0001
.1500	-.0030	-.0008	.1341	-.0027	-.0007
.1750	-.0062	-.0016	.1564	-.0055	-.0014
.2000	-.0092	-.0024	.1788	-.0082	-.0021
.2250	-.0120	-.0031	.2011	-.0107	-.0028
.2500	-.0145	-.0038	.2234	-.0130	-.0034
.2750	-.0169	-.0044	.2458	-.0151	-.0039
.3000	-.0190	-.0049	.2681	-.0170	-.0044
.3250	-.0210	-.0054	.2905	-.0187	-.0049
.3500	-.0227	-.0059	.3128	-.0203	-.0053
.3750	-.0243	-.0063	.3352	-.0218	-.0056
.4000	-.0258	-.0067	.3575	-.0230	-.0060
.4250	-.0270	-.0070	.3798	-.0242	-.0063
.4500	-.0281	-.0073	.4022	-.0252	-.0065
.4750	-.0291	-.0075	.4245	-.0260	-.0067
.5000	-.0299	-.0077	.4469	-.0267	-.0069
.5250	-.0305	-.0079	.4692	-.0273	-.0071
.5500	-.0310	-.0080	.4916	-.0277	-.0072
.5750	-.0313	-.0081	.5139	-.0280	-.0072
.6000	-.0314	-.0081	.5363	-.0281	-.0073
.6250	-.0314	-.0081	.5586	-.0281	-.0073
.6500	-.0312	-.0081	.5809	-.0279	-.0072
.6750	-.0309	-.0080	.6033	-.0276	-.0071
.7000	-.0303	-.0079	.6256	-.0271	-.0070
.7250	-.0296	-.0077	.6480	-.0265	-.0069
.7500	-.0287	-.0074	.6703	-.0257	-.0066
.7750	-.0276	-.0071	.6927	-.0247	-.0064
.8000	-.0262	-.0068	.7150	-.0235	-.0061
.8250	-.0246	-.0064	.7373	-.0220	-.0057
.8500	-.0227	-.0059	.7597	-.0203	-.0053
.8750	-.0207	-.0054	.7820	-.0185	-.0048
.9000	-.0184	-.0048	.8044	-.0164	-.0043
.9250	-.0154	-.0040	.8267	-.0137	-.0036
.9500	-.0112	-.0029	.8491	-.0100	-.0026
.9750	-.0058	-.0015	.8714	-.0052	-.0013
1.0000	0.0000	0.0000	.8938	0.0000	0.0000

Y= -20.0679

Y/R/2= -.9769

CHCRD= 1.5688

SLOPES, DZ/DY, AT SLOPE POINTS, FROM FRONT TO REAR

.1936 .0976 .0419 .0049-.0208-.0397-.0549-.0681-.0807-.0939-.1093-.1301-.1647-.2609
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -2.3371 DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
.0000	-.0408	-.0106	.0000	-.0640	-.0166
.0250	-.0457	-.0118	.0392	-.0717	-.0186
.0500	-.0506	-.0131	.0784	-.0794	-.0206
.0750	-.0553	-.0143	.1177	-.0867	-.0224
.1000	-.0592	-.0153	.1569	-.0928	-.0240
.1250	-.0620	-.0161	.1961	-.0973	-.0252
.1500	-.0641	-.0166	.2353	-.1006	-.0260
.1750	-.0657	-.0170	.2745	-.1030	-.0267
.2000	-.0668	-.0173	.3138	-.1049	-.0271
.2250	-.0677	-.0175	.3530	-.1062	-.0275
.2500	-.0682	-.0176	.3922	-.1069	-.0277
.2750	-.0684	-.0177	.4314	-.1072	-.0278
.3000	-.0683	-.0177	.4706	-.1071	-.0277
.3250	-.0680	-.0176	.5098	-.1066	-.0276
.3500	-.0675	-.0175	.5491	-.1058	-.0274
.3750	-.0668	-.0173	.5883	-.1048	-.0271
.4000	-.0659	-.0171	.6275	-.1034	-.0268
.4250	-.0649	-.0168	.6667	-.1018	-.0264
.4500	-.0638	-.0165	.7059	-.1000	-.0259
.4750	-.0625	-.0162	.7452	-.0980	-.0254
.5000	-.0611	-.0158	.7844	-.0959	-.0248
.5250	-.0596	-.0154	.8236	-.0935	-.0242
.5500	-.0580	-.0150	.8628	-.0909	-.0235
.5750	-.0562	-.0145	.9020	-.0882	-.0228
.6000	-.0544	-.0141	.9413	-.0853	-.0221
.6250	-.0524	-.0136	.9805	-.0822	-.0213
.6500	-.0503	-.0130	1.0197	-.0789	-.0204
.6750	-.0481	-.0125	1.0589	-.0755	-.0195
.7000	-.0458	-.0119	1.0981	-.0719	-.0186
.7250	-.0434	-.0112	1.1373	-.0681	-.0176
.7500	-.0409	-.0106	1.1766	-.0641	-.0166
.7750	-.0382	-.0099	1.2158	-.0599	-.0155
.8000	-.0353	-.0091	1.2550	-.0553	-.0143
.8250	-.0322	-.0083	1.2942	-.0505	-.0131
.8500	-.0290	-.0075	1.3334	-.0454	-.0118
.8750	-.0256	-.0066	1.3727	-.0401	-.0104
.9000	-.0220	-.0057	1.4119	-.0345	-.0089
.9250	-.0178	-.0046	1.4511	-.0279	-.0072
.9500	-.0126	-.0033	1.4903	-.0198	-.0051
.9750	-.0065	-.0017	1.5295	-.0102	-.0026
1.0000	0.0000	0.0000	1.5688	0.0000	0.0000

Y= -19.1528

Y/R/2= -.9323

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0353 .0253 .0186 .0133 .0086 .0043 .0002-.0038-.0078-.0120-.0166-.0224-.0313-.0576
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.0925DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0016	-.0016	.0000	-.0032	-.0031
.0250	-.0025	-.0024	.0500	-.0050	-.0048
.0500	-.0034	-.0033	.1000	-.0068	-.0066
.0750	-.0043	-.0041	.1500	-.0085	-.0082
.1000	-.0050	-.0049	.2000	-.0101	-.0097
.1250	-.0057	-.0055	.2500	-.0114	-.0111
.1500	-.0063	-.0061	.3000	-.0126	-.0122
.1750	-.0068	-.0066	.3500	-.0137	-.0132
.2000	-.0073	-.0071	.4000	-.0147	-.0142
.2250	-.0078	-.0075	.4500	-.0155	-.0150
.2500	-.0082	-.0079	.5000	-.0163	-.0157
.2750	-.0085	-.0082	.5500	-.0170	-.0164
.3000	-.0088	-.0085	.6000	-.0176	-.0170
.3250	-.0090	-.0087	.6500	-.0181	-.0175
.3500	-.0093	-.0089	.7000	-.0185	-.0179
.3750	-.0094	-.0091	.7500	-.0189	-.0182
.4000	-.0096	-.0093	.8000	-.0192	-.0185
.4250	-.0097	-.0094	.8500	-.0194	-.0187
.4500	-.0098	-.0094	.9000	-.0195	-.0188
.4750	-.0098	-.0095	.9500	-.0196	-.0189
.5000	-.0098	-.0095	1.0000	-.0196	-.0189
.5250	-.0097	-.0094	1.0500	-.0195	-.0188
.5500	-.0097	-.0093	1.1000	-.0193	-.0187
.5750	-.0096	-.0092	1.1500	-.0191	-.0185
.6000	-.0094	-.0091	1.2000	-.0188	-.0182
.6250	-.0092	-.0089	1.2500	-.0185	-.0179
.6500	-.0090	-.0087	1.3000	-.0181	-.0174
.6750	-.0088	-.0085	1.3500	-.0176	-.0170
.7000	-.0085	-.0082	1.4000	-.0170	-.0164
.7250	-.0082	-.0079	1.4500	-.0163	-.0158
.7500	-.0078	-.0075	1.5000	-.0156	-.0151
.7750	-.0074	-.0071	1.5500	-.0148	-.0143
.8000	-.0069	-.0067	1.6000	-.0139	-.0134
.8250	-.0064	-.0062	1.6500	-.0129	-.0124
.8500	-.0059	-.0057	1.7000	-.0117	-.0113
.8750	-.0053	-.0051	1.7500	-.0106	-.0102
.9000	-.0046	-.0045	1.8000	-.0093	-.0090
.9250	-.0039	-.0037	1.8500	-.0077	-.0074
.9500	-.0028	-.0027	1.9000	-.0055	-.0053
.9750	-.0014	-.0014	1.9500	-.0029	-.0028
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -17.4583

Y/P/2= -.8498

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0404 .0295 .0225 .0170 .0122 .0079 .0037-.0005-.0050-.0098-.0155-.0227-.0338-.0644
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= .0328DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
.0000	.0006	.0006	.0000	.0011	.0011
.0250	-.0004	-.0004	.0500	-.0009	-.0009
.0500	-.0015	-.0014	.1000	-.0029	-.0028
.0750	-.0025	-.0024	.1500	-.0049	-.0047
.1000	-.0034	-.0032	.2000	-.0067	-.0065
.1250	-.0041	-.0040	.2500	-.0083	-.0080
.1500	-.0048	-.0047	.3000	-.0097	-.0093
.1750	-.0055	-.0053	.3500	-.0109	-.0106
.2000	-.0060	-.0058	.4000	-.0121	-.0117
.2250	-.0066	-.0064	.4500	-.0132	-.0127
.2500	-.0071	-.0068	.5000	-.0141	-.0136
.2750	-.0075	-.0072	.5500	-.0150	-.0145
.3000	-.0079	-.0076	.6000	-.0158	-.0152
.3250	-.0082	-.0080	.6500	-.0165	-.0159
.3500	-.0085	-.0082	.7000	-.0171	-.0165
.3750	-.0088	-.0085	.7500	-.0176	-.0170
.4000	-.0090	-.0087	.8000	-.0181	-.0175
.4250	-.0092	-.0089	.8500	-.0185	-.0178
.4500	-.0094	-.0091	.9000	-.0188	-.0181
.4750	-.0095	-.0092	.9500	-.0190	-.0184
.5000	-.0096	-.0093	1.0000	-.0192	-.0185
.5250	-.0096	-.0093	1.0500	-.0193	-.0186
.5500	-.0097	-.0093	1.1000	-.0193	-.0187
.5750	-.0096	-.0093	1.1500	-.0193	-.0186
.6000	-.0096	-.0092	1.2000	-.0191	-.0185
.6250	-.0095	-.0091	1.2500	-.0189	-.0183
.6500	-.0093	-.0090	1.3000	-.0186	-.0180
.6750	-.0091	-.0088	1.3500	-.0183	-.0176
.7000	-.0089	-.0086	1.4000	-.0178	-.0172
.7250	-.0086	-.0083	1.4500	-.0173	-.0167
.7500	-.0083	-.0080	1.5000	-.0166	-.0160
.7750	-.0079	-.0077	1.5500	-.0159	-.0153
.8000	-.0075	-.0072	1.6000	-.0150	-.0145
.8250	-.0070	-.0067	1.6500	-.0140	-.0135
.8500	-.0064	-.0062	1.7000	-.0128	-.0124
.8750	-.0058	-.0056	1.7500	-.0116	-.0112
.9000	-.0051	-.0050	1.8000	-.0103	-.0099
.9250	-.0043	-.0041	1.8500	-.0088	-.0082
.9500	-.0031	-.0030	1.9000	-.0062	-.0060
.9750	-.0016	-.0016	1.9500	-.0032	-.0031
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -15.7638

Y/R/2= -.7673

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0320 .0241 .0179 .0125 .0076 .0029-.0019-.0069-.0124-.0186-.0270-.0395-.0740
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0576 .1750 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.0378066666

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0007	-.0006	0.0000	-.0013	-.0013
.0250	-.0018	-.0017	.0500	-.0035	-.0034
.0500	-.0029	-.0028	.1000	-.0058	-.0056
.0750	-.0040	-.0038	.1500	-.0079	-.0077
.1000	-.0050	-.0048	.2000	-.0099	-.0096
.1250	-.0058	-.0056	.2500	-.0116	-.0112
.1500	-.0066	-.0063	.3000	-.0131	-.0127
.1750	-.0073	-.0070	.3500	-.0145	-.0140
.2000	-.0079	-.0076	.4000	-.0157	-.0152
.2250	-.0084	-.0082	.4500	-.0169	-.0163
.2500	-.0090	-.0086	.5000	-.0179	-.0173
.2750	-.0094	-.0091	.5500	-.0188	-.0182
.3000	-.0098	-.0095	.6000	-.0196	-.0190
.3250	-.0102	-.0098	.6500	-.0204	-.0197
.3500	-.0105	-.0101	.7000	-.0210	-.0203
.3750	-.0108	-.0104	.7500	-.0215	-.0208
.4000	-.0110	-.0106	.8000	-.0220	-.0212
.4250	-.0112	-.0108	.8500	-.0224	-.0216
.4500	-.0113	-.0109	.9000	-.0227	-.0219
.4750	-.0114	-.0110	.9500	-.0229	-.0221
.5000	-.0115	-.0111	1.0000	-.0230	-.0222
.5250	-.0115	-.0111	1.0500	-.0230	-.0222
.5500	-.0115	-.0111	1.1000	-.0230	-.0222
.5750	-.0114	-.0110	1.1500	-.0229	-.0221
.6000	-.0113	-.0109	1.2000	-.0227	-.0219
.6250	-.0112	-.0108	1.2500	-.0224	-.0216
.6500	-.0110	-.0106	1.3000	-.0220	-.0212
.6750	-.0107	-.0104	1.3500	-.0215	-.0207
.7000	-.0104	-.0101	1.4000	-.0209	-.0202
.7250	-.0101	-.0098	1.4500	-.0202	-.0195
.7500	-.0097	-.0094	1.5000	-.0194	-.0188
.7750	-.0093	-.0089	1.5500	-.0185	-.0179
.8000	-.0087	-.0084	1.6000	-.0174	-.0169
.8250	-.0081	-.0078	1.6500	-.0162	-.0157
.8500	-.0074	-.0072	1.7000	-.0149	-.0144
.8750	-.0067	-.0065	1.7500	-.0135	-.0130
.9000	-.0059	-.0057	1.8000	-.0118	-.0114
.9250	-.0049	-.0047	1.8500	-.0098	-.0095
.9500	-.0035	-.0034	1.9000	-.0071	-.0069
.9750	-.0018	-.0018	1.9500	-.0037	-.0036
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -14.0693

Y/P/2= -.6849

CHORD= 2.0000

SLOPES.DZ/DX,AT SLOPE POINTS,FROM FRONT TO REAR

.0477 .0342 .0254 .0185 .0125 .0071 .0019-.0034-.0089-.0150-.0221-.0311-.0448-.0829
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.1143DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0020	-.0019	.0000	-.0040	-.0039
.0250	-.0032	-.0031	.0500	-.0064	-.0062
.0500	-.0044	-.0043	.1000	-.0088	-.0085
.0750	-.0056	-.0054	.1500	-.0111	-.0108
.1000	-.0066	-.0064	.2000	-.0132	-.0128
.1250	-.0075	-.0073	.2500	-.0151	-.0146
.1500	-.0083	-.0081	.3000	-.0167	-.0161
.1750	-.0091	-.0088	.3500	-.0181	-.0175
.2000	-.0097	-.0094	.4000	-.0194	-.0188
.2250	-.0103	-.0100	.4500	-.0206	-.0199
.2500	-.0108	-.0105	.5000	-.0217	-.0210
.2750	-.0113	-.0109	.5500	-.0226	-.0219
.3000	-.0117	-.0113	.6000	-.0235	-.0227
.3250	-.0121	-.0117	.6500	-.0242	-.0234
.3500	-.0124	-.0120	.7000	-.0248	-.0240
.3750	-.0127	-.0123	.7500	-.0254	-.0245
.4000	-.0129	-.0125	.8000	-.0258	-.0249
.4250	-.0131	-.0126	.8500	-.0262	-.0253
.4500	-.0132	-.0128	.9000	-.0264	-.0255
.4750	-.0133	-.0128	.9500	-.0266	-.0257
.5000	-.0133	-.0129	1.0000	-.0267	-.0258
.5250	-.0133	-.0129	1.0500	-.0267	-.0257
.5500	-.0133	-.0128	1.1000	-.0265	-.0256
.5750	-.0132	-.0127	1.1500	-.0263	-.0254
.6000	-.0130	-.0126	1.2000	-.0260	-.0251
.6250	-.0128	-.0124	1.2500	-.0256	-.0248
.6500	-.0126	-.0121	1.3000	-.0251	-.0243
.6750	-.0123	-.0119	1.3500	-.0245	-.0237
.7000	-.0119	-.0115	1.4000	-.0238	-.0230
.7250	-.0115	-.0111	1.4500	-.0230	-.0222
.7500	-.0110	-.0107	1.5000	-.0221	-.0213
.7750	-.0105	-.0101	1.5500	-.0210	-.0203
.8000	-.0099	-.0095	1.6000	-.0198	-.0191
.8250	-.0092	-.0089	1.6500	-.0184	-.0177
.8500	-.0084	-.0081	1.7000	-.0168	-.0162
.8750	-.0076	-.0073	1.7500	-.0152	-.0147
.9000	-.0067	-.0064	1.8000	-.0133	-.0129
.9250	-.0055	-.0053	1.8500	-.0110	-.0106
.9500	-.0040	-.0038	1.9000	-.0080	-.0077
.9750	-.0021	-.0020	1.9500	-.0041	-.0040
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -12.3748

Y/R/2= -.6024

CHORD= 2.0000

SLOPES DZ/DX AT SLOPE POINTS FROM FRONT TO REAR

.0506 .0360 .0264 .0189 .0125 .0066 .0009-.0048-.0108-.0174-.0250-.0347-.0496-.0908
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.1860DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0032	-.0031	.0000	-.0065	-.0063
.0250	-.0045	-.0044	.0500	-.0090	-.0087
.0500	-.0058	-.0056	.1000	-.0116	-.0112
.0750	-.0070	-.0068	.1500	-.0141	-.0136
.1000	-.0082	-.0079	.2000	-.0163	-.0158
.1250	-.0091	-.0088	.2500	-.0182	-.0176
.1500	-.0100	-.0096	.3000	-.0199	-.0193
.1750	-.0107	-.0104	.3500	-.0214	-.0207
.2000	-.0114	-.0110	.4000	-.0228	-.0220
.2250	-.0120	-.0116	.4500	-.0240	-.0232
.2500	-.0126	-.0121	.5000	-.0251	-.0243
.2750	-.0131	-.0126	.5500	-.0261	-.0252
.3000	-.0135	-.0130	.6000	-.0270	-.0260
.3250	-.0139	-.0134	.6500	-.0277	-.0268
.3500	-.0142	-.0137	.7000	-.0283	-.0274
.3750	-.0144	-.0139	.7500	-.0289	-.0279
.4000	-.0146	-.0141	.8000	-.0293	-.0283
.4250	-.0148	-.0143	.8500	-.0296	-.0286
.4500	-.0149	-.0144	.9000	-.0298	-.0288
.4750	-.0150	-.0145	.9500	-.0300	-.0289
.5000	-.0150	-.0145	1.0000	-.0300	-.0290
.5250	-.0149	-.0144	1.0500	-.0299	-.0289
.5500	-.0149	-.0144	1.1000	-.0297	-.0287
.5750	-.0147	-.0142	1.1500	-.0294	-.0284
.6000	-.0145	-.0140	1.2000	-.0291	-.0281
.6250	-.0143	-.0138	1.2500	-.0286	-.0276
.6500	-.0140	-.0135	1.3000	-.0280	-.0270
.6750	-.0136	-.0132	1.3500	-.0273	-.0263
.7000	-.0132	-.0128	1.4000	-.0264	-.0255
.7250	-.0128	-.0123	1.4500	-.0255	-.0246
.7500	-.0122	-.0118	1.5000	-.0244	-.0236
.7750	-.0116	-.0112	1.5500	-.0232	-.0224
.8000	-.0109	-.0105	1.6000	-.0218	-.0211
.8250	-.0101	-.0098	1.6500	-.0203	-.0196
.8500	-.0093	-.0089	1.7000	-.0185	-.0179
.8750	-.0083	-.0081	1.7500	-.0167	-.0161
.9000	-.0073	-.0071	1.8000	-.0146	-.0141
.9250	-.0060	-.0058	1.8500	-.0121	-.0117
.9500	-.0044	-.0042	1.9000	-.0087	-.0084
.9750	-.0023	-.0022	1.9500	-.0045	-.0044
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -10.6803

Y/P/2= -.5199

CHORD= 2.0000

SLOPES, DZ/DY, AT SLOPE POINTS, FROM FRONT TO REAR

.0531 .0374 .0272 .0192 .0123 .0060-.0000-.0061-.0125-.0195-.0276-.0380-.0538-.0977
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.2532DEGREES

LOCAL FLAVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA Y	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0044	-.0043	.0000	-.0088	-.0085
.0250	-.0058	-.0056	.0500	-.0115	-.0111
.0500	-.0071	-.0069	.1000	-.0142	-.0137
.0750	-.0084	-.0081	.1500	-.0168	-.0162
.1000	-.0096	-.0092	.2000	-.0191	-.0185
.1250	-.0106	-.0102	.2500	-.0211	-.0204
.1500	-.0114	-.0111	.3000	-.0229	-.0221
.1750	-.0122	-.0118	.3500	-.0245	-.0236
.2000	-.0129	-.0125	.4000	-.0259	-.0250
.2250	-.0136	-.0131	.4500	-.0271	-.0262
.2500	-.0141	-.0136	.5000	-.0283	-.0273
.2750	-.0146	-.0141	.5500	-.0292	-.0283
.3000	-.0151	-.0145	.6000	-.0301	-.0291
.3250	-.0154	-.0149	.6500	-.0308	-.0298
.3500	-.0157	-.0152	.7000	-.0315	-.0304
.3750	-.0160	-.0154	.7500	-.0320	-.0309
.4000	-.0162	-.0156	.8000	-.0324	-.0313
.4250	-.0163	-.0158	.8500	-.0327	-.0316
.4500	-.0164	-.0159	.9000	-.0329	-.0317
.4750	-.0165	-.0159	.9500	-.0329	-.0318
.5000	-.0165	-.0159	1.0000	-.0329	-.0318
.5250	-.0164	-.0158	1.0500	-.0328	-.0317
.5500	-.0163	-.0157	1.1000	-.0326	-.0314
.5750	-.0161	-.0156	1.1500	-.0322	-.0311
.6000	-.0159	-.0153	1.2000	-.0318	-.0307
.6250	-.0156	-.0151	1.2500	-.0312	-.0301
.6500	-.0153	-.0147	1.3000	-.0305	-.0295
.6750	-.0148	-.0143	1.3500	-.0297	-.0287
.7000	-.0144	-.0139	1.4000	-.0288	-.0278
.7250	-.0139	-.0134	1.4500	-.0277	-.0268
.7500	-.0133	-.0128	1.5000	-.0265	-.0256
.7750	-.0126	-.0122	1.5500	-.0252	-.0243
.8000	-.0118	-.0114	1.6000	-.0237	-.0228
.8250	-.0110	-.0106	1.6500	-.0219	-.0212
.8500	-.0100	-.0097	1.7000	-.0200	-.0194
.8750	-.0090	-.0087	1.7500	-.0180	-.0174
.9000	-.0079	-.0076	1.8000	-.0158	-.0153
.9250	-.0065	-.0063	1.8500	-.0130	-.0126
.9500	-.0047	-.0045	1.9000	-.0094	-.0091
.9750	-.0024	-.0024	1.9500	-.0049	-.0047
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -8.9858

Y/P/2= -.4374

CHORD= 2.0000

SLOPES.DZ/DX.AT SLOPE POINTS.FROM FRONT TO REAR

.0551 .0385 .0277 .0193 .0121 .0054-.0010-.0074-.0141-.0214-.0300-.0409-.0576-.1038
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR
 .0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.3189DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
0.0000	-.0056	-.0054	0.0000	-.0111	-.0108
.0250	-.0070	-.0067	.0500	-.0139	-.0134
.0500	-.0083	-.0081	.1000	-.0167	-.0161
.0750	-.0097	-.0094	.1500	-.0194	-.0187
.1000	-.0109	-.0105	.2000	-.0218	-.0211
.1250	-.0119	-.0115	.2500	-.0239	-.0231
.1500	-.0128	-.0124	.3000	-.0257	-.0248
.1750	-.0136	-.0132	.3500	-.0273	-.0263
.2000	-.0144	-.0139	.4000	-.0287	-.0277
.2250	-.0150	-.0145	.4500	-.0300	-.0290
.2500	-.0156	-.0150	.5000	-.0311	-.0301
.2750	-.0161	-.0155	.5500	-.0321	-.0310
.3000	-.0165	-.0159	.6000	-.0330	-.0319
.3250	-.0169	-.0163	.6500	-.0337	-.0326
.3500	-.0172	-.0166	.7000	-.0343	-.0332
.3750	-.0174	-.0168	.7500	-.0348	-.0336
.4000	-.0176	-.0170	.8000	-.0352	-.0340
.4250	-.0177	-.0171	.8500	-.0355	-.0343
.4500	-.0178	-.0172	.9000	-.0356	-.0344
.4750	-.0178	-.0172	.9500	-.0357	-.0344
.5000	-.0178	-.0172	1.0000	-.0356	-.0344
.5250	-.0177	-.0171	1.0500	-.0354	-.0342
.5500	-.0176	-.0170	1.1000	-.0351	-.0339
.5750	-.0173	-.0168	1.1500	-.0347	-.0335
.6000	-.0171	-.0165	1.2000	-.0342	-.0330
.6250	-.0168	-.0162	1.2500	-.0335	-.0324
.6500	-.0164	-.0158	1.3000	-.0328	-.0316
.6750	-.0159	-.0154	1.3500	-.0319	-.0308
.7000	-.0154	-.0149	1.4000	-.0308	-.0298
.7250	-.0148	-.0143	1.4500	-.0297	-.0287
.7500	-.0142	-.0137	1.5000	-.0284	-.0274
.7750	-.0135	-.0130	1.5500	-.0269	-.0260
.8000	-.0126	-.0122	1.6000	-.0253	-.0244
.8250	-.0117	-.0113	1.6500	-.0234	-.0226
.8500	-.0107	-.0103	1.7000	-.0214	-.0206
.8750	-.0096	-.0093	1.7500	-.0192	-.0186
.9000	-.0084	-.0081	1.8000	-.0168	-.0162
.9250	-.0069	-.0067	1.8500	-.0139	-.0134
.9500	-.0050	-.0048	1.9000	-.0100	-.0096
.9750	-.0026	-.0025	1.9500	-.0052	-.0050
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -7.2913

Y/R/2= -.3549

CHORD= 2.0000

SLOPES.DZ/DX.AT SLOPE POINTS.FROM FRONT TO REAR

.0565 .0392 .0280 .0192 .0116 .0046-.0020-.0087-.0157-.0233-.0322-.0436-.0610-.1092
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.3878DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DIT Z)COS(DIH)
.0000	-.0068	-.0065	.0000	-.0135	-.0131
.0250	-.0082	-.0079	.0500	-.0164	-.0158
.0500	-.0096	-.0093	.1000	-.0192	-.0186
.0750	-.0110	-.0106	.1500	-.0220	-.0212
.1000	-.0122	-.0118	.2000	-.0245	-.0236
.1250	-.0133	-.0128	.2500	-.0266	-.0257
.1500	-.0142	-.0137	.3000	-.0284	-.0274
.1750	-.0150	-.0145	.3500	-.0300	-.0290
.2000	-.0157	-.0152	.4000	-.0315	-.0304
.2250	-.0164	-.0158	.4500	-.0328	-.0317
.2500	-.0170	-.0164	.5000	-.0339	-.0328
.2750	-.0175	-.0169	.5500	-.0349	-.0337
.3000	-.0179	-.0173	.6000	-.0358	-.0345
.3250	-.0182	-.0176	.6500	-.0365	-.0352
.3500	-.0185	-.0179	.7000	-.0371	-.0358
.3750	-.0188	-.0181	.7500	-.0375	-.0362
.4000	-.0189	-.0183	.8000	-.0379	-.0366
.4250	-.0190	-.0184	.8500	-.0381	-.0368
.4500	-.0191	-.0185	.9000	-.0382	-.0369
.4750	-.0191	-.0184	.9500	-.0382	-.0369
.5000	-.0190	-.0184	1.0000	-.0381	-.0368
.5250	-.0189	-.0183	1.0500	-.0378	-.0365
.5500	-.0187	-.0181	1.1000	-.0375	-.0362
.5750	-.0185	-.0179	1.1500	-.0370	-.0357
.6000	-.0182	-.0176	1.2000	-.0364	-.0351
.6250	-.0178	-.0172	1.2500	-.0357	-.0345
.6500	-.0174	-.0168	1.3000	-.0348	-.0336
.6750	-.0169	-.0163	1.3500	-.0338	-.0327
.7000	-.0164	-.0158	1.4000	-.0327	-.0316
.7250	-.0157	-.0152	1.4500	-.0315	-.0304
.7500	-.0150	-.0145	1.5000	-.0301	-.0290
.7750	-.0142	-.0138	1.5500	-.0285	-.0275
.8000	-.0134	-.0129	1.6000	-.0267	-.0258
.8250	-.0124	-.0119	1.6500	-.0247	-.0239
.8500	-.0113	-.0109	1.7000	-.0226	-.0218
.8750	-.0101	-.0098	1.7500	-.0203	-.0196
.9000	-.0089	-.0086	1.8000	-.0177	-.0171
.9250	-.0073	-.0070	1.8500	-.0146	-.0141
.9500	-.0052	-.0051	1.9000	-.0105	-.0101
.9750	-.0027	-.0026	1.9500	-.0055	-.0053
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -5.5968

Y/R/2= -.2724

CHORD= 2.0000

SLOPES.DZ/DX.AT SLOPE POINTS.FROM FRONT TO REAR

.0572 .0393 .0277 .0186 .0108 .0036-.0033-.0102-.0174-.0253-.0345-.0462-.0641-.1140
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.4682DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0082	-.0079	.0000	-.0163	-.0158
.0250	-.0096	-.0093	.0500	-.0192	-.0186
.0500	-.0111	-.0107	.1000	-.0221	-.0214
.0750	-.0125	-.0120	.1500	-.0249	-.0241
.1000	-.0137	-.0132	.2000	-.0274	-.0265
.1250	-.0148	-.0143	.2500	-.0295	-.0285
.1500	-.0157	-.0152	.3000	-.0314	-.0303
.1750	-.0165	-.0159	.3500	-.0330	-.0319
.2000	-.0172	-.0166	.4000	-.0344	-.0332
.2250	-.0179	-.0172	.4500	-.0357	-.0345
.2500	-.0184	-.0178	.5000	-.0368	-.0356
.2750	-.0189	-.0182	.5500	-.0378	-.0365
.3000	-.0193	-.0186	.6000	-.0386	-.0373
.3250	-.0196	-.0190	.6500	-.0393	-.0379
.3500	-.0199	-.0192	.7000	-.0398	-.0385
.3750	-.0201	-.0194	.7500	-.0402	-.0389
.4000	-.0203	-.0196	.8000	-.0405	-.0392
.4250	-.0204	-.0197	.8500	-.0407	-.0393
.4500	-.0204	-.0197	.9000	-.0408	-.0394
.4750	-.0203	-.0197	.9500	-.0407	-.0393
.5000	-.0202	-.0196	1.0000	-.0405	-.0391
.5250	-.0201	-.0194	1.0500	-.0402	-.0388
.5500	-.0199	-.0192	1.1000	-.0398	-.0384
.5750	-.0196	-.0189	1.1500	-.0392	-.0379
.6000	-.0193	-.0186	1.2000	-.0385	-.0372
.6250	-.0189	-.0182	1.2500	-.0377	-.0364
.6500	-.0184	-.0178	1.3000	-.0368	-.0355
.6750	-.0179	-.0172	1.3500	-.0357	-.0345
.7000	-.0172	-.0167	1.4000	-.0345	-.0333
.7250	-.0166	-.0160	1.4500	-.0331	-.0320
.7500	-.0158	-.0153	1.5000	-.0316	-.0306
.7750	-.0150	-.0145	1.5500	-.0300	-.0289
.8000	-.0140	-.0136	1.6000	-.0281	-.0271
.8250	-.0130	-.0125	1.6500	-.0259	-.0251
.8500	-.0118	-.0114	1.7000	-.0237	-.0228
.8750	-.0106	-.0103	1.7500	-.0212	-.0205
.9000	-.0093	-.0090	1.8000	-.0185	-.0179
.9250	-.0076	-.0074	1.8500	-.0152	-.0147
.9500	-.0055	-.0053	1.9000	-.0110	-.0106
.9750	-.0028	-.0027	1.9500	-.0057	-.0055
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -3.9023

Y/R/2= -.1900

CHORD= 2.0000

SLOPES•DZ/DX•AT SLOPE POINTS•FROM FRONT TO REAR

.0568 .0385 .0265 .0172 .0092 .0019-.0052-.0122-.0196-.0276-.0370-.0490-.0674-.1185
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .8107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.5818DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0102	-.0098	.0000	-.0203	-.0196
.0250	-.0116	-.0112	.0500	-.0232	-.0224
.0500	-.0130	-.0126	.1000	-.0260	-.0252
.0750	-.0144	-.0139	.1500	-.0288	-.0278
.1000	-.0156	-.0151	.2000	-.0313	-.0302
.1250	-.0167	-.0161	.2500	-.0334	-.0322
.1500	-.0176	-.0170	.3000	-.0352	-.0340
.1750	-.0184	-.0177	.3500	-.0367	-.0355
.2000	-.0191	-.0184	.4000	-.0381	-.0368
.2250	-.0197	-.0190	.4500	-.0393	-.0380
.2500	-.0202	-.0195	.5000	-.0404	-.0390
.2750	-.0206	-.0199	.5500	-.0413	-.0399
.3000	-.0210	-.0203	.6000	-.0420	-.0406
.3250	-.0213	-.0206	.6500	-.0426	-.0412
.3500	-.0215	-.0208	.7000	-.0431	-.0416
.3750	-.0217	-.0210	.7500	-.0434	-.0420
.4000	-.0218	-.0211	.8000	-.0436	-.0422
.4250	-.0219	-.0211	.8500	-.0437	-.0422
.4500	-.0218	-.0211	.9000	-.0437	-.0422
.4750	-.0218	-.0210	.9500	-.0435	-.0420
.5000	-.0216	-.0209	1.0000	-.0432	-.0418
.5250	-.0214	-.0207	1.0500	-.0428	-.0414
.5500	-.0211	-.0204	1.1000	-.0423	-.0409
.5750	-.0208	-.0201	1.1500	-.0416	-.0402
.6000	-.0204	-.0197	1.2000	-.0409	-.0395
.6250	-.0200	-.0193	1.2500	-.0399	-.0386
.6500	-.0194	-.0188	1.3000	-.0389	-.0376
.6750	-.0189	-.0182	1.3500	-.0377	-.0364
.7000	-.0182	-.0176	1.4000	-.0364	-.0351
.7250	-.0175	-.0169	1.4500	-.0349	-.0337
.7500	-.0166	-.0161	1.5000	-.0333	-.0321
.7750	-.0157	-.0152	1.5500	-.0315	-.0304
.8000	-.0147	-.0142	1.6000	-.0294	-.0284
.8250	-.0136	-.0131	1.6500	-.0272	-.0263
.8500	-.0124	-.0120	1.7000	-.0247	-.0239
.8750	-.0111	-.0107	1.7500	-.0222	-.0214
.9000	-.0097	-.0093	1.8000	-.0193	-.0187
.9250	-.0079	-.0077	1.8500	-.0159	-.0153
.9500	-.0057	-.0055	1.9000	-.0114	-.0110
.9750	-.0030	-.0029	1.9500	-.0059	-.0057
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -2.2078 Y/P/2= -.1075 CHORD= 2.0000

SLOPE= .02/DX AT SLOPE POINTS FROM FRONT TO REAR

.0536 .0350 .0228 .0134 .0053-.0021-.0092-.0162-.0236-.0317-.0411-.0532-.0718-.1237
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.8085DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
0.0000	-.0141	-.0136	0.0000	-.0282	-.0273
.0250	-.0155	-.0149	.0500	-.0309	-.0299
.0500	-.0168	-.0162	.1000	-.0336	-.0325
.0750	-.0181	-.0175	.1500	-.0363	-.0350
.1000	-.0193	-.0186	.2000	-.0386	-.0372
.1250	-.0202	-.0196	.2500	-.0405	-.0391
.1500	-.0210	-.0203	.3000	-.0421	-.0407
.1750	-.0217	-.0210	.3500	-.0435	-.0420
.2000	-.0223	-.0216	.4000	-.0447	-.0431
.2250	-.0229	-.0221	.4500	-.0457	-.0441
.2500	-.0233	-.0225	.5000	-.0466	-.0450
.2750	-.0236	-.0228	.5500	-.0473	-.0457
.3000	-.0239	-.0231	.6000	-.0478	-.0462
.3250	-.0241	-.0233	.6500	-.0482	-.0466
.3500	-.0243	-.0234	.7000	-.0485	-.0469
.3750	-.0243	-.0235	.7500	-.0487	-.0470
.4000	-.0243	-.0235	.8000	-.0487	-.0470
.4250	-.0243	-.0234	.8500	-.0486	-.0469
.4500	-.0242	-.0233	.9000	-.0483	-.0467
.4750	-.0240	-.0232	.9500	-.0480	-.0463
.5000	-.0237	-.0229	1.0000	-.0475	-.0458
.5250	-.0234	-.0226	1.0500	-.0469	-.0453
.5500	-.0231	-.0223	1.1000	-.0461	-.0446
.5750	-.0226	-.0219	1.1500	-.0453	-.0437
.6000	-.0221	-.0214	1.2000	-.0443	-.0428
.6250	-.0216	-.0209	1.2500	-.0432	-.0417
.6500	-.0210	-.0202	1.3000	-.0419	-.0405
.6750	-.0203	-.0196	1.3500	-.0405	-.0392
.7000	-.0195	-.0188	1.4000	-.0390	-.0377
.7250	-.0187	-.0180	1.4500	-.0373	-.0361
.7500	-.0177	-.0171	1.5000	-.0355	-.0343
.7750	-.0167	-.0162	1.5500	-.0335	-.0323
.8000	-.0156	-.0151	1.6000	-.0312	-.0302
.8250	-.0144	-.0139	1.6500	-.0288	-.0278
.8500	-.0131	-.0126	1.7000	-.0261	-.0252
.8750	-.0117	-.0113	1.7500	-.0234	-.0226
.9000	-.0102	-.0098	1.8000	-.0203	-.0196
.9250	-.0083	-.0080	1.8500	-.0166	-.0161
.9500	-.0060	-.0058	1.9000	-.0119	-.0115
.9750	-.0031	-.0030	1.9500	-.0062	-.0060
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -.6803 Y/P/2= -.0331 CHOPD= 2.0000

SLOPES DZ/DY AT SLOPE POINTS FROM FRONT TO REAR

.0396 .0201 .0075-.0023-.0105-.0178-.0246-.0311-.0378-.0450-.0534-.0644-.0819-.1331
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHOPD ANGLE OF ATTACK IN X-Z PLANE= -1.6002DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA Y	DELTA Z	(DLT Z)COS(DTH)
.0000	-.0279	-.0270	.0000	-.0559	-.0540
.0250	-.0289	-.0279	.0500	-.0579	-.0559
.0500	-.0299	-.0289	.1000	-.0599	-.0578
.0750	-.0309	-.0298	.1500	-.0618	-.0597
.1000	-.0317	-.0306	.2000	-.0634	-.0612
.1250	-.0323	-.0312	.2500	-.0646	-.0624
.1500	-.0327	-.0316	.3000	-.0654	-.0632
.1750	-.0330	-.0319	.3500	-.0660	-.0638
.2000	-.0332	-.0321	.4000	-.0665	-.0642
.2250	-.0334	-.0322	.4500	-.0667	-.0645
.2500	-.0334	-.0323	.5000	-.0668	-.0645
.2750	-.0334	-.0322	.5500	-.0667	-.0645
.3000	-.0333	-.0321	.6000	-.0665	-.0642
.3250	-.0331	-.0319	.6500	-.0661	-.0639
.3500	-.0328	-.0317	.7000	-.0656	-.0634
.3750	-.0325	-.0314	.7500	-.0650	-.0628
.4000	-.0321	-.0310	.8000	-.0642	-.0620
.4250	-.0316	-.0306	.8500	-.0633	-.0611
.4500	-.0311	-.0301	.9000	-.0623	-.0602
.4750	-.0306	-.0295	.9500	-.0611	-.0591
.5000	-.0299	-.0289	1.0000	-.0599	-.0578
.5250	-.0293	-.0283	1.0500	-.0585	-.0565
.5500	-.0285	-.0275	1.1000	-.0570	-.0551
.5750	-.0277	-.0268	1.1500	-.0554	-.0536
.6000	-.0269	-.0259	1.2000	-.0537	-.0519
.6250	-.0259	-.0251	1.2500	-.0519	-.0501
.6500	-.0250	-.0241	1.3000	-.0499	-.0482
.6750	-.0239	-.0231	1.3500	-.0479	-.0462
.7000	-.0228	-.0221	1.4000	-.0457	-.0441
.7250	-.0217	-.0209	1.4500	-.0433	-.0419
.7500	-.0204	-.0197	1.5000	-.0409	-.0395
.7750	-.0191	-.0185	1.5500	-.0382	-.0369
.8000	-.0177	-.0171	1.6000	-.0354	-.0342
.8250	-.0162	-.0156	1.6500	-.0324	-.0313
.8500	-.0146	-.0141	1.7000	-.0291	-.0282
.8750	-.0129	-.0125	1.7500	-.0258	-.0249
.9000	-.0111	-.0107	1.8000	-.0223	-.0215
.9250	-.0090	-.0087	1.8500	-.0181	-.0175
.9500	-.0064	-.0062	1.9000	-.0129	-.0124
.9750	-.0033	-.0032	1.9500	-.0067	-.0064
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -20.3397

Y/R/2= -.9901

CHCRD=

.8938

SLOPES·DZ/DX·AT SLOPE POINTS·FROM FRONT TO REAR

.2050 .1550 .1229 .0982 .0774 .0587 .0412 .0239 .0061-.0130-.0349-.0626-.1044-.2194
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHCRD ANGLE OF ATTACK IN X-Z PLANE= 1.0866DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	.0329	.0085	0.0000	.0294	.0076
.0250	.0278	.0072	.0223	.0248	.0064
.0500	.0226	.0059	.0447	.0202	.0052
.0750	.0176	.0046	.0670	.0157	.0041
.1000	.0130	.0034	.0894	.0116	.0030
.1250	.0089	.0023	.1117	.0079	.0020
.1500	.0052	.0013	.1341	.0046	.0012
.1750	.0018	.0005	.1564	.0016	.0004
.2000	-.0013	-.0003	.1788	-.0012	-.0003
.2250	-.0043	-.0011	.2011	-.0038	-.0010
.2500	-.0070	-.0018	.2234	-.0063	-.0016
.2750	-.0095	-.0025	.2458	-.0085	-.0022
.3000	-.0118	-.0031	.2681	-.0105	-.0027
.3250	-.0139	-.0036	.2905	-.0124	-.0032
.3500	-.0159	-.0041	.3128	-.0142	-.0037
.3750	-.0176	-.0046	.3352	-.0158	-.0041
.4000	-.0193	-.0050	.3575	-.0172	-.0045
.4250	-.0207	-.0054	.3798	-.0185	-.0048
.4500	-.0220	-.0057	.4022	-.0197	-.0051
.4750	-.0232	-.0060	.4245	-.0207	-.0054
.5000	-.0242	-.0063	.4469	-.0216	-.0056
.5250	-.0250	-.0065	.4692	-.0224	-.0058
.5500	-.0257	-.0067	.4916	-.0230	-.0059
.5750	-.0262	-.0068	.5139	-.0235	-.0061
.6000	-.0266	-.0069	.5363	-.0238	-.0062
.6250	-.0269	-.0070	.5586	-.0240	-.0062
.6500	-.0269	-.0070	.5809	-.0241	-.0062
.6750	-.0268	-.0069	.6033	-.0240	-.0062
.7000	-.0266	-.0069	.6256	-.0238	-.0061
.7250	-.0261	-.0068	.6480	-.0234	-.0060
.7500	-.0255	-.0066	.6703	-.0228	-.0059
.7750	-.0247	-.0064	.6927	-.0221	-.0057
.8000	-.0236	-.0061	.7150	-.0211	-.0055
.8250	-.0223	-.0058	.7373	-.0199	-.0052
.8500	-.0207	-.0054	.7597	-.0185	-.0048
.8750	-.0190	-.0049	.7820	-.0170	-.0044
.9000	-.0170	-.0044	.8044	-.0152	-.0039
.9250	-.0143	-.0037	.8267	-.0128	-.0033
.9500	-.0105	-.0027	.8491	-.0094	-.0024
.9750	-.0055	-.0014	.8714	-.0049	-.0013
1.0000	0.0000	0.0000	.8938	0.0000	0.0000

Y= -20.0679

Y/R/2= -.9769

CHORD= 1.5688

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.2386 .1376 .0775 .0368 .0079-.0139-.0315-.0467-.0607-.0743-.0888-.1063-.1333-.2197
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.6625 DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0116	-.0030	0.0000	-.0181	-.0047
.0250	-.0176	-.0046	.0392	-.0276	-.0071
.0500	-.0237	-.0061	.0784	-.0371	-.0096
.0750	-.0294	-.0076	.1177	-.0462	-.0119
.1000	-.0344	-.0089	.1569	-.0539	-.0140
.1250	-.0383	-.0099	.1961	-.0601	-.0155
.1500	-.0414	-.0107	.2353	-.0649	-.0168
.1750	-.0438	-.0113	.2745	-.0688	-.0178
.2000	-.0459	-.0119	.3138	-.0720	-.0186
.2250	-.0476	-.0123	.3530	-.0747	-.0193
.2500	-.0489	-.0127	.3922	-.0768	-.0199
.2750	-.0499	-.0129	.4314	-.0783	-.0203
.3000	-.0506	-.0131	.4706	-.0794	-.0206
.3250	-.0511	-.0132	.5098	-.0801	-.0207
.3500	-.0513	-.0132	.5491	-.0804	-.0208
.3750	-.0513	-.0133	.5883	-.0804	-.0208
.4000	-.0511	-.0132	.6275	-.0802	-.0207
.4250	-.0507	-.0131	.6667	-.0796	-.0206
.4500	-.0502	-.0130	.7059	-.0788	-.0204
.4750	-.0495	-.0128	.7452	-.0777	-.0201
.5000	-.0487	-.0126	.7844	-.0764	-.0198
.5250	-.0478	-.0124	.8236	-.0749	-.0194
.5500	-.0467	-.0121	.8628	-.0732	-.0190
.5750	-.0455	-.0118	.9020	-.0713	-.0185
.6000	-.0441	-.0114	.9413	-.0693	-.0179
.6250	-.0427	-.0110	.9805	-.0670	-.0173
.6500	-.0411	-.0106	1.0197	-.0645	-.0167
.6750	-.0394	-.0102	1.0589	-.0618	-.0160
.7000	-.0376	-.0097	1.0981	-.0590	-.0153
.7250	-.0357	-.0092	1.1373	-.0559	-.0145
.7500	-.0336	-.0087	1.1766	-.0527	-.0136
.7750	-.0314	-.0081	1.2158	-.0493	-.0128
.8000	-.0291	-.0075	1.2550	-.0456	-.0118
.8250	-.0265	-.0069	1.2942	-.0416	-.0108
.8500	-.0239	-.0062	1.3334	-.0375	-.0097
.8750	-.0212	-.0055	1.3727	-.0332	-.0086
.9000	-.0183	-.0047	1.4119	-.0287	-.0074
.9250	-.0149	-.0038	1.4511	-.0233	-.0060
.9500	-.0106	-.0027	1.4903	-.0166	-.0043
.9750	-.0055	-.0014	1.5295	-.0086	-.0022
1.0000	0.0000	0.0000	1.5688	0.0000	0.0000

Y= -19.1528

Y/R/P= -.9323

CHORD= 2.0000

SLOPES/DZ/DX AT SLOPE POINTS FROM FRONT TO REAR

-.0034-.0121-.0176-.0217-.0249-.0276-.0299-.0320-.0342-.0367-.0400-.0447-.0527-.0769
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR
 .0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.78180DFGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0311	-.0300	0.0000	-.0622	-.0601
.0250	-.0310	-.0300	.0500	-.0621	-.0599
.0500	-.0310	-.0299	.1000	-.0619	-.0598
.0750	-.0309	-.0298	.1500	-.0617	-.0596
.1000	-.0307	-.0296	.2000	-.0614	-.0593
.1250	-.0304	-.0294	.2500	-.0608	-.0588
.1500	-.0301	-.0291	.3000	-.0602	-.0581
.1750	-.0297	-.0287	.3500	-.0594	-.0574
.2000	-.0293	-.0283	.4000	-.0585	-.0565
.2250	-.0288	-.0278	.4500	-.0576	-.0557
.2500	-.0283	-.0273	.5000	-.0566	-.0547
.2750	-.0278	-.0268	.5500	-.0555	-.0537
.3000	-.0272	-.0263	.6000	-.0544	-.0526
.3250	-.0266	-.0257	.6500	-.0532	-.0514
.3500	-.0260	-.0251	.7000	-.0520	-.0502
.3750	-.0253	-.0245	.7500	-.0507	-.0490
.4000	-.0247	-.0238	.8000	-.0494	-.0477
.4250	-.0240	-.0232	.8500	-.0480	-.0463
.4500	-.0233	-.0225	.9000	-.0466	-.0450
.4750	-.0225	-.0218	.9500	-.0451	-.0436
.5000	-.0218	-.0211	1.0000	-.0436	-.0421
.5250	-.0210	-.0203	1.0500	-.0421	-.0406
.5500	-.0202	-.0195	1.1000	-.0405	-.0391
.5750	-.0194	-.0188	1.1500	-.0389	-.0375
.6000	-.0186	-.0180	1.2000	-.0372	-.0359
.6250	-.0178	-.0172	1.2500	-.0355	-.0343
.6500	-.0169	-.0163	1.3000	-.0338	-.0326
.6750	-.0160	-.0155	1.3500	-.0320	-.0309
.7000	-.0151	-.0146	1.4000	-.0302	-.0292
.7250	-.0142	-.0137	1.4500	-.0283	-.0274
.7500	-.0132	-.0128	1.5000	-.0264	-.0255
.7750	-.0122	-.0118	1.5500	-.0244	-.0236
.8000	-.0112	-.0108	1.6000	-.0224	-.0216
.8250	-.0101	-.0098	1.6500	-.0202	-.0195
.8500	-.0090	-.0087	1.7000	-.0180	-.0174
.8750	-.0078	-.0076	1.7500	-.0157	-.0152
.9000	-.0067	-.0064	1.8000	-.0133	-.0129
.9250	-.0053	-.0051	1.8500	-.0106	-.0103
.9500	-.0037	-.0036	1.9000	-.0075	-.0072
.9750	-.0019	-.0019	1.9500	-.0038	-.0037
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -17.4583

Y/R/2= -.8498

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0138 .0038-.0028-.0078-.0121-.0160-.0198-.0235-.0273-.0316-.0365-.0429-.0528-.0806
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.2775066666666666 DEGREES

LOCAL FLEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0223	-.0215	0.0000	-.0446	-.0431
.0250	-.0227	-.0219	.0500	-.0453	-.0438
.0500	-.0230	-.0222	.1000	-.0460	-.0444
.0750	-.0233	-.0225	.1500	-.0467	-.0451
.1000	-.0236	-.0228	.2000	-.0471	-.0455
.1250	-.0237	-.0229	.2500	-.0474	-.0458
.1500	-.0238	-.0230	.3000	-.0475	-.0459
.1750	-.0238	-.0230	.3500	-.0475	-.0459
.2000	-.0237	-.0229	.4000	-.0474	-.0458
.2250	-.0236	-.0228	.4500	-.0472	-.0456
.2500	-.0235	-.0227	.5000	-.0469	-.0453
.2750	-.0233	-.0225	.5500	-.0466	-.0450
.3000	-.0231	-.0223	.6000	-.0461	-.0445
.3250	-.0228	-.0220	.6500	-.0456	-.0440
.3500	-.0225	-.0217	.7000	-.0450	-.0435
.3750	-.0222	-.0214	.7500	-.0443	-.0428
.4000	-.0218	-.0210	.8000	-.0436	-.0421
.4250	-.0214	-.0207	.8500	-.0428	-.0413
.4500	-.0210	-.0202	.9000	-.0419	-.0405
.4750	-.0205	-.0198	.9500	-.0410	-.0396
.5000	-.0200	-.0193	1.0000	-.0400	-.0386
.5250	-.0194	-.0188	1.0500	-.0389	-.0376
.5500	-.0189	-.0182	1.1000	-.0378	-.0365
.5750	-.0183	-.0177	1.1500	-.0366	-.0353
.6000	-.0177	-.0171	1.2000	-.0353	-.0341
.6250	-.0170	-.0164	1.2500	-.0340	-.0328
.6500	-.0163	-.0157	1.3000	-.0326	-.0315
.6750	-.0155	-.0150	1.3500	-.0311	-.0300
.7000	-.0148	-.0143	1.4000	-.0295	-.0285
.7250	-.0140	-.0135	1.4500	-.0279	-.0270
.7500	-.0131	-.0127	1.5000	-.0262	-.0253
.7750	-.0122	-.0118	1.5500	-.0244	-.0236
.8000	-.0112	-.0109	1.6000	-.0225	-.0217
.8250	-.0102	-.0099	1.6500	-.0204	-.0197
.8500	-.0092	-.0088	1.7000	-.0183	-.0177
.8750	-.0080	-.0078	1.7500	-.0161	-.0155
.9000	-.0069	-.0066	1.8000	-.0137	-.0133
.9250	-.0055	-.0053	1.8500	-.0111	-.0107
.9500	-.0039	-.0038	1.9000	-.0078	-.0076
.9750	-.0020	-.0019	1.9500	-.0040	-.0039
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -15.7638

Y/F/2= -.7673

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0210 .0095 .0019-.0040-.0091-.0137-.0181-.0224-.0270-.0319-.0376-.0450-.0563-.0880
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR
 .0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.1987066RFFS

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA Y	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0209	-.0202	0.0000	-.0418	-.0404
.0250	-.0215	-.0207	.0500	-.0429	-.0415
.0500	-.0220	-.0212	.1000	-.0440	-.0425
.0750	-.0225	-.0217	.1500	-.0450	-.0435
.1000	-.0229	-.0221	.2000	-.0458	-.0443
.1250	-.0232	-.0224	.2500	-.0464	-.0448
.1500	-.0234	-.0226	.3000	-.0468	-.0452
.1750	-.0235	-.0227	.3500	-.0470	-.0454
.2000	-.0236	-.0228	.4000	-.0472	-.0455
.2250	-.0236	-.0228	.4500	-.0472	-.0456
.2500	-.0236	-.0228	.5000	-.0471	-.0455
.2750	-.0235	-.0227	.5500	-.0469	-.0453
.3000	-.0233	-.0225	.6000	-.0467	-.0451
.3250	-.0231	-.0224	.6500	-.0463	-.0447
.3500	-.0229	-.0221	.7000	-.0458	-.0443
.3750	-.0227	-.0219	.7500	-.0453	-.0438
.4000	-.0224	-.0216	.8000	-.0447	-.0432
.4250	-.0220	-.0213	.8500	-.0440	-.0425
.4500	-.0216	-.0209	.9000	-.0433	-.0418
.4750	-.0212	-.0205	.9500	-.0424	-.0410
.5000	-.0207	-.0200	1.0000	-.0415	-.0401
.5250	-.0202	-.0196	1.0500	-.0405	-.0391
.5500	-.0197	-.0190	1.1000	-.0394	-.0381
.5750	-.0191	-.0185	1.1500	-.0383	-.0370
.6000	-.0185	-.0179	1.2000	-.0370	-.0358
.6250	-.0179	-.0173	1.2500	-.0357	-.0345
.6500	-.0172	-.0166	1.3000	-.0344	-.0332
.6750	-.0164	-.0159	1.3500	-.0329	-.0318
.7000	-.0157	-.0151	1.4000	-.0313	-.0302
.7250	-.0148	-.0143	1.4500	-.0297	-.0286
.7500	-.0140	-.0135	1.5000	-.0279	-.0270
.7750	-.0130	-.0126	1.5500	-.0261	-.0252
.8000	-.0120	-.0116	1.6000	-.0241	-.0232
.8250	-.0110	-.0106	1.6500	-.0219	-.0212
.8500	-.0098	-.0095	1.7000	-.0197	-.0190
.8750	-.0087	-.0084	1.7500	-.0174	-.0168
.9000	-.0074	-.0072	1.8000	-.0149	-.0144
.9250	-.0060	-.0058	1.8500	-.0120	-.0116
.9500	-.0043	-.0041	1.9000	-.0085	-.0082
.9750	-.0022	-.0021	1.9500	-.0044	-.0042
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -14.0693

Y/F/2= -.6849

CHORD= 2.0000

SLOPES,DZ/DX,AT SLOPE POINTS,FROM FRONT TO REAR

.0266 .0137 .0053-.0012-.0069-.0120-.0170-.0219-.0269-.0325-.0389-.0471-.0597-.0949
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.1561DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0202	-.0195	0.0000	-.0404	-.0390
.0250	-.0209	-.0201	.0500	-.0417	-.0403
.0500	-.0215	-.0206	.1000	-.0431	-.0416
.0750	-.0222	-.0214	.1500	-.0443	-.0428
.1000	-.0227	-.0219	.2000	-.0454	-.0439
.1250	-.0231	-.0223	.2500	-.0462	-.0446
.1500	-.0234	-.0226	.3000	-.0468	-.0452
.1750	-.0236	-.0228	.3500	-.0472	-.0456
.2000	-.0238	-.0230	.4000	-.0475	-.0459
.2250	-.0239	-.0231	.4500	-.0477	-.0461
.2500	-.0239	-.0231	.5000	-.0478	-.0462
.2750	-.0239	-.0231	.5500	-.0478	-.0461
.3000	-.0238	-.0230	.6000	-.0476	-.0460
.3250	-.0237	-.0229	.6500	-.0474	-.0458
.3500	-.0235	-.0227	.7000	-.0470	-.0454
.3750	-.0233	-.0225	.7500	-.0466	-.0450
.4000	-.0230	-.0223	.8000	-.0461	-.0445
.4250	-.0227	-.0220	.8500	-.0455	-.0439
.4500	-.0224	-.0216	.9000	-.0448	-.0433
.4750	-.0220	-.0213	.9500	-.0440	-.0425
.5000	-.0216	-.0208	1.0000	-.0431	-.0417
.5250	-.0211	-.0204	1.0500	-.0422	-.0408
.5500	-.0206	-.0199	1.1000	-.0412	-.0398
.5750	-.0200	-.0193	1.1500	-.0400	-.0387
.6000	-.0194	-.0187	1.2000	-.0388	-.0375
.6250	-.0188	-.0181	1.2500	-.0375	-.0362
.6500	-.0181	-.0174	1.3000	-.0361	-.0349
.6750	-.0173	-.0167	1.3500	-.0346	-.0335
.7000	-.0165	-.0160	1.4000	-.0331	-.0319
.7250	-.0157	-.0151	1.4500	-.0314	-.0303
.7500	-.0148	-.0143	1.5000	-.0296	-.0286
.7750	-.0138	-.0134	1.5500	-.0277	-.0267
.8000	-.0128	-.0124	1.6000	-.0256	-.0247
.8250	-.0117	-.0113	1.6500	-.0234	-.0226
.8500	-.0105	-.0102	1.7000	-.0210	-.0203
.8750	-.0093	-.0090	1.7500	-.0186	-.0180
.9000	-.0080	-.0077	1.8000	-.0160	-.0154
.9250	-.0065	-.0062	1.8500	-.0129	-.0125
.9500	-.0046	-.0044	1.9000	-.0092	-.0089
.9750	-.0024	-.0023	1.9500	-.0047	-.0046
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -12.3748

Y/R/2= -.6024

CHCRD= 2.0000

SLOPES.DZ/DX.AT SLOPE POINTS.FROM FRONT TO REAR

.0314 .0174 .0083 .0011-.0050-.0106-.0160-.0213-.0269-.0329-.0399-.0489-.0627-.1011
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.1193DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0195	-.0189	0.0000	-.0391	-.0377
.0250	-.0203	-.0196	.0500	-.0407	-.0393
.0500	-.0211	-.0204	.1000	-.0423	-.0408
.0750	-.0219	-.0211	.1500	-.0438	-.0423
.1000	-.0225	-.0218	.2000	-.0451	-.0435
.1250	-.0230	-.0223	.2500	-.0461	-.0445
.1500	-.0234	-.0226	.3000	-.0468	-.0452
.1750	-.0237	-.0229	.3500	-.0474	-.0458
.2000	-.0239	-.0231	.4000	-.0479	-.0462
.2250	-.0241	-.0233	.4500	-.0482	-.0466
.2500	-.0242	-.0234	.5000	-.0484	-.0468
.2750	-.0243	-.0234	.5500	-.0485	-.0469
.3000	-.0242	-.0234	.6000	-.0485	-.0468
.3250	-.0242	-.0233	.6500	-.0483	-.0467
.3500	-.0240	-.0232	.7000	-.0481	-.0464
.3750	-.0239	-.0231	.7500	-.0477	-.0461
.4000	-.0236	-.0228	.8000	-.0473	-.0457
.4250	-.0234	-.0226	.8500	-.0468	-.0452
.4500	-.0231	-.0223	.9000	-.0461	-.0446
.4750	-.0227	-.0219	.9500	-.0454	-.0439
.5000	-.0223	-.0215	1.0000	-.0446	-.0431
.5250	-.0218	-.0211	1.0500	-.0437	-.0422
.5500	-.0213	-.0206	1.1000	-.0427	-.0412
.5750	-.0208	-.0201	1.1500	-.0416	-.0401
.6000	-.0202	-.0195	1.2000	-.0404	-.0390
.6250	-.0195	-.0189	1.2500	-.0391	-.0377
.6500	-.0188	-.0182	1.3000	-.0377	-.0364
.6750	-.0181	-.0175	1.3500	-.0362	-.0349
.7000	-.0173	-.0167	1.4000	-.0346	-.0334
.7250	-.0164	-.0159	1.4500	-.0329	-.0317
.7500	-.0155	-.0150	1.5000	-.0310	-.0300
.7750	-.0145	-.0140	1.5500	-.0291	-.0281
.8000	-.0135	-.0130	1.6000	-.0269	-.0260
.8250	-.0123	-.0119	1.6500	-.0246	-.0238
.8500	-.0111	-.0107	1.7000	-.0222	-.0214
.8750	-.0098	-.0095	1.7500	-.0197	-.0190
.9000	-.0085	-.0082	1.8000	-.0169	-.0164
.9250	-.0069	-.0066	1.8500	-.0137	-.0133
.9500	-.0049	-.0047	1.9000	-.0098	-.0094
.9750	-.0025	-.0024	1.9500	-.0050	-.0049
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -10.6803

Y/P/2= -.5199

CHORD= 2.0000

SLOPES DZ/DY AT SLOPE POINTS, FROM FRONT TO REAR

.0356 .0207 .0109 .0032-.0033-.0093-.0151-.0208-.0267-.0332-.0407-.0504-.0651-.1063
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.0825DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
-.0000	-.0189	-.0183	-.0000	-.0370	-.0365
.0250	-.0198	-.0191	.0500	-.0396	-.0382
.0500	-.0207	-.0200	.1000	-.0414	-.0400
.0750	-.0216	-.0208	.1500	-.0431	-.0417
.1000	-.0223	-.0215	.2000	-.0446	-.0431
.1250	-.0229	-.0221	.2500	-.0458	-.0442
.1500	-.0234	-.0226	.3000	-.0467	-.0451
.1750	-.0237	-.0229	.3500	-.0474	-.0458
.2000	-.0240	-.0232	.4000	-.0480	-.0464
.2250	-.0242	-.0234	.4500	-.0485	-.0468
.2500	-.0244	-.0236	.5000	-.0488	-.0471
.2750	-.0245	-.0237	.5500	-.0490	-.0473
.3000	-.0245	-.0237	.6000	-.0491	-.0474
.3250	-.0245	-.0237	.6500	-.0490	-.0473
.3500	-.0244	-.0236	.7000	-.0489	-.0472
.3750	-.0243	-.0235	.7500	-.0486	-.0469
.4000	-.0241	-.0233	.8000	-.0482	-.0466
.4250	-.0239	-.0231	.8500	-.0477	-.0461
.4500	-.0236	-.0228	.9000	-.0472	-.0456
.4750	-.0232	-.0225	.9500	-.0465	-.0449
.5000	-.0229	-.0221	1.0000	-.0457	-.0442
.5250	-.0224	-.0217	1.0500	-.0448	-.0433
.5500	-.0219	-.0212	1.1000	-.0439	-.0424
.5750	-.0214	-.0207	1.1500	-.0428	-.0413
.6000	-.0208	-.0201	1.2000	-.0416	-.0402
.6250	-.0202	-.0195	1.2500	-.0403	-.0390
.6500	-.0195	-.0188	1.3000	-.0389	-.0376
.6750	-.0187	-.0181	1.3500	-.0374	-.0362
.7000	-.0179	-.0173	1.4000	-.0358	-.0346
.7250	-.0170	-.0165	1.4500	-.0341	-.0329
.7500	-.0161	-.0156	1.5000	-.0322	-.0311
.7750	-.0151	-.0146	1.5500	-.0302	-.0292
.8000	-.0140	-.0135	1.6000	-.0280	-.0271
.8250	-.0128	-.0124	1.6500	-.0257	-.0248
.8500	-.0116	-.0112	1.7000	-.0232	-.0224
.8750	-.0103	-.0099	1.7500	-.0206	-.0199
.9000	-.0089	-.0086	1.8000	-.0177	-.0171
.9250	-.0072	-.0070	1.8500	-.0144	-.0139
.9500	-.0051	-.0050	1.9000	-.0103	-.0099
.9750	-.0027	-.0026	1.9500	-.0053	-.0051
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -8.9858

Y/R/2= -.4374

CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0394 .0236 .0133 .0052-.0017-.0081-.0141-.0202-.0265-.0333-.0413-.0515-.0671-.1106
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -1.0427DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
0.0000	-.0182	-.0176	0.0000	-.0364	-.0352
.0250	-.0192	-.0185	.0500	-.0384	-.0371
.0500	-.0202	-.0195	.1000	-.0404	-.0390
.0750	-.0211	-.0204	.1500	-.0423	-.0409
.1000	-.0220	-.0212	.2000	-.0439	-.0424
.1250	-.0226	-.0219	.2500	-.0453	-.0437
.1500	-.0232	-.0224	.3000	-.0463	-.0448
.1750	-.0236	-.0228	.3500	-.0472	-.0456
.2000	-.0240	-.0231	.4000	-.0479	-.0463
.2250	-.0242	-.0234	.4500	-.0485	-.0468
.2500	-.0245	-.0236	.5000	-.0489	-.0473
.2750	-.0246	-.0238	.5500	-.0492	-.0475
.3000	-.0247	-.0238	.6000	-.0494	-.0477
.3250	-.0247	-.0239	.6500	-.0494	-.0477
.3500	-.0247	-.0238	.7000	-.0493	-.0476
.3750	-.0246	-.0237	.7500	-.0491	-.0475
.4000	-.0244	-.0236	.8000	-.0488	-.0472
.4250	-.0242	-.0234	.8500	-.0484	-.0468
.4500	-.0240	-.0231	.9000	-.0479	-.0463
.4750	-.0236	-.0228	.9500	-.0473	-.0457
.5000	-.0233	-.0225	1.0000	-.0466	-.0450
.5250	-.0229	-.0221	1.0500	-.0457	-.0442
.5500	-.0224	-.0216	1.1000	-.0448	-.0433
.5750	-.0219	-.0211	1.1500	-.0437	-.0422
.6000	-.0213	-.0206	1.2000	-.0426	-.0411
.6250	-.0207	-.0200	1.2500	-.0413	-.0399
.6500	-.0200	-.0193	1.3000	-.0399	-.0386
.6750	-.0192	-.0186	1.3500	-.0384	-.0371
.7000	-.0184	-.0178	1.4000	-.0368	-.0356
.7250	-.0175	-.0169	1.4500	-.0351	-.0339
.7500	-.0166	-.0160	1.5000	-.0332	-.0321
.7750	-.0156	-.0150	1.5500	-.0312	-.0301
.8000	-.0145	-.0140	1.6000	-.0289	-.0280
.8250	-.0132	-.0128	1.6500	-.0265	-.0256
.8500	-.0120	-.0116	1.7000	-.0240	-.0232
.8750	-.0107	-.0103	1.7500	-.0213	-.0206
.9000	-.0092	-.0089	1.8000	-.0184	-.0178
.9250	-.0075	-.0072	1.8500	-.0150	-.0145
.9500	-.0053	-.0052	1.9000	-.0107	-.0103
.9750	-.0029	-.0027	1.9500	-.0055	-.0053
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -7.2913 Y/R/2= -.3549 CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0428 .0263 .0155 .0071-.0002-.0068-.0131-.0194-.0260-.0332-.0415-.0522-.0685-.1140
CORRESPONDING Y/C LOCATIONS FROM FRONT TO REAR
.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.9962DEGREES

LOCAL ELEVATION

Y/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
-.0000	-.0174	-.0168	-.0000	-.0348	-.0336
.0250	-.0185	-.0178	-.0500	-.0369	-.0357
.0500	-.0196	-.0189	.1000	-.0391	-.0378
.0750	-.0206	-.0199	.1500	-.0412	-.0398
.1000	-.0215	-.0208	.2000	-.0430	-.0415
.1250	-.0222	-.0215	.2500	-.0445	-.0429
.1500	-.0228	-.0220	.3000	-.0456	-.0441
.1750	-.0233	-.0225	.3500	-.0466	-.0450
.2000	-.0237	-.0229	.4000	-.0475	-.0458
.2250	-.0241	-.0232	.4500	-.0481	-.0465
.2500	-.0243	-.0235	.5000	-.0487	-.0470
.2750	-.0245	-.0237	.5500	-.0491	-.0474
.3000	-.0247	-.0238	.6000	-.0493	-.0476
.3250	-.0247	-.0239	.6500	-.0494	-.0477
.3500	-.0247	-.0239	.7000	-.0494	-.0477
.3750	-.0247	-.0238	.7500	-.0493	-.0476
.4000	-.0245	-.0237	.8000	-.0491	-.0474
.4250	-.0244	-.0235	.8500	-.0487	-.0471
.4500	-.0241	-.0233	.9000	-.0483	-.0466
.4750	-.0239	-.0230	.9500	-.0477	-.0461
.5000	-.0235	-.0227	1.0000	-.0470	-.0454
.5250	-.0231	-.0223	1.0500	-.0462	-.0447
.5500	-.0227	-.0219	1.1000	-.0453	-.0438
.5750	-.0222	-.0214	1.1500	-.0443	-.0428
.6000	-.0216	-.0209	1.2000	-.0432	-.0417
.6250	-.0210	-.0203	1.2500	-.0420	-.0405
.6500	-.0203	-.0196	1.3000	-.0406	-.0392
.6750	-.0196	-.0189	1.3500	-.0391	-.0378
.7000	-.0188	-.0181	1.4000	-.0375	-.0362
.7250	-.0179	-.0173	1.4500	-.0358	-.0345
.7500	-.0169	-.0164	1.5000	-.0339	-.0327
.7750	-.0159	-.0154	1.5500	-.0318	-.0308
.8000	-.0148	-.0143	1.6000	-.0296	-.0286
.8250	-.0136	-.0131	1.6500	-.0272	-.0263
.8500	-.0123	-.0119	1.7000	-.0246	-.0237
.8750	-.0109	-.0106	1.7500	-.0219	-.0211
.9000	-.0095	-.0091	1.8000	-.0189	-.0183
.9250	-.0077	-.0074	1.8500	-.0154	-.0149
.9500	-.0055	-.0053	1.9000	-.0110	-.0106
.9750	-.0028	-.0028	1.9500	-.0057	-.0055
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -5.5968

Y/R/2= -.2724

CHORD= 2.0000

SLOPES.DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0459 .0289 .0177 .0090 .0015-.0053-.0119-.0184-.0252-.0326-.0413-.0523-.0693-.1165
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.9355DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
-.0000	-.0163	-.0158	-.0000	-.0327	-.0315
.0250	-.0175	-.0169	.0500	-.0350	-.0338
.0500	-.0187	-.0180	.1000	-.0373	-.0360
.0750	-.0198	-.0191	.1500	-.0395	-.0382
.1000	-.0207	-.0200	.2000	-.0415	-.0401
.1250	-.0215	-.0208	.2500	-.0431	-.0416
.1500	-.0222	-.0214	.3000	-.0444	-.0429
.1750	-.0228	-.0220	.3500	-.0455	-.0440
.2000	-.0232	-.0224	.4000	-.0464	-.0448
.2250	-.0236	-.0228	.4500	-.0472	-.0456
.2500	-.0239	-.0231	.5000	-.0479	-.0462
.2750	-.0242	-.0233	.5500	-.0483	-.0467
.3000	-.0243	-.0235	.6000	-.0487	-.0470
.3250	-.0244	-.0236	.6500	-.0489	-.0472
.3500	-.0245	-.0237	.7000	-.0490	-.0473
.3750	-.0245	-.0236	.7500	-.0489	-.0473
.4000	-.0244	-.0236	.8000	-.0488	-.0471
.4250	-.0243	-.0234	.8500	-.0485	-.0469
.4500	-.0241	-.0232	.9000	-.0481	-.0465
.4750	-.0238	-.0230	.9500	-.0476	-.0460
.5000	-.0235	-.0227	1.0000	-.0470	-.0454
.5250	-.0231	-.0223	1.0500	-.0463	-.0447
.5500	-.0227	-.0219	1.1000	-.0454	-.0439
.5750	-.0222	-.0215	1.1500	-.0445	-.0429
.6000	-.0217	-.0210	1.2000	-.0434	-.0419
.6250	-.0211	-.0204	1.2500	-.0422	-.0407
.6500	-.0204	-.0197	1.3000	-.0409	-.0395
.6750	-.0197	-.0190	1.3500	-.0394	-.0381
.7000	-.0190	-.0183	1.4000	-.0378	-.0365
.7250	-.0181	-.0174	1.4500	-.0361	-.0349
.7500	-.0171	-.0165	1.5000	-.0343	-.0331
.7750	-.0161	-.0156	1.5500	-.0322	-.0311
.8000	-.0150	-.0145	1.6000	-.0300	-.0290
.8250	-.0138	-.0133	1.6500	-.0276	-.0266
.8500	-.0125	-.0121	1.7000	-.0250	-.0241
.8750	-.0111	-.0107	1.7500	-.0222	-.0215
.9000	-.0096	-.0093	1.8000	-.0193	-.0186
.9250	-.0079	-.0076	1.8500	-.0157	-.0152
.9500	-.0056	-.0054	1.9000	-.0112	-.0109
.9750	-.0029	-.0028	1.9500	-.0058	-.0056
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -3.9023 Y/R/2= -.1900 CHORD= 2.0000

SLOPES, DZ/DX, AT SLOPE POINTS, FROM FRONT TO REAR

.0491 .0316 .0202 .0113 .0036-.0034-.0101-.0168-.0237-.0314-.0402-.0516-.0690-.1175
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR
 .0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= -.8419 DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA X	DELTA Z	(DLT Z)COS(DTH)
-.0000	-.0147	-.0142	-.0000	-.0294	-.0284
.0250	-.0159	-.0154	.0500	-.0319	-.0308
.0500	-.0172	-.0166	.1000	-.0344	-.0332
.0750	-.0184	-.0177	.1500	-.0367	-.0355
.1000	-.0194	-.0188	.2000	-.0388	-.0375
.1250	-.0203	-.0196	.2500	-.0406	-.0392
.1500	-.0210	-.0203	.3000	-.0420	-.0406
.1750	-.0216	-.0209	.3500	-.0433	-.0418
.2000	-.0222	-.0214	.4000	-.0443	-.0428
.2250	-.0226	-.0218	.4500	-.0452	-.0437
.2500	-.0230	-.0222	.5000	-.0460	-.0444
.2750	-.0233	-.0225	.5500	-.0466	-.0450
.3000	-.0235	-.0227	.6000	-.0470	-.0454
.3250	-.0237	-.0229	.6500	-.0474	-.0457
.3500	-.0238	-.0230	.7000	-.0475	-.0459
.3750	-.0238	-.0230	.7500	-.0476	-.0460
.4000	-.0238	-.0230	.8000	-.0476	-.0459
.4250	-.0237	-.0229	.8500	-.0474	-.0458
.4500	-.0235	-.0227	.9000	-.0471	-.0455
.4750	-.0233	-.0225	.9500	-.0467	-.0451
.5000	-.0231	-.0223	1.0000	-.0461	-.0446
.5250	-.0227	-.0220	1.0500	-.0455	-.0439
.5500	-.0224	-.0216	1.1000	-.0447	-.0432
.5750	-.0219	-.0212	1.1500	-.0438	-.0424
.6000	-.0214	-.0207	1.2000	-.0428	-.0414
.6250	-.0209	-.0201	1.2500	-.0417	-.0403
.6500	-.0202	-.0195	1.3000	-.0405	-.0391
.6750	-.0195	-.0189	1.3500	-.0391	-.0378
.7000	-.0188	-.0181	1.4000	-.0376	-.0363
.7250	-.0180	-.0173	1.4500	-.0359	-.0347
.7500	-.0171	-.0165	1.5000	-.0341	-.0329
.7750	-.0161	-.0155	1.5500	-.0321	-.0310
.8000	-.0150	-.0145	1.6000	-.0300	-.0289
.8250	-.0138	-.0133	1.6500	-.0276	-.0266
.8500	-.0125	-.0121	1.7000	-.0250	-.0241
.8750	-.0112	-.0108	1.7500	-.0223	-.0215
.9000	-.0097	-.0094	1.8000	-.0194	-.0187
.9250	-.0079	-.0076	1.8500	-.0158	-.0153
.9500	-.0057	-.0055	1.9000	-.0113	-.0109
.9750	-.0029	-.0028	1.9500	-.0059	-.0057
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -2.2078

Y/P/2= -.1075

CHGRD= 2.0000

SLOPES.DZ/DY.AT SLOPE POINTS.FROM FRONT TO REAR

.0532 .0355 .0240 .0150 .0073 .0003-.0064-.0131-.0202-.0279-.0369-.0484-.0662-.1157
CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR

.0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN Y-Z PLANE= -.6409DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DTH)	DELTA Y	DELTA Z	(DLT Z)COS(DTH)
-.0000	-.0112	-.0108	-.0000	-.0224	-.0216
.0250	-.0125	-.0121	.0500	-.0250	-.0242
.0500	-.0139	-.0134	.1000	-.0277	-.0268
.0750	-.0152	-.0146	.1500	-.0303	-.0293
.1000	-.0163	-.0158	.2000	-.0326	-.0315
.1250	-.0173	-.0167	.2500	-.0346	-.0334
.1500	-.0181	-.0175	.3000	-.0362	-.0350
.1750	-.0188	-.0182	.3500	-.0376	-.0364
.2000	-.0194	-.0188	.4000	-.0389	-.0376
.2250	-.0200	-.0193	.4500	-.0400	-.0386
.2500	-.0205	-.0198	.5000	-.0409	-.0395
.2750	-.0209	-.0201	.5500	-.0417	-.0403
.3000	-.0212	-.0205	.6000	-.0424	-.0409
.3250	-.0214	-.0207	.6500	-.0429	-.0414
.3500	-.0216	-.0209	.7000	-.0432	-.0418
.3750	-.0217	-.0210	.7500	-.0435	-.0420
.4000	-.0218	-.0211	.8000	-.0436	-.0421
.4250	-.0218	-.0211	.8500	-.0436	-.0421
.4500	-.0218	-.0210	.9000	-.0435	-.0420
.4750	-.0216	-.0209	.9500	-.0433	-.0418
.5000	-.0215	-.0207	1.0000	-.0429	-.0415
.5250	-.0212	-.0205	1.0500	-.0425	-.0410
.5500	-.0209	-.0202	1.1000	-.0419	-.0405
.5750	-.0206	-.0199	1.1500	-.0412	-.0398
.6000	-.0202	-.0195	1.2000	-.0404	-.0390
.6250	-.0197	-.0190	1.2500	-.0394	-.0381
.6500	-.0192	-.0185	1.3000	-.0384	-.0370
.6750	-.0186	-.0179	1.3500	-.0371	-.0359
.7000	-.0179	-.0173	1.4000	-.0358	-.0346
.7250	-.0172	-.0166	1.4500	-.0343	-.0332
.7500	-.0163	-.0158	1.5000	-.0327	-.0316
.7750	-.0154	-.0149	1.5500	-.0309	-.0298
.8000	-.0144	-.0139	1.6000	-.0289	-.0279
.8250	-.0133	-.0129	1.6500	-.0266	-.0257
.8500	-.0121	-.0117	1.7000	-.0242	-.0234
.8750	-.0108	-.0105	1.7500	-.0217	-.0210
.9000	-.0095	-.0091	1.8000	-.0189	-.0183
.9250	-.0078	-.0075	1.8500	-.0155	-.0150
.9500	-.0056	-.0054	1.9000	-.0111	-.0108
.9750	-.0029	-.0028	1.9500	-.0058	-.0056
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

Y= -.6803 Y/P/2= -.0331 CHORD= 2.0000

SLOPES DZ/DX AT SLOPE POINTS, FROM FRONT TO REAR

.0632 .0465 .0360 .0280 .0212 .0148 .0086 .0021-.0048-.0126-.0219-.0340-.0525-.1031
 CORRESPONDING X/C LOCATIONS FROM FRONT TO REAR
 .0536 .1250 .1964 .2679 .3393 .4107 .4821 .5536 .6250 .6964 .7679 .8393 .9107 .9821

CHORD ANGLE OF ATTACK IN X-Z PLANE= .1300DEGREES

LOCAL ELEVATION

X/C	Z/C	(Z/C)COS(DIH)	DELTA X	DELTA Z	(DLT Z)COS(DIH)
-.0000	.0024	.0023	-.0000	.0048	.0047
.0250	.0008	.0008	.0500	.0016	.0016
.0500	-.0008	-.0007	.1000	-.0016	-.0015
.0750	-.0023	-.0022	.1500	-.0046	-.0045
.1000	-.0037	-.0036	.2000	-.0075	-.0072
.1250	-.0050	-.0048	.2500	-.0100	-.0096
.1500	-.0061	-.0059	.3000	-.0122	-.0117
.1750	-.0071	-.0068	.3500	-.0141	-.0137
.2000	-.0080	-.0077	.4000	-.0160	-.0155
.2250	-.0089	-.0086	.4500	-.0177	-.0171
.2500	-.0096	-.0093	.5000	-.0193	-.0186
.2750	-.0104	-.0100	.5500	-.0207	-.0200
.3000	-.0110	-.0106	.6000	-.0220	-.0213
.3250	-.0116	-.0112	.6500	-.0232	-.0224
.3500	-.0121	-.0117	.7000	-.0243	-.0234
.3750	-.0126	-.0122	.7500	-.0252	-.0244
.4000	-.0130	-.0126	.8000	-.0261	-.0252
.4250	-.0134	-.0129	.8500	-.0268	-.0259
.4500	-.0137	-.0132	.9000	-.0274	-.0265
.4750	-.0140	-.0135	.9500	-.0279	-.0270
.5000	-.0142	-.0137	1.0000	-.0283	-.0274
.5250	-.0143	-.0138	1.0500	-.0286	-.0277
.5500	-.0144	-.0139	1.1000	-.0288	-.0279
.5750	-.0144	-.0139	1.1500	-.0289	-.0279
.6000	-.0144	-.0139	1.2000	-.0288	-.0278
.6250	-.0143	-.0138	1.2500	-.0287	-.0277
.6500	-.0142	-.0137	1.3000	-.0283	-.0274
.6750	-.0140	-.0135	1.3500	-.0279	-.0270
.7000	-.0137	-.0132	1.4000	-.0273	-.0264
.7250	-.0133	-.0128	1.4500	-.0266	-.0257
.7500	-.0129	-.0124	1.5000	-.0257	-.0248
.7750	-.0123	-.0119	1.5500	-.0247	-.0238
.8000	-.0117	-.0113	1.6000	-.0234	-.0226
.8250	-.0109	-.0106	1.6500	-.0219	-.0211
.8500	-.0101	-.0098	1.7000	-.0202	-.0195
.8750	-.0092	-.0089	1.7500	-.0184	-.0178
.9000	-.0082	-.0079	1.8000	-.0163	-.0157
.9250	-.0068	-.0066	1.8500	-.0136	-.0131
.9500	-.0049	-.0048	1.9000	-.0099	-.0095
.9750	-.0026	-.0025	1.9500	-.0052	-.0050
1.0000	0.0000	0.0000	2.0000	0.0000	0.0000

APPENDIX E

COMPUTER PROGRAM LISTING

This program has been written in FORTRAN IV language for the CDC Cyber 173 computer system with NOS 1.3 operating system. The program is briefly described in Appendix A of this report. Minor modifications to the program may be necessary to achieve successful execution on other computers, as discussed in Appendix A. The following table is an index to the computer program listing:

Name	Letter Designation	Page
PROGRAM GEOMETRY	A	98
PROGRAM WINGAL	A	117
SUBROUTINE FTLUP	B	118
SUBROUTINE SIMEQ	C	120
PROGRAM CIRCUL2	D	123
SUBROUTINE GAMCAL	E	144
SUBROUTINE DRAGSUB	F	145
SUBROUTINE DRACAL	G	146
SUBROUTINE CCAL	H	148
SUBROUTINE CONCAL	I	149
SUBROUTINE SNTAN	J	150
SUBROUTINE LOGS	K	159
PROGRAM ZOCDETM	L	162
SUBROUTINE INFSUB	M	168
SUBROUTINE SPLINE	N	170
SUBROUTINE TRIMAT	O	173

This program is stored under user number 496125E on the NASA/LARC computer system, with program GEOMETRY stored in permanent file WDES, and all other programs and subroutines stored in permanent WDEM. An example of the necessary control cards for execution of this program appears on the following page.

EXAMPLE OF CONTROL CARDS FOR EXECUTION OF CURRENT
COMPUTER CODE AT NASA/LaRC

```
KUHL,T677,CM135000.          91212      WDES WDEM (KUHL)
USER,
CHARGE,
GET,WDES.
RFL,64000.
COPY,INPUT,TAPES.
REWIND,TAPES.
COPYSBF,TAPES.OUTPUT.
REWIND,TAPES.
FTN,I=WDES,STATIC.
LDSET,PRESET=INDEF.
LGO,TAPES.
REWIND(TAPE50)
RFL,135000.
GET,WDEM.
ATTACH,FTNMLIP/UN=LIBRARY.
ATTACH,LRCGOSF/UN=LIBRARY.
FTN,I=WDFM,R=GLO,STATIC.
LDSET,LIB=LRCGOSF/FTNMLIP,PRESET=INDEF.
GLO.
EXIT.
```

PROGRAM LISTING

PROGRAM GEOMETRY

PROGRAM GEOMETRY 74/74 OPT=1 STATIC FTN 4,7,485 81/01/27, 13.

```

1      PROGRAM GEOMETRY(INPUT,OUTPUT,TAPF5=INPUT,TAPF6=OUTPUT,TAPE25,TAPF
150)
      DIMENSION XPRF(25),YPRF(25),SAP(25),A(25),RSAP(25),X(25),Y(
5      125),ROTSV(2),SA(2),VROPD(51),SPY(50,2),KFX(2),IYL(50,2),IYT
      2(50,2)
      DIMENSION LSEFG(10),Z(10),YJ(10),PJ(10)
      DIMENSION PCTX(50),PCT7(50)
      DIMENSION NTOT(2),NRRK(2),TOT(2),BRK(2),SEGG(10)
10     COMMON /ALL/ ROT,M,BETA,PTEST,QTEST,TPLSCW(50),Q(400),PN(400),PV(
      1400),S(400),PSI(400),PHI(50),7H(50),NSSW
      COMMON /MAINOMF/ ICODFOF,TOTAL,AAN(2),XS(2),YS(2),KFCTS(2),XREG(2
15     15,2),YREG(25,2),AREG(25,2),DIH(25,2),MCD(25,2),XX(25,2),YY(25,2),A
      25(25,2),TTWD(25,2),MMCD(25,2),AN(2),ZZ(25,2),IFLAG
      COMMON /ONFTHPF/ TWIST(2),CREF,SREF,CAVE,CLDFS,STRUE,AR,ARTRUE,RT
15     1CDHT(2),CONFIG,NSSWSV(2),MSV(2),KROT,PLAN,IPLAN,MACH,SSWA(50)
      COMMON /CORPDD/ CHORD(50),XTE(50),KRIT,TSPAN,TSPANA
      REAL MACH
      RFWIND 50
20     C
      C      THIS PROGRAM IS A SLIGHT REVISION OF THE GEOMETRY PROGRAM
      C      DESCRIBED IN NASA TN D-8090, BY JOHN E. LAMAR
      C      PROGRAM CIRCUL2 CONTAINS THE TREFFTZ PLANE OPTIMIZATION
      C      USING THE 2-D ADVANCED PANEL THEORY OF NASA CP-3154, BY
      C      JOHN M. KUHLMAN. FURTHER REFERENCES AND A DESCRIPTION
25     C      OF THE THEORY ARE GIVEN AS COMMENTS IN PROGRAM CIRCUL2.
      C      PROGRAM ZOCDETM FOLLOWS THE MEAN CAMBER INTEGRATION PRO-
      C      GRAM OF TN D-8090
      C
30     C      PART ONE - GEOMETRY COMPUTATION
      C
      C      SECTION ONE - INPUT OF REFERENCE WING POSITION
      C
35     C      ICODFOF = 0
      C      TOTAL = 0.
      C      PTEST = 0.
      C      QTEST = 0.
      C      TWIST(1) = 0.
40     C      TWIST(2) = 0.
      C      IF (TOTAL.EQ.0.) RTCDHT(1)=RTCDHT(2)=0.
      C      YTOL = 1.F - 10

```

(cont'd)

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	R1/01/27. 13.35.39	PAGE	2
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		AZY = 1.E + 13	A	43
		PITTT = 4. * ATAN(1.)	A	44
45		PIT = PITTT / 2.	A	45
		RAD = 180. / PITTT	A	46
		IF (TOTAL .GT. 0.) GO TO 70	A	47
		RTCDHT(1) = 0.	A	48
		RTCDHT(2) = RTCDHT(1)	A	49
50	C		A	50
	C		A	51
	C	SET PLAN EQUAL TO 1. FOR A WING ALONE COMPUTAION - EVEN FOR A	A	52
	C	VARIABLE SWFEP WING	A	53
	C	SET PLAN EQUAL TO 2. FOR A WING - TAIL COMBINATION	A	54
55	C		A	55
	C	SET TOTAL EQUAL TO THE NUMBER OF SETS	A	56
	C	OF GROUP TWO DATA PROVIDED	A	57
	C		A	58
		READ (5,1080) PLAN,TOTAL,CREF,SREF,XPREF	A	59
60		IF (EOF(5)) 980,10	A	60
	10	IPLAN = PLAN	A	61
	C		A	62
	C		A	63
	C	SET AAN(IT) EQUAL TO THE MAXIMUM NUMBER OF CURVES REQUIRED TO	A	64
65	C	DEFINE THE PLANFORM PERIMETER OF THE (IT) PLANFORM.	A	65
	C		A	66
	C	SET RTCDHT(IT) EQUAL TO THE ROOT CHORD HEIGHT OF THE LIFTING	A	67
	C	SURFACE (IT),WHOSE PERIMETER POINTS ARE BEING READ IN, WITH	A	68
	C	RESPECT TO THE WING ROOT CHORD HEIGHT	A	69
70	C		A	70
		WRITE (6,1060)	A	71
		DO 60 IT = 1,IPLAN	A	72
		READ (5,1010) AAN(IT),XS(IT),YS(IT),RTCDHT(IT)	A	73
		N = AAN(IT)	A	74
75		NJ = N + 1	A	75
		MAK = 0	A	76
		IF (IPLAN .EQ. 1) PRICON = 10H	A	77
		IF (IPLAN .EQ. 2 .AND. IT .EQ. 1) PRICON = 10H FIRST	A	78
		IF (IPLAN .EQ. 2 .AND. IT .EQ. 2) PRICON = 10H SECOND	A	79
80		WRITE (6,1070) PRICON,N,RTCDHT(IT),XS(IT),YS(IT)	A	80
		WRITE (6,1100)	A	81
		DO 50 I = 1,N1	A	82
		READ (5,1080) XPRFG(I,IT),YPRFG(I,IT),DIH(I,IT),AMCD	A	83
		XPRFG(I,IT) = XPRFG(I,IT) - XPRFF	A	84

PROGRAM GEOMETRY (Continued)

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PROGRAM GEOMETRY      74/74      OPT=1 STATIC      FTN 4,7+495      81/01/27. 13.35.30      PAGE      3

85      MCD(I,IT) = AMCD      A 85
      IF (I .EQ. 1) GO TO 50      A 86
      IF (MAK .NE. 0 .OR. MCD(I - 1,IT) .NE. 2) GO TO 20      A 87
      MAK = I - 1      A 88
20      IF (ABS(YREG(I - 1,IT) - YREG(I,IT)) .LT. YTOL) GO TO 30      A 89
90      ARFG(I - 1,IT) = (XREG(I - 1,IT) - XREG(I,IT)) / (YREG(I - 1,IT) -
      1 YREG(I,IT))      A 91
      ASWP = ATAN(ARFG(I - 1,IT)) * RAD      A 92
      GO TO 40      A 93
30      YREG(I,IT) = YREG(I - 1,IT)      A 94
95      ARFG(J - 1,IT) = AZY      A 95
      ASWP = 90.      A 96
40      J = I - 1      A 97
C      A 98
C      WRITE PLANFORM PERIMETER POINTS AND ANGLES      A 99
100      C      A 100
      WRITE (6,1160) J,XREG(J,IT),YREG(J,IT),ASWP,DIH(J,IT),MCD(J,IT)      A 101
      DIH(J,IT) = TAN(DIH(J,IT)) / RAD      A 102
50      CONTINUE      A 103
      KCTS(IT) = MAK      A 104
105      WRITE (6,1160) N1,XREG(N1,IT),YREG(N1,IT)      A 105
60      CONTINUE      A 106
C      A 107
C      PART 1 - SECTION 2      A 108
C      READ GROUP 2 DATA AND COMPUTE DESIRED WING POSITION      A 109
110      C      A 110
      C      A 111
      C      SET SA(1),SA(2) EQUAL TO THE SWEEP ANGLE,IN DEGREES, FOR THE FIRST      A 112
      C      CURVE(S) THAT CAN CHANGE SWEEP FOR EACH PLANFORM      A 113
      C      A 114
115      70 READ (5,1150) CONFIG,SCW,VTC,MACH,CLES,SA(1),SA(2)      A 115
C      A 116
      C      WRITE (6,1090) CONFIG      A 117
      IF (EOF(5)) 980,80      A 118
80      IF (PTFST .NE. 0. .AND. QTST .NE. 0.) GO TO 1000      A 119
120      IF (SCW .EQ. 0.) GO TO 100      A 120
      DO 90 I = 1,50      A 121
90      TRLSCW(I) = SCW      A 122
      GO TO 110      A 123
100      READ (5,1080) STA      A 124
125      NSTA = STA      A 125
      READ (5,1080) (TRLSCW(I),TRLSCW(I + 1),TRLSCW(I + 2),TRLSCW(I + 3))      A 126

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PROGRAM GEOMETRY (Continued)

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1,TRLSCW(I + 4),TRLSCW(I + 5),TRLSCW(I + 6),TRLSCW(I + 7),I = 1,NST A 127
2A.R) A 128
110 DO 360 IT = 1,IPLAN A 129
130 N = AAN(IT) A 130
N1 = N + 1 A 131
DO 120 I = 1,N A 132
XREF(I) = XREG(I,IT) A 133
YREF(I) = YREG(I,IT) A 134
135 A(I) = AREG(I,IT) A 135
RSAR(I) = ATAN(A(I)) A 136
IF (A(I) .EQ. AZY) RSAR(I) = PIT A 137
120 CONTINUE A 138
XREF(N1) = XREG(N1,IT) A 139
YREF(N1) = YREG(N1,IT) A 140
140 IF (KFACTS(IT) .GT. 0) GO TO 130 A 141
K = 1 A 142
SA(IT) = RSAR(I) * PAD A 143
GO TO 140 A 144
145 130 K = KFACTS(IT) A 145
140 WRITE (6,1120) K,SA(IT),IT A 146
SP = SA(IT) / PAD A 147
IF (ABS(SB - RSAR(K)) .GT. (.1 / PAD)) GO TO 170 A 148
C REFERENCE PLANFORM COORDINATES ARE STORED UNCHANGED FOR WINGS A 149
C WITHOUT CHANGE IN SWEEP A 150
DO 160 I = 1,N A 151
X(I) = XREF(I) A 152
Y(I) = YREF(I) A 153
155 IF (RSAR(I) .EQ. PIT) GO TO 150 A 154
A(I) = TAN(RSAR(I)) A 155
GO TO 160 A 156
150 A(I) = AZY A 157
160 SAR(I) = RSAR(I) A 158
X(N1) = XREF(N1) A 159
Y(N1) = YREF(N1) A 160
GO TO 340 A 161
C A 162
C CHANGES IN WING SWEEP ARE MADE HERE A 163
C A 164
165 170 IF (MCD(K,IT) .NE. 2) GO TO 990 A 165
KA = K - 1 A 166
DO 180 I = 1,KA A 167
X(I) = XREF(I) A 168

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PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7.485	81/01/27. 13.35.39	PAGE	5
						A 169
170		Y(I) = YREF(I)				A 170
	180	SAR(I) = RSAR(I)				A 171
	C	DETERMINE LEADING EDGE INTERSECTION BETWEEN FIXED AND VARIABLE				A 172
	C	SWEEP WING SECTIONS				A 173
		SAR(K) = SR				A 174
		A(K) = TAN(SP)				A 175
175		SAI = SR - RSAR(K)				A 176
		X(K + 1) = XS(IT) + (XREF(K + 1) - XS(IT)) * COS(SAI) + (YREF(K +				A 177
		1) - YS(IT)) * SIN(SAI)				A 178
		Y(K + 1) = YS(IT) + (YREF(K + 1) - YS(IT)) * COS(SAI) - (XREF(K +				A 179
		1) - XS(IT)) * SIN(SAI)				A 180
180		IF (ABS(SR - SAR(K - 1)) .LT. (.1 / RAD)) GO TO 190				A 181
		Y(K) = X(K + 1) - X(K - 1) - A(K) * Y(K + 1) + A(K - 1) * Y(K - 1)				A 182
		Y(K) = Y(K) / (A(K - 1) - A(K))				A 183
		X(K) = A(K) * X(K - 1) - A(K - 1) * X(K + 1) + A(K - 1) * A(K) * (A 184
		1Y(K + 1) - Y(K - 1))				A 185
185		X(K) = X(K) / (A(K) - A(K - 1))				A 186
		GO TO 200				A 187
	C	ELIMINATE EXTRANEOUS BREAKPOINTS				A 188
	190	X(K) = XREF(K - 1)				A 189
		Y(K) = YREF(K - 1)				A 190
190		SAR(K) = SAR(K - 1)				A 191
	200	K = K + 1				A 192
	C	SWEEP THE BREAKPOINTS ON THE VARIABLE SWEEP PANEL				A 193
	C	(IT ALSO KEEPS SWEEP ANGLES IN FIRST OR FOURTH QUADRANTS)				A 194
	210	K = K + 1				A 195
195		SAR(K - 1) = SAI + RSAR(K - 1)				A 196
	220	IF (SAR(K - 1) .LE. PIT) GO TO 230				A 197
		SAR(K - 1) = SAR(K - 1) - 3.1415927				A 198
		GO TO 220				A 199
	230	IF (SAR(K - 1) .GE. (- PIT)) GO TO 240				A 200
200		SAR(K - 1) = SAR(K - 1) + 3.1415927				A 201
		GO TO 230				A 202
	240	IF ((SAR(K - 1)) .LT. .0) GO TO 250				A 203
		IF (SAR(K - 1) - PIT) 280,260,260				A 204
	250	IF (SAR(K - 1) + PIT) 270,270,280				A 205
205	260	A(K - 1) = A7Y				A 206
		GO TO 290				A 207
	270	A(K - 1) = -A7Y				A 208
		GO TO 290				A 209
	280	A(K - 1) = TAN(SAR(K - 1))				A 210
210	290	KK = MCD(K, IT)				A 211

PROGRAM GEOMTRY (Continued)

PROGRAM GEOMTRY	74/74	OPT=1	STATIC	FTN 4,7,485	R1/01/27. 13.35.39	PAGE	6
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		IF (KK .EQ. 1) GO TO 300	A 211
		Y(K) = YS(IT) + (YREF(K) - YS(IT)) * COS(SAJ) - (XREF(K) - XS(IT))	A 212
		1 * SIN(SAI)	A 213
215		X(K) = XS(IT) + (XREF(K) - XS(IT)) * COS(SAI) + (YREF(K) - YS(IT))	A 214
		1 * SIN(SAI)	A 215
		GO TO 210	A 216
	C	DETERMINE THE TRAILING EDGE INTERSECTION	A 217
	C	BETWEEN FIXED AND VARIABLE SWEEP WING SECTIONS	A 218
220		300 IF (ABS(PSAR(K) - SAR(K - 1)) .LT. (.1 / RAD)) GO TO 310	A 219
		Y(K) = XREF(K + 1) - X(K - 1) - A(K) * YPEF(K + 1) + A(K - 1) * Y(A 220
		1K - 1)	A 221
		Y(K) = Y(K) / (A(K - 1) - A(K))	A 222
		X(K) = A(K) * X(K - 1) - A(K - 1) * XREF(K + 1) + A(K - 1) * A(K)	A 223
		1 * (YREF(K + 1) - Y(K - 1))	A 224
225		X(K) = X(K) / (A(K) - A(K - 1))	A 225
		GO TO 320	A 226
		310 X(K) = XREF(K + 1)	A 227
		Y(K) = YREF(K + 1)	A 228
		320 K = K + 1	A 229
230	C	STORE REFERENCE PLANFORM COORDINATES ON INBOARD FIXED TRAILING	A 230
	C	EDGE	A 231
		DO 330 I = K,N1	A 232
		X(I) = XREF(I)	A 233
		Y(I) = YREF(I)	A 234
235		330 SAR(I - 1) = PSAR(I - 1)	A 235
		340 DO 350 I = 1,N	A 236
		XX(I,IT) = X(I)	A 237
		YY(I,IT) = Y(I)	A 238
		MMCD(I,IT) = MCD(I,IT)	A 239
240		TTWD(I,IT) = DIH(I,IT)	A 240
		350 AS(I,IT) = A(I)	A 241
		XX(N1,IT) = X(N1)	A 242
		YY(N1,IT) = Y(N1)	A 243
		AN(IT) = AAN(IT)	A 244
245		360 CONTINUE	A 245
	C		A 246
	C	LINE UP BREAKPOINTS AMONG PLANFORMS	A 247
	C		A 248
		ROTSV(1) = 0.	A 249
250		ROTSV(2) = 0.	A 250
		WRITE (6,1180)	A 251
		DO 480 IT = 1,1PLAN	A 252

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE	R
295	DO 440 I = 1,N1					A 295	
	IF ((Q(I) - HIGH) .GE. 0.) GO TO 440					A 296	
	HIGH = Q(I)					A 297	
	IH = I					A 298	
	440 CONTINUE					A 299	
300	IF (J .NE. 1) GO TO 450					A 300	
	BOTSV(IT) = HIGH					A 301	
	KFX(IT) = IH					A 302	
	450 Q(IH) = 1.					A 303	
	SPY(J,IT) = HIGH					A 304	
305	IF (IH .GT. KFX(IT)) GO TO 460					A 305	
	IYL(J,IT) = 1					A 306	
	IYT(J,IT) = 0					A 307	
	GO TO 470					A 308	
	460 IYL(J,IT) = 0					A 309	
310	IYT(J,IT) = 1					A 310	
	470 CONTINUE					A 311	
	480 CONTINUE					A 312	
	C					A 313	
	C					A 314	
315	C					A 315	
	C					A 316	
	C					A 317	
	C					A 318	
	KROT = 1					A 319	
	IF (BOTSV(1) .GE. BOTSV(2)) KROT = 2					A 320	
320	BOT = BOTSV(KROT)					A 321	
	C					A 322	
	C					A 323	
	C					A 324	
	TSPAN = 0					A 325	
325	ISAVE = KFX(KROT) - 1					A 326	
	I = KFX(KBOT) - 2					A 327	
	490 IF (I .EQ. 0) GO TO 500					A 328	
	IF (TTWD(I,KROT) .EQ. TTWD(ISAVE,KROT)) GO TO 510					A 329	
	500 CTWD = COS(ATAN(TTWD(ISAVE,KROT)))					A 330	
330	TLGTH = (YY(ISAVE + 1,KROT) - YY(I + 1,KBOT)) / CTWD					A 331	
	TSPAN = TSPAN + TLGTH					A 332	
	IF (I .EQ. 0) GO TO 520					A 333	
	ISAVE = I					A 334	
	510 I = I - 1					A 335	
335	GO TO 490					A 336	
	520 VI = TSPAN / VIC						

PROGRAM GEOMETRY (Continued)

	PROGRAM GEOMETRY	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE	9
				VSTOL = VI / 2		A 337		
	C			TSPAN = 0.		A 338		
340				KBIT = 2		A 339		
				IF (IPLAN .EQ. 1) GO TO 560		A 340		
				IF (KROT .EQ. 2) KBIT = 1		A 341		
				ISAVEA = KFX(KBIT) - 1		A 342		
				IA = KFX(KBIT) - 2		A 343		
345		530		IF (IA .EQ. 0) GO TO 540		A 344		
				IF (TTWD(IA,KBIT) .EQ. TTWD(ISAVEA,KBIT)) GO TO 550		A 345		
		540		CTWDA = COS(ATAN(TTWD(ISAVEA,KBIT)))		A 346		
				TLGTHA = (YY(ISAVEA + 1,KBIT) - YY(IA + 1,KBIT)) / CTWDA		A 347		
				TSPAN = TSPAN + TLGTHA		A 348		
350				IF (IA .EQ. 0) GO TO 560		A 349		
				ISAVEA = IA		A 350		
		550		IA = IA - 1		A 351		
				GO TO 530		A 352		
		560		CONTINUE		A 353		
355	C			ELIMINATE PLANFORM BREAKPOINTS WHICH ARE WITHIN (R/2)/2000 UNITS		A 354		
	C			LATERALLY		A 355		
	C					A 356		
				DO 580 IT = 1,IPLAN		A 357		
				N = AN(IT)		A 358		
360				N1 = N + 1		A 359		
				DO 580 J = 1,N		A 360		
				AA = ABS(SPY(J,IT) - SPY(J + 1,IT))		A 361		
				IF (AA .EQ. 0. .OR. AA .GT. ABS(TSPAN / 2000.)) GO TO 580		A 362		
				IF (AA .GT. YTOL) WRITE (6,1210) SPY(J + 1,IT),SPY(J,IT)		A 363		
365				DO 570 I = 1,N1		A 364		
				IF (YY(I,IT) .NE. SPY(J + 1,IT)) GO TO 570		A 365		
				YY(I,IT) = SPY(J,IT)		A 366		
		570		CONTINUE		A 367		
				SPY(J + 1,IT) = SPY(J,IT)		A 368		
370		580		CONTINUE		A 369		
	C					A 370		
	C			COMPUTE Z COORDINATES		A 371		
	C					A 372		
				DO 620 IT = 1,IPLAN		A 373		
375				JM = N1 = AN(IT) + 1.		A 374		
				DO 590 JZ = 1,N1		A 375		
		590		ZZ(JZ,IT) = RTCDHT(IT)		A 376		
				JZ = 1		A 377		
						A 378		

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE 10
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380	600 JZ = JZ + 1	A 379
	IF (JZ .GT. KFX(IT)) GO TO 610	A 380
	ZZ(JZ,IT) = ZZ(JZ - 1,IT) + (YY(JZ,IT) - YY(JZ - 1,IT)) * TTWD(JZ	A 381
	1 - 1,IT)	A 382
	GO TO 600	A 383
385	610 JM = JM - 1	A 384
	IF (JM .EQ. KFX(IT)) GO TO 620	A 385
	ZZ(JM,IT) = ZZ(JM + 1,IT) + (YY(JM,IT) - YY(JM + 1,IT)) * TTWD(JM,	A 386
	1IT)	A 387
	GO TO 610	A 388
390	620 CONTINUE	A 389
	C	A 390
	C WRITE PLANFORM PERIMETER POINTS ACTUALLY USED IN THE COMPUTATIONS	A 391
	C	A 392
	WRITE (6,1100)	A 393
	DO 640 IT = 1,IPLAN	A 394
395	N = AN(IT)	A 395
	N1 = N + 1	A 396
	IF (IT .EQ. 2) WRITE (6,1200)	A 397
	DO 630 KK = 1,N	A 398
	TOUT = ATAN(TTWD(KK,IT)) * RAD	A 399
400	AOUT = ATAN(AS(KK,IT)) * RAD	A 400
	IF (AS(KK,IT) .EQ. A7Y) AOUT = 90.	A 401
	WRITE (6,1110) KK,XX(KK,IT),YY(KK,IT),ZZ(KK,IT),AOUT,TOUT,MMCD(KK,	A 402
	1IT)	A 403
	630 CONTINUE	A 404
405	WRITE (6,1110) N1,XX(N1,IT),YY(N1,IT),ZZ(N1,IT)	A 405
	640 CONTINUE	A 406
	C	A 407
	C SFLECT WAKE BREAKPOINTS FOR USE IN CIRCUL2	A 408
	C NOTE THAT WAKE INTERSECTIONS MUST BE INCLUDED	A 409
410	C AS WAKE BREAKPOINTS	A 410
	C	A 411
	C THIS REQUIRES A SLIGHT CHANGE IN DIHEDRAL ACROSS	A 412
	C THE INTERSECTION POINT ON BOTH PLANFORMS	A 413
	C	A 414
415	IT = 1	A 415
	JKT = 1	A 416
	650 JI = JKT + 1	A 417
	YJ(JKT) = YY(1,IT)	A 418
	Z(JKT) = ZZ(1,IT)	A 419
420	PJ(JKT) = ATAN(TTWD(1,IT)) * RAD	A 420

PROGRAM GEOMETRY (Continued)

	PROGRAM GEOMETRY	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE	11
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		YJ(J1) = YY(?,IT)	A 421
		Z(J1) = ZZ(?,IT)	A 422
		PJ(J1) = ATAN(TTWD(?,IT)) * RAD	A 423
425		N = AN(IT)	A 424
		JKT = J1 + 1	A 425
		N1 = N - 1	A 426
		YMINT = 0.	A 427
		DO 660 J = 1,N	A 428
430	660	YMINT = AMIN1(YMINT,YY(J,IT))	A 429
		DO 690 KK = 2,N1	A 430
		K1 = KK + 1	A 431
		JM = JKT - 1	A 432
		JM2 = JKT - 2	A 433
		K2 = KK + 2	A 434
435		IF (YY(KK,IT) .EQ. YMINT) GO TO 700	A 435
		IF (YY(K1,IT) .EQ. YY(KK,IT) .AND. YY(K2,IT) .GT. YY(K1,IT)) GO TO	A 436
		1 700	A 437
		IF (YY(K1,IT) .GT. YY(KK,IT) .AND. YY(K2,IT) .GT. YY(K1,IT)) GO TO	A 438
		1 700	A 439
440		TOUT = ATAN(TTWD(KK,IT)) * RAD	A 440
		IF (YY(KK,IT) .NE. YY(K1,IT)) GO TO 670	A 441
		PJ(JKT - 1) = ATAN(TTWD(K1,IT)) * RAD	A 442
		GO TO 690	A 443
445	670	YJ(JKT) = YY(K1,IT)	A 444
		Z(JKT) = ZZ(K1,IT)	A 445
		PJ(JKT) = ATAN(TTWD(K1,IT)) * RAD	A 446
		IF (PJ(JM2) .NE. PJ(JM)) GO TO 680	A 447
		YJ(JM) = YJ(JKT)	A 448
		Z(JM) = Z(JKT)	A 449
450		PJ(JM) = PJ(JKT)	A 450
		JKT = JM	A 451
	680	CONTINUE	A 452
		JKT = JKT + 1	A 453
	690	CONTINUE	A 454
455		JKT = JKT + 1	A 455
	700	CONTINUE	A 456
		IF (IT .EQ. IPLAN) GO TO 710	A 457
		IT = IT + 1	A 458
		GO TO 650	A 459
460		710 CONTINUE	A 460
	C		A 461
	C	MOVF PLANFORM TWO BREAKPOINTS VERTICALLY TO COINCIDE	A 462

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27, 13.35.39	PAGE	12
	C	WITH POINT AT SAME Y ON PLANFORM ONE IF Y VALUES SAME			A	463
	C	AND ARS DIFF 7 VALUES, LESS THAN TOLERANCE, DIF7			A	464
465	C				A	465
		IF (IPLAN .EQ. 1) GO TO 730			A	466
		DIFY = 1.F - 07			A	467
		DIF7 = 1.E - 04			A	468
		JKT1 = JKT - 1			A	469
470		DO 720 IC = 1, JKT1			A	470
		YCOMP = YJ(IC)			A	471
		ZCOMP = Z(IC)			A	472
		DO 720 JC = 1, JKT1			A	473
475		IF (ARS(YJ(JC) - YCOMP) .LT. DIFY .AND. ARS(Z(JC) - ZCOMP) .LT. DIFZ) 7(JC) = ZCOMP			A	474
		720 CONTINUE			A	475
		730 CONTINUE			A	476
	C				A	477
480	C	PART ONE - SECTION THREE - LAY OUT YAWED HORSESHOE VORTICES			A	478
	C				A	479
		STRUE = 0.			A	480
		NSSWSV(1) = 0			A	481
		NSSWSV(2) = 0			A	482
485		MSV(1) = 0			A	483
		MSV(2) = 0			A	484
		DO 820 IT = 1, IPLAN			A	485
		N1 = AN(IT) + 1.			A	486
		I = 0			A	487
		J = 1			A	488
490		YIN = ROTSV(IT)			A	489
		ILE = KFX(IT)			A	490
		ITE = KFX(IT)			A	491
	C	DETERMINE SPANWISE BORDERS OF HORSESHOE VORTICES			A	492
495	740	IXL = 0			A	493
		IXT = 0			A	494
		I = I + 1			A	495
		CPHI = COS(ATAN(TTWD(ILE, ITE)))			A	496
		IF (YIN .GE. (SPY(J, IT) + VSTOL * CPHI)) GO TO 750			A	497
500	C	BORDER IS WITHIN VORTEX SPACING TOLERANCE (VSTOL) OF BREAKPOINT			A	498
	C	THEREFORE USE THE NEXT BREAKPOINT INBOARD FOR THE BORDER			A	499
		VBORD(I) = YIN			A	500
		GO TO 780			A	501
	C	USE NOMINAL VORTEX SPACING TO DETERMINE THE BORDER			A	502
	750	VBORD(I) = SPY(J, IT)			A	503
					A	504

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTM 4.7+485	81/01/27. 13.35.39	PAGE 13
505	C	COMPUTE SUBSCRIPTS ILE AND ITE TO INDICATE WHICH		A	505
	C	BREAKPOINTS ARE ADJACENT AND WHETHER THEY ARE ON THE WING LEADING		A	506
	C	EDGE OR THE TRAILING EDGE		A	507
		760 IF (J .GE. N1) GO TO 770		A	508
		IF (SPY(J,IT) .NE. SPY(J + 1,IT)) GO TO 770		A	509
510		IXL = IXL + IYL(J,IT)		A	510
		IXT = IXT + IYT(J,IT)		A	511
		J = J + 1		A	512
		GO TO 760		A	513
		770 YIN = SPY(J,IT)		A	514
515		IXL = IXL + IYL(J,IT)		A	515
		IXT = IXT + IYT(J,IT)		A	516
		J = J + 1		A	517
		780 CONTINUE		A	518
		IPHI = ILE - IXL		A	519
520		IF (J .GE. N1) IPHI = 1		A	520
		YIN = YIN - VI * COS(ATAN(TTWD(IPHI,IT)))		A	521
		IF (I .NE. 1) GO TO 800		A	522
		790 ILE = ILE - IXL		A	523
		ITF = ITF + IXT		A	524
525		GO TO 740		A	525
	C	COMPUTE COORDINATES FOR CHORDWISE ROW OF HORSESHOE VORTICES		A	526
		800 YQ = (VRORD(I - 1) + VRORD(I)) / 2.		A	527
		HW = (VRORD(I) - VRORD(I - 1)) / 2.		A	528
		IM1 = I - 1 + NSSWSV(1)		A	529
530		ZH(IM1) = Z7(ILF,IT) + (YQ - YY(ILF,IT)) * TTWD(ILF,IT)		A	530
		PHI(IM1) = TTWD(ILE,IT)		A	531
		SSWWA(IM1) = AS(ILE,IT)		A	532
		XLE = XX(ILF,IT) + AS(ILE,IT) * (YQ - YY(ILF,IT))		A	533
		XET = XX(ITF,IT) + AS(ITF,IT) * (YQ - YY(ITF,IT))		A	534
535		XLOCAL = (XLE - XET) / TPLSCW(IM1)		A	535
	C			A	536
	C	COMPUTE WING AREA PROJECTED TO THE X - Y PLANE		A	537
	C			A	538
		STRUE = STRUF + XLOCAL * TPLSCW(IM1) * (HW * 2.) * 2.		A	539
540	C			A	540
		NSCW = TPLSCW(IM1)		A	541
		DO #10 JCW = 1,NSCW		A	542
		AJCW = JCW - 1		A	543
		XLEL = XLE - AJCW * XLOCAL		A	544
545		NTS = JCW + MSV(1) + MSV(2)		A	545
		PN(NTS) = XLEL - .25 * XLOCAL		A	546

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE 14
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		PV(NTS) = XLEL - .75 * XLOCAL	A 547
		PSI(NTS) = ((XLF - PN(NTS)) * AS(ITF,IT) + (PN(NTS) - XFT) * AS(ILE,IT)) / (XLE - XFT)	A 548
550		S(NTS) = MW / CPHI	A 549
		Q(NTS) = YO	A 550
	810	CONTINUE	A 551
		MSV(IT) = MSV(IT) + NSCW	A 552
	C		A 553
555	C	TEST TO DETERMINE WHEN WING ROOT IS REACHED	A 554
		IF (VPRD(I)) .LT. YPRG(1,IT)) GO TO 790	A 555
	C		A 556
		NSSWSV(IT) = I - 1	A 557
	820	CONTINUE	A 558
560		M = MSV(1) + MSV(2)	A 559
	C		A 560
	C	COMPUTE ASPECT RATIO AND AVERAGE CHORD	A 561
	C		A 562
		ROT = -ROT	A 563
565		AR = 4. * ROT * ROT / SPFF	A 564
		ARTRUF = 4. * ROT * ROT / STRUE	A 565
		CAVE = STRUF / (2. * ROT)	A 566
		RFTA = (1. - MACH * MACH) ** .5	A 567
		WRITE (6,1240) M	A 568
570		WRITE (6,1250) (IT,MSV(IT),NSSWSV(IT),IT = 1,IPLAN)	A 569
		IF (SCW .NE. 0.) WRITE (6,1220) SCW	A 570
		SCWJK = SCW	A 571
		IF (SCW .EQ. 0.) WRITE (6,1230) (TRLSCW(I),I = 1,NSTA)	A 572
	C		A 573
575	C	APPLY PRANDTL-GLAUERT CORRECTION	A 574
	C		A 575
		DO 830 NV = 1,M	A 576
		PSI(NV) = ATAN(PSI(NV) / PETA)	A 577
		PN(NV) = PN(NV) / PETA	A 578
580	830	PV(NV) = PV(NV) / PETA	A 579
		NSSW = NSSWSV(1) + NSSWSV(2)	A 580
		JN = 0	A 581
		DO 850 JSSW = 1,NSSW	A 582
		CHORD(JSSW) = 0.	A 583
585		NSCW = TRLSCW(JSSW)	A 584
		DO 840 JSCW = 1,NSCW	A 585
		JN = JN + 1	A 586
		CHORD(JSSW) = CHORD(JSSW) - 2. * (PV(JN) - PN(JN)) * RFTA	A 587
			A 588

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE 15
	R40	CONTINUE		A 589	
590	R50	XTE(JSSW) = (PV(JN) + (PV(JN) - PN(JN)) / 2.) * BETA		A 590	
		PHISUM = 0.		A 591	
		DO 860 IKY = 1,NSSW		A 592	
		PHISUM = PHISUM + PHI(IKY)		A 593	
	R60	CONTINUE		A 594	
595	C			A 595	
	C	FORCE USE OF PROGRAM CIRCUL?		A 596	
	C			A 597	
		IFLAG = 2		A 598	
	C			A 599	
600	C	READ CHORD LOAD SHAPES TO BE USED IN NEXT OVERLAY		A 600	
	C			A 601	
		READ (5,1300) XCFW,XCFT		A 602	
	C			A 603	
	C	READ TPEFFTZ PLANE DRAG ANALYSIS DATA FOR NEXT OVERLAY		A 604	
605	C			A 605	
	C	NLLINE=NO OF LIFTING LINES		A 606	
	C			A 607	
	C	FJFLAG=0. FOR CL CONSTRAINT ONLY		A 608	
	C	FJFLAG=1. FOR CL,CM CONSTRAINTS		A 609	
610	C	FJFLAG=2. FOR CL,CB CONSTRAINTS		A 610	
	C	FJCTL=0. FOR NO THICKNESS OF PLOTS		A 611	
	C	FJCTL=1. FOR NO THICKNESS; PLOT MEAN CAMBERS		A 612	
	C	FJCTL=2. FOR THICKNESS; PLOT AIRFOIL SHAPES		A 613	
	C			A 614	
615	C			A 615	
	C	FSLP=1. FOR PUNCHED OUTPUT OF SURFACE SLOPES(SFE PROG 70CDETM)		A 616	
	C	FSLP=0. FOR NO PUNCHED OUTPUT OF SURFACE SLOPES		A 617	
	C			A 618	
		NLLINE = IPLAN		A 619	
620		JFLAG = 0		A 620	
		READ (5,1020) FJFLAG,FJCTL,FSLP		A 621	
		JCTL = IFIX(FJCTL)		A 622	
		JFLAG = IFIX(FJFLAG)		A 623	
		JSLP = IFIX(FSLP)		A 624	
625		ICT = 0		A 625	
		INC = 0		A 626	
		IST = 1		A 627	
		ISP = 0		A 628	
		JST = 1		A 629	
630		JSP = 0		A 630	

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1	STATIC	FTN 4.7+485	R1/01/27. 13.35.39	PAGE 16
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	JNC = 0	A 631
A70	CONTINUE	A 632
	ICT = ICT + 1	A 633
635	IF (ICT .GT. NLLINE) GO TO P90	A 634
	READ (5,1020) PRK(ICT),TOT(ICT)	A 635
	NBRK(ICT) = IFIX(BRK(ICT))	A 636
	NTOT(ICT) = IFIX(TOT(ICT))	A 637
	ISP = ISP + NBRK(ICT)	A 638
	IST = IST + INC	A 639
640	NBRJ = NBRK(ICT) - 1	A 640
	JSP = JSP + NBRJ	A 641
	JST = JST + JNC	A 642
	READ (5,1020) (SFGG(I),I = JST,JSP)	A 643
	DO 880 I = JST,JSP	A 644
645	880 LSEG(I) = IFIX(SFGG(I))	A 645
	INC = NBRK(ICT)	A 646
	JNC = NBRJ	A 647
	GO TO A70	A 648
P90	CONTINUE	A 649
650	CRRM = 0.	A 650
	IF (JFLAG .EQ. 0 .OR. JFLAG .EQ. 1) GO TO 900	A 651
	READ (5,1030) CRRM	A 652
900	CONTINUE	A 653
655	WRITE (6,1050) XPREF	A 654
	C	A 655
	C READ THICKNESS DISTRIBUTION FOR USE IN ZOCDETH	A 656
	C THIS DATA MUST BE SPECIFIED ONLY IF JCTL IS NOT ZFPO	A 657
	C SPECIFY PERCENT X/C TABLE ,FOLLOWED BY T/ZC TABLE	A 658
	C	A 659
660	C IF JCTL IS NOT ZFPO, THEN LANGLEY PLOTTING SUBROUTINE	A 660
	C INFOPLOT IS USED TO PLOT THE DESIGNED AIRFOIL SECTIONS	A 661
	C IN PLANES NORMAL TO THE WING PLANE, OR THE CAMBER SURFACE	A 662
	C	A 663
	C ONLY ONE THICKNESS DIST FOR ALL SPAN STATIONS MAY	A 664
665	C BE SPECIFIED	A 665
	C	A 666
	C N75 IS NO OF PCTX,PCTZ VALUES SPECIFIED, WHERE PCTZ	A 667
	C IS ONE HALF OF TOTAL MAX THICKNESS OVER LOCAL WING	A 668
	C CHORD	A 669
670	C	A 670
	C N75 MUST BE LESS THAN 51	A 671
	C	A 672

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.35.39	PAGE	17
		IF (JCTL .EQ. 0) GO TO 910			A 673	
		IF (JCTL .EQ. 1) GO TO 910			A 674	
675		READ (5,1020) FN7S			A 675	
		NZS = IFIX(FN7S)			A 676	
		READ (5,1040) (PCTX(I),I = 1,NZS)			A 677	
		READ (5,1040) (PCTZ(I),I = 1,NZS)			A 678	
	910	CONTINUE			A 679	
680		IF (M .GT. 400) GO TO 940			A 680	
		NSW = NSSWSV(1) + NSSWSV(2)			A 681	
		IF (NSW .GT. 50) GO TO 930			A 682	
		ITSV = 0			A 683	
		DO 920 IT = 1,IPLAN			A 684	
685		IF (AN(IT) .LE. 25.) GO TO 920			A 685	
		WRITE (6,1280) IT,AN(IT)			A 686	
		ITSV = 1			A 687	
	920	CONTINUE			A 688	
		IF (ITSV .GT. 0) GO TO 960			A 689	
690		GO TO 950			A 690	
	930	WRITE (6,1270) NSW			A 691	
		GO TO 960			A 692	
	940	WRITE (6,1260) M			A 693	
		GO TO 960			A 694	
695		950 REWIND 25			A 695	
		WRITE (25) ROT,M,RETA,PTEST,QTEST,TRLSCW,Q,PN,PV,S,PSI,PHI,7H,NSSW			A 696	
		1,TWIST,CREF,SPFF,CAVE,CLOES,STRUE,AP,ARTRUE,RTCDHT,CONFIG,NSSWSV,M			A 697	
		2SV,KROT,PLAN,IPLAN,MACH,SSWA,CHORD,XTE,KBIT,TSPAN,TSPAN,XCFW,XCF			A 698	
		3T,IFLAG,YREG(1,1),YREG(1,2),ALLINF,NTOT,NBRK,1SEG,YJ,7,PJ,SCWJK,JF			A 699	
700		4LAG,CBPM,VBORD,XPREF,PCTX,PCTZ,NZS,JCTL,JSLP			A 700	
		END FILE 25			A 701	
		WRITE (6,1290)			A 702	
		WRITE (50,1310)			A 703	
		GO TO 970			A 704	
705		960 TOTAL = TOTAL - 1.			A 705	
		WRITE (50,1320)			A 706	
	970	CONTINUE			A 707	
		END FILE 50			A 708	
		STOP			A 709	
710		980 ICODEOF = 1			A 710	
		WRITE (6,1130) CONFIG			A 711	
		GO TO 960			A 712	
	990	ICODEOF = 2			A 713	
		WRITE (6,1140) K,IT			A 714	

PROGRAM GEOMETRY (Continued)

PROGRAM GEOMETRY	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/77. 13.35.39	PAGE 1A
715	GO TO 960				A 715
	1000 ICODEOF = 3				A 716
	WRITE (6,1170) PTEST,QTEST				A 717
	GO TO 960				A 718
	C				A 719
720	C				A 720
	C				A 721
	1010 FORMAT (3F10.4,F10.7)				A 722
	1020 FORMAT (10F5.0)				A 723
	1030 FORMAT (3F10.0)				A 724
725	1040 FORMAT (6F10.0)				A 725
	1050 FORMAT (/45X,20HX SHIFT OF ORIGIN = .F10.4,6H UNITS/)				A 726
	1060 FORMAT (1H1//63X,13HGEOMETRY DATA)				A 727
	1070 FORMAT (///45X,A10.22HREFERENCE PLANFORM HAS,13,7H CURVES//12X,19H				A 728
	1ROOT CHORD HEIGHT =,F14.8,4X,29HVARIBLE SWEEP PIVOT POSITION,4X,6				A 729
730	2HX(S) =,F12.5,5X,6HY(S) =,F12.5//46X,40HBREAK POINTS FOR THE REFER				A 730
	3ENCE PLANFORM /)				A 731
	1080 FORMAT (8F10.4)				A 732
	1090 FORMAT (1H1//47X,17HCONFIGURATION NO.,F8.0//)				A 733
	1100 FORMAT (22X,5HPOINT,6X,1HX,11X,1HY,11X,1H7,10X,5HSWEEP,7X,8HDIHEDR				A 734
735	1AL,4X,4HMOVE/6AX,5HANGLE,8X,5HANGLE,6X,4HCODE//)				A 735
	1110 FORMAT (20X,15,3F12.5,2F14.5,16)				A 736
	1120 FORMAT (/40X,5HCURVE,13,9H IS SWEEP,F12.5,20H DEGRFES ON PLANFORM,				A 737
	113)				A 738
	1130 FOPMAT (1H1//41X,43HEND OF FILE ENCOUNTERED AFTER CONFIGURATION,F				A 739
740	17.0)				A 740
	1140 FORMAT (1H1//18X,45HTHE FIRST VARIABLE SWEEP CURVE SPECIFIED (K =				A 741
	1,13,44H) DOES NOT HAVE AN M CODE OF 2 FOR PLANFORM,I4)				A 742
	1150 FORMAT (5F5.1,2F10.4)				A 743
	1160 FORMAT (26X,15,2F12.5,2F16.5,4X,I4)				A 744
745	1170 FORMAT (1H1//1X,38HERROR - PROGRAM CANNOT PROCESS PTEST =,F5.1,12				A 745
	1H AND QTEST =,F5.1)				A 746
	1180 FORMAT (/48X,35HBREAK POINTS FOR THIS CONFIGURATION//)				A 747
	1190 FORMAT (28X,5HPOINT,6X,1HX,11X,1HY,11X,5HSWEEP,10X,8HDIHEDRAL,7X,4				A 748
	1HMOVE/38X,3HREF,9X,3HREF,10X,5HANGLE,11X,5HANGLE,9X,4HCODE//)				A 749
750	1200 FORMAT (/52X,2PHSECOND PLANFORM BREAK POINTS/)				A 750
	1210 FORMAT (///25X,34HTHE BREAKPOINT LOCATED SPANWISE AT,F11.5,3X,20H				A 751
	1HAS BEEN ADJUSTED TO,F9.5//)				A 752
	1220 FORMAT (/43X,F5.0,41H HORSESHOE VORTICES IN EACH CHORDWISE ROW)				A 753
	1230 FORMAT (/23X,9HRTABLE OF HORSESHOE VORTICES IN EACH CHORDWISE ROW				A 754
755	1(FROM TIP TO ROOT BEGINNING WITH FIRST PLANFORM)//25F5.0/25F5.0)				A 755
	1240 FORMAT (///33X,15,62H HORSESHOE VORTICES USED ON THE LEFT HALF OF T				A 756

PROGRAM WINGAL

PROGRAM WINGAL 74/74 OPT=1 STATIC FTN 4,7,485 81/01/27, 13,38.34 PAGE 1

1	OVERLAY (WINGTL,0,0)	A	1
	PROGRAM WINGAL (OUTPUT,TAPF6=OUTPUT,TAPE10,TAPF20,TAPE25,PUNCH)	A	2
	COMMON /AL/ ROT,M,RETA,PTFST,QTEST,TBLSCW(50),Q(400),PN(400),PV(A	3
	1400),S(400),PSI(400),PHI(50),7H(50),NSSW	A	4
5	COMMON /ONFHRE/ TWIST(2),CREF,SREF,CAVE,CLOFS,STRUE,AR,ARTRUE,RT	A	5
	ICDHT(2),CONFIG,NSSWSV(2),MSV(2),KROT,PLAN,IPLAN,MACH,SSWWA(50),XCF	A	6
	2W,XCFT,YREG(1,2),CRRM,VRORD(51),XPREF	A	7
	COMMON /TOTHRF/ CIR(400)	A	8
	COMMON /CCPRDD/ CHORD(50),XTE(50),KRIT,TSPAN,TSPANA	A	9
10	COMMON /JMK/ NTOT(2),NPRK(2),LSEG(10),YJ(10),Z(10),PJ(10),SCWJK	A	10
	COMMON /JK2/ PCTX(50),PCT7(50),NZS,JCTL,JSLP	A	11
	COMMON /FEM/ NSPT(4),NLLINE,JFLAG	A	12
	REAL MACH	A	13
	C	A	14
15	C	A	15
	C VORTEX LATTICE AERODYNAMIC COMPUTATION	A	16
	C	A	17
	REWIND 25	A	18
	READ (25) ROT,M,RETA,PTFST,QTEST,TBLSCW,Q,PN,PV,S,PSI,PHI,7H,NSSW,	A	19
20	1TWIST,CREF,SREF,CAVE,CLOFS,STRUE,AR,ARTRUE,RTICDHT,CONFIG,NSSWSV,MS	A	20
	2V,KPOT,PLAN,IPLAN,MACH,SSWWA,CHORD,XTE,KRIT,TSPAN,TSPANA,XCFW,XCFT	A	21
	3,IFLAG,YREG(1,1),YREG(1,2),NLLINE,NTOT,NPRK,LSEG,YJ,Z,PJ,SCWJK,JFL	A	22
	4AG,CRRM,VRORD,XPREF,PCTX,PCT7,NZS,JCTL,JSLP	A	23
	C	A	24
25	C	A	25
	WINGTL = 6LWINGTL	A	26
	RECALL = 6HRECALL	A	27
	C	A	28
	C	A	29
30	CALL OVERLAY (WINGTL,1,0,RECALL)	A	30
	C	A	31
	CALL OVERLAY (WINGTL,2,0,RECALL)	A	32
	STOP	A	33
	READ (5)	A	34
35	RFAD (5,10)	A	35
	WRITE (6,10)	A	36
	C	A	37
	10 FORMAT (1X)	A	38
	END	A	39-

SUBROUTINE FILUP

SUBROUTINE FILUP	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27..13.38.34	PAGE	1
1						R	1
	C	SUBROUTINE FILUP (X,Y,M,N,VARI,VARD)				R	2
	C	***DOCUMENT DATE 09-12-69 SUPROUTINE REVISED 07-07-69 *****				R	3
		MODIFICATION OF LIBRARY INTERPOLATION SUBROUTINE FILUP				R	4
		DIMENSION VARI(1), VARD(1), V(3), YY(2)				R	5
5		DIMENSION II(43)				R	6
	C	INITIALIZE ALL INTERVAL POINTERS TO -1.0 FOR MONOTONICITY CHECK				R	7
	C	DATA (II(J),J=1,43)/43*-1/				R	8
		MA = IABS(M)				R	9
10	C					R	10
	C	ASSIGN INTERVAL POINTER FOR GIVEN VARI TABLE				R	11
	C	THE SAME POINTER WILL BE USED ON A GIVEN VARI TABLE EVERY TIME				R	12
		LI = MOD(LOC(VARI(1)),43) + 1				R	13
		I = II(LI)				R	14
15		IF (I .GE. 0) GO TO 60				R	15
		IF (N .LT. 2) GO TO 60				R	16
	C					R	17
	C	MONOTONICITY CHECK				R	18
		IF (VARI(I) - VARI(I-1)) 20,20,40				R	19
20	C	ERROR IN MONOTONICITY				R	20
	10	K = LOC(VARI(1))				R	21
		PRINT 170, J,K, (VARI(J), J = 1,N), (VARD(J), J = 1,N)				R	22
		STOP				R	23
	C	MONOTONIC DECREASING				R	24
25	20	DO 30 J = 2,N				R	25
		IF (VARI(J) - VARI(J - 1)) 30,10,10				R	26
	30	CONTINUE				R	27
		GO TO 60				R	28
	C	MONOTONIC INCREASING				R	29
30	40	DO 50 J = 2,N				R	30
		IF (VARI(J) - VARI(J - 1)) 10,10,50				R	31
	50	CONTINUE				R	32
	C					R	33
	C	INTERPOLATION				R	34
35	60	IF (I .LE. 0) I = 1				R	35
		IF (I .GE. N) I = N - 1				R	36
		IF (N .LE. 1) GO TO 70				R	37
		IF (MA .NE. 0) GO TO 80				R	38
	C	ZERO ORDER				R	39
40	70	Y = VARD(1)				R	40
		GO TO 160				R	41
	C	LOCATE I INTERVAL (X(I).LE.X.LT.X(I+1))				R	42

(cont'd)

SUBROUTINE FILUP (Concluded)

SUBROUTINE FILUP

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      80 IF ((VARI(I) - X) * (VARI(I + 1) - X)) 110,110,90          R 43
      C IN GIVES DIRECTION FOR SEARCH OF INTERVALS                 R 44
45      90 IN = SIGN(1.0,(VARI(I + 1) - VARI(I)) * (X - VARI(I)))   R 45
      C IF X OUTSIDE ENDPOINTS, EXTRAPOLATE FROM END INTERVAL     R 46
      100 IF ((I + IN) .LE. 0) GO TO 110                          R 47
      IF ((I + IN) .GE. N) GO TO 110                              R 48
      I = I + IN                                                  R 49
50      IF ((VARI(I) - X) * (VARI(I + 1) - X)) 110,110,100       R 50
      110 IF (MA .EQ. 2) GO TO 120                                 R 51
      C                                                            R 52
      C FIRST ORDER                                               R 53
      Y = (VARD(I) * (VARI(I + 1) - X) - VARD(I + 1) * (VARI(I) - X)) /
55      1(VARI(I + 1) - VARI(I))                                  R 54
      GO TO 160                                                  R 55
      C                                                            R 56
      C SECOND ORDER                                              R 57
      C                                                            R 58
      120 IF (N .EQ. 2) GO TO 10                                  R 59
      IF (I .EQ. (N - 1)) GO TO 140                              R 60
      IF (I .EQ. 1) GO TO 130                                   R 61
      C PICK THIRD POINT                                         R 62
      SK = VARI(I + 1) - VARI(I)                                  R 63
      IF ((SK * (X - VARI(I - 1))) .LT. (SK * (VARI(I + 2) - X))) GO TO
65      1140                                                       R 64
      130 L = I                                                  R 65
      GO TO 150                                                  R 66
      140 L = I - 1                                              R 67
      150 V(1) = VARI(L) - X                                       R 68
      V(2) = VARI(L + 1) - X                                       R 69
      V(3) = VARI(L + 2) - X                                       R 70
      YY(1) = (VARD(L) * V(2) - VARD(L + 1) * V(1)) / (VARI(L + 1) - VAR
70      II(L))                                                    R 71
      YY(2) = (VARD(L + 1) * V(3) - VARD(L + 2) * V(2)) / (VARI(L + 2) -
75      1 VARI(L + 1))                                             R 72
      Y = (YY(1) * V(3) - YY(2) * V(1)) / (VARI(L + 2) - VARI(L)) R 73
      160 II(LI) = I                                             R 74
      RETURN                                                    R 75
      C                                                            R 76
      C                                                            R 77
80      C                                                            R 78
      C                                                            R 79
      C                                                            R 80
      C                                                            R 81
      170 FORMAT (1H1,50H TABLE BELOW OUT OF ORDER FOR FILUP AT POSITION ,
      115,731H X TABLE IS STORED IN LOCATION ,06,/(8G15.8)
      FMP                                                         R 82
      R 83
      R 84

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(Cont'd)

SUBROUTINE SIMEQ

SUBROUTINE SIMEQ		74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	1
1	C	SUBROUTINE SIMEQ (A,N,B,M,DETERM,IPIVOT,NMAX,ISCALF)			C	1	
	C	SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS			C	2	
	C	*** DOCUMENT DATE 08-01-68 SUBROUTINE REVISED 08-01-68 *****			C	3	
	C				C	4	
5		DIMENSION IPIVOT(N), A(NMAX,N), B(NMAX,M)			C	5	
		EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX,T,SWAP)			C	6	
	C				C	7	
	C	INITIALIZATION			C	8	
	C				C	9	
10		10	ISCALF = 0	C	10		
			R1 = 10.0 ** 100	C	11		
			R2 = 1.0 / R1	C	12		
			DETERM = 1.0	C	13		
			DO 20 J = 1,N	C	14		
15		20	IPIVOT(J) = 0	C	15		
			DO 380 I = 1,N	C	16		
	C				C	17	
	C	SEARCH FOR PIVOT ELEMENT			C	18	
	C				C	19	
20			AMAX = 0.0	C	20		
			DO 70 J = 1,N	C	21		
			IF (IPIVOT(J) = 1) 30,70,30	C	22		
		30	DO 60 K = 1,N	C	23		
			IF (IPIVOT(K) = 1) 40,60,390	C	24		
25		40	IF (ABS(AMAX) = ABS(A(J,K))) 50,60,60	C	25		
		50	IROW = J	C	26		
			ICOLUM = K	C	27		
			AMAX = A(J,K)	C	28		
		60	CONTINUE	C	29		
30		70	CONTINUE	C	30		
			IF (AMAX) 90,80,90	C	31		
		80	DETERM = 0.0	C	32		
			ISCALF = 0	C	33		
			GO TO 390	C	34		
35		90	IPIVOT(ICOLUM) = IPIVOT(ICOLUM) + 1	C	35		
	C				C	36	
	C	INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL			C	37	
	C				C	38	
			IF (IROW = ICOLUM) 100,140,100	C	39		
40		100	DETERM = -DETERM	C	40		
			DO 110 L = 1,N	C	41		
			SWAP = A(IROW,L)	C	42		

(Cont'd)

SUBROUTINE SIMEQ (Continued)

SUBROUTINE SIMEQ 74/74 OPT=1 STATIC

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	A(IROW,L) = A(ICOLUM,L)	C 43
45	110 A(ICOLUM,L) = SWAP	C 44
	IF (M) 140,140,120	C 45
	120 DO 130 L = 1,M	C 46
	SWAP = R(IROW,L)	C 47
	B(IROW,L) = R(ICOLUM,L)	C 48
	130 R(ICOLUM,L) = SWAP	C 49
50	140 PIVOT = A(ICOLUM,ICOLUM)	C 50
	IF (PIVOT) 150,80,150	C 51
	C	C 52
	C SCALE THE DETERMINANT	C 53
	C	C 54
55	150 PIVOTI = PIVOT	C 55
	IF (ABS(DETERM) - R1) 180,160,160	C 56
	160 DETERM = DETERM / R1	C 57
	ISCALE = ISCALE + 1	C 58
	IF (ABS(DETERM) - R1) 210,170,170	C 59
60	170 DETERM = DETERM / R1	C 60
	ISCALE = ISCALE + 1	C 61
	GO TO 210	C 62
	180 IF (ABS(DETERM) - R2) 190,190,210	C 63
	190 DETERM = DETERM * R1	C 64
65	ISCALE = ISCALE - 1	C 65
	IF (ABS(DETERM) - R2) 200,200,210	C 66
	200 DETERM = DETERM * R1	C 67
	ISCALE = ISCALE - 1	C 68
	210 IF (ABS(PIVOTI) - R1) 240,220,220	C 69
70	220 PIVOTI = PIVOTI / R1	C 70
	ISCALE = ISCALE + 1	C 71
	IF (ABS(PIVOTI) - R1) 270,230,230	C 72
	230 PIVOTI = PIVOTI / R1	C 73
	ISCALE = ISCALE + 1	C 74
75	GO TO 270	C 75
	240 IF (ABS(PIVOTI) - R2) 250,250,270	C 76
	250 PIVOTI = PIVOTI * R1	C 77
	ISCALE = ISCALE - 1	C 78
	IF (ABS(PIVOTI) - R2) 260,260,270	C 79
80	260 PIVOTI = PIVOTI * R1	C 80
	ISCALE = ISCALE - 1	C 81
	270 DETERM = DETERM * PIVOTI	C 82
	C	C 83
	C DIVIDE PIVOT POW BY PIVOT ELEMENT	C 84

SUBROUTINE SIMEQ (Concluded)

SUBROUTINE SIMEQ	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.28.34	PAGE 3
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85	C	DO 290 L = 1,N	C 85
		IF (IPIVOT(L) - 1) 280,290,390	C 86
		280 A(ICOLUM,L) = A(ICOLUM,L) / PIVOT	C 87
		290 CONTINUE	C 88
90		IF (M) 320,320,300	C 89
		300 DO 310 L = 1,M	C 90
		310 B(ICOLUM,L) = B(ICOLUM,L) / PIVOT	C 91
	C		C 92
	C	REDUCE NON-PIVOT ROWS	C 93
95	C		C 94
		320 DO 380 L1 = 1,N	C 95
		IF (L1 - ICOLUM) 330,380,330	C 96
		330 T = A(L1,ICOLUM)	C 97
		DO 350 L = 1,N	C 98
100		IF (IPIVOT(L) - 1) 340,350,390	C 99
		340 A(L1,L) = A(L1,L) - A(ICOLUM,L) * T	C 100
		350 CONTINUE	C 101
		IF (M) 380,380,360	C 102
		360 DO 370 L = 1,M	C 103
105		370 B(L1,L) = B(L1,L) - B(ICOLUM,L) * T	C 104
		380 CONTINUE	C 105
		390 RETURN	C 106
		END	C 107
			C 108-

PROGRAM CIRCUL2

PPOGRAM CIRCUL2 74/74 OPT=1 STATIC

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PAGE 1

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1:      OVERLAY (WINGTL,1.0)                D  1
      PROGRAM CIRCUL2                       D  2
      DIMENSION A(53,53), COPAG(53), JPIVGT(53), NMA(2), PPP(50), ZZH(5 D  3
11), YR(50), YC(50), T1(53,53), T2(53,53), T3(53,53), T4(53,53), T5 D  4
5      2(53,53), T6(53,53), PKK(50), XTT(51) D  5
      DIMENSION YINT1(50), YINT2(50), CORD1(50), CORD2(50), XT1(50), XT D  6
12(50), WN(2), YY(2)                       D  7
      DIMENSION CKP(51), CKM(51), CBI(50)   D  8
      DIMENSION PERIF(10), YJK(50), ZJK(50), PJK(50), DTHETA(10), RGAM( D  9
10      151), AINT(6)                       D 10
      DIMENSION PPI(400,1), YCTR(100)       D 11
      DIMENSION CRD(53)                     D 12
      COMMON /ALL/ POT,M,RETA,PTEST,OTFST,TBLSCW(50),O(400),PN(400),PV( D 13
1400),S(400),PSI(400),PHI(50),ZH(50),NSSW D 14
15      COMMON /ONETHRF/ TWIST(2),CREP,SPEF,CAVE,CLDFS,STRUE,AR,ARTRUF,PT D 15
1CDHT(2),CONF16,NSSWSV(2),MSV(2),KBOT,PLAN,IPLAN,MACH,SSWA(50),XCF D 16
2W,XCFY,YREG(1,2),CRPM,VRORD(51),XPREF D 17
      COMMON /TOTHRF/ CIR(400)              D 18
      COMMON /CCRRDD/ CHORD(50),XTE(50),KRIT,TSPAN,TSPANA D 19
20      COMMON /COR/ CORSUM                  D 20
      COMMON /JMK/ NTOT(2),NRPK(2),LSEG(10),YJ(10),Z(10),PJ(10),SCWJK D 21
      COMMON /TEL/ TOL,TOL2                 D 22
      COMMON /SEG/ SJK(50)                  D 23
      COMMON /FEN/ NSPT(4),NLLINE,JFLAG D 24
25      C THIS PROGRAM PERFORMS A TREFFITZ PLANE OPTIMIZATION D 25
      C TO COMPUTE THE ROUND CIRCULATION DISTRIBUTION FOR D 26
      C MINIMUM INDUCED DRAG FOR ONE OR TWO SYMMETRIC, INTER- D 27
      C ACTING SUBSONIC PLANFORMS. AN ADVANCED-PANEL THEORY D 28
      C DEVELOPED IN NASA CR-3154, JUNE, 1979, IS USED. D 29
30      C D 30
      C THIS PROGRAM HAS BEEN WRITTEN BY DR. JOHN M. KUHLMAN, D 31
      C DEPT. OF MECHANICAL ENGRNG, MECHANICS, OLD DOMINION D 32
      C UNIVERSITY, NORFOLK, VA, 23508. D 33
      C UNDER NASA GRANT NSG-1357, DR. JOHN E. LAMAR, TECH- D 34
35      C NICAL MONITOR. D 35
      C D 36
      C AN OPTIMIZATION CODE ORIGINALLY WRITTEN TO IMPLEMENT THIS D 37
      C THEORY HAS BEEN DESCRIBED IN A USER'S MANUAL, ODU RESEARCH D 38
      C FOUNDATION TECHNICAL PROGRESS REPORT DATED NOVEMBER, 1979, D 39
40      C GRANT NSG-1357 (FEDD DOC.) MODIFICATIONS AND ADDITIONS TO THIS D 40
      C THEORY TO ALLOW IMPLEMENTATION IN THE CURRENT DESIGN CODE D 41
      C HAVE BEEN DESCRIBED IN A PAPER BY J. KUHLMAN PUBLISHED D 42

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PROGRAM CIRCUL2 (Continued)

	PROGRAM CIRCUL2	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	2
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	C						D	44
45	C						D	45
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	20						D	78
							D	79
80	C						D	80
	C						D	81
							D	82
	C						D	83
	C						D	84

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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85	NMA(1) = NMA(2) = 0	D 85
	PI = 4. * ATAN(1.)	D 86
	RAD = 180. / PI	D 87
	ROTL = ABS(TSPAN)	D 88
	ROL = ABS(TSPAN)	D 89
90	DO 30 I = 1,NSV	D 90
	K1 = (I - 1) * NSCWJK + 1	D 91
	YCTR(I) = Q(K1)	D 92
	30 CONTINUE	D 93
	NTOT1 = NTOT + 1	D 94
95	NTOT3 = NTOT + 3	D 95
	IL = NTOT1	D 96
	DO 40 I = 1,NTOT3	D 97
	CDRAG(I) = 0.	D 98
	DO 40 J = 1,NTOT3	D 99
100	40 A(I,J) = 0.	D 100
	SCWMIN = 20.	D 101
	DO 50 I = 1,NSSW	D 102
	50 SCWMIN = AMIN1(SCWMIN,TRLSCW(I))	D 103
	NSCWMIN = SCWMIN	D 104
105	II = 1	D 105
	NSV1 = NSSWSV(1)	D 106
	NSV2 = NSSWSV(2)	D 107
	DO 90 I = 1,IPLAN	D 108
	NSVI = NSSWSV(I)	D 109
110	IC = MSV(1) + (I - 1) * MSV(2)	D 110
	ID = IC + 1	D 111
	I7 = NSV1 + (I - 1) * NSV2	D 112
	YCAT = YREG(1,I)	D 113
	DO 70 J = 1,NSVI	D 114
115	JJ = J + (I - 1) * NSVI	D 115
	II = II + TRLSW(JJ)	D 116
	IE = NSVI - J + 1	D 117
	ITL = TRLSW(I7)	D 118
	ID = ID - ITL	D 119
120	IA = ID + ITL	D 120
	IF (IA .GT. IC) YCAT = YCAT - S(ID)	D 121
	IF (IA .GT. IC) GO TO 60	D 122
	YCAT = YCAT - S(ID) - S(IA)	D 123
	60 I7 = I7 - 1	D 124
125	YR(IE) = YCAT	D 125
	70 CONTINUE	D 126

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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	DO 80 J = 1,NSVI	D 127
	JJ = J + (I - 1) * NSVI	D 128
	YC(JJ) = YR(J)	D 129
130	80 CONTINUE	D 130
	90 CONTINUE	D 131
	NSPT(I) = 1	D 132
	ICT = 0	D 133
	JST = 1	D 134
135	JSP = 0	D 135
	INC = 0	D 136
	ISP = 0	D 137
	NADD = 1	D 138
	NTOTD = 0	D 139
140	100 CONTINUE	D 140
	ICT = ICT + 1	D 141
	IF (ICT .GT. NLLINE) GO TO 260	D 142
	NR = NBRK(ICT)	D 143
	ICP = ICT + 1	D 144
145	NSPT(ICP) = NTOT(ICT) + NADD	D 145
	WRITE (6,1430) ICT	D 146
	WRITE (6,1410)	D 147
	IST = INC + 1	D 148
	ISP = JSP + NR	D 149
150	DO 110 I = IST,ISP	D 150
	110 WRITE (6,1420) YJ(I),Z(I),PJ(I)	D 151
	WRITE (6,1440) NTOT(ICT)	D 152
	NPR = NBRK(ICT) - 1	D 153
	JSP = JST + NPR - 1	D 154
155	DO 120 I = JST,JSP	D 155
	ITEM = JST - 1 + I	D 156
	120 WRITE (6,1450) ITEM,LSEG(I)	D 157
	DO 130 J = 1,NPR	D 158
	I = IST + J - 1	D 159
160	130 PERIF(J) = SQRT((Z(I + 1) - Z(I)) ** 2 + (YJ(I + 1) - YJ(I)) ** 2)	D 160
	DTOT = 0.	D 161
	DO 140 I = 1,NPR	D 162
	140 DTOT = DTOT + PERIF(I)	D 163
	WRITE (6,1460) DTOT	D 164
165	DO 170 I = 1,NPR	D 165
	IF (I .EQ. NPR) GO TO 150	D 166
	DTHFTA(I) = PI / (FLOAT(LSFG(NBRK(ICT) - I - 1 + JST)))	D 167
	GO TO 160	D 168

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2	74/74	OPT=1 STATIC	FTN 4,7,485	81/01/27. 13,38,34	PAGE 5
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170	150 CONTINUE	D 169
	DTHETA(I) = PI / (2. * FLOAT(LSEG(NBRK(ICT) - I - 1 + JST)))	D 170
	160 CONTINUE	D 171
	170 CONTINUE	D 172
	CONST = 1. / RAD	D 173
	NBRJ = NBRK(ICT)	D 174
175	DO 180 I = 1,NBRJ	D 175
	J = IST - 1 + I	D 176
	180 PJ(J) = CONST * PJ(J)	D 177
	RH = 0.5 * PERIF(NBR)	D 178
	I = NSPT(ICT)	D 179
180	IF (NBR .NE. 1) GO TO 190	D 180
	SJK(I) = 0.5 * PERIF(I) * (1. - COS(DTHETA(I)))	D 181
	GO TO 200	D 182
	190 SJK(I) = 0.5 * RH * (1. - COS(DTHETA(I)))	D 183
	200 PJK(I) = PJ(ISP - 1)	D 184
185	NN = 0 + NTOLD	D 185
	DO 240 I = 1,NBR	D 186
	NN = NN + LSEG(JSP + 1 - I)	D 187
	IF (I .EQ. 1 .AND. J .EQ. 1) GO TO 210	D 188
	RH = 0.5 * PERIF(NBRK(ICT) - I)	D 189
190	GO TO 220	D 190
	210 CONTINUE	D 191
	RH = PERIF(NBRK(ICT) - I)	D 192
	220 CONTINUE	D 193
	LL = LSEG(JSP + 1 - I)	D 194
195	DO 230 J = 1,LL	D 195
	IF (I .EQ. 1 .AND. J .EQ. 1) GO TO 230	D 196
	NM = NN - LL + J	D 197
	PJK(NM) = PJ(NBR + 1 - I + INC)	D 198
	SJK(NM) = 0.50 * RH * (COS(FLOAT(J) * DTHETA(I)) - COS(FLOAT(J - 1	D 199
200	1) * DTHETA(I)))	D 200
	SJK(NM) = ABS(SJK(NM))	D 201
	230 CONTINUE	D 202
	240 CONTINUE	D 203
	NST = NSPT(ICT)	D 204
205	YJK(NST) = YJ(ISP) + SJK(NST) * COS(PJK(NST))	D 205
	ZJK(NST) = ZJ(ISP) + SJK(NST) * SIN(PJK(NST))	D 206
	NSEG = NTOT(ICT) + NTOLD	D 207
	NST = NSPT(ICT) + 1	D 208
	DO 250 I = NST,NSFG	D 209
210	YJK(I) = YJK(I - 1) + SJK(I - 1) * COS(PJK(I - 1)) + SJK(I) * COS(D 210

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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      1PJK(I)
      ZJK(I) = 7JK(I - 1) + SJK(I - 1) * SIN(PJK(I - 1)) + SJK(I) * SIN(
      1PJK(I))
215 250 CONTINUE
      NTOLD = NTOT(ICT)
      INC = NB
      NADD = NSPT(ICP)
      JST = JSP + 1
      GO TO 100
220 260 CONTINUE
      WRITE (6,1470)
      WRITE (6,1480) (I,YJK(I),7JK(I),PJK(I),I = 1,NTOTT)
      WRITE (6,1490)
      RSAVE = 0.
225      DO 270 J = 1,JF
      RCOM = 2. * ARS(YJ(J))
      RSAVE = AMAX1(RSAVE,RCOM)
270 CONTINUE
      WRITE (6,1500) (I,SJK(I),J = 1,NTOTT)
230 C TOLERANCES SET HERE ARE FOR SINGULARITIES IN INTEGRALS
      C TOL IS TOLERANCE FOR ATAN INTEGRALS
      C TOL2 IS TOLERANCE FOR LOG INTEGRALS
      SMIN = SJK(1)
      DO 280 I = 1,NTOTT
235      STEM = SJK(I)
280 SMIN = AMIN1(SMIN,STEM)
      TOL = 5.E - 05 * SMIN * NSPT(2)
      TOL2 = TOL
      DO 290 I = 1,NTOT3
240      DO 290 J = 1,NTOT3
      T1(I,J) = 0.
      T2(I,J) = 0.
      T3(I,J) = 0.
      T4(I,J) = 0.
245      T5(I,J) = 0.
      T6(I,J) = 0.
290 CONTINUE
      DO 300 I = 1,NTOTT
      I1 = I + 1
250      DO 300 J = 1,NTOTT
      J1 = J + 1
      CALL DRACAL (I,J,YJK,7JK,PJK,AINT)

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PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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	T1(I1,J1) = AINT(1)	D 253
	T2(I1,J1) = AINT(2)	D 254
255	T3(I1,J1) = AINT(3)	D 255
	T4(I1,J1) = AINT(4)	D 256
	T5(I1,J1) = AINT(5)	D 257
	T6(I1,J1) = AINT(6)	D 258
	300 CONTINUE	D 259
260	DO 420 I = 1,NTOTT	D 260
	I1 = I + 1	D 261
	DO 420 J = 1,NTOTT	D 262
	J1 = J + 1	D 263
	A(I,J) = T3(I1,J1) - T4(I1,J1) - T5(I1,J1) + T6(I1,J1)	D 264
265	DO 310 K = 1,NLLINE	D 265
	IC = NSPT(K)	D 266
	IF (I .EQ. IC) GO TO 330	D 267
	310 CONTINUE	D 268
	A(I,J) = A(I,J) + T3(I1 - 1,J1) - T4(I1 - 1,J1) + T5(I1 - 1,J1) -	D 269
270	T6(I1 - 1,J1)	D 270
	DO 320 K = 1,NLLINE	D 271
	JC = NSPT(K)	D 272
	IF (J .EQ. JC) GO TO 350	D 273
	320 CONTINUE	D 274
275	A(I,J) = A(I,J) + T3(I1 - 1,J1 - 1) + T4(I1 - 1,J1 - 1) + T5(I1 -	D 275
	11,J1 - 1) + T6(I1 - 1,J1 - 1)	D 276
	330 CONTINUE	D 277
	DO 340 K = 1,NLLINE	D 278
	JC = NSPT(K)	D 279
280	IF (J .EQ. JC) GO TO 350	D 280
	340 CONTINUE	D 281
	A(I,J) = A(I,J) + T3(I1,J1 - 1) + T4(I1,J1 - 1) - T5(I1,J1 - 1) -	D 282
	T6(I1,J1 - 1)	D 283
	350 CONTINUE	D 284
285	A(I,J) = A(I,J) + 1.5 * SJK(I) * (T1(I1,J1) - T2(I1,J1))	D 285
	DO 360 K = 1,NLLINE	D 286
	JC = NSPT(K)	D 287
	IF (J .EQ. JC) GO TO 370	D 288
	360 CONTINUE	D 289
290	A(I,J) = A(I,J) + 1.5 * SJK(I) * (T1(I1,J1 - 1) + T2(I1,J1 - 1))	D 290
	370 CONTINUE	D 291
	DO 380 K = 1,NLLINE	D 292
	IC = NSPT(K)	D 293
	IF (I .EQ. IC) GO TO 410	D 294

PROGRAM CIRCUL2 (Continued)

	PROGRAM CIRCUL2	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	8
295	380	CONTINUE					D 295	
		A(I,J) = A(I,J) + .5 * SJK(I - 1) * (T1(I1 - 1,J1) - T2(I1 - 1,J1)					D 296	
		1)					D 297	
		DO 390 K = 1,NLLINE					D 298	
		JC = NSPT(K)					D 299	
300		IF (J .EQ. JC) GO TO 400					D 300	
	390	CONTINUE					D 301	
		A(I,J) = A(I,J) + .5 * SJK(I - 1) * (T1(I1 - 1,J1 - 1) + T2(I1 - 1,					D 302	
		1,J1 - 1))					D 303	
	400	CONTINUE					D 304	
305	410	CONTINUE					D 305	
		A(I,J) = A(I,J) * 0.25					D 306	
	420	CONTINUE					D 307	
		DO 560 I = 1,NTOTT					D 308	
		I1 = I + 1					D 309	
310		DO 430 K = 1,NLLINE					D 310	
		IC = NSPT(K)					D 311	
		ISP = NSPT(K + 1) - 1					D 312	
		IF (I .EQ. IC) GO TO 500					D 313	
	430	CONTINUE					D 314	
315		SCOM = 0.5 * (SJK(I) + SJK(I - 1))					D 315	
		TEMP = 0.					D 316	
		NST = NSPT(1)					D 317	
		NSTP = NSPT(2) - 1					D 318	
		IF (I .LE. NSTP) GO TO 440					D 319	
320		NST = NSTP + 1					D 320	
		NSTP = NSPT(3) - 1					D 321	
	440	CONTINUE					D 322	
		LL = NSPT(2)					D 323	
		DO 490 J = 1,NTOTT					D 324	
325		J1 = J + 1					D 325	
		AT = T1(I1,J1 - 1) + T2(I1,J1 - 1)					D 326	
		IF (J .EQ. 1) AT = 0.0					D 327	
		IF (J .EQ. LL) AT = 0.0					D 328	
		TEMP = .5 * SJK(I - 1) * (T1(I1,J1) - T2(I1,J1) + AT)					D 329	
330		IF (I .EQ. NSTP) GO TO 480					D 330	
		IS = I + 1					D 331	
		DO 470 IP = IS,NSTP					D 332	
		IP1 = IP + 1					D 333	
		AT = 0.0					D 334	
335		DO 450 K = 1,NLLINE					D 335	
		JC = NSPT(K)					D 336	

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2	74/74	OPT=1 STATIC	FTN 4,7+485	R1/01/27. 13.38.34	PAGE	9
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	IF (J .EQ. JC) GO TO 460	D 337
450	CONTINUE	D 338
	AT = T1(IP1,J1 - 1) + T2(IP1,J1 - 1)	D 339
340	460 CONTINUE	D 340
	470 TFMP = TEMP + SCON * (T1(IP1,J1) - T2(IP1,J1) + AT)	D 341
	480 CONTINUE	D 342
	A(I,J) = A(I,J) + TFMP	D 343
	A(I,J) = A(I,J) / SREF	D 344
345	490 CONTINUE	D 345
	GO TO 550	D 346
	500 CONTINUE	D 347
	SCON = .5 * SJK(I)	D 348
	DO 540 J = 1,NTOTT	D 349
350	J1 = J + 1	D 350
	TEMP = 0.	D 351
	DO 530 IP = I,ISP	D 352
	IP1 = IP + 1	D 353
	AT = 0.0	D 354
355	DO 510 K = 1,NLLINE	D 355
	JC = NSPT(K)	D 356
	IF (J .EQ. JC) GO TO 520	D 357
	510 CONTINUE	D 358
	AT = T1(IP1,J1 - 1) + T2(IP1,J1 - 1)	D 359
360	520 CONTINUE	D 360
	TEMP = TEMP + SCON * (T1(IP1,J1) - T2(IP1,J1) + AT)	D 361
	530 CONTINUE	D 362
	A(I,J) = A(I,J) + TFMP	D 363
	A(I,J) = A(I,J) / SREF	D 364
365	540 CONTINUE	D 365
	550 CONTINUE	D 366
	560 CONTINUE	D 367
	DO 570 I = 1,NTOTT	D 368
	DO 570 J = 1,NTOTT	D 369
370	570 T1(I,J) = 2. * A(I,J)	D 370
	DO 580 I = 1,NTOTT	D 371
	DO 580 J = 1,NTOTT	D 372
	A(I,J) = 2. * A(I,J) + T1(J,I)	D 373
	580 CONTINUE	D 374
375	C	D 375
	C T1(I,J) NOW HAS A MATRIX FOR CDI CALCULATION	D 376
	C	D 377
	A(IL,IL) = 0.0	D 378

PROGRAM CIRCUL2 (Continued)

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PROGRAM CIRCUL2      74/74      OPT=1 STATIC      FTN 4.7+485      81/01/27. 13.3R.34      PAGE 10

      DO 610 I = 1,NTOTT                                D 379
      AT = 0.0                                           D 380
      DO 590 K = 1,NLLINE                                D 381
      IC = NSPT(K)                                       D 382
      IF (I .EQ. IC) GO TO 600                          D 383
590  CONTINUE                                           D 384
      AT = COS(PJK(I - 1)) * SJK(I - 1) ** 2          D 385
385  CONTINUE                                           D 386
      A(IL,I) = (2. * COS(PJK(I))) * SJK(I) ** 2 + AT) * 4. / (3. * SREF) D 387
610  CONTINUE                                           D 388
      ICT = 1                                           D 389
390  NST = 2                                           D 390
      NSP = NSPT(2) - 1                                 D 391
620  CONTINUE                                           D 392
      IF (ICT .GT. NLLINE) GO TO 670                  D 393
      SUMX = 0.0                                        D 394
395  L = NSPT(ICT)                                       D 395
      DO 630 I = NST,NSP                                D 396
      SUMX = SUMX + COS(PJK(I)) * SJK(I)              D 397
630  CONTINUE                                           D 398
      A(IL,L) = A(IL,L) + (4. / SREF) * SJK(L) * SUMX D 399
400  DO 660 I = NST,NSP                                D 400
      SUMX = COS(PJK(I)) * SJK(I) * SJK(I - 1)      D 401
      II = I + 1                                       D 402
      IF (I .EQ. NSP) GO TO 650                       D 403
405  DO 640 J = II,NSP                                  D 404
      SUMX = SUMX + COS(PJK(J)) * SJK(J) * (SJK(I) + SJK(I - 1)) D 405
640  CONTINUE                                           D 406
650  CONTINUE                                           D 407
      A(IL,I) = A(IL,I) + 4. / SREF * SUMX           D 408
660  CONTINUE                                           D 409
410  IF (ICT .EQ. 2) GO TO 670                        D 410
      NST = NSP + 2                                    D 411
      NSP = NSPT(3) - 1                                D 412
      ICT = ICT + 1                                    D 413
      GO TO 620                                        D 414
415  CONTINUE                                           D 415
670  DO 680 I = 1,NTOTT                                D 416
      A(IL,I) = 2. * A(IL,I)                          D 417
      A(I,IL) = A(IL,I)                              D 418
420  CONTINUE                                           D 419
      CDRAG(IL) = CLDPS                                D 420

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PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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	C		D 421
	C	NOW CALCULATE PITCH AND BENDING MOMENT CONSTRAINTS	D 422
	C		D 423
		JCT = IL	D 424
425		IF (JFLAG .EQ. 0 .OR. JFLAG .EQ. 2) GO TO 890	D 425
		JCT = JCT + 1	D 426
	C		D 427
	C	PITCH CONSTRAINT	D 428
	C		D 429
430		WRITE (6,1510)	D 430
		DO 690 J = 1,NSV1	D 431.
		YINT1(J) = YCTP(J)	D 432
		XT1(J) = XTE(J)	D 433
		CORD1(J) = CHORD(J)	D 434
435	690	CONTINUE	D 435
		DO 700 J = 1,NSV2	D 436
		JJ = J + NSV1	D 437
		YINT2(J) = YCTR(JJ)	D 438
		XT2(J) = XTE(JJ)	D 439
440		CORD2(J) = CHORD(JJ)	D 440
	700	CONTINUE	D 441
		NSPM = NSPT(2) - 1	D 442
		DO 780 J = 1,NTOTT	D 443
		IF (J .GE. NSPT(2)) GO TO 720	D 444
445		YKJ = YJK(J) - SJK(J) * COS(PJK(J))	D 445
		CALL FTLUP (YKJ,CRL, + 1,NSV1,YINT1,CORD1)	D 446
		CALL FTLUP (YKJ,XTL, + 1,NSV1,YINT1,XT1)	D 447
		NSM = NSV1 - 1	D 448
		DY = YINT1(NSV1) - YINT1(NSM)	D 449
450		SLP = (XT1(NSV1) - XT1(NSM)) / DY	D 450
		SLP2 = (CORD1(NSV1) - CORD1(NSM)) / DY	D 451
		XTP = XT1(NSV1) + SLP * ARS(YINT1(NSV1))	D 452
		CRP = CORD1(NSV1) + SLP2 * ABS(YINT1(NSV1))	D 453
		IF (J .EQ. NSPM) GO TO 710	D 454
455		YKJ = YJK(J) + SJK(J) * COS(PJK(J))	D 455
		CALL FTLUP (YKJ,CRP, + 1,NSV1,YINT1,CORD1)	D 456
		CALL FTLUP (YKJ,XTP, + 1,NSV1,YINT1,XT1)	D 457
	710	CONTINUE	D 458
		GO TO 740	D 459
460	720	CONTINUE	D 460
		YKJ = YJK(J) - SJK(J) * COS(PJK(J))	D 461
		CALL FTLUP (YKJ,XTL, + 1,NSV2,YINT2,XT2)	D 462

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2	74/74	OPT=1 STATIC	FTN 4,7,485	81/01/27. 13,38,34	PAGE 12
		CALL FTLUP (YKJ,CRL, + 1,NSV2,YINT2,CORD2)			D 463
		NSM = NSV2 - 1			D 464
465		DY = YINT2(NSV2) - YINT2(NSM)			D 465
		SLP = (XT2(NSV2) - XT2(NSM)) / DY			D 466
		SLP2 = (CORD2(NSV2) - CORD2(NSM)) / DY			D 467
		XTP = XT2(NSV2) + SLP * ABS(YINT2(NSV2))			D 468
		CRP = CORD2(NSV2) + SLP2 * ABS(YINT2(NSV2))			D 469
470		IF (J .EQ. NTOTT) GO TO 730			D 470
		YKJ = YJK(J) + SJK(J) * COS(PJK(J))			D 471
		CALL FTLUP (YKJ,CRP, + 1,NSV2,YINT2,CORD2)			D 472
		CALL FTLUP (YKJ,XTP, + 1,NSV2,YINT2,XT2)			D 473
	730	CONTINUE			D 474
475	740	CONTINUE			D 475
		XTEM = XCFW			D 476
		JCK = NSPT(2)			D 477
		IF (J .GE. JCK) XTEM = XCFT			D 478
		IF (XTEM .EQ. 1.) GO TO 760			D 479
480		AXSUM = 0.0			D 480
		ASUM = 0.0			D 481
		DO 750 K = 1,NSCWJK			D 482
		XCK = (K - 0.75) / SCWJK			D 483
		AI = (1. - XCK) / SCWJK / (1. - XTEM)			D 484
485		XI = 1. + (0.75 - K) / SCWJK			D 485
		IF (XCK .LE. XTEM) AI = 1. / SCWJK			D 486
		ASUM = ASUM + AI			D 487
		AXSUM = AXSUM + AI * XI			D 488
	750	CONTINUE			D 489
490		CON = AXSUM / ASUM			D 490
		GO TO 770			D 491
	760	CONTINUE			D 492
		CON = 0.5			D 493
	770	CONTINUE			D 494
495		XCP = XTP + CRP * CON			D 495
		XCL = XTL + CRL * CON			D 496
		CKP(J) = (XCL + XCP) * 0.5			D 497
		CKM(J) = (XCP - XCL) * 0.5			D 498
	780	CONTINUE			D 499
500		DO 810 J = 1,NTOTT			D 500
		A(JCT,J) = SJK(J) ** 2 * (CKP(J) + 4. * CKM(J)) * COS(PJK(J)) / 3			D 501
		DO 790 K = 1,MLLINE			D 502
		JCK = NSPT(K)			D 503
		IF (J .EQ. JCK) GO TO 800			D 504

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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505      790 CONTINUE                                D 505
          A(JCT,J) = A(JCT,J) + SJK(J - 1) ** 2 * (CKM(J - 1) + 2. * CKP(J -
          1 1)) * COS(PJK(J - 1)) / 3                D 506
800 CONTINUE                                        D 507
810 CONTINUE                                        D 508
          STEM = 0.0                                  D 509
510      DO 870 J = 1,NTOTT                            D 510
          .DO 820 K = 1,NLLINE                          D 511
          JCK = NSPT(K)                                  D 512
          IF (J .EQ. JCK) GO TO 830                      D 513
515      820 CONTINUE                                    D 514
          STEM = SJK(J) + SJK(J - 1)                    D 515
          A(JCT,J) = A(JCT,J) + 2. * COS(PJK(J)) * SJK(J) * SJK(J - 1) * CKP
          1(J)                                           D 516
          GO TO 840                                       D 517
520      830 CONTINUE                                    D 518
          STEM = SJK(J)                                  D 519
          TEMP = 0.0                                       D 520
          IST = J + 1                                       D 521
525      ISP = NTOTT                                       D 522
          IF (J .LE. NSPM) ISP = NSPM                       D 523
          IF (J .EQ. ISP) GO TO 840                          D 524
          DO 850 I = IST,ISP                                  D 525
          TEMP = TEMP + 2. * STEM * CKP(I) * SJK(I) * COS(PJK(I)) D 526
530      850 CONTINUE                                    D 527
          A(JCT,J) = A(JCT,J) + TEMP                       D 528
          860 CONTINUE                                    D 529
          870 CONTINUE                                    D 530
          SUMATT = 0.                                       D 531
535      DO 880 J = 1,NTOTT                            D 532
          A(JCT,J) = 4. * A(JCT,J) / (SREF + CREF)         D 533
          A(J,JCT) = A(JCT,J)                             D 534
          CRD(J) = A(JCT,J)                                D 535
          880 CONTINUE                                    D 536
          CDRA8(JCT) = 0.                                    D 537
540      890 CONTINUE                                    D 538
          IF (JFLAG .EQ. 0 .OR. JFLAG .EQ. 1) GO TO 1020 D 539
          JCT = JCT + 1                                     D 540
          C                                                D 541
          C                                                D 542
          C                                                D 543
          C                                                D 544
545      C ROOT BEHNDING CONSTRAINT                       D 545
          C                                                D 546
          C

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PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2	74/74 OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE 14
	DO 900 I = 1,NTOTT			D 547
	PKK(I) = PJK(I)			D 548
	PJK(I) = 0.0			D 549
550	900 CONTINUE			D 550
	C			D 551
	WRITE (6,1520)			D 552
	DO 960 J = 1,NTOTT			D 553
	NSPT = NTOTT			D 554
555	IF (J .GE. NSPT(2)) GO TO 910			D 555
	NSPT = NSPT(2) - 1			D 556
	910 CONTINUE			D 557
	A(JCT,J) = 0.			D 558
	DO 920 K = 1,NLLINE			D 559
560	JCHK = NSPT(K)			D 560
	IF (J .EQ. JCHK) GO TO 940			D 561
	920 CONTINUE			D 562
	DL = YJK(J) * COS(PJK(J)) + ZJK(J) * SIN(PJK(J))			D 563
	A(JCT,J) = 2. * SJK(J) * SJK(J - 1) * DL			D 564
565	IF (J .EQ. NSPT) GO TO 960			D 565
	JJ = J + 1			D 566
	DO 930 K = JJ,NSPT			D 567
	DL = YJK(K) * COS(PJK(K)) + ZJK(K) * SIN(PJK(K))			D 568
	A(JCT,J) = A(JCT,J) + 2. * SJK(K) * DL * (SJK(J) + SJK(J - 1))			D 569
570	930 CONTINUE			D 570
	GO TO 960			D 571
	940 CONTINUE			D 572
	J1 = JCHK + 1			D 573
	DL = YJK(J1) * COS(PJK(J1)) + ZJK(J1) * SIN(PJK(J1))			D 574
575	A(JCT,J) = 2. * SJK(J1) * DL * SJK(JCHK)			D 575
	DO 950 K = 3,NSPT			D 576
	DL = YJK(K) * COS(PJK(K)) + ZJK(K) * SIN(PJK(K))			D 577
	A(JCT,1) = A(JCT,1) + SJK(1) * 2. * DL * SJK(K)			D 578
	950 CONTINUE			D 579
580	960 CONTINUE			D 580
	DO 990 J = 1,NTOTT			D 581
	DL = YJK(J) * COS(PJK(J)) + ZJK(J) * SIN(PJK(J))			D 582
	A(JCT,J) = A(JCT,J) + SJK(J) ** 3 / 3. + 4. * SJK(J) ** 2 * DL / 3			D 583
	1.			D 584
585	DO 970 K = 1,NLLINE			D 585
	JCHK = NSPT(K)			D 586
	IF (J .EQ. JCHK) GO TO 980			D 587
	970 CONTINUE			D 588

PROGRAM CIRCUL2 (Continued)

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PROGRAM CIRCUL2   .74/74   OPT=1 STATIC           FTN 4,7+485           81/01/27, 13,38,34           PAGE   15

          DLM = YJK(J - 1) * COS(PJK(J - 1)) + ZJK(J - 1) * SIN(PJK(J - 1))   D 589
590      A(JCT,J) = A(JCT,J) + SJK(J - 1) ** 3 / 3. + 2. * SJK(J - 1) ** 2   D 590
          1 * DLM / 3.                                                         D 591
          980 CONTINUE                                                         D 592
          A(JCT,J) = -A(JCT,J) * 2. / (SREF * BSAVE / 2.)                     D 593
          990 CONTINUE                                                         D 594
595      DO 1000 L = 1,NTOTT                                                    D 595
          1000 CRI(L) = A(JCT,L)                                               D 596
          CRRM = CRBM * CLOS * 0.5 * 0.424413                                  D 597
          CDRAG(JCT) = CRRM                                                    D 598
          C                                                                       D 599
600      DO 1010 I = 1,NTOTT                                                    D 600
          1010 PJK(I) = PKK(I)                                                 D 601
          C                                                                       D 602
          1020 CONTINUE                                                         D 603
          CALL SIMEQ (A,JCT,CDRAG,1,DETERM,IPIVOT,53,ISCALE)                  D 604
605      CDRAG(IL) = 0.                                                         D 605
          WRITE (6,1530)                                                         D 606
          DO 1100 I = 1,NTOTT                                                    D 607
          WNORM = 0.                                                            D 608
          DO 1090 J = 1,NTOTT                                                    D 609
610      SS = SJK(J)                                                            D 610
          CALL CCAL (I,J,YJK,ZJK,PJK,SS,AA,BR,DD,FF,GG,FF,AJ,AK,RR,TT,UU,WW)   D 611
          CALL CONCAL (AA,BR,FF,GG,SS,A1,B,C,DI,F,G,CJ,CK,CL,CM,CN,CO,CP)      D 612
          IF (RR .EQ. 0.) GO TO 1030                                             D 613
          P = 2. * (ATAN(C / ABS(RR)) - ATAN(DI / ABS(RR))) / ABS(RR)          D 614
615      GO TO 1040                                                              D 615
          1030 CONTINUE                                                         D 616
          P = 2. / (FF - 2. * SS) - 2. / (FF + 2. * SS)                        D 617
          1040 CONTINUE                                                         D 618
          IF (UU .EQ. 0.) GO TO 1050                                             D 619
620      QQ = 2. * (ATAN((AJ + 2. * SS) / ABS(UU)) - ATAN((AJ - 2. * SS) /   D 620
          ABS(UU))) / ABS(UU)                                                   D 621
          GO TO 1060                                                            D 622
          1050 CONTINUE                                                         D 623
          QQ = 2. / (AJ - 2. * SS) - 2. / (AJ + 2. * SS)                       D 624
625      1060 CONTINUE                                                         D 625
          Z1 = (SS * SS + FF * SS + GG) / (SS * SS - FF * SS + GG)             D 626
          Z2 = (SS * SS + AJ * SS + AK) / (SS * SS - AJ * SS + AK)             D 627
          A11J = (P * A1 + 0.5 * BR * ALOG(71)) / (2. * PI)                   D 628
          A31J = (CL * P + 2. * BR * SS + CO * ALOG(71)) / (2. * SS * PI)     D 629
630      CALL CONCAL (DD,FE,AJ,AK,SS,A2,B,C,DI,F,G,CJ,CK,CL,CM,CN,CO,CP)      D 630

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PROGRAM CIRCUL2 (Continued)

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PROGRAM CIRCUL2      74/74      OPT=1 STATIC                      FTN 4.7+485          81/01/27. 13.38.34      PAGE 16

      A2IJ = -(QQ * A2 + 0.5 * FE * ALOG(Z2)) / (2. * PI)      D 631
      A4IJ = -(CL * QQ + 2. * FE * SS + CO * ALOG(Z2)) / (2. * SS * PI) D 632
      DO 1070 K = 1,NLLINE                                       D 633
      KK = K + 1                                                 D 634
635      KCHK = NSPT(KK) - 1                                       D 635
      IF (J .EQ. KCHK) GO TO 1080                                 D 636
      1070 CONTINUE                                             D 637
      WNORM = WNORM + .5 * (CDRAG(J + 1) + CDRAG(J)) * (A1IJ + A2IJ) + 0 D 638
      1.5 * (CDRAG(J + 1) - CDRAG(J)) * (A3IJ + A4IJ)          D 639
640      GO TO 1090                                             D 640
      1080 CONTINUE                                             D 641
      WNORM = WNORM + 0.5 * CDRAG(J) * (A1IJ + A2IJ - A3IJ - A4IJ) D 642
      1090 CONTINUE                                             D 643
C      WASH AT WING IS 0.5 WASH AT MINUS INFINITY              D 644
645      WNORM = WNORM / 2.                                       D 645
      WOP = WNORM / COS(PJK(I))                                  D 646
      WRITE (6,1540) I,WNORM,WOP                                 D 647
      1100 CONTINUE                                             D 648
650      DO 1110 I = 1,NTOTT                                       D 649
      CALL GAMCAL (I,IL,SJK,CDRAG,BGAMO)                         D 650
      BGAM(I) = BGAMO                                           D 651
      1110 CONTINUE                                             D 652
      BGAM(IL) = BGAM(NTOTT) + CDRAG(NTOTT) * SJK(NTOTT)      D 653
655      WRITE (6,1560)                                           D 654
      DO 1140 I = 1,IL                                           D 655
      IF (I .EQ. IL) GO TO 1120                                  D 656
      ETA = 2. * ( - YJK(I) + SJK(I) * COS(PJK(I))) / BSAVF   D 657
      GO TO 1130                                               D 658
      1120 CONTINUE                                             D 659
660      ETA = 0.                                                 D 660
      1130 CONTINUE                                             D 661
      WRITE (6,1550) I,BGAM(I),CDRAG(I),ETA                    D 662
      1140 CONTINUE                                             D 663
C      D 664
665      C      COMPUTE FARFIELD CM                               D 665
      C      D 666
      IF (JFLAG .NE. 1) GO TO 1160                              D 667
      SUMATT = 0.                                               D 668
      DO 1150 J = 1,NTOTT                                       D 669
670      SUMATT = SUMATT + CRD(J) * CDRAG(J)                    D 670
      1150 CONTINUE                                             D 671
      1160 CONTINUE                                             D 672

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PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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		CD = 0.	D 673
	C		D 674
675	C	CALCULATE CDI USING T1. WHICH IS DRAG MATRIX	D 675
	C		D 676
		DO 1180 I = 1,NTOTT	D 677
		CDI = 0.0	D 678
		DO 1170 J = 1,NTOTT	D 679
680		CDI = CDI + T1(I,J) * CDRAG(J)	D 680
	1170	CONTINUE	D 681
		CD = CD + CDI * CDRAG(I)	D 682
	1180	CONTINUE	D 683
		WRITE (6,1570) CD	D 684
685		IF (JFLAG .NE. 2) GO TO 1200	D 685
		CR = 0.	D 686
		DO 1190 J = 1,NTOTT	D 687
	1190	CR = CR + CRI(J) * CDRAG(J)	D 688
		WRITE (6,1580) CR	D 689
690	1200	CONTINUE	D 690
	C		D 691
	C	NOW MUST INTERPOLATE TO GET ROUND CIRCLATIONS FOR VLM GFOM	D 692
	C		D 693
		PJK(IL) = PJK(NTOTT)	D 694
		JS = 0	D 695
695	C	WRITE (6,159)	D 696
		DO 1290 I = 1,JPLAN	D 697
		NT0 = NTOT(I)	D 698
		NT01 = NT0 + 1	D 699
700		XTFM = XCFW	D 700
		IF (I .EQ. 2) XTEM = XCFT	D 701
		ASUM = 0.	D 702
		IF (XTEM .EQ. 1.) GO TO 1220	D 703
		DO 1210 K = 1,NSCWJK	D 704
705		XCK = (K - .75) / SCWJK	D 705
		AI = (1. - XCK) / (SCWJK * (1. - XTEM))	D 706
		IF (XCK .LE. XTFM) AI = 1. / SCWJK	D 707
		ASUM = ASUM + AI	D 708
	1210	CONTINUE	D 709
710		GO TO 1230	D 710
	1220	CONTINUE	D 711
		ASUM = 1.	D 712
	1230	CONTINUE	D 713
		DO 1240 L = 1,NT0	D 714

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2	74/74	OPT=1	STATIC	FTN 4.7+485	R1/01/27. 13.38.34	PAGE 18
715	J = L + JS				D 715	
	Z7H(L) = YJK(J) - SJK(J) * COS(PJK(J))				D 716	
	X7T(L) = RGAM(J) / SCWJK				D 717	
1240	CONTINUE				D 718	
	IF (I.EQ. 1) GO TO 1250				D 719	
720	ZZH(NT01) = 0.				D 720	
	X7T(NT01) = RGAM(IL) / SCWJK				D 721	
C	WRITE (6,161)				D 722	
	GO TO 1260				D 723	
1250	CONTINUE				D 724	
725	Z7H(NT01) = 0.				D 725	
	X7T(NT01) = (RGAM(NT0) + CDRAG(NT0) * SJK(NT0)) / SCWJK				D 726	
1260	CONTINUE				D 727	
	DO 1270 K = 1,NT01				D 728	
C	WRITE (6,163) K,Z7H(K),X7T(K)				D 729	
730	1270 CONTINUE				D 730	
	NSV1 = NSSWSV(I)				D 731	
	DO 1280 J = 1,NSV1				D 732	
	JJ = J + (I - 1) * NSSWSV(I)				D 733	
	JK = 1 + (JJ - 1) * (IFIX(SCWJK))				D 734	
735	CALL FTLUP (0(JK),PPI(JJ,1), + 1,NT01,ZZH,X7T)				D 735	
	PPP(JJ) = PPI(JJ,1) / ASUM				D 736	
1280	CONTINUE				D 737	
	JS = NT01 - 1				D 738	
1290	CONTINUE				D 739	
740	JK = 0				D 740	
C					D 741	
C	CALCULATIONS OF NORMAL WASH AND NWSH/COS(PHI)				D 742	
C					D 743	
	NSVTOT = NSV1 + NSV2				D 744	
745	DO 1300 I = 1,NSVTOT				D 745	
	K = 1 + (I - 1) * NSCWJK				D 746	
1300	CONTINUE				D 747	
C	WRITE(6,153)				D 748	
	DO 1340 I = 1,NSVTOT				D 749	
750	WNORM = 0.				D 750	
	K = 1 + (I - 1) * NSCWJK				D 751	
	RPHI = ATAN(PHI(I))				D 752	
	DO 1330 J = 1,NSVTOT				D 753	
	L = 1 + (J - 1) * NSCWJK				D 754	
755	SPHI = ATAN(PHI(J))				D 755	
	YY(I) = Q(K) - Q(L)				D 756	

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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	YY(2) = Q(K) + Q(L)	D 757
	ZZ = ZH(I) - ZH(J)	D 758
	SNN = S(L)	D 759
760	DO 1320 KK = 1,2	D 760
	DSIGN = 1.	D 761
	FSIGN = 1.	D 762
	IF (KK .EQ. 2) GO TO 1310	D 763
	IF (YY(1) .LT. TOLC) FSIGN = -1.	D 764
765	IF (YY(1) .LT. (- TOLC)) DSIGN = -1.	D 765
	1310 YYY = YY(KK)	D 766
	CALL DRAGSUB (RPHI,SPHI,YYY,ZZ,SNN,DSIGN,FSIGN,WNK)	D 767
	WN(KK) = WNK	D 768
	SPHI = -SPHI	D 769
770	1320 CONTINUE	D 770
	WNORM = WNORM + PP1(J,1) * (WN(1) - WN(2)) * SCWJK	D 771
	1330 CONTINUE	D 772
	WNORM = WNORM / (2. * PI) / 2.	D 773
	WOP = WNORM / (COS(RPHI))	D 774
775	C WRITE (6,154) I,WNORM,WOP	D 775
	1340 CONTINUE	D 776
	DO 1360 I = 1,IPLAN	D 777
	KA = 1 + (I - 1) * NSSWSV(1)	D 778
780	KR = NSSWSV(1) + (I - 1) * NSSWSV(2)	D 779
	D = XCFW	D 780
	IF (I .EQ. 2) D = XCFT	D 781
	DO 1350 J = KA,KB	D 782
	NSCW = TBLSCW(J)	D 783
	AI = NSCW * D + 0.75	D 784
785	IMAX = INT(AI)	D 785
	DO 1350 K = 1,NSCW	D 786
	JK = JK + 1	D 787
	E = 1.	D 788
	IF (K .GT. IMAX) E = (1. - (K - .75) / NSCW) / (1. - D)	D 789
790	CIR(JK) = PPP(J) * E	D 790
	1350 CONTINUE	D 791
	1360 CONTINUE	D 792
	WRITE (6,1630) CLDES	D 793
	NR = 0	D 794
795	DO 1370 NV = 1,NSSW	D 795
	NSCW = TBLSCW(NV)	D 796
	NP = NR + 1	D 797
	NR = NR + NSCW	D 798

PROGRAM CIRCUL2 (Continued)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC FTN 4.7+485 81/01/27. 13.38.34 PAGE 20

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      PHIPR = ATAN(PHI(NV)) * RAD                      D 799
800    IF (NV .EQ. (NSSWSV(1) + 1)) WRITE (6,1640)      D 800
      DO 1370 I = NP,NR                                D 801
      PNPR = PN(I) * BETA                              D 802
      PVPR = PV(I) * BETA                              D 803
805    PSIPR = ATAN(PETA * TAN(PSI(I))) * RAD          D 804
      WRITE (6,1650) PNPR,PVPR,Q(I),ZH(NV),S(I),PSIPR,PHIPR,CIR(I) D 805
1370  CONTINUE                                         D 806
      WRITE (6,1610)                                    D 807
      WRITE (6,1620) CREF,CAVE,STRUE,SREF,ROT,AR,ARTRUE,MACH D 808
      WRITE (6,1590) XCFW                               D 809
810    WRITE (6,1600) XCFW                             D 810
      CLTOT = CMTOT = 0.                               D 811
      DO 1390 I = 1,NSSW                               D 812
      IF (I .EQ. 1) WRITE (6,1670)                    D 813
      IF (I .EQ. (NSSWSV(1) + 1)) WRITE (6,1680)      D 814
815    SPANLD = 0.                                      D 815
      DO 1380 IJ = 1,NSCWMIN                           D 816
      IK = (I - 1) * NSCWMIN + IJ                     D 817
      SPANLD = SPANLD + 2. * CIR(IK) * COS(ATAN(PHI(I))) D 818
      CLTOT = CLTOT + R. * S(IK) * CIR(IK) / SREF * COS(ATAN(PHI(I))) D 819
820    CMTOT = CMTOT + R. * S(IK) * CIR(IK) * PN(IK) * BETA * COS(ATAN(PH
      I(I))) / (SREF * CREF)                          D 820
1380  CONTINUE                                         D 821
      WRITE (6,1700) Q(IK),SPANLD                     D 822
825    IF (I .EQ. NSSWSV(1)) CL1 = CLTOT              D 823
      IF (I .EQ. NSSWSV(1)) CM1 = CMTOT              D 824
      IF (I .EQ. NSSWSV(1)) WRITE (6,1690) CL1,CM1    D 825
      IF (I .EQ. NSSW .AND. IPLAN .EQ. 2) CL2 = CLTOT - CL1 D 826
      IF (I .EQ. NSSW .AND. IPLAN .EQ. 2) CM2 = CMTOT - CM1 D 827
      IF (I .EQ. NSSW .AND. IPLAN .EQ. 2) WRITE (6,1690) CL2,CM2 D 828
830 1390 CONTINUE                                       D 829
      C                                                 D 830
      IF (JFLAG .EQ. 1.) CMTOT = SUMATT               D 831
      WRITE (6,1660) CLDES,CLTOT,CMTOT,CD             D 832
      C                                                 D 833
835  C                                                 D 834
      C 162 FORMAT(35X,46HDATA USED TO INTERPOLATE BACK TO VLMC GEOMETRY/? D 835
      C 5X,1HY,10X,5HGAMMA/)                          D 836
      C                                                 D 837
1400  C 162 FORMAT(//25X,39HTOTAL NO WAKE SEGMENTS ABOVE MAX OF 50/) D 838
1410  C 162 FORMAT(//35X,13HWAKE GEOMETRY///32X,1HY,12X,1HZ,10X,3HPHI//) D 839
840  C 1620 FORMAT (28X,3F11.5)                       D 840

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PROGRAM CIRCUL2 (Concluded)

PROGRAM CIRCUL2 74/74 OPT=1 STATIC

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	1430	FORMAT (35X,APPLANFORM,14)	D 841
	1440	FORMAT (//25X,33H NO OF WAKE VORTICITY SEGMENTS = ,I5/)	D 842
	1450	FORMAT (25X,3PHWAKE VORTICITY SEGS ON WING SEGMENT NO.,I5,1H=,I5/)	D 843
	1460	FORMAT (30X,33HTOTAL PLANFORM PERIPHERAL LENGTH=,F15.5/)	D 844
845	1470	FORMAT (//20X,PHSEGMT NO.,10X,1HY,15X,1H7,15X,3HPHI/)	D 845
	1480	FORMAT (25X,15,3F15.6)	D 846
	1490	FORMAT (//25X,1H1,5X,6HSNN(I)/)	D 847
	1500	FORMAT (25X,15,F12.5)	D 848
	1510	FORMAT (//25X,23HPITCH CONSTRAINT ACTIVE/)	D 849
850	1520	FORMAT (//25X,32HPENDING MOMENT CONSTRAINT ACTIVE)	D 850
	1530	FORMAT (//33X,1H1,7X,PHDOWNWASH,7X,10HW/COS(PHI)/)	D 851
	1540	FORMAT (30X,15,2F15.5)	D 852
	1550	FORMAT (20X,15,4F13.5)	D 853
855	1560	FORMAT (//21X,5HSEGMT,3X,10HROUND CIRC,2X,10HSHED STRTH,7X,3META// 1)	D 854 D 855
	1570	FORMAT (///25X,63HCD CALCULATED USING DIRECT OPTIMIZATION LINEAR S HSHED DIST = ,F15.5/)	D 856 D 857
	1580	FORMAT (//25X,66HCR CALAULATED USING DIRECT OPTIMIZATION LINEAR ³ SH HED SHEET DIST = ,E15.5/)	D 858 D 859
860	1590	FORMAT (///70X,5HA1 = ,F10.5/)	D 860
	1600	FORMAT (//70X,5HA2 = ,F10.5/)	D 861
	1610	FORMAT (////4X,11H REF. CHORD,6X,25HC AVERAGE TRUE AREA ,2X,1 14HREFERENCE APFA,9X,3HR/2,8X,7HREF. AR,8X,7HTRUE AP,4X,11HMACH NUM 2PER/)	D 862 D 863 D 864
865	1620	FORMAT (RF15.5)	D 865
	1630	FORMAT (1H1,///25X,1HX11X,1HX,11X,1HY,11X,1HZ,12X,1HS,5X,9HC/4 SWF 1EP,4X,PHOIHEDRAL,3X,10HGAMMA/H AT/24X,3HC/4,9X,4H3C/4,42X,5HANGLE, 27X,5HANGLE,4X,6HCLOS=,F7.4/)	D 866 D 867 D 868
	1640	FORMAT (//45X,45HSECOND PLANFORM HORSESHOE VORTEX DESCRIPTIONS/)	D 869
870	1650	FORMAT (17X,RF12.5)	D 870
	1660	FORMAT (////15X,11HCL DESIGN =,F10.6,5X,12HCL COMPUTED=,F10.6,5X, 112HCM COMPUTED=,F10.3,5X,5HCD V=,F10.6)	D 871 D 872
	1670	FORMAT (////40X,56HF I R S T P L A N F O R M S P A N L O 1A D I N G//60X,1HY,11X,4HCL*C)	D 873 D 874
875	1680	FORMAT (////40X,56HS E C O N D P L A N F O R M S P A N L 1O A D I N G//60X,1HY,11X,4HCL*C)	D 875 D 876
	1690	FORMAT (//50X,30HCL DEVELOPED ON THIS PLANFORM=,F10.6/50X,30HCM DE VELOPED ON THIS PLANFORM=,F10.6)	D 877 D 878
880	1700	FORMAT (55XF10.5,3XF10.5)	D 879
		END	D 880-

SUBROUTINE DRAGSUB

SUBROUTINE DRAGSUB 74/74 OPT=1 STATIC

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1	SUBROUTINE DRAGSUB (R.A.Y.7.S.IS.JS.WNK)	F 1
	REAL IS,JS	F 2
	ZP = Z + S * SIN(A)	F 3
	YP = Y + S * COS(A)	F 4
5	ZM = Z - SIN(A) * S	F 5
	YM = Y - S * COS(A)	F 6
	RL = SQRT(ZP ** 2 + YP ** 2)	F 7
	RR = SQRT(ZM ** 2 + YM ** 2)	F 8
	ZPOYP = ZP / YP	F 9
10	ZMOYM = ZM / YM	F 10
	PHILTLJ = ATAN(ZPOYP)	F 11
	PHIRTLJ = ATAN(ZMOYM)	F 12
	PLMPI = PHILTLJ - R	F 13
	PRMPI = PHIRTLJ - R	F 14
15	COSPLI = COS(PLMPI)	F 15
	COSPRI = COS(PRMPI)	F 16
	WNK = IS * COSPLI / RL - JS * COSPRI / RR	F 17
	RETURN	F 18
	END	F 19-

SUBROUTINE DRACAL

SURROUTINE DRACAL	74/74 OPT=1 STATIC	FTN 4,7+485	81/01/27. 13.38.34	PAGE	1
1	SURROUTINE DRACAL (I,J,YHH,ZHH,PPP,AINT)			G	1
	C			G	2
	C	SURROUTINE DRACAL		G	3
	C			G	4
5	TREFFTZ PLANE DRAG ANALYSIS ASSUMES PIECEWISE LINEARLY VARYING			G	5
	C	SHED VORTICITY SHEET STRENGTH		G	6
	C			G	7
	C	CALCULATE INTEGRALS A THROUGH F FOR DRAG COEF CALCULATION		G	8
	C			G	9
10	CALLS SUBROUTINES LOGS,SNTAN,CCAL,CONCAL			G	10
	C			G	11
	C	DIMENSION AINT(6)		G	12
	C	DIMENSION YHH(1), ZHH(1), PPP(1)		G	13
	C	COMMON /SEG/ SNN(50)		G	14
15	PI = 4. * ATAN(1.)			G	15
	C	S = SNN(J)		G	16
	C	CALL CCAL (I,J,YHH,ZHH,PPP,S,AA,RR,DD,FF,GG,EE,AJ,AK,RR,TT,UU,WW)		G	17
	C	CALL CONCAL (AA,RR,FF,GG,S,A,B,C,D,F,G,CJ,CK,CL,CM,CN,CO,CP,1)		G	18
	C	S = SNN(I)		G	19
20	CALL LOGS (S,CJ,F,RELN,RESLN,RES2LN,RES3LN)			G	20
	C	CALL SNTAN (S,C,RR,RP,TT,RTAN,RSTAN,RS2TAN,RS3TAN,RS4TAN)		G	21
	C	AAAAAA = A * RTAN + B * RSTAN + BB * RELN / 4		G	22
	C	BBBBBB = 2. * (CL * RTAN + CM * RSTAN + CN * RS2TAN) + CO * RELN +		G	23
	C	1 CP * RESLN		G	24
25	CCCCCC = A * RSTAN + B * RS2TAN + BB * RESLN / 4			G	25
	C	DDDDDD = 2. * (CL * RSTAN + CM * RS2TAN + CN * RS3TAN) + CO * RESL		G	26
	C	LN + CP * RES2LN		G	27
	C	EEEEEE = A * RS2TAN + B * RS3TAN + BB * RES2LN / 4		G	28
	C	FFFFFF = 2. * (CL * RS2TAN + CM * RS3TAN + CN * RS4TAN) + CO * RES		G	29
30	LN + CP * RES3LN			G	30
	C	CALL LOGS (S,CK,G,RELN,RESLN,RES2LN,RES3LN)		G	31
	C	CALL SNTAN (S,D,RR,RR,TT,RTAN,RSTAN,RS2TAN,RS3TAN,RS4TAN)		G	32
	C	AAAAAA = AAAAAA - A * RTAN - B * RSTAN - BB * RELN / 4		G	33
	C	BBBBBB = BBBBBB - 2. * (CL * RTAN + CM * RSTAN + CN * RS2TAN) - CO		G	34
35	1 * RELN - CP * RESLN			G	35
	C	CCCCCC = CCCCCC - A * RSTAN - B * RS2TAN - BB * RESLN / 4		G	36
	C	DDDDDD = DDDDDD - 2. * (CL * RSTAN + CM * RS2TAN + CN * RS3TAN) -		G	37
	C	1CO * RESLN - CP * RES2LN		G	38
	C	EEEEEE = EEEEE - A * RS2TAN - B * RS3TAN - BB * RES2LN / 4		G	39
40	FFFFFF = FFFFFFF - 2. * (CL * RS2TAN + CM * RS3TAN + CN * RS4TAN) -			G	40
	C	1 CO * RES2LN - CP * RES3LN		G	41
	C	S = SNN(J)		G	42

(cont'd)

SUBROUTINE DRACAL (Concluded)

SUBROUTINE DRACAL	74/74 OPT=1 STATIC	FTN 4.7+485	81/01/27, 13.38.34	PAGE	2
	CALL CONCAL (DD,EE,AJ,AK,S,A,B,C,D,F,G,CJ,CK,CL,CM,CN,CO,CP,2)			G	43
	S = SNN(I)			G	44
45	CALL LOGS (S,CJ,F,RELN,RESLN,RES2LN,RES3LN)			G	45
	CALL SNTAN (S,C,FE,UU,WW,RTAN,RSTAN,RS2TAN,RS3TAN,RS4TAN)			G	46
	AAAAAA = AAAAAA - A * RTAN - B * RSTAN - EE * RELN / 4			G	47
	BBBBBB = BBBBBB - 2. * (CL * RTAN + CM * RSTAN + CN * RS2TAN) - CO			G	48
	1 * RELN - CP * RESLN			G	49
50	CCCCCC = CCCCCC - A * RSTAN - B * RS2TAN - EE * RESLN / 4			G	50
	DDDDDD = DDDDDD - 2. * (CL * RSTAN + CM * RS2TAN + CN * RS3TAN) -			G	51
	1CO * RESLN - CP * RES2LN			G	52
	EEEEEF = EEEFEF - A * RS2TAN - B * RS3TAN - EE * RES2LN / 4			G	53
	FFFFFF = FFFFFFF - 2. * (CL * RS2TAN + CM * RS3TAN + CN * RS4TAN) -			G	54
55	1 CO * RES2LN - CP * RES3LN			G	55
	CALL LOGS (S,CK,G,RELN,RESLN,RES2LN,RES3LN)			G	56
	CALL SNTAN (S,D,FE,UU,WW,PTAN,RSTAN,RS2TAN,RS3TAN,RS4TAN)			G	57
	AAAAAA = AAAAAA + A * RTAN + B * PSTAN + EF * RELN / 4			G	58
	BBBBBB = BBBBBB + 2. * (CL * RTAN + CM * RSTAN + CN * RS2TAN) + CO			G	59
60	1 * RELN + CP * RESLN			G	60
	CCCCCC = CCCCCC + A * RSTAN + B * RS2TAN + EE * RESLN / 4			G	61
	DDDDDD = DDDDDD + 2. * (CL * RSTAN + CM * RS2TAN + CN * RS3TAN) +			G	62
	1CO * RESLN + CP * RES2LN			G	63
	EEEEEE = EEEFEF + A * RS2TAN + B * RS3TAN + EE * RES2LN / 4			G	64
65	FFFFFF = FFFFFFF + 2. * (CL * RS2TAN + CM * RS3TAN + CN * RS4TAN) +			G	65
	1 CO * RES2LN + CP * RES3LN			G	66
	SK = SNN(J)			G	67
	AAAAAA = AAAAAA / PI			G	68
	BBBBBB = BBBBBB / (2. * PI * SK) + (2. * S / PI) * (RR - EE)			G	69
70	CCCCCC = CCCCCC / PI			G	70
	DDDDDD = DDDDDD / (2. * PI * SK)			G	71
	EEEEEE = EEEFEF / (2 * PI * S)			G	72
	FFFFFF = FFFFFFF / (4. * PI * S * SK) + (RR - FF) * S * S / (3 * PI			G	73
	1)			G	74
75	AINI(1) = AAAAAA			G	75
	AINI(2) = BBBBBB			G	76
	AINI(3) = CCCCCC			G	77
	AINI(4) = DDDDDD			G	78
	AINI(5) = EEEFEF			G	79
80	AINI(6) = FFFFFFF			G	80
	RETURN			G	81
	END			G	82-

SUBROUTINE CCAL

SUBROUTINE CCAL	74/74	OPT=1	STATIC	FTN 4,7+485	R1/01/27. 13.38.34	PAGE	1
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1	SUBROUTINE CCAL (I,J,YHH,7HH,PPP,S,AA,RR,DD,FF,GG,EE,J,I,KK,RR,TT,U	H	1
	1U,WW)	H	2
	C	H	3
	C	H	4
5	SUBROUTINE CCAL	H	5
	C	H	6
	C	H	7
	C	H	8
	C	H	9
	REAL JJ,KK	H	10
10	DIMENSION YHH(1), 7HH(1), PPP(1)	H	11
	DYIJ = YHH(I) - YHH(J)	H	12
	D7IJ = 7HH(I) - 7HH(J)	H	13
	COI = COS(PPP(I))	H	14
	SII = SIN(PPP(I))	H	15
15	COJ = COS(PPP(J))	H	16
	SIJ = SIN(PPP(J))	H	17
	AA = DYIJ * COJ + D7IJ * SII	H	18
	BB = -COS(PPP(J) - PPP(I))	H	19
	FF = -2 * (DYIJ * COJ + D7IJ * SIJ)	H	20
20	GG = DYIJ * DYIJ + D7IJ * D7IJ	H	21
	DYIJP = YHH(I) + YHH(J)	H	22
	D7IJP = D7IJ	H	23
	DD = DYIJP * COI + D7IJP * SII	H	24
	EE = COS(PPP(J) + PPP(I))	H	25
25	JJ = 2. * (DYIJP * COJ - D7IJP * SIJ)	H	26
	KK = DYIJP * DYIJP + D7IJP * D7IJP	H	27
	RR = 2 * (DYIJ * SIJ - D7IJ * COJ)	H	28
	TT = 2 * SIN(PPP(J) - PPP(I))	H	29
	UU = 2. * (DYIJP * SIJ + D7IJP * COJ)	H	30
30	WW = 2. * SIN(PPP(J) + PPP(I))	H	31
	RETURN	H	32-
	END	H	32-

SUBROUTINE CONCAL

SURROUTINE CONCAL 74/74 OPT=1 STATIC

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1		SURROUTINE CONCAL (AA,RR,FF,GG,S,A,R,C,D,F,G,J,K,L,M,N,O,P)	I	1
	C		I	2
	C	SURROUTINE CONCAL	I	3
	C		I	4
5	C	CALCULATES GEOMETRICAL CONSTANTS NEEDED IN EVALUATION OF INTEGRALS	I	5
	C		I	6
		REAL J,K,L,M,N	I	7
		A = AA - 0.5 * RR * FF	I	8
		P = 1. - RR * RR	I	9
10		C = FF + 2. * S	I	10
		D = FF - 2. * S	I	11
		F = S * S + S * FF + GG	I	12
		G = S * S - S * FF + GG	I	13
		J = 2. * (AA + S * RR)	I	14
15		K = 2. * (AA - S * RR)	I	15
		L = 0.5 * (RR * FF * FF - AA * FF - 2. * RR * GG)	I	16
		M = 0.5 * (- FF - 6. * AA * RR + 4. * FF * RR * RR)	I	17
		N = 2. * (RR * RR - 1.) * RR	I	18
		O = 0.5 * (AA - FF * RR)	I	19
20		P = 0.5 * (1. - 2. * RR * RR)	I	20
		RETURN	I	21
		END	I	22-

SUBROUTINE SNTAN

SUBROUTINE SNTAN	74/74	OPT=1 STATIC	FTN 4,7+485	81/01/27. 13.38.34	PAGE	1
1		SUBROUTINE SNTAN (S,C,BB,RR,TT,RTAN,RSTAN,RS2TAN,RS3TAN,RS4TAN)	J	1		
	C		J	2		
	C	SUBROUTINE SNTAN .	J	3		
	C		J	4		
5	C	EVALUATES INTFGRALS OF THE FORM S**N*ATAN((C+2*BB*S)/(RR+S*TT))	J	5		
	C	ALL DIVIDED BY (RR+S*TT)	J	6		
	C	WITH RESPECT TO S BETWEEN LIMITS OF -S AND S FOR N=0,1,2,3.	J	7		
	C		J	8		
	C	ATAN PART OF INTEGRAND APPROXIMATED AS A QUADRATIC IN S WHICH IS	J	9		
10	C	FORCED THROUGH ATAN VALUES AT -S,0,AND S.	J	10		
	C		J	11		
	C	A,C ARE CALCULATED IN SUBROUTINE CONCAL	J	12		
	C	RR,RP,TT ARE CALCULATED IN SUBROUTINE CCAL	J	13		
	C		J	14		
15	C	RESULTS ARE RTAN,RSTAN,RS2TAN,RS3TAN	J	15		
	C	APPROXIMATE INTEGRAL EVALUATED USING MACSYMA PROGRAM OF MIT PROJ.	J	16		
	C	EVALUATION OF INTEGRALS FOR TT=0. REGIND AT AT LAREL 10	J	17		
	C	SINGULAR INTEGRALS EVALUATED AT APPROXIMATE ENDPOINTS,+ -SAWAY	J	18		
	C	MIDRANGE SINGULARITIES EXCLUDED,ATAN PART OF INT APPROX-	J	19		
20	C	IMATED AS 2 QUADRATICS	J	20		
	C		J	21		
		COMMON /TEL/ TOL,TOL2	J	22		
		DIMENSION AA1(3,3), AA(3), IPIVOT(3)	J	23		
		RPR = PR	J	24		
25		SSS = S	J	25		
		CCC = C	J	26		
		RTAN = 0.0	J	27		
		RSTAN = 0.0	J	28		
		RS2TAN = 0.0	J	29		
30		RS3TAN = 0.0	J	30		
		RS4TAN = 0.0	J	31		
		IF (TT .EQ. 0.0 .AND. ABS(RR) .LT. 1E - 08) GO TO 70	J	32		
		IF (TT .EQ. 0.0 .AND. RR .EQ. 0.0) GO TO 70	J	33		
		IF (TT .EQ. 0.0) GO TO 40	J	34		
35	C		J	35		
	C	FIRST, CHECK FOR MIDRANGE SINGULARITIES,EXCLUDING ANY FOUND	J	36		
	C		J	37		
		SZERO = -RR / TT	J	38		
40		IF (ABS(ABS(SZERO) - S) .LT. 1E - 04 .AND. ABS(SZERO) .LE. S) GO T	J	39		
		10 30	J	40		
		IF (SZERO .GT. 0.0 .AND. SZERO .LT. S) GO TO 160	J	41		
		IF (SZERO .LT. 0.0 .AND. SZERO .GT. -S) GO TO 160	J	42		

(Cont'd)

SUBROUTINE SNTAN (Continued)

	SUBROUTINE SNTAN	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	2
	10	CONTINUE					J	43
		C = ATAN2(CCC,ARS(PR))					J	44
45		C1 = .5 * (ATAN2((CCC + 2. * RR * S),ARS(RR + TT * S)) + ATAN2((CC					J	45
		1C - 2. * RR * S),ARS(RR - TT * S))) - C					J	46
		C1 = C1 / (S * S)					J	47
		C2 = (ATAN2((CCC + 2. * RR * S),ARS(RR + TT * S))) / S - C / S - C					J	48
		11 * S					J	49
50	C						J	50
	C	INTEGRAND NOW IS (C1*S*S+C2*S+C)*S**N/(RR+TT*S)					J	51
	C						J	52
		CLOGR = ALOG(ARS((PR + TT * S) / (PR - TT * S)))					J	53
		CON0 = (C * TT * TT - C2 * RR * TT + C1 * RR * RR) / (TT ** 3)					J	54
55		CON1 = (C2 * TT - C1 * PR) / (TT * TT)					J	55
		PTAN = CON0 * CLOGR + 2. * S * CON1					J	56
		CON2 = (C * TT * TT - C2 * RR * TT + C1 * RR * RR) / (TT ** 3)					J	57
		CON3 = (C * PR * TT * TT - C2 * RR * RR * TT + C1 * PR ** 3) / (TT					J	58
		1 ** 4)					J	59
60		RSTAN = 2. * S * CON2 - CON3 * CLOGR + 2. * C1 * TT * TT * S ** 3					J	60
		1/ (3 * TT ** 3)					J	61
		CON4 = (C * RP * RR * TT * TT - C2 * RR ** 3 * TT + C1 * RR ** 4)					J	62
		1/ (TT ** 5)					J	63
		CON5 = 4. * C2 * TT ** 3 - 4. * C1 * RP * TT ** 2					J	64
65		CON5 = CON5 / (12 * TT ** 4)					J	65
		CON6 = (- C * RR * TT * TT + C2 * PR * RR * TT - C1 * RR ** 3) /					J	66
		1(TT ** 4)					J	67
		RS2TAN = CON4 * CLOGR + 2. * CON5 * S ** 3 + 2. * S * CON6					J	68
		CON8 = 20. * (C * TT ** 4 - C2 * RP * TT ** 3 + C1 * RP ** 2 * TT					J	69
70		1** 2) / (60 * TT ** 5)					J	70
		CON9 = (C * RR ** 2 * TT ** 2 - C2 * RR ** 3 * TT + C1 * RR ** 4)					J	71
		1/ (TT ** 5)					J	72
		CON10 = C * RR ** 3 * TT ** 2 - C2 * RR ** 4 * TT + C1 * RR ** 5					J	73
		CON10 = CON10 / (TT ** 6)					J	74
75		RS3TAN = 2. * CON8 * S ** 3 + 2. * CON9 * S - CON10 * CLOGR + 24.					J	75
		1* C1 * TT ** 4 * S ** 5 / (60 * TT ** 5)					J	76
		CONA = (C * RR ** 4 * TT ** 2 - C2 * RR ** 5 * TT + C1 * RR ** 6)					J	77
		1/ (TT ** 7)					J	78
		CONR = (C2 * TT - C1 * RR) / (5 * TT ** 2)					J	79
80		CONC = (- C * RR * TT ** 2 + C2 * RR ** 2 * TT - C1 * RR ** 3) /					J	80
		1(3 * TT ** 4)					J	81
		COND = CONC * RR ** 2 / (TT ** 2 / 3)					J	82
		RS4TAN = CONA * CLOGR + CONR * 2 * S ** 5 + CONC * 2 * S ** 3 + CO					J	83
		1ND * 2 * S					J	84

SUBROUTINE SNTAN (Continued)

SUBROUTINE SNTAN	74/74 OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE 3
85	IF (RR .GT. 0.) GO TO 20		J 85	
	RTAN = -RTAN		J 86	
	RSTAN = -RSTAN		J 87	
	RS2TAN = -RS2TAN		J 88	
	RS3TAN = -RS3TAN		J 89	
90	RS4TAN = -RS4TAN		J 90	
	20 CONTINUE		J 91	
	GO TO 130		J 92	
	30 CONTINUE		J 93	
	SAWAY = S - TOL		J 94	
95	S = SAWAY		J 95	
	GO TO 10		J 96	
	C		J 97	
	C		J 98	
	C	FOR CASE OF RR NOT ZERO, TT=0.0	J 99	
100	40 CONTINUE		J 100	
	RR = ABS(RR)		J 101	
	ALNUM = (2 * RR) ** 2 * S ** 2 + 4 * C * RR * S + RR ** 2 + C **		J 102	
	12		J 103	
	ALDEN = (2 * RR) ** 2 * S ** 2 - 4 * C * RR * S + RR ** 2 + C **		J 104	
105	12		J 105	
	IF (ALNUM .EQ. 0.0 .OR. ALDEN .EQ. 0.0) GO TO 50		J 106	
	GO TO 60		J 107	
	50 CONTINUE		J 108	
	S = S - TOL		J 109	
110	ALNUM = (2 * RR) ** 2 * S ** 2 + 4 * C * RR * S + RR ** 2 + C **		J 110	
	12		J 111	
	ALDEN = (2 * RR) ** 2 * S ** 2 - 4 * C * RR * S + RR ** 2 + C **		J 112	
	12		J 113	
	60 RATLN = ALOG(ALNUM / ALDEN)		J 114	
115	TNDIF = ATAN2((C + 2. * RR * S), RR) - ATAN2((C - 2. * RR * S), RR)		J 115	
	TNSUM = ATAN2((C + 2. * RR * S), RR) + ATAN2((C - 2. * RR * S), RR)		J 116	
	RTAN = -(0.25 * RR / RB) * RATLN + 0.5 * C * TNDIF / RR		J 117	
	RTAN = RTAN / RR + S * TNSUM / RR		J 118	
	RSTAN = 0.5 * (S * S + (RR * RR - C * C) / (2 * RR) ** 2) * TNDIF		J 119	
120	1- .5 * RR * S / RB + ((.5 * C * RR) / (2 * RR) ** 2) * RATLN		J 120	
	RSTAN = RSTAN / RR		J 121	
	RS2TAN = (S ** 3 / 3) * TNSUM + ((RR ** 3 - 3 * C ** 2 * RR) / (48		J 122	
	1 * RR ** 3)) * RATLN + C * RR * S / (3 * RR ** 2) - ((6 * C * RR *		J 123	
	2 * 2 - 2 * C ** 3) / (6 * (2 * RR) ** 3) * TNDIF		J 124	
125	RS2TAN = RS2TAN / RB		J 125	
	RS3TAN = (S ** 4 / 4) * TNDIF - ((C * RR ** 3 - C ** 3 * RR) / (32		J 126	

SUBROUTINE SNTAN (Continued)

SUBROUTINE SNTAN	74/74	OPT=1 STATIC	FTN 4.7+485	R1/01/27. 13.38.34	PAGE 4
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	1 * RR ** 4) * RATLN - TNDIF * (RR ** 4 - 6 * C ** 2 * RR ** 2 + C	J 127
	2 ** 4) / (64 * RR ** 4) - RR * S ** 3 / (12 * RB) - S * (9 * C **	J 128
	32 * RP ** 2 - 3 * RR ** 4) / (48 * RR * RR ** 3)	J 129
130	RS3TAN = RS3TAN / RP	J 130
	RS4TAN = (S ** 5 / (5 * RR)) * TNSUM + TNDIF * (5 * C * RR ** 6 -	J 131
	110 * C ** 3 * RP ** 4 + C ** 5 * RR ** 2) / (160 * RR ** 5 * RR **	J 132
	2 3) - PATLN * (RR ** 6 - 10 * C ** 2 * RR ** 4 + 5 * C ** 4 * RP *	J 133
	3 * 2) / (320 * RR ** 2 * RR ** 5) + C * S ** 3 / (15 * RR ** 2) + S	J 134
135	4 * (C ** 3 - C * RR ** 2) / (10 * RR ** 4)	J 135
	GO TO 130	J 136
	C	J 137
	C	J 138
	C	J 139
	FOR CASE OF RP=TT=0.0, IF I=J	J 139
140	70 TOP = C + 2. * RR * S	J 140
	ROT = C - 2. * RR * S	J 141
	IF (C .EQ. 0.0 .AND. RB .EQ. 0.0) GO TO 130	J 142
	SRAD = -C / (2. * RR)	J 143
	SRADAR = ABS(SRAD)	J 144
145	IF (SRADAR .LT. S) GO TO 80	J 145
	GO TO 90	J 146
	80 CONTINUE	J 147
	SUL = SRAD - TOL	J 148
	SLL = SRAD + TOL	J 149
150	CLOGR1 = ALOG(TOP / (C + 2. * RR * SLL))	J 150
	CLOGR2 = ALOG((C + 2. * RP * SUL) / ROT)	J 151
	CLOGR = CLOGR1 + CLOGR2	J 152
	RTAN = -(0.5 / RB) * CLOGR	J 153
155	RSTAN = (.25 * C / RP ** 2) * CLOGR - (.5 / RB) * (2. * S - SLL +	J 154
	1SUL)	J 155
	RS2TAN = -(C ** 2 / (8. * RR ** 3)) * CLOGR + (C / (4. * RR ** 2))	J 156
	1 * (2. * S - SLL + SUL) - (.25 / RB) * (SUL * SUL - SLL * SLL)	J 157
	RS3TAN = (C ** 3 / (16. * RR ** 4)) * CLOGR - (2. * S ** 3 - SLL * SLL * SLL	J 158
	1 * 3 + SUL ** 3) / (6. * RB) - (C * C / (8. * RR ** 3)) * (2. * S -	J 159
160	2 SLL + SUL) + (C / (8. * RB * RB)) * (SUL * SUL - SLL * SLL)	J 160
	RS4TAN = -(C ** 4 / (32. * RR ** 5)) * CLOGR - (SUL ** 4 - SLL **	J 161
	14) / (8. * RB) + (C / (12. * RB * RB)) * (2. * S ** 3 - SLL ** 3 +	J 162
	2 SUL ** 3) - C ** 2 * (SUL ** 2 - SLL * SLL) / (16. * RB ** 3) + C	J 163
	3 ** 3 * (2. * S - SLL + SUL) / (16. * RB ** 4)	J 164
165	GO TO 130	J 165
	90 CONTINUE	J 166
	IF (ABS(TOP) .LT. 1E - 9 .OR. ABS(ROT) .LT. 1E - 9) GO TO 120	J 167
	IF (TOP .LE. 0.0) GO TO 110	J 168

SUBROUTINE SNTAN (Continued)

SUBROUTINE SNTAN 74/74 OPT=1 STATIC

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	160 CONTINUE	J 211
	WRITE (6,250)	J 212
	SUL = SZERO - TOL	J 213
	SLL = SZERO + TOL	J 214
215	SMID1 = S - 0,5 * ARS(S - SLL)	J 215
	SMID2 = -S + 0,5 * ARS(- S - SUL)	J 216
	ANG1 = ATAN2((C + 2. * RR * S),ABS(RR + TT * S))	J 217
	ANG2 = ATAN2((C + 2. * RR * SMID1),ARS(RR + TT * SMID1))	J 218
	ANG3P = ATAN2((C + 2. * RR * SLL),ARS(RR + TT * SLL))	J 219
220	ANG3 = ATAN2((C - 2. * RR * S),ABS(RR - TT * S))	J 220
	ANG4 = ATAN2((C + 2. * RR * SMID2),ARS(RR + TT * SMID2))	J 221
	ANG5 = ATAN2((C + 2. * RR * SUL),ARS(RR + TT * SUL))	J 222
	DO 220 I = 1,2	J 223
	IF (I, EQ. 2) GO TO 170	J 224
225	AA1(1,1) = SUL * SUL	J 225
	AA1(1,2) = SUL	J 226
	AA1(1,3) = 1.	J 227
	AA1(2,3) = 1.	J 228
	AA1(3,3) = 1.	J 229
230	AA1(2,1) = SMID2 * SMID2	J 230
	AA1(2,2) = SMID2	J 231
	AA1(3,1) = S * S	J 232
	AA1(3,2) = -S	J 233
	AA(1) = ANG5	J 234
235	AA(2) = ANG4	J 235
	AA(3) = ANG3	J 236
	CLOGP = ALOG((RR + TT * SUL) / (RR - TT * S))	J 237
	SUSEF = SMID2	J 238
	DELS = SUL + S	J 239
240	DELS2 = SUL ** 2 - S ** 2	J 240
	DELS3 = SUL ** 3 + S ** 3	J 241
	DELS4 = SUL ** 4 - S ** 4	J 242
	DELS5 = SUL ** 5 + S ** 5	J 243
	DELS6 = SUL ** 6 - S ** 6	J 244
245	GO TO 180	J 245
	170 CONTINUE	J 246
	AA1(1,1) = S * S	J 247
	AA1(1,2) = S	J 248
	AA1(1,3) = 1.	J 249
250	AA1(2,3) = 1.	J 250
	AA1(3,3) = 1.	J 251
	AA1(2,1) = SMID1 * SMID1	J 252

SUBROUTINE SNTAN (Continued)

SUBROUTINE SNTAN	74/74	OPT=1 STATIC	FTN 4,7+4R5	R1/01/27, 13.38.34	PAGE 7
					J 253
					J 254
255					J 255
					J 256
					J 257
					J 258
					J 259
260					J 260
					J 261
					J 262
					J 263
					J 264
265					J 265
					J 266
					J 267
180					J 268
					J 269
270					J 270
					J 271
					J 272
					J 273
					J 274
275					J 275
					J 276
					J 277
					J 278
					J 279
280					J 280
					J 281
					J 282
					J 283
					J 284
285					J 285
					J 286
					J 287
					J 288
					J 289
290					J 290
					J 291
					J 292
					J 293
					J 294

SUBROUTINE SNTAN (Continued)

SUBROUTINE SNTAN	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	8
295	CON42 = (- C * PR * TT ** 2 + C2 * RR ** 2 * TT - C1 * RR ** 3) /	J 295				
	1 (2 * TT ** 4)	J 296				
	CONA = (C * PP ** 4 * TT ** 2 - C2 * RR ** 5 * TT + C1 * RR ** 6)	J 297				
	1/ (TT ** 7)	J 298				
	CONB = (C2 * TT - C1 * PP) / (5 * TT ** 2)	J 299				
300	CONC = (- C * RR * TT ** 2 + C2 * RR ** 2 * TT - C1 * RR ** 3) /	J 300				
	1 (3 * TT ** 4)	J 301				
	COND = CONC * RR ** 2 / (TT ** 2 / 3)	J 302				
	CONE = (C * TT ** 2 - C2 * PR * TT + C1 * RR ** 2) / (4 * TT ** 3)	J 303				
	CONF = C1 / (6 * TT)	J 304				
305	CONG = CONE * RR ** 2 * 2 / (TT ** 2)	J 305				
	IF (I .EQ. 1) GO TO 190	J 306				
	IF (I .EQ. 2 .AND. (RR + TT * SUSE) .GT. 0.) GO TO 190	J 307				
	RTAN = RTAN - CON0 * CLOGP + CON1 * DELS + CON11 * DELS2	J 308				
	RSTAN = RSTAN - CON21 * DFLS2 + CON2 * DELS - CON3 * CLOGR + C1 *	J 309				
310	1DELS3 / (3 * TT)	J 310				
	RS2TAN = RS2TAN - CON4 * CLOGR + CON5 * DELS3 + CON31 * DELS2 + C0	J 311				
	1N32 * DELS4 + CON6 * DELS	J 312				
	RS3TAN = RS3TAN - CON41 * DELS4 + CON8 * DFLS3 + CON42 * DELS2 + C	J 313				
	1ON9 * DELS - CON10 * CLOGR + C1 * DELS5 / (5 * TT)	J 314				
315	RS4TAN = RS4TAN - CONA * CLOGR + CONB * DFLS5 + CONE * DELS4 + CON	J 315				
	IF * DELS6 + CONC * DELS3 + CONG * DELS2 + COND * DFLS	J 316				
	GO TO 200	J 317				
	190 CONTINUE	J 318				
	RTAN = RTAN + CON0 * CLOGR + CON1 * DELS + CON11 * DELS2	J 319				
320	RSTAN = RSTAN + CON21 * DFLS2 + CON2 * DFLS - CON3 * CLOGR + C1 *	J 320				
	1DELS3 / (3 * TT)	J 321				
	RS2TAN = RS2TAN + CON4 * CLOGR + CON5 * DELS3 + CON31 * DFLS2 + C0	J 322				
	1N32 * DELS4 + CON6 * DELS	J 323				
	RS3TAN = RS3TAN + CON41 * DELS4 + CON8 * DELS3 + CON42 * DELS2 + C	J 324				
325	1ON9 * DELS - CON10 * CLOGR + C1 * DELS5 / (5 * TT)	J 325				
	RS4TAN = RS4TAN + CONA * CLOGR + CONB * DELS5 + CONE * DELS4 + CON	J 326				
	IF * DELS6 + CONC * DELS3 + CONG * DELS2 + COND * DFLS	J 327				
	200 CONTINUE	J 328				
	IF (I .EQ. 2) GO TO 210	J 329				
330	IF (I .EQ. 1 .AND. (PR - TT * S) .GT. 0.) GO TO 210	J 330				
	RTAN = -RTAN	J 331				
	RSTAN = -RSTAN	J 332				
	RS2TAN = -RS2TAN	J 333				
	RS3TAN = -RS3TAN	J 334				
335	RS4TAN = -RS4TAN	J 335				
	210 CONTINUE	J 336				

SUBROUTINE SNTAN (Concluded)

SUBROUTINE SNTAN	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	9
	220	CONTINUE		J 337		
		GO TO 130		J 338		
340	230	CONTINUE		J 339		
		RR = RRR		J 340		
		S = SSS		J 341		
		C = CCC		J 342		
		RETURN		J 343		
	C			J 344		
345	240	FORMAT (30X,43H ONE OF THE ENDPOINTS HAS A NEGATIVE LOG ARG)		J 345		
	250	FORMAT (30X,11H 80 ENTERED)		J 346		
		END		J 347-		

SUBROUTINE LOGS

SUBROUTINE LOGS

74/74 OPT=1 STATIC

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1		SUBROUTINE LOGS (S,F,D,RELN,RESLN,RES2LN,RES3LN)	K 1
	C		K 2
	C	SUBROUTINE LOGS	K 3
	C		K 4
5	C	CALCULATES INTEGRALS OF FORM $S^{**N} * A * LOG(S^{**S} + E^{**S} + D)$ WITH	K 5
	C	RESPECT TO S OVER LIMITS OF -S TO S FOR N=0,1,2,3.	K 6
	C		K 7
	C	S= PANEL SEGMENT HALFWIDTH	K 8
	C	E,D ARE CALCULATED IN SUBROUTINE CONCAL	K 9
10	C	INTEGRAL RESULTS ARE RELN,RESLN,RES2LN,RES3LN	K 10
	C		K 11
	C	EVALUATION OF INTEGRALS PERFORMED USING MACSYMA ALGEBRAIC	K 12
	C	MANIPULATION PROGRAM OF MIT PROJECT MAC	K 13
	C	IF I=J INTEGRAL EVALUATED AT APPROXIMATE ENDPOINTS,+-SAWAY	K 14
15	C		K 15
		COMMON /TEL/ DIM,TOL2	K 16
		REAL LATB,LADP,L1,L2,L3,L4	K 17
		TOL = TOL2	K 18
		RELN = 0.0	K 19
20		RESLN = 0.0	K 20
		RES2LN = 0.0	K 21
		RES3LN = 0.0	K 22
		SS = S	K 23
		A = S * S + E * S + D	K 24
25		B = S * S - E * S + D	K 25
		A = ARS(A)	K 26
		B = ARS(B)	K 27
		AA = ARS(A)	K 28
		BB = ARS(B)	K 29
30		IF (AA .LE. 0.000000001) GO TO 60	K 30
		IF (BB .LE. 0.000000001) GO TO 60	K 31
10		DISC = E * E - 4 * D	K 32
		DIS0 = SQRT(ARS(DISC))	K 33
		DIS = E * E - 2 * D	K 34
35		DIS3 = E ** 3 - 3 * D * E	K 35
		DIS4 = (E * E - 4 * D) * (E * E - D)	K 36
		DIS44 = E ** 4 - 4 * D * E * E + 2 * D * D	K 37
		DIS5 = E ** 5 - 6 * D * E * E * E + 8 * D * D * E	K 38
		LATR = ALOG(A * B)	K 39
40		LADP = ALOG(A / B)	K 40
		IF (AA .LE. 0.000000001) S = SAWAY	K 41
		IF (BB .LE. 0.000000001) S = SAWAY	K 42

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(Cont'd)

SUBROUTINE LOGS (Continued)

SUBROUTINE LOGS	74/74	OPT=1 STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	2	
						RE = S * LATB + 0.5 * E * LADR	K 43
						FSP = F + 2 * S	K 44
45						ESM = F - 2 * S	K 45
						IF (DISC) 40,30,20	K 46
	20					CONTINUE	K 47
						L1 = E - DISQ + 2 * S	K 48
						L2 = E + DISQ + 2 * S	K 49
50						L3 = E - DISQ - 2 * S	K 50
						L4 = E + DISQ - 2 * S	K 51
						DIFFLN = ALOG(L1 * L4 / L2 / L3)	K 52
						PELN = RE - 4 * S - 0.5 * DISQ * DIFFLN	K 53
						PESLN = 0.5 * LADR * S ** 2 + (0.25 * E * DISC / DISQ) * DIFFLN	K 54
55						RESLN = RESLN - 0.25 * DIS * LADR + E * S	K 55
						RES2LN = (S ** 3 / 3) * LATP - DIS4 / (6 * DISQ) * DIFFLN + LADR *	K 56
						1 (DIS3 / 6) - 4 * S ** 3 / 9 - 6 * DIS ** S / 9	K 57
						RFS3LN = 0.25 * S ** 4 * LADR + DIS5 / (8 * DISQ) * DIFFLN - LADR	K 58
						1 * (DIS44 / 8) + F * S ** 3 / 6 + 0.5 * S * DIS3	K 59
60						GO TO 50	K 60
	30					CLOGRT = ALOG(ARS(ESP / FSP))	K 61
						RELN = S * LATP - 4 * S + F * CLOGRT	K 62
						RESLN = 0.5 * S ** 2 * LADR - 0.5 * DIS * CLOGRT + E * S	K 63
						RES2LN = (S ** 3 * LATP + DIS3 * CLOGRT + (DIS4) * ((1 / ESP) - (1	K 64
65						1 / FSP)) - 2 * S * DIS) / 3 - 4 * (S ** 3) / 9	K 65
						RES3LN = 0.25 * S ** 4 * LADR - DIS44 * 0.25 * CLOGRT - .25 * DIS5	K 66
						1 * (1 / ESP - 1 / FSP) + F * S ** 3 / 6 + 0.5 * S * DIS3	K 67
						GO TO 50	K 68
	40					TNRAT = ATAN2(FSP,DISQ) - ATAN2(ESM,DISQ)	K 69
70						RELN = RE - 4 * S - (DISC / DISQ) * TNRAT	K 70
						RESLN = 0.5 * (S ** 2 - 0.5 * DIS) * LADR + 0.5 * F * DISC / DISQ	K 71
						1 * TNRAT + E * S	K 72
						RES2LN = S ** 3 / 3 * LATP + (DIS3 / 6) * LADR - (DIS4 / (3 * DISQ	K 73
						1)) * TNRAT - 4 * S ** 3 / 9 - 2 * S * DIS / 3	K 74
75						RES3LN = (0.25 * S ** 4 - DIS44 / 8) * LADR + 0.25 * DIS5 / DISQ *	K 75
						1 TNRAT + E * S ** 3 / 6 + S * DIS3 / 2	K 76
	50					CONTINUE	K 77
						GO TO 70	K 78
	60					CONTINUE	K 79
80						SAWAY = S - TOL	K 80
						A = SAWAY * SAWAY + F * SAWAY + D	K 81
						B = SAWAY * SAWAY - F * SAWAY + D	K 82
						A = ARS(A)	K 83
						B = ARS(B)	K 84

SUBROUTINE LOGS (Concluded)

SUBROUTINE LOGS

74/74

OPT=1 STATIC

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85

GO TO 10
70 CONTINUE
S = SS
RETURN
END

K 85
K 86
K 87
K 88
K 89-

PROGRAM ZOCDETM

PROGRAM ZOCDETM 74/74 OPT=1 STATIC FTN 4.7+485 81/01/27. 13.38.34 PAGE 1

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1      OVFRLAY (WINGTL,2,0)                                L  1
      PROGRAM ZOCDFTM                                       L  2
      DIMENSION YY(2), FV(2), FW(2), DZDX(400), XXCC(20), WCU(20) L  3
      DIMENSION X3C4(22), ALOC(22,1), T(41), SS(41,1), SS1(41,1), SS2(4 L  4
5      11,1), S2(22,1), S3(22,1), DELY(22,1), H(22), PSUM(41,1) L  5
      DIMENSION ZOCM(41), ZOCC(30), PDUM(41,1)             L  6
      DIMENSION ZUPA(41), ZLOA(41), PTX(41), ZMC(41)       L  7
      DIMENSION WK(455)                                     L  8
10     COMMON /ALL/ POT,M,PETA,PTFST,QTEST,TRLSCW(50),Q(400),PN(400),PV( L  9
      1400),S(400),PSI(400),PHI(50),ZH(50),NSSW            L 10
      COMMON /TOTHRF/ CIR(400)                             L 11
      COMMON /CCRDD/ CHORD(50),XTE(50),KRIT,TSPAN,TSPANA   L 12
      COMMON /INSUR23/ APSI,APHI,XX,YYY,ZZ,SNN,TOLC        L 13
      COMMON /JK2/ PCTX(50),PCT7(50),NZS,JCTL,JSLP        L 14
15     C                                                     L 15
      C                                                     L 16
      C PART 3 - COMPUTE Z/C VERSUS X/C                     L 17
      C                                                     L 18
      C                                                     L 19
20     C THE TOLERANCE SET AT THIS POINT IN THE PROGRAM MAY NEED TO BE L 20
      C CHANGED FOR COMPUTERS OTHER THAN THE CDC 6000 SERIFS L 21
      C                                                     L 22
      C                                                     L 23
      WRITE (6,280)                                         L 24
25     TOLC = (ROT * 15.E - 05) ** 2                       L 25
      PI = 4. * ATAN(1.)                                    L 26
      RAD = 180. / PI                                       L 27
      I77 = 1                                               L 28
      NNV = TRLSCW(I77)                                     L 29
30     DO 30 NV = 1,M                                       L 30
      DZDX(NV) = 0.                                         L 31
      I7 = 1                                                L 32
      NNN = TRLSCW(I7)                                     L 33
      DO 20 NN = 1,M                                       L 34
35     APHI = ATAN(PHI(I7))                                 L 35
      APSI = PSI(NN)                                        L 36
      XX = PV(NV) - PN(NN)                                  L 37
      YY(1) = Q(NV) - Q(NN)                                 L 38
      YY(2) = Q(NV) + Q(NN)                                 L 39
40     ZZ = 7H(I77) - 7H(I7)                               L 40
      SNN = S(NN)                                          L 41
      DO 10 I = 1,2                                         L 42

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(Cont'd)

PROGRAM ZOCDEIM (Continued)

PROGRAM ZOCDEIM	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	2
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	YYY = YY(I)	L 43
	CALL INFSUB (ROT,FV(I),FW(I))	L 44
45	APHI = -APHI	L 45
	APSI = -APSI	L 46
	10 CONTINUE	L 47
	FVN = FW(1) + FW(2) - (FV(1) + FV(2)) * PHI(I77)	L 48
	DZDX(NV) = DZDX(NV) + FVN * CIR(NN) / 12.5663704	L 49
50	IF (NN .LT. NNN .OR. NN .EQ. M) GO TO 20	L 50
	I7 = I7 + 1	L 51
	NNN = NNN + TRLSCW(I7)	L 52
	20 CONTINUE	L 53
	IF (NV .LT. NNV .OR. NV .EQ. M) GO TO 30	L 54
55	I77 = I77 + 1	L 55
	NNV = NNV + TRLSCW(I77)	L 56
	30 CONTINUE	L 57
	C	L 58
	C	L 59
60	C	L 60
	C	L 61
	C	L 62
	IF (JSLP .NF. 1) GO TO 40	L 63
	PUNCH 240, (DZDX(NN), NN = 1, M)	L 64
65	40 CONTINUE	L 65
	REWIND 10	L 66
	IF (JCTL .EQ. 0) GO TO 50	L 67
	CALL PSEUDO	L 68
	50 CONTINUE	L 69
70	LA = 1	L 70
	LB = 0	L 71
	DO 230 I = 1, NSSW	L 72
	IN = TRLSCW(I)	L 73
	CPHI = COS(ATAN(PHI(I)))	L 74
75	IF (I .EQ. 1) GO TO 60	L 75
	LA = LA + TRLSCW(I - 1)	L 76
	60 LB = LB + TRLSCW(I)	L 77
	DO 70 J = LA, LB	L 78
	N = J - LA + 1	L 79
80	WOU(N) = -DZDX(J)	L 80
	XXCC(N) = (N - 0.25) / IN	L 81
	K = IN + 1 + LA - J	L 82
	X3C4(K) = PV(J) * PFTA	L 83
	70 ALOC(K) = -DZDX(J)	L 84

PROGRAM ZOCDETM (Continued)

PROGRAM ZOCDETM	74/74	CPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	3
85	Y = Q(LA) / POT					L	85
	WRITE (6,250) Q(LA),Y,CHORD(I)					L	86
	WRITE (6,290)					L	87
	WRITE (6,360) (WOU(IJ),IJ = 1,IN)					L	88
	WRITE (6,300)					L	89
90	WRITE (6,360) (XXCC(IJ),IJ = 1,IN)					L	90
	K1 = IN + 2					L	91
	K2 = IN + 1					L	92
	ALOC(1) = ALOC(2)					L	93
	ALOC(K1) = ALOC(K2)					L	94
95	X3C4(1) = XTF(I)					L	95
	X3C4(K1) = XTF(I) + CHORD(I)					L	96
	D1 = 0.					L	97
	D2 = 0.					L	98
	DO 80 L = 1,41					L	99
100	80 T(L) = XTE(I) + CHORD(I) * (L - 1) * .025					L	100
	IW = 0					L	101
	CALL SPLINE (22,1,41,K1,1,41,X3C4,ALOC,Y,A,SS,SS1,SS2,S2,S3,DELY,H					L	102
	1,IW,D1,D2,1,PSUM)					L	103
	DO 90 L = 1,40					L	104
105	K = 42 - L					L	105
	J = 41 - L					L	106
	90 PSUM(K) = PSUM(J)					L	107
	PSUM(1) = 0.					L	108
	ALPIN = ATAN(PSUM(41) / CHORD(I)) * RAD					L	109
110	WRITE (6,330) ALPIN					L	110
	WRITE (6,310)					L	111
	IF (JCTL .EQ. 2) GO TO 100					L	112
	WRITE (6,320)					L	113
	GO TO 110					L	114
115	100 CONTINUE					L	115
	WRITE (6,350)					L	116
	110 CONTINUE					L	117
	DO 150 L = 1,41					L	118
	K = 42 - L					L	119
120	XOC = 1. + (XTE(I) - T(K)) / CHORD(I)					L	120
	ZOC = PSUM(K) / CHORD(I)					L	121
	ZOCM(L) = -ZOC					L	122
	X = XOC * CHORD(I)					L	123
	ZOCPP = ZOC * CPHI					L	124
125	ZMC(L) = -ZOCPP					L	125
	DLTZPP = PSUM(K) * CPHI					L	126

PROGRAM ZOCDETM (Continued)

PROGRAM ZOCDETM 74/74 OPT=1 STATIC

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	IF (JCTL .NE. 2) GO TO 120	L 127
	CALL CSIUNI (50,NZS,1,1,1,PCTX,PCTZ,XOC,THK, - 1,WK)	L 128
	ZOCU = ZOCPR - THK	L 129
130	ZOCL = ZOCPR + THK	L 130
	ZUP = ZOCU * CHORD(I)	L 131
	ZLO = ZOCL * CHORD(I)	L 132
	ZUPA(L) = ZOCU	L 133
	ZLOA(L) = ZOCL	L 134
135	120 CONTINUE	L 135
	IF (JCTL .EQ. 2) GO TO 130	L 136
	WRITE (6,260) XOC,ZOC,ZOCPR,X,PSUM(K),DLTZPR	L 137
	GO TO 140	L 138
	130 CONTINUE	L 139
140	140 WRITE (6,340) XOC,ZOC,ZOCPR,ZOCU,ZOCL,X,PSUM(K),DLTZPR,ZUP,ZLO	L 140
	140 CONTINUE	L 141
	150 CONTINUE	L 142
	WRITE (6,370)	L 143
	DO 160 L = 1,19	L 144
145	ZOCK(L) = ZOCM(L)	L 145
	160 CONTINUE	L 146
	DO 170 L = 20,30	L 147
	LL = 2 * L - 19	L 148
	ZOCK(L) = ZOCM(LL)	L 149
150	170 CONTINUE	L 150
	IF (JCTL .NE. 2) GO TO 200	L 151
	DO 180 L = 1,21	L 152
	LL = 1 + (L - 1) * 2	L 153
	ZUPA(L) = ZUPA(LL)	L 154
155	ZLOA(L) = ZLOA(LL)	L 155
	180 PTX(L) = 0.05 * (FLOAT(L - 1))	L 156
	WRITE (10,270) (PTX(L),L = 1,21)	L 157
	WRITE (10,270) (ZUPA(L),L = 1,21)	L 158
	WRITE (10,270) (ZLOA(L),L = 1,21)	L 159
160	DO 190 L = 1,21	L 160
	ZUPA(L) = -ZUPA(L)	L 161
190	ZLOA(L) = -ZLOA(L)	L 162
	CALL THFOPLT (0,21,PTX,1,ZUPA,1,0.1., - .5,0.5,0.0,3,RHX/C,12,12H	L 163
	17/C COS(PHI),0)	L 164
165	THET = 0.	L 165
	XL = 5.5	L 166
	YL = 8.	L 167
	HT = 0.3	L 168

PROGRAM ZOCDETM (Continued)

PROGRAM ZOCDETM	74/74	OPT=1 STATIC	FTN 4,7+485	81/01/27, 13,38,34	PAGE	5
170	CALL NOTATE (XL,YL,HT,6HCHORD=,THET,6)				L 169	
	YL = 7.				L 170	
	CALL NOTATE (XL,YL,HT,6HY/R/2=,THET,6)				L 171	
	XL = 8.				L 172	
	YL = 8.				L 173	
175	CALL NUMBER (XL,YL,HT,CHORD(I),THET,3)				L 174	
	YL = 7.				L 175	
	CALL NUMBER (XL,YL,HT,Y,THET,4)				L 176	
	CALL INFOPLT (1,21,PTX,1,7LOA,1,0,,1., - .5,0.5,0.0,3,3HX/C,12,12H				L 177	
	1Z/C COS(PHI),0)				L 178	
200	CONTINUE				L 179	
180	IF (JCTL .NE. 1) GO TO 220				L 180	
	DO 210 L = 1,41				L 181	
210	PTX(L) = 0.025 * FLOAT(L - 1)				L 182	
	CALL INFOPLT (1,41,PTX,1,7MC,1,0,,1., - .5,0.5,0.0,3,3HX/C,12,12HZ				L 183	
	1/C COS(PHI),0)				L 184	
185	THET = 0.				L 185	
	XL = 5.5				L 186	
	YL = 8.				L 187	
	HT = 0.3				L 188	
190	CALL NOTATE (XL,YL,HT,6HCHORD=,THET,6)				L 189	
	YL = 7.				L 190	
	CALL NOTATE (XL,YL,HT,6HY/R/2=,THET,6)				L 191	
	XL = 8.				L 192	
	YL = 8.				L 193	
195	CALL NUMBER (XL,YL,HT,CHORD(I),THET,3)				L 194	
	YL = 7.				L 195	
	CALL NUMBER (XL,YL,HT,Y,THET,4)				L 196	
220	CONTINUE				L 197	
	WRITE (10,270) (ZOCK(L),L = 1,30)				L 198	
230	CONTINUE				L 199	
200	END FILE 10				L 200	
	REWIND 10				L 201	
	C				L 202	
	240 FORMAT (8F10.6)				L 203	
	250 FORMAT (35X,2HY=,F10.4,11X,6HY/R/2=,F10.4,11X,6HCHORD=,F10.4//)				L 204	
205	260 FORMAT (23X,F9.4,5(5XF9.4))				L 205	
	270 FORMAT (7F10.6)				L 206	
	280 FORMAT (1H1,55X,20HLOCAL ELEVATION DATA///)				L 207	
	290 FORMAT (41X,47HSLOPES,07/OX,AT SLOPE POINTS,FRONT TO REAR/)				L 208	
	300 FORMAT (42X,46HCORRESPONDING X/C LOCATIONS FROM FRONT TO REAR/)				L 209	
210	310 FORMAT (///49X,15HLOCAL ELEVATION///)				L 210	

PROGRAM ZOCDETM (Concluded)

PROGRAM ZOCDETM 74/74 OPT=1 STATIC FTN 4.7.485 81/01/27. 13.38.34 PAGE 6

	320	FORMAT (29X,3HX/C,11X,3H7/C,5X,13H(Z/C)COS(DIH),5X,7HDELTA X,7X,7H	L 211
		1DELTA Z,3X,15H(DLT Z)COS(DIH)/)	L 212
	330	FORMAT (///34X,35MCHORD ANGLE OF ATTACK IN X-Z PLANE=,F9.4,7HDEGRE	L 213
		1FS)	L 214
215	340	FORMAT (4X,F9.4,9(4X,F9.4))	L 215
	350	FORMAT (8X,3HX/C,9X,3H7/C,4X,12HZ/C COS(DIH),1X,15HZ/C US COS(DIH)	L 216
		1,1X,15HZ/C LS COS(DIH),1X,7HDELTA X,4X,7HDELTA Z,1X,15H(DLT Z)COS(L 217
		2DIH),1X,13HZ US COS(DIH),1X,13HZ LS COS(DIH)/)	L 218
	360	FORMAT (5X,20F6.4)	L 219
220	370	FORMAT (1H1)	L 220
		END	L 221-

SUBROUTINE INFSUB

SUBROUTINE INFSUB	74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	1
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1	SUBROUTINE INFSUB (ROT,FVI,FWI)	M	1
	COMMON /INSUP23/ PSII,APHII,XXX,YYY,ZZZ,SNN,TOLRNC	M	2
	FC = COS(PSII)	M	3
	FS = SIN(PSII)	M	4
5	FT = FS / FC	M	5
	FPC = COS(APHII)	M	6
	FPS = SIN(APHII)	M	7
	FPT = FPS / FPC	M	8
	F1 = XXX + SNN * FT * FPC	M	9
10	F2 = YYY + SNN * FPC	M	10
	F3 = ZZZ + SNN * FPS	M	11
	F4 = XXX - SNN * FT * FPC	M	12
	F5 = YYY - SNN * FPC	M	13
	F6 = ZZZ - SNN * FPS	M	14
15	FFA = (XXX ** 2 + (YYY * FPS) ** 2 + FPC ** 2 * ((YYY * FT) ** 2 +	M	15
	1 (ZZZ / FC) ** 2 - 2. * XXX * YYY * FT) - 2. * ZZZ * FPC * (YYY *	M	16
	2FPS + XXX * FT * FPS))	M	17
	FFB = (F1 * F1 + F2 * F2 + F3 * F3) ** .5	M	18
	FFC = (F4 * F4 + F5 * F5 + F6 * F6) ** .5	M	19
20	FFD = F5 * F5 + F6 * F6	M	20
	FFE = F2 * F2 + F3 * F3	M	21
	FFF = (F1 * FPC * FT + F2 * FPC + F3 * FPS) / FFB - (F4 * FPC * FT	M	22
	1 + F5 * FPC + F6 * FPS) / FFC	M	23
	C	M	24
25	C	M	25
	C THE TOLFRANCE SET AT THIS POINT IN THE PROGRAM MAY NEED TO BE	M	26
	C CHANGED FOR COMPUTERS OTHER THAN THE CDC 6000 SERIES	M	27
	C	M	28
	C	M	29
30	C	M	30
	IF (ABS(FFA) .LT. (ROT * 15.E - 5) ** 2) GO TO 10	M	31
	FWONE = (XXX * FPS - ZZZ * FT * FPC) * FFF / FFA	M	32
	FWONE = (YYY * FT - XXX) * FFF / FFA * FPC	M	33
	GO TO 20	M	34
35	10 FWONE = 0.	M	35
	FWONE = 0.	M	36
	C	M	37
40	20 IF (ABS(FFD) .LT. TOLRNC) GO TO 30	M	38
	FVTWO = F6 * (1. - F4 / FFC) / FFD	M	39
	FWTWO = -F5 * (1. - F4 / FFC) / FFD	M	40
	GO TO 40	M	41
	30 FVTWO = 0.	M	42
	FWTWO = 0.	M	42

(Cont'd)

SUBROUTINE INFSUB (Concluded)

SUBROUTINE INFSUB 74/74 OPT=1 STATIC

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	C		M 43
		40 IF (ABS(FFE) .LT. TOLPNC) GO TO 50	M 44
45		FVTHRE = -F3 * (1. - F1 / FFP) / FFE	M 45
		FWTHRE = F2 * (1. - F1 / FFP) / FFE	M 46
		GO TO 60	M 47
		50 FVTHRE = 0.	M 48
		FWTHRE = 0.	M 49
50	C		M 50
		60 FVI = FVONE + FVTWO + FVTHRE	M 51
		FWI = FWONE + FWTWO + FWTHRE	M 52
		RETURN	M 53
		END	M 54-

SUBROUTINE SPLINE

SUBROUTINE SPLINE 74/74 OPT=1 STATIC

FTN 4.7+485

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PAGE 1

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1      SUBROUTINE SPLINE (MNPTS,MNCVS,MMAX,N,NCVS,M,X,Y,T,PROXIN,SS,SS1,S  N  1
      S2,S3,DELY,H,IW,D1,D2,KAR,PSUM)  N  2
      DIMENSION TH(50),DFLH(50,1),CT(50),TH2(50),DELSQH(50),ST2(50  N  3
      1,1)  N  4
5      DIMENSION PSUM(MMAX,MNCVS)  N  5
      DIMENSION X(MNPTS),Y(MNPTS,MNCVS),T(MMAX),DELY(MNPTS,MNCVS),S  N  6
      12(MNPTS,MNCVS),S3(MNPTS,MNCVS),SS1(MMAX,MNCVS),SS(MMAX,MNCVS),  N  7
      2H(MNPTS),SS2(MMAX,MNCVS),PROXIN(MNCVS),DELSQY(50),H2(50),C(50  N  8
      3),D(50)  N  9
10     DIMENSION D1(NCVS),D2(NCVS),KAB(NCVS)  N 10
      IF (IW) 90,10,90  N 11
10     N1 = N - 1  N 12
      IW = 2  N 13
      DO 80 K = 1,NCVS  N 14
      DO 20 I = 1,N1  N 15
      H(I) = X(I + 1) - X(I)  N 16
      II = I + 1  N 17
      DELY(I,K) = (Y(II,K) - Y(I,K)) / H(I)  N 18
20     C(I) = H(I)  N 19
      DO 30 I = 2,N1  N 20
      H2(I) = (H(I - 1) + H(I)) * 2.  N 21
      DELSQY(I) = (DELY(I,K) - DELY(I - 1,K)) * 6.  N 22
30     CONTINUE  N 23
      IF (KAB(K) .EQ. 0) GO TO 40  N 24
25     H2(1) = 2. * H(1)  N 25
      H2(N) = 2. * H(N1)  N 26
      DELSQY(1) = 6. * (DELY(1,K) - D1(K))  N 27
      DELSQY(N) = (D2(K) - DELY(N1,K)) * 6.  N 28
      GO TO 50  N 29
30     H2(1) = 1.0  N 30
      H2(N) = 1.0  N 31
      C(1) = 0.0  N 32
      H(N1) = 0.0  N 33
      DELSQY(1) = 0.0  N 34
      DELSQY(N) = 0.0  N 35
35     CALL TRIMAT (H,H2,C,DELSQY,D,N)  N 36
      DO 60 I = 1,N  N 37
      S2(I,K) = D(I)  N 38
      H(N1) = C(N1)  N 39
40     DO 70 I = 1,N1  N 40
      II = I + 1  N 41
      70 S3(I,K) = (S2(II,K) - S2(I,K)) / H(I)  N 42

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SUBROUTINE SPLINE (Continued)

SUBROUTINE SPLINE	74/74	OPT=1	STATIC	FTN 4.7+485	R1/01/27. 13.38.34	PAGE	?
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	80	CONTINUE		N	43
	90	CONTINUE		N	44
45		J = 0		N	45
	100	J = J + 1		N	46
		I = 1		N	47
		IF (T(J) - X(1)) 140,170,110		N	48
	110	IF (T(J) - X(N)) 130,150,140		N	49
50	120	IF (T(J) - X(I)) 160,170,130		N	50
	130	I = I + 1		N	51
		GO TO 120		N	52
	140	CONTINUE		N	53
		PRINT 250, J		N	54
55		PRINT 260, (X(I), I = 1, N)		N	55
		PRINT 260, (Y(I), I = 1, N)		N	56
		GO TO 190		N	57
	150	I = N		N	58
	160	CONTINUE		N	59
60		IW = -I		N	60
		I = I - 1		N	61
	170	DO 180 K = 1, NCVS		N	62
		HT1 = T(J) - X(I)		N	63
		II = I + 1		N	64
65		HT2 = T(J) - X(II)		N	65
		PROD = HT1 * HT2		N	66
		SS2(J,K) = S2(I,K) + HT1 * S3(I,K)		N	67
		DELSQS = (S2(I,K) + S2(II,K) + SS2(J,K)) / 6.		N	68
		SS(J,K) = Y(I,K) + HT1 * DELY(I,K) + PROD * DELSQS		N	69
70		SS1(J,K) = DELY(I,K) + (HT1 + HT2) * DELSQS + PROD * S3(I,K) / 6.0		N	70
	180	CONTINUE		N	71
	190	CONTINUE		N	72
		IF (J .LT. M) GO TO 100		N	73
		M1 = M - 1		N	74
75		DO 240 K = 1, NCVS		N	75
		DO 200 I = 1, M1		N	76
		TH(I) = T(I + 1) - T(I)		N	77
		II = I + 1		N	78
		DELF(I,K) = (SS(II,K) - SS(I,K)) / TH(I)		N	79
80		CT(I) = TH(I)		N	80
	200	CONTINUE		N	81
		DO 210 I = 2, M		N	82
		TH2(I) = (TH(I - 1) + TH(I)) * 2.		N	83
		DELSQH(I) = (DELF(I,K) - DELF(I - 1,K)) * 6.		N	84

SUBROUTINE SPLINE (Concluded)

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SUBROUTINE SPLINE		74/74	OPT=1	STATIC	FTN 4.7+485	81/01/27. 13.38.34	PAGE	3
85	210	CONTINUE					N	85
		TH2(1) = TH2(M) = 1.					N	86
		CT(1) = 0					N	87
		TH(M1) = 0					N	88
		DELSQH(1) = DELSQH(M) = 0.					N	89
90		CALL TRIMAT (TH,TH2,CT,DELSQH,D,M)					N	90
		DO 220 I = 1,M					N	91
		ST2(I,K) = D(I)					N	92
	220	CONTINUE					N	93
		TH(M1) = CT(M1)					N	94
95		PROXIN(K) = 0.0					N	95
		DO 230 I = 1,M1					N	96
		II = I + 1					N	97
		PROXIN(K) = PROXIN(K) + .5 * TH(I) * (SS(I,K) + SS(II,K)) - TH(I)					N	98
		1** 3 * (ST2(I,K) + ST2(II,K)) / 24.					N	99
100		PSUM(I,K) = PROXIN(K)					N	100
	230	CONTINUE					N	101
	240	CONTINUE					N	102
		RETURN					N	103
	C						N	104
105	C						N	105
	250	FORMAT (I4,24HTH ARGUMENT OUT OF RANGE)					N	106
	260	FORMAT (10F10.3)					N	107
		END					N	108-

SUBROUTINE TRIMAT

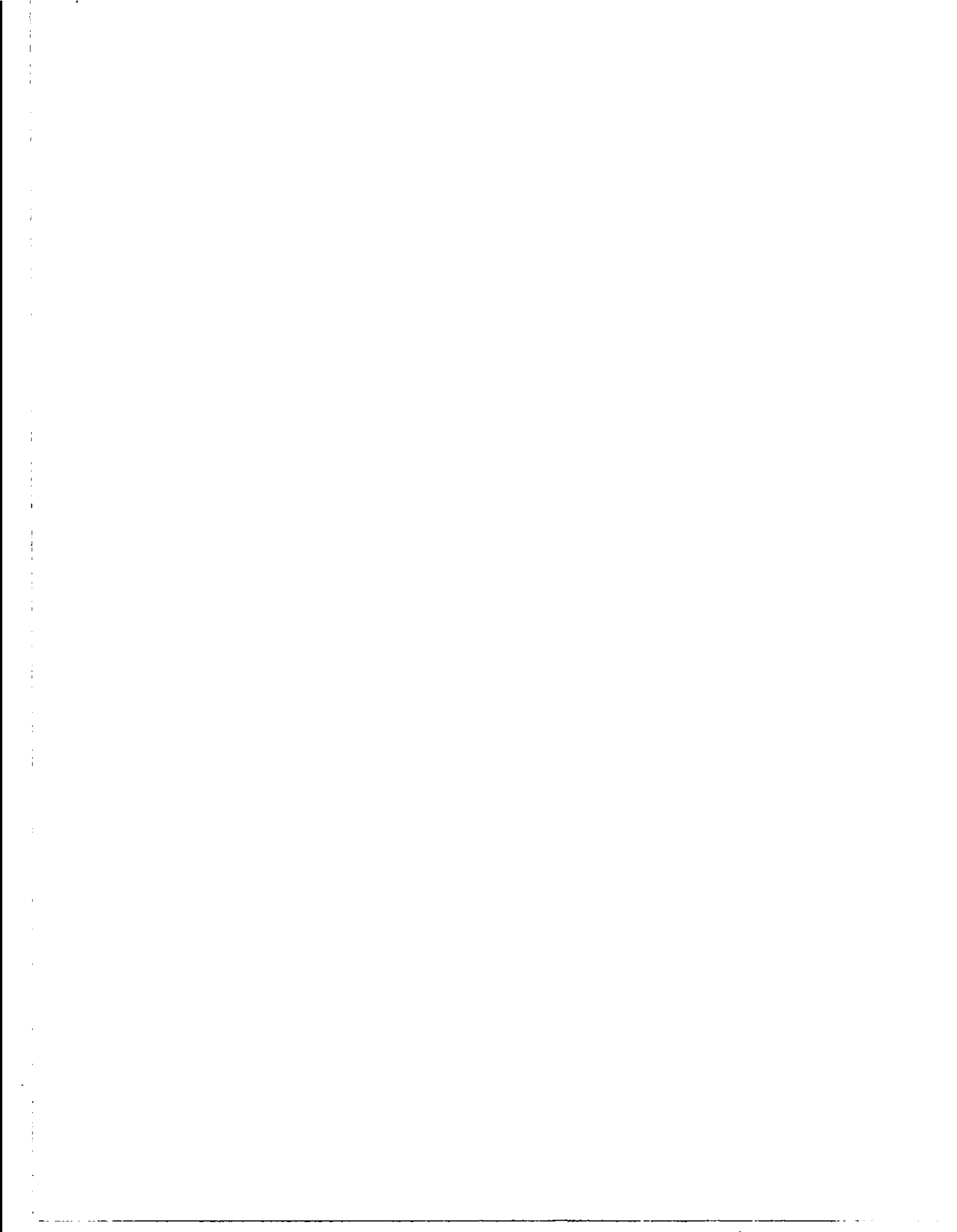
SUBROUTINE TRIMAT 74/74 OPT=1 STATIC

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PAGE 1

1		SUBROUTINE TRIMAT (A,B,C,D,T,N)	0	1
		DIMENSION A(1), B(1), C(1), D(1), T(1), W(50), SV(50), G(50)	0	2
	C		0	3
	C	THIS ROUTINE SOLVES THE TRIDIAGONAL (EXCEPT TWO ELEMENTS) MATRIX	0	4
5	C		0	5
		W(1) = B(1)	0	6
		SV(1) = C(1) / B(1)	0	7
		G(1) = D(1) / W(1)	0	8
		NM1 = N - 1	0	9
10		DO 20 K = 2,N	0	10
		KM1 = K - 1	0	11
		W(K) = B(K) - A(KM1) * SV(KM1)	0	12
		IF (K .EQ. N) GO TO 10	0	13
		SV(K) = C(K) / W(K)	0	14
15		10 G(K) = (D(K) - A(KM1) * G(KM1)) / W(K)	0	15
		20 CONTINUE	0	16
		T(N) = G(N)	0	17
		DO 30 K = 1,NM1	0	18
		KK = N - K	0	19
20		T(KK) = G(KK) - SV(KK) * T(KK + 1)	0	20
		30 CONTINUE	0	21
		RETURN	0	22
		END	0	23-



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16. Abstract A subsonic, linearized aerodynamic theory, wing design program for one or two planforms has been developed which uses a vortex lattice near-field model and a higher order panel method in the far field. The theoretical development of the wake model and its implementation in the vortex lattice design code are summarized in this report and sample results are given. Detailed program usage instructions, sample input and output data, and a program listing are presented in the Appendixes. The far-field wake model assumes a wake vortex sheet whose strength varies piecewise linearly in the spanwise direction. From this model analytical expressions for lift coefficient, induced drag coefficient, pitching moment coefficient, and bending moment coefficient have been developed. From these relationships a direct optimization scheme is used to determine the optimum wake vorticity distribution for minimum induced drag, subject to constraints on lift, and pitching or bending moment. Integration spanwise yields the bound circulation, which is interpolated in the near-field vortex lattice to obtain the design camber surface(s).					
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